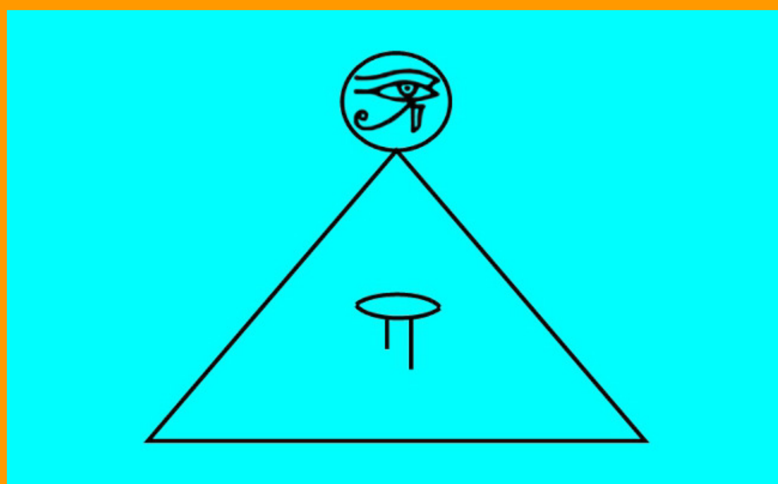
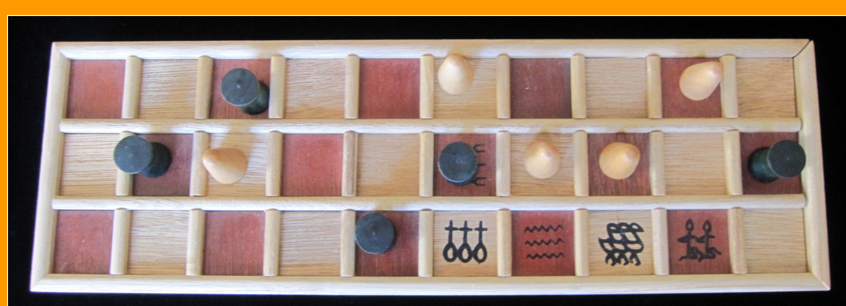
The Cosmic Game

Secrets of the Senet Oracle Board



Douglass A. White, Ph.D.

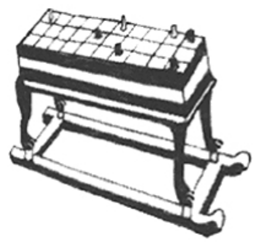


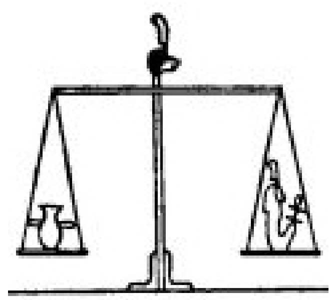
Delta Point Educational Technologies

The Cosmic Game:
Secrets of the Senet Oracle Board

by

Douglass A. White, Ph.D.





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Caveat Lector
(Let the Reader Beware)

There is a genre of books in which authors from outside the academic establishment explore mysterious relics of the ancient past and propose various theories and interpretations that range from alien visitations, to lost Atlantean civilizations, and ancient conspiracies. Critics often assail such works as "pseudoarchaeology" or "fringe science" in an attempt to discredit them despite the fact that such works often contain a large amount of interesting and sometimes accurate material researched with great gusto from the author's pet viewpoint, much of which may be considered either cranky or creative.

Up front in this prefatory note I announce that the following monograph is an unabashed work belonging to this fringe genre of pseudoarchaeology, because I deliberately do not follow the canons of professional archaeology. I meander to the syncopated beat of a distant African drum. The artifacts I discuss are genuine. The measurements and data that I present are accurate (barring possible typographical errors or mistakes in calculation.) The experiments are probably doable -- but perhaps not exactly in the way I suggest, and I do not have ironclad proof that such experiments ever occurred in ancient times. Therefore much of my evidence for ancient science is circumstantial or speculative. I intend my theories and interpretations mainly as doorways opening to new realms of exploration that may awaken your imagination to possibilities that can take you beyond your current assumptions about the reality of the ancients and the reality in which we currently reside.

In short you may read this work as a serious scientific investigation, as pseudoscience, or as a flight of fantasy into the world of science fiction. It probably contains a bit of all these viewpoints. My hope is that you find the material entertaining and possibly able to pique your curiosity to wonder whether our world might contain realities that stretch far beyond the standard interpretations.

In this work you will find lots of numbers and symbols, some of which invite you to follow some easy calculations. If you wish to follow along, for the most part you won't need more than a pocket calculator. If you are not the calculating type, you can skip through the numbers and equations. Just focus on the discussions of the data.

Throughout this essay I cite the **Wikipedia** many times. Before we start exploring I would like to express my gratitude to the contributors who have made such a wonderful online resource available to the world as a shared treasury of knowledge. I have also tried to document all other sources that I made use of and hope interested readers will go study the sources I mention and/or quote from for more details. As for the interpretations I create and present in this essay, they are mine and you will have to decide where to file them in your reality. In any case I will clarify, update, and amend this work as time permits and welcome your comments and suggestions.

Douglass A. White, Ph.D.
Fairfield, IA 2012

From a Story told in the Middle Kingdom about the Old Kingdom

*. . . Prince Hordadef stood before the king [Khufu, builder of the Great Pyramid during Egypt's Fourth Dynasty], and he said: "Your Majesty has heard tales regarding the wonders performed by magicians in other days, [*Lichtheim translates: "of the skills of those who have passed away . . . one cannot tell truth from falsehood" *] but I can bring forth a worker of marvels who now lives in the kingdom."*

King Khufu said: "And who is he, my son?"

*"His name is Dedi," answered Prince Hordadef. "He is a very old man, for his years are a hundred and ten . . . and he knows the secrets of the habitation of the god Thoth [*Lichtheim translates: " he knows the number(s) of the secret chambers of the sanctuary of Thoth"*], which Your Majesty has desired to know so that you may design the chambers of your pyramid."* (The name Dedi can also be read as Jedi, Jeda, or Jed-jeda.)

King Khufu said: "Go now and find this man for me, Hordadef."

[Prince Hardedef finds the magician Dedi and brings him to the court of Khufu. During his audience with King Khufu Magician Dedi performs a sleight-of-hand in which he apparently cuts off the head of an animal and then restores it. After seeing this demonstration . . .] *His Majesty then spoke to the magician and said: "It is told that you possess the secrets of the dwelling of the god Thoth."*

*Dedi answered: "I do not possess them, but I know where they are concealed, and that is within a temple chamber at Heliopolis. There the plans are kept in a box, . . ." [*Lichtheim translates: "Please, I do not know their number, O king, my lord. But I know the place where it is." Said his majesty: "Where is that?" Said this Dedi: "There is a chest of flint in the building called 'Inventory' in On. It is in that chest."*] "It is no insignificant person who shall bring them to Your Majesty."*

"I would fain know who will deliver them unto me," King Khufu said.

[Dedi tells King Khufu it will be Userkaf, the first king of the next dynasty who will bring the chest. . . . Unfortunately, the story goes on to tell about the birth of Userkaf and his two brothers, the first three kings of Dynasty Five, but the story then breaks off and we never learn what happened to the box that contains the number(s) of the secret chambers of the sanctuary of Thoth.]
The city of On was called by the Greeks "Heliopolis" (City of the Sun), and was located in what is now modern Cairo. There is a mystery here, because Khufu would not have been alive when the location of the box was revealed according to the magician's prediction and the Great Pyramid would have already been finished.

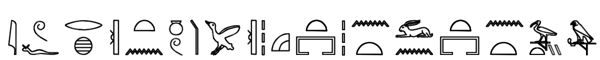
The information contained in the box would be the secret numbers that encode the structure of the universe. Khufu wanted to use these numbers in the design of his Great Pyramid. We now know that the successors of Userkaf and his brothers were Wenas [Unas, the last of the Fifth Dynasty pharaohs], and the early Sixth Dynasty pharaohs who had the magnificent **Pyramid Texts** carved on the walls of their pyramids, and these contain many of the Secrets of Thoth and may be relevant to the story.

Nevertheless, I believe that the missing portion of the story in the damaged Westcar Papyrus relates how Khufu found a way to gain access to the box and its secret information. The Egyptians loved humor and liked to keep their most important secrets openly and repeatedly -- but discreetly -- displayed in public awareness in the form of elaborate interlocking artistic and architectural conventions. In a word, I believe that the story alludes in an elaborately contorted and humorous way to the well-known Senet Board. The statement that it was held in a temple's inventory building tells us that Khufu was interested in the sacred and much more secret Senet Oracle Board rather than the profane Senet Game Board that was widely used by the public for amusement and gambling. The layout of the deities on the Oracle Board contains important keys to the numbers and the geometry that encoded the essence of ancient Egyptian science.

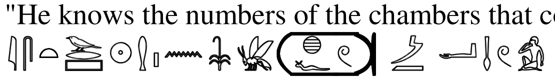
This book is about that Senet Oracle Box, the sacred artifacts it contains, and the numbers encoded in its geometry that reveal the secret chambers of the sanctuary of Thoth -- i.e. our physical universe. The story that contains the passage I quoted above may be found in Papyrus Westcar (P. Berlin 3033). The papyrus dates from the Hyksos period (Middle Kingdom) and is written in classical Middle Egyptian, but relates a series of linked stories that supposedly go back to the time of Pharaoh Khufu, builder of the Great Pyramid and his successors. You can find the complete translation that I quoted excerpts from in italics online at :

http://www.reshafim.org.il/ad/egypt/texts/westcar_papyrus.htm.

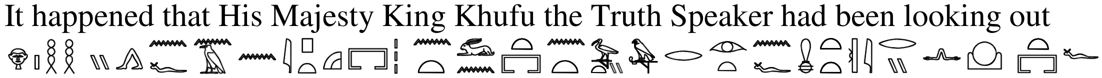
The brief comparison passages that I quoted in regular type face are from Miriam Lichtheim's translation that is published in **Ancient Egyptian Literature, Volume I: The Old and Middle Kingdoms** (Berkeley and Los Angeles: University of California Press, 1975.) Below is my version of the essential statements about the box.



Awef rekh tennu apetu net Wenet net Jehuti.
"He knows the numbers of the chambers that comprise the rectangular box that is Thoth's."



Aset weresh Hem en Suten Baty Khufu M*a*@kheru
It happened that His Majesty King Khufu the Truth Speaker had been looking out



her hehy nef na en Apetu net Wenet net Jehuty er aret nef matet ary A*a*khet-f.
for some time [to find] these chambers that comprise the rectangular box that is Thoth's to make for himself a copy for his Temple of [Eternal] Samadhi (Khufu's Great Pyramid).
. . . .

Jed an Jed-jeda: "Hes-ta, ne rekh-a tennu. Ary-a *t*y @nekh Weja Seneb.

Said Jed-jeda: "Praise you, but I do not know the numbers -- may you have life, strength, and health."

Aw-a, Sut[en], rekh-kua bu nety set am." [But, O king, I know where it is.]

Jed an Hem-f: "Awa ref tennu w*a*?" [Said his Majesty: "Where are the numbers?"]

Jed an Jed-jeda pen: "Aw @fdet am net des em '@t Sapety' ren-s.
This Jed-jeda said: "In a stone box on which is carved its name,
which is "Chamber of Judgment".

em Awen, m@k setem-*a*t @fdet.
It is in the City of On, and an assistant administrative priest cares for the box.

The above is my transcription of the text with my transliteration and translation. As you can see, different translators interpret the details of the text quite differently -- although the general drift of the story is quite clear. The glyphs I transliterate with the symbol @ are pronounced like a grunt deep in the throat, such as when you say "Africa" with a strong emphasis on the first syllable. The term "Wenet" is glossed as a room, chamber, or square box. The Senet Oracle Box is rectangular in shape and consists of 30 square "chambers". The Oracle Board is incised on top of the box and divides it into chambers. These are the houses or temples of various deities. The "numbers" (tennu) would be the measurements involved in the various dimensions of the box. Khufu wants to use the measurements of the box in the design of the chambers in his Great Pyramid. Jed-jeda explains that the box has the name of the Chamber of Judgment (@t Sapety) carved on it. The word "Des" is a knife, to carve, or flint. However, it also can be used to indicate a portal in the Dewat (subconscious realm), suggesting that the box is a portal leading into the deep regions of mental and physical space. This information also tells us that the box contains the proper layout of the Judgment of the Heart Tableau that is well known from the **Book of the Dead**. From this we know that the box is not the Game Board, but the Oracle Board. The Game Board contains a sequence that represents a clock or calendar. The Oracle Board contains the symmetrical relationships of sacred geometry that explain how the physical world organizes itself in space. The City of On (Awen) was a sacred city dedicated to Ra and Tem that was located near the Giza plateau where Khufu was building his Great Pyramid. Jed-jeda tells us that the box with this layout was kept in a temple at On by a special priest. The kingly children will be born of the wife of Lord Sakhbu, the priest of Ra (Hemt W@b pu en R@, Neb Sa*kh*bu). This connects the box again to the Temple of Ra in On. The eldest of the sons will become high priest in On (Wer-m*a* em Awen).

The magician's name (Jed-jeda "My Double Pillar") is written with the pillar of Osiris doubled. The pillar glyph stands for stability. Its doubling suggests the paired quantization of physical phenomena. The two pillars also suggest the name of Baba, the first son of Osiris. Baba is the archetypal shaman in ancient Egypt and is a form of

Thoth, suggesting that the magician may be an avatar of Thoth communicating with Khufu. The prince's name suggests that he is an avatar of Horus, the second son of Osiris. We may then surmise that Khufu represents Osiris and will be embodied as such eternally in his Great Pyramid.

If this all sounds puzzling, read on. This book will unravel some of the mystery. For more details read my two-volume work, **The Senet Tarot of Ancient Egypt**.

What If . . . .?

"This is my box, this is my box.
I never travel without my box . . . ."
-- Kaspar
"Amahl and the Night Visitors"
operetta by Gian Carlo Menotti

In Menotti's operetta Amahl is a crippled child who lives in poverty with his mother. Three kings named Melchior, Balthazar, and Kaspar have discovered through their studies of the stars that a remarkable child has just been born. They set out to visit the child, and one night on their journey they happen to stop for a rest at the humble dwelling where Amahl and his mother live. Amahl is curious about a special box that King Kaspar carries about with him wherever he goes.

Kaspar tells Amahl, "This is my box, this is my box. I never travel without my box." Then he explains that inside the box there are three drawers. The first drawer contains seven types of colored stones: carnelian, moonstone, red coral, lapis lazuli, jasper, topaz, and ruby. The second drawer contains all kinds of beads. The third drawer contains licorice sticks.

What if the Wizard King Kaspar's magic box has on its top surface the checkerboard layout of the Senet Oracle Game Board? The seven types of stones may then represent the seven playing pieces and the seven chakras of a person's body (suggested by Kaspar's belief in their ability to preserve health). The first drawer could contain two sets of the seven stones, each set having a special shape, so they can be used as the pawns in the game. The prayer beads then represent the mantras of the various gods and their houses on the game board. They are probably strung together and used during the cycle of meditations practiced throughout the calendar month. The third drawer then contains the game's throwing sticks (an ancient form of dice). In this case the sticks are made of licorice root. Four or five slivers of licorce root can be used for generating the moves in the game and the indications of the oracle. The root slivers can also be chewed on to enjoy their sweet flavor. The name Kaspar (Caspar) comes from "Gizbar", an ancient Mesopotamian word for a Treasurer and retains that meaning in Hebrew to this day. Kaspar lives up to his name as the bearer of the treasure box that contains precious stones, precious knowledge, sweet snacks, and endless fun and games.

The Cosmic Science of the Ancient Egyptians Encoded in the Senet Oracle Game Board

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"This is a Neolithic itinerary whereby the Megalithic could achieve what it did without later mathematical methods. The hypothesis *requires* an evolution of metrology so as to notate counting, develop counts as accurate lengths, find differences between astronomical periods, and develop geometrical techniques to identify numerical relationships between these periods. This *requirement* then fits with the evidence within monuments and their geometries containing exactly the right measures and system of metrology."
-- Richard Heath
"A Proposed Itinerary for Megalithic Astronomical Development" (2009)

Summary

In this monograph I examine a well-known artifact that has survived among the remnants of ancient Egyptian civilization -- the Senet Oracle Game Board. Tutankhamen's tomb contained four such Senet Boards or Boxes. Tombs and papyri contain many depictions and descriptions of the important role this small item played in Egyptian culture in its dual role as a game and a divination tool. I will explore the possibility that the Senet Board encodes in its geometry and symbology profound insights into the science and technology of Egypt's megalithic culture as well as a quintessential expression of its spiritual tradition. Using modern science to peer into the distant past we can only wonder "what if". Nevertheless, the primary data I bring to light in this paper exist in the artifact, regardless of how we interpret them. Perhaps my speculations will lead to the uncovering of new or previously overlooked evidence that will further illuminate our understanding of the ancients and unfold new insights into our contemporary investigations of the universe.

General Introduction to the Senet Oracle Game Board

For several decades I have been collecting Tarot decks as one of my hobbies. Having also acquired a taste for exploration and a modest talent at research, I often wondered why no authors in all the books I read about the Tarot could produce convincing evidence that the deck went back further than the Middle Ages despite the persistent claims that Tarot was somehow deeply connected to the Jewish Qabbalah and even went back to ancient Egypt.

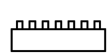
During the first decade of this century I began searching for evidence of the early development of the Tarot in ancient Egypt. To aid in that project I set about learning ancient Egyptian and eventually translated several of the surviving texts that seemed most relevant to my research as an aid to more deeply understanding them. Eventually I wrote a book in two volumes reporting my discoveries that I called **The Senet Tarot of Ancient Egypt**. I also designed and published a Tarot deck based on my research into ancient Egyptian civilization. Those works will serve as a background to this monograph, and readers interested in knowing more details about the Tarot and its antecedents in ancient Egypt should consult those works, as they cover a lot of material that is not included in this work but is nevertheless quite relevant to the contents of this work.

In this monograph I will focus primarily on certain details of the Senet Oracle Game Board as we know it existed in ancient Egypt and as I have reconstructed it in some detail through my research. My arguments for this paper will depend on what is known for certain about the Senet Board from surviving artifacts. The information added by my reconstruction of the Game Board's missing details may serve to add further highlights, but is not essential to the basic thesis. To what extent the scientific information I find and interpret in the Senet Board based on our present-day "hindsight" was actually understood or used by ancient Egyptians will have to await further research. Nevertheless, what I have uncovered so far is real data directly or indirectly embedded in the artifacts and holds tantalizing promise of further possible revelations.

For those who are not yet familiar with my earlier works and want to move on quickly into this paper, here is a brief summary of the Senet Oracle Game Board hypothesis. The name of the game in Egyptian means passing, going beyond, or transcending. A secondary meaning is an image, copy, likeness, or archetype. Other connotations include smelling, kissing, embracing, and adoring; a foundation or a beginning. Chapter 115:7 of the **Book of the Dead** describes Senet as "The Passing of Ra" [through his archetypal forms]. The Egyptian glyph for the Senet game board (men) goes back at least to the first dynasty and grids for game boards are attested from the Old Kingdom up to the Ptolemaic period. The game gradually lost popularity after Egypt was assimilated into the Roman Empire and first Roman, then Christian, and finally Muslim culture was imposed on its people.

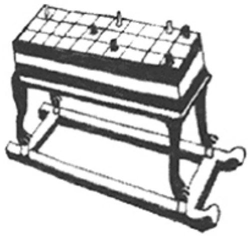
The glyph for the board means "foundation" and is the main root of another word (a-men) that means invisible or hidden, but that word also can be analyzed as "dear foundation". The name of the game (Senet) means to pass beyond, but also has a secondary connotation that suggests an image or a replication. The two slanted lines on the oval glyph may suggest duality or two of a kind.

Some Senet boards were simply grids consisting of a rectangle containing 30 squares arranged in three rows of ten squares each with no symbols embedded in them. Others had symbols inscribed on a few squares, and occasionally boards had symbols on each square, although no complete example survives -- the two such remaining decorated boards being considerably damaged. However, by using a surviving Egyptian text about the game as a primary source plus some guesswork based on knowledge of the Tarot, I have made a tentative reconstruction of the glyphs and intended inscriptions on the missing squares. However, the contents of the reconstructed portion of the Game Board squares is not necessary information for this study. As the glyph for the Board shows, the game often took the form of a rectangular box in which the pawns and the dice or throwing sticks could be stored.

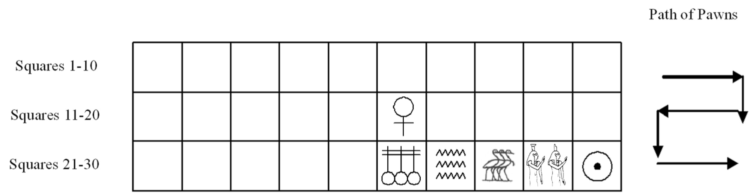


The Senet Oracle Game Board Glyph "Men"

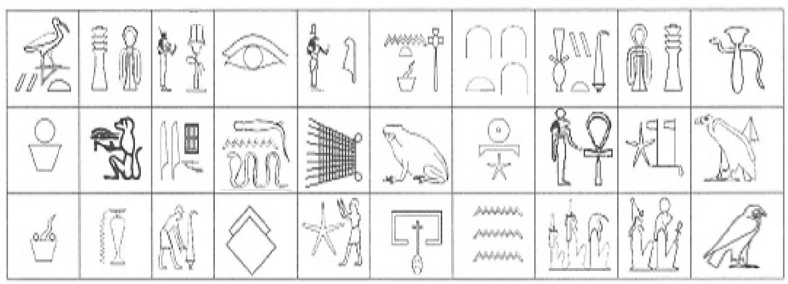
An Unmarked Senet Board with Pawns on a Fancy Table



A Senet Game Board with Several Symbols



A Reconstructed Senet Game Board with Symbols on Each Square



A Senet Game Board with Symbols Represented as Corresponding Deities

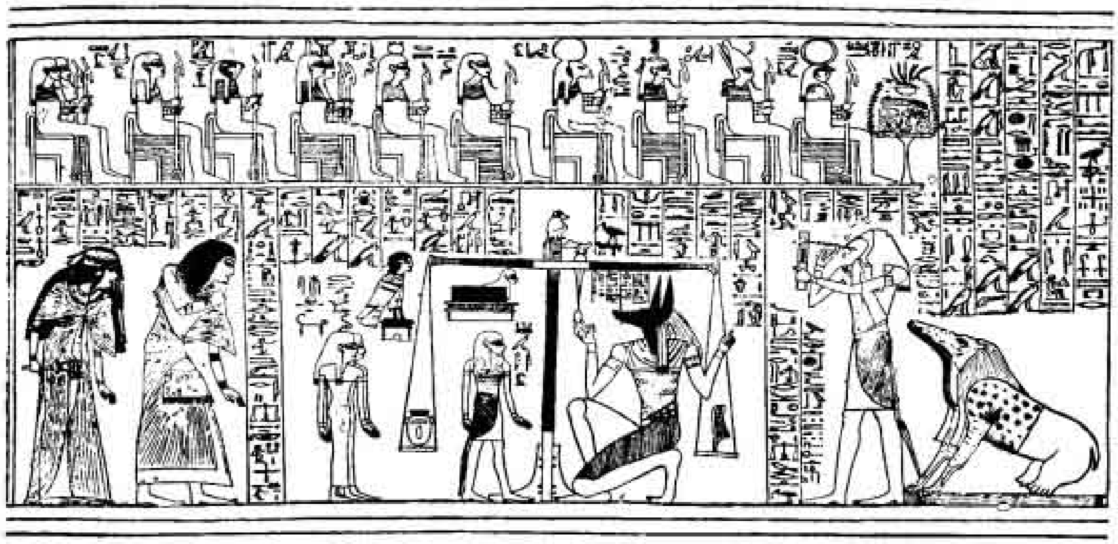
The symbols that survive on some Senet Game Boards correspond to standard deities in the Egyptian pantheon and were used by Egyptians as shorthand mnemonics instead of drawing the full figures as I show them above. Each deity (called a "net-er" transcendental being) represents a nature archetype, and the layout as a whole represents a voyage of adventure and evolution from life to death, to resurrection, and apotheosis as an immortal transcendental light being.

As the Senet Game evolved, people began to use it also for divination. Apparently a number of different layouts were developed, and one (or a group) of them represented the Judgment of the Heart Tableau that was central to the sacred book that is popularly known as **The Book of the Dead**, but was known to ancient Egyptians as **The Ascension into the Light of Day**. Using standard formats from that book plus the **Amduat** text illustrating the afterworld journey I produced a demonstration Senet Oracle Board. Although no Senet Board with such a layout has survived, there is considerable circumstantial evidence that such boards once existed. Of course the Game Board layout could also be used as a divination tool.

A Model of a Senet Oracle Board

My Senet Oracle Board arrangement is based on the ritual list of deities hailed at the beginning of the **Senet Game Text**, which more or less corresponds to lists and illustrations in standard versions of the **Book of the Dead**.

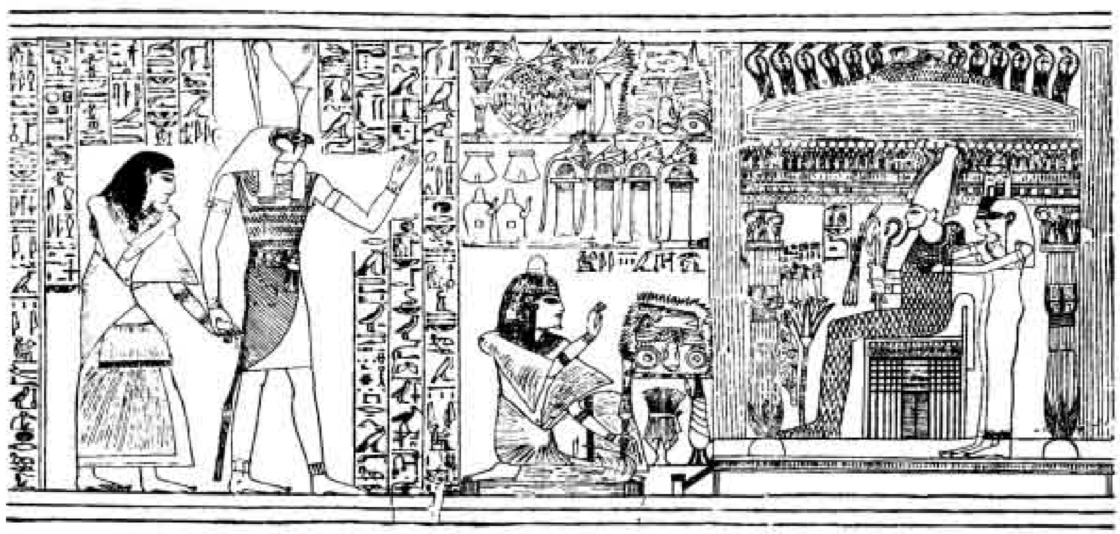
The four mummy kings in the middle of the middle row represent the four states of the elements (sons of Horus) and can be seen in miniature on the lotus table in front of Osiris (middle row, 2nd from right) and also represent the traditional four canopic jars. A first century CE oracle board, probably used in the Temple of Isis in Rome, survives and contains many of the same deities, but in yet another sequence, suggesting that various temples and cults designed their own Oracle Boards and there probably was no absolute standard.



The Judgment of the Heart Tableau in the Papyrus of Ani

The ten thrones in the upper panel correspond to the Senet Oracle Board row of heaven.

Compare this Drawing to my Senet Oracle Board Layout (p. 10) and the Standard Cubit Ruler (p. 81).



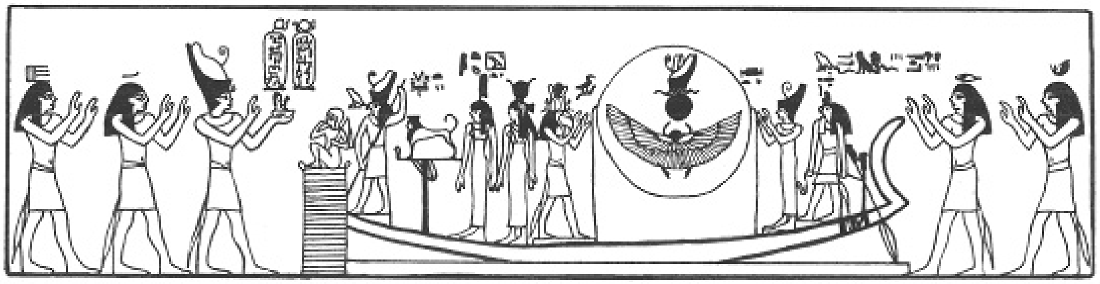
(The lower panel is a continuation of the upper panel in the scroll.)

Horus Guides Ani to the Chapel where Osiris in Mummy Wrappings Sits on His Throne

The 4 canopic mummies of the elements stand on a lotus table before Osiris.

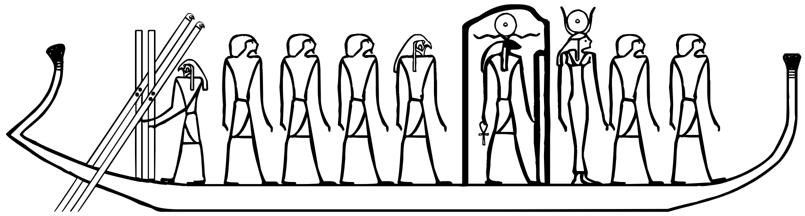
Isis and Nephthys stand behind Osiris to support him.

The middle row of the Senet Oracle Board roughly matches examples of passengers and retinue often found in traditional depictions of the Solar Boat (see drawing below).



Solar Boat Designed by Ptolemy IV at Edfu
(Ra is the Solar Disk on the Horizon with a Flying Scarab)

Ra is the "secret" identity of Osiris. Fetal Horus sits on the bow of the boat. Behind him we find Horus as a young adult wielding a harpoon to protect the boat, Opener-of-Ways (as human-headed jackal), Maat, Hathor, and Thoth. In the stern Net, a stand-in for Osiris, adores the Solar Disk, and Horus as the Pilot steers the boat. Pharaoh and the Lords of the Four Senses stand in adoration pose facing the bow and stern of the boat. Pharaoh offers a small image of Maat (Truth) to Ra and his retinue.



Solar Boat from the <u>Amduat</u> (Ram-headed Ra-Awef Stands under the Canopy)
In front of Ra we find in the bow Opener-of-Ways (in human form), Lord of Touch, and Hathor (Love and Light). Behind Ra we find Horus of Adorations, The Energy of Air (Lord of Hearing), Awakener (Lord of Vision), Lord of Taste, and Horus as the Pilot of the Boat.

Although I can not produce a surviving example of a Senet Oracle Board with my exact layout drawn on it, the figures and sequences in the top and bottom rows are familiar in the funerary texts and the figures in the top row also closely match the sequence of deity names on the cubit rule that I show on page 81 below.

Egyptian Senet Boards often had only a few symbols or none at all. The upper row stood for the Realm of Heaven, the bottom row was the Realm of Earth, and the middle row was the Realm of Magic. The Egyptians described the Realm of Magic in the **Amduat**. It includes sleep, dreaming, meditation, bardo states, alchemy and other forms of material or spiritual transformation.

The Senet Oracle Game Board was a treasured part of Egyptian culture from the beginning of the Old Kingdom and perhaps even predynastic times. The young and obscure pharaoh Tutankhamen had 4 Senet Boards in his very small tomb along with thousands of other amazing artifacts, so we can imagine what treasures must have been cached in the vast tombs of great pharaohs such as Sety I and Rameses II before they were looted.

The Council of Thirty and Unity

The Senet Board is divided into 30 Houses, and each House is like a Temple or a Palace for one of the archetypal nature deities. The Egyptians referred to the nature archetypes on the Board as the Thirty Elders or Thirty Judges ∩∩∩ (Ma'byu). Sometimes they used the deity determinative with the number 30 (∩∩∩). The Senet Oracle Board symbolized the court in which the Council of Thirty sat: ∩∩∩ (Ma'byt), a term that punned on "M*a*' Beyt" (House of Truth).

Ironically the word "ma'ba" means harpoon. This same glyph, given the pronunciation "wa@", means one. (The @ sign stands for a short grunt deep in the throat). Thus the name of the Thirty could also mean One. We can take that as meaning 30 + 1 = 31 or that the Thirty form a Unified Wholeness. I suspect that both senses were involved, partly because there was sometimes reference to a "President" of the Thirty ∩∩∩ (Pet Ma'biu), who could be one of the Thirty or an extra one who presided over the Thirty. He could be called the Great President of the Thirty (Pet Wer Ma'biu) and was sometimes spoken of as being in the South. This to me suggests Menew (also known as Amen), who had major temples in Karnak and Akhmim.

The evidence to support Menew as the President of the Thirty is found in the fact that his name is written with the Senet Board Glyph, suggesting that he somehow represents the whole Senet Oracle Game Board and thus unifies all Thirty of the archetypes. The name Menew means "Foundation" and the form Amen means "Hidden". The name of the Game played on the Board is Senet, which means "Transcendence". The purpose of the game was to move pieces across the Board until they passed beyond the Board into the Transcendental Realm of Amen. In other words the Game was a model for the process of creation and evolution. Players put their pawns on the Board, moved them through all the Houses, and then made them pass beyond the Board in order to win.

With this brief introduction, we are ready to begin our exploration of the science in the Senet Board. As we proceed in our discussion refer back to these Senet Board images.

A Brief Introduction to Ancient Egyptian Mathematics

Now we are ready to penetrate into one of the secrets of ancient Egyptian mathematics that contains the key to their understanding of Unified Field Physics. Once you understand it, the myths of Egypt become clearer as does the significance of the Scale of Judgment and something we will call the Senet Spiral and discuss in detail later.

First we will look at the usual way Egyptians multiplied numbers. For example, if you want to multiply 37×65, write the two numbers at the top of two columns. Then write the powers of 2 under 37 up to the largest result that does not exceed 37. Opposite each power of 2 under the 65 heading write that power of 2 times 65 -- in other words first write 65 and then double it for each power of 2 in the left column. Then start with the largest power of 2 that does not exceed 37 (i.e. the bottom number in the left column and subtract that power of 2 from 37. Then subtract from the remainder the largest power of 2 that does not exceed the remainder. Continue until you have subtracted away all of 37. The powers of 2 that you used are the components of your answer, so check off those particular items in the power of 2 column. Then add up the corresponding numbers in the doubles of the 65 column. The sum will be your answer.

37	65
*1	65
2	130
*4	260
8	520
16	1040
*32	2080

37 - 32 = 5; 5 - 4 = 1; 1 - 1 = 0.

So we star 1, 4, and 32 and add the corresponding numbers in the right-hand column: 2080 + 260 + 65 = 2405, which is the correct answer. As an exercise you can switch the order of the multiplier and multiplicand and see if you get the same answer. You can also try multiplying other numbers this way until the process is easy and natural for you.

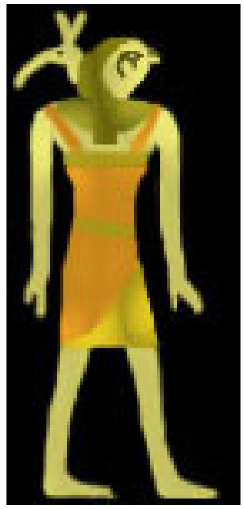
From this example it is clear that the Egyptians wrote numbers with base 10 but did calculations with base 2. For most daily calculations they did not have to go over 64 in the powers of 2, so this naturally comprised the Egyptian "Book of Changes".

Now we will turn to the problem of scaling in mathematics. According to Egyptian mythology, after Set murdered Osiris, Horus wanted to avenge his father Osiris and went to war with Set. The battle went back and forth, and during the struggle Horus made use of something mysterious called a "Na'r" from which he shot a harpoon at Set and wounded him in the testicles. Later Set injured an eye of Horus with a beam of fire (a laser?). Finally an accord was reached under which Horus ruled Upper and Lower Nilotic Egypt and Set ruled the desert lands.

Later after a long period a king called Mena (written with the Senet Game Board glyph) and also called by his Horus *serekh* name, Na'r mer  unified Egypt and became the first ruler of the first dynasty of classical Egypt. The word "na'r" is generally taken to mean a cuttle fish or a catfish. However, the glyph was often borrowed to mean a baboon. Presumably from the association of the baboon with the scribal totem as a form of Thoth-Baba, the glyph was also associated with a reed pen. "The Harpooner" is one of the epithets of Horus. This can refer to the weapon that Horus uses against Set when he castrates him. On the other hand it can be a reed pen provided by Baba the Baboon as an even more powerful weapon. Perhaps Thoth in the guise of Horus' elder brother Baba convinced him that the pen is mightier than the sword, and a well-put epigram is more effective than a well-won battle.

We recall that the glyph for a harpoon has an alternate reading (w*a*') with the meaning of One. Egyptians often represented the battle between Horus and Set with an image of their two heads on a single body. The more they fight as enemies the more they simply harm themselves and demonstrate the inseparable unity of all phenomena.

The subtle connection between the Thirty Divine Judges and the concept of Unity expressed by the harpoon glyph, brought to mind the idea that Horus was bound to win because he fought for the Unity of Egypt. The Universe is a Unity at its Foundation, no matter how diverse it may seem to be. Set is the archetype for the illusion of diversity.



Horus and Set on a Single Body

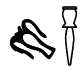
This mythical drama suggests a clue as to how the Egyptians described the Universe mathematically. We have seen that they expressed numbers in a base 10 system. They also expressed fractions as portions of a wholeness. In other words, with a couple of special exceptions, fractions always had a numerator of 1. This tells us that they considered fractions to be the inverse of whole numbers. The notation for a fraction was simply to place the mouth radical over a whole number and that transformed the whole number into its inverse.

If we think of this as a symbolic representation of the struggle between Horus and Set, we realize that if Horus, the restorer of wholeness, represents whole numbers, Set, the fragmenter of relations and the dismemberer of Osiris, represents fractions. The irony is that no matter what fraction Set removes to destroy wholeness, Horus chooses the inverse whole number that restores wholeness. For example, if Set removes 1/27th of wholeness, then Horus chooses 27 as his weapon against that fraction and unity returns when they "clash" in multiplication. Thus the inverse multiplication of ratios in Egyptian was easy.

Originally Horus ruled the North and Set ruled the South. Horus rules numbers above the mouth radical, and Set ruled numbers below the mouth radical.

The fulcrum point of the battle was at Hermopolis, the city of Thoth where the Baboon lives. On the Scale of Judgment we find the Na'r, a little golden baboon, sitting right over the fulcrum. The formula for the operation of the Scale expresses the mathematics of the reciprocal operations.

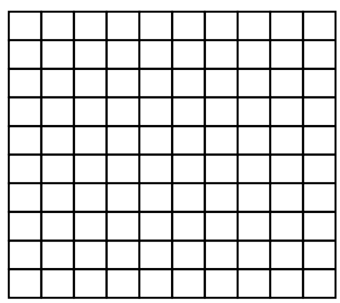
At the founding of the first dynasty a great leader ruled for the first time over a unified Egypt and greatly extended her influence. Egyptologists usually read his name as Na'r Mer. The first glyph depicts a cuttlefish, and the second glyph depicts a branding iron.



Neither of those interpretations makes much sense as the name of a pharaoh. I suspect that the glyphs were homophones for other words. I would pronounce the name Na'r-*a*b. My interpretation is that this is a name that honors Baba-Thoth. "Na'r" stands for the baboon scribal totem. "*A*b" may stand for the leopard totem of Baba and the shaman priest, and may also encode for the heart and the heart's desires, since Baba-Thoth's sacred domain was in the Heart Chakra, known to the Greeks as Hermopolis, City of Hermes. "Ab" was the word for heart in Egyptian.

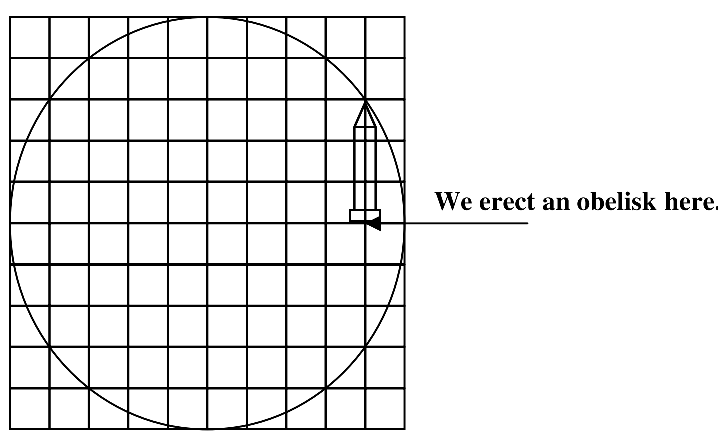
The Sacred Geometry of the Senet Board

We will start our exploration of Egyptian sacred geomety with a large square made by tiling a 10x10 grid of squares. This figure will represent the blueprint grid for the base of the Great Pyramid, and an example of the type of canevas grids used by master builders, artists, and craftsment for the design of all Egyptian classical art and architecture so as to maintain proper scale and dimensions.



We will inscribe a circle within the large square grid. The circle represents the sun that shines over the Great Pyramid and makes the grid come alive with light, energy, and life.

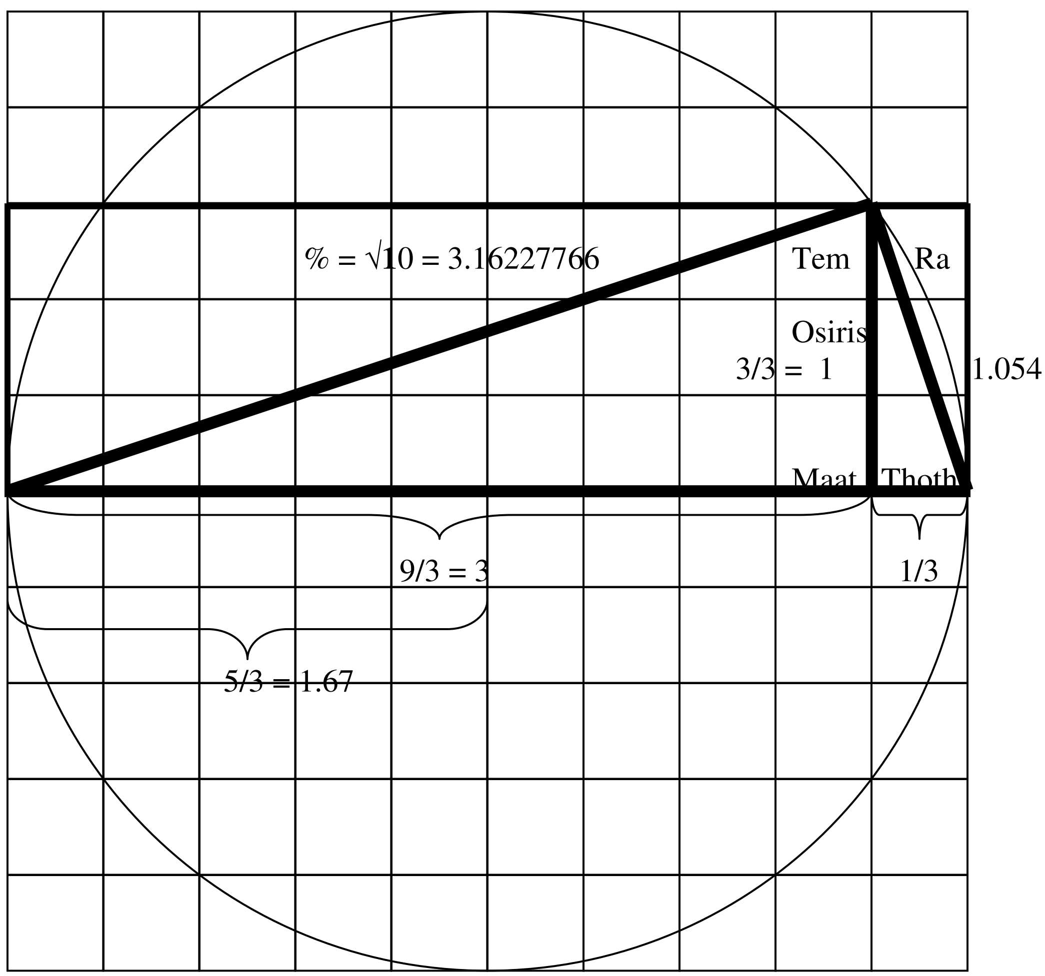
Symbolic Paving Grid at the Base of the Great Pyramid with the Sun above It



We will enlarge the square on the page with its sides parallel to the sides of the page. Then we will draw a horizontal diameter that bisects the large square and the circle in the middle. The line is parallel to the sides of the grid that are parallel to the bottom of the page. The right side is east and the left side is west.

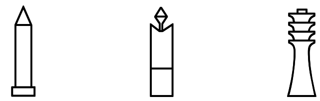
On the paving grid we erect an obelisk 𓉶 with a height of 3 small grid squares such that it divides the diameter into a portion of 1 square width on the right and 9 square widths on the left. We thereby mark off a 3x10 rectangle of small squares. This will be our Senet Oracle Board at the scale of the Great Pyramid. Each unit will be 1/3.

The Senet Oracle Board on the Giza Grid with Its Basic Dimensions



The small square in the upper right corner of the Senet Board Rectangle represents the House of Ra as he rises over the horizon in the East. The small square in the lower right hand corner of the rectangle is the House of Thoth. The obelisk is the Tower of Tem, whose House is the second small square from the right on the top row of the Senet Oracle Board rectangle (and the second small square from the right on the bottom row of the

Senet Game Board). The House of Osiris is in the middle row of the Oracle Board just below the House of Tem and represents the shaft of the obelisk, known as the "Jed", or Pillar of Osiris. The base of the Pillar is anchored in Truth, the House of Maat, consort of Thoth, that is below the Houses of Tem and Osiris and next to the House of Thoth.



The obelisk is the Light Tower of Tem and also the Jed Pillar of Osiris. We draw a line from the pyramidion tip of Tem's Obelisk Tower all the way to the end of the diameter on the far left side of the large square. This defines the hypotenuse of the shadow thrown from the obelisk as the sun rises. The shadow on the ground is the diameter of 9/3 units that extends from the obelisk base to the left edge of the large square. Three is a sacred number in Egyptian cosmology, and the Egyptians loved to form trinities of their deities, often forming family units (father, mother, child).

The leftmost small square on the bottom row of the Senet Board Rectangle is the House of the Lover (See my Oracle Board and the Papyrus of Ani. Trace a line from the tip of Tem's tall "tower" crown down to the serpent rattle of Hathor that Ani's wife holds over her genital area on the Papyrus of Ani). This corner is where the sun's light from the tip of the obelisk meets the shadow of the tip of the obelisk on the ground and defines the diameter. The Lover is Osiris as the Shadow of Ra joining with Hathor-Isis, his beloved consort. The serpent rattle is sacred to the Love Goddess, Hathor. Ani's wife was a sacred dancer in the temple of Hathor. The time span of a person's life is measured by tracing the shadow of the gnomon obelisk of Tem along the bottom row from its shadow tip to its real base in Truth (Maat). As the sun passes overhead from East to West, the shadow draws back into the Obelisk along the bottom row of the Oracle Board illustrating the stages of life -- conception, birth, infancy, adolescence, maturity, career, retirement, death, and return to balance in the self. When the sun passes beyond the base of the gnomon, Thoth measures the value of the light shadow and reports directly via a diagonal to Ra in heaven the results obtained on earth. (See the little triangle formed by Thoth's papyrus slip, his writing brush, and his forearm holding the brush.) In this way Thoth generates the small similar triangle of three squares that condenses the larger 3-by-9 triangle into a miniaturized "report" by fractally scaling it and rotating it 90º.

Next we can establish proportional numerical values for the geometry. We assign the value of 1/3 to the side of each small square. Thus the House of Thoth occupies a space of 1/3 on Earth. The House of Ra occupies a space of 1/3 in Heaven, and Sejem transmits the message of Thoth to Ra in Heaven through the 1/3 of the astral firmament region in the sky. Thoth as "Trismegistus" (Thrice Great) embraces all three layers into One (3/3) with his comprehensive Intelligence.

The height of the Obelisk Tower of Tem that rests on the foundation stone of Truth (code for the name of Maat, consort of Thoth) is therefore 3/3 = 1.

The Foundation Stone of Truth (Maat) can also represent a Pyramid Casing Stone. Osiris stands on the Truth of Balanced Unity. The relative dimensions of the Senet Board appear in the stone's profile: 9, 10, 3, 3.162. The length of the shadow of the Obelisk on the Earth is 9/3 = 3.
The transmission line from the tip of Thoth's tail to the topmost tip of the Obelisk (where the division between square 1 and square 2 meets the top of the board) is

$$[(1)^2 + (1/3)^2]^{½} = \sqrt{(10/9)} = \sqrt{1.1111} = 1.054.$$

The ratio of that line to the column divider that goes up through the back of Ra's throne in the Papyrus of Ani comes to about 62/59, which is about 1.051. A rougher estimate gives the simple ratio 15/14, which we shall discover is significant in this geometry.

The length of the beam of light from the tip of Tem's Obelisk to the tip of the Obelisk shadow on the ground is $(\sqrt{10}) = 3.16227766$.

The length of the large circle's radius is half the diameter = 5/3 = 1.67.

The circumference of the large solar disk is π (10/3) = 31.4159 / 3 = 10.47196.

Passing Through the Invisible Portal

We will enter into the secret domain of the Senet Board Spiritual Science through a gateway principle of sacred Egyptian geometry that was first discovered by Schwaller de Lubicz. By studying Schwaller's measurements of the ancient temples at Luxor and Karnak I realized how the Egyptians hid the Senet Oracle Board in the awesome gateway of the Amen Temple in Karnak to symbolize the Invisible Portal into the realm of Egyptian science. This insight had eluded Schwaller's careful investigations.

Ancient Egypt was famous as a highly developed civilization that held many great secrets about the universe. Much of what we know about Egypt comes from Greek scholars who studied in Egypt and then attempted to pass on what they had learned. Herodotus frequently refuses to report certain details of what he saw and learned because he says the priests swore him to secrecy.

However, I think Herodotus was spoofed by the Egyptians as a tourist and a neophyte. My theory is that the Egyptians were very proud of what they had accomplished and did not wish for it to be lost to posterity. Therefore they used solid megalithic artifacts to record what they knew in a very public manner. All the most important secrets were put on open display in engraved texts and symbolic artistic and architectural forms so that those with discerning eyes would be able to figure out the knowledge. They also used multi-layered messages to express information in a highly compact form. Then they embedded the messages in popular games and customs so that the common people would support the survival of the information even if they were not aware of its deeper significance.

The Senet Oracle Game Board was just such an ingenious invention. The variety of interesting ways of playing with a Senet Board ensured its widespread popularity. By devising the board as a miniature pantheon it became a compact and portable spiritual tool for Egyptians. The adaptation of the board as an oracle added yet another level of interest. The Senet Board could be used to resolve practical problems in a person's life.

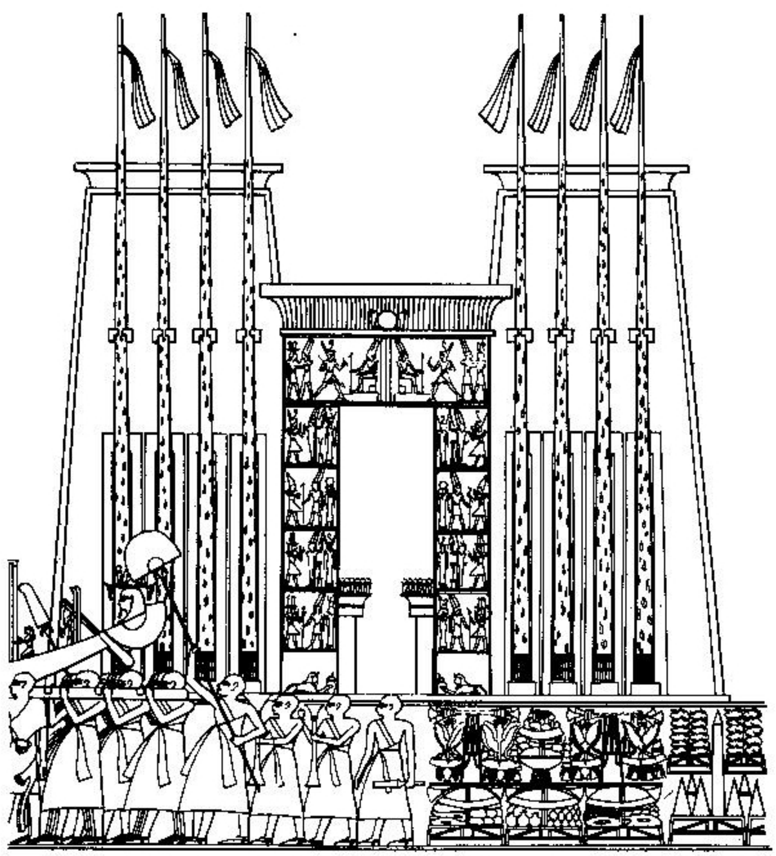
However, the Senet Board was also designed as a precise scientific tool and was dedicated to the highest spiritual level of existence that Egyptians called "Amen", the Invisible Foundation. To the Egyptians the highest form of God is invisible because His Essence lies beyond the senses and at the same time embraces in His Essence all the diversity of creation. Thus they called the game of life "Senet" because a player passes through all forms of creation when engaging with it and transcends beyond them all as a primary goal. The Oracle Game Board is a precise mathematical grid carved on the foundation stone of Reality. The Egyptians used grids to scale their designs accurately from the drawing board to finished artifacts of any size from miniature to gigantic. The Egyptians used Cartesian grids as mathematical tools thousands of years before Descartes was born.

Given the close connection of the Senet Board to the principle of AMEN, it would seem to make sense that the Egyptians would find a way to encode the essential concept of the Senet Board into the Great Temple of Amen in Karnak, one of the most important and largest sacred sites ever constructed by mankind. The Temple of Amen erected on this site at Karnak was the focus of major celebrations for centuries during the New Kingdom and remains today as a truly awesome remnant of ancient Egyptian civilization.

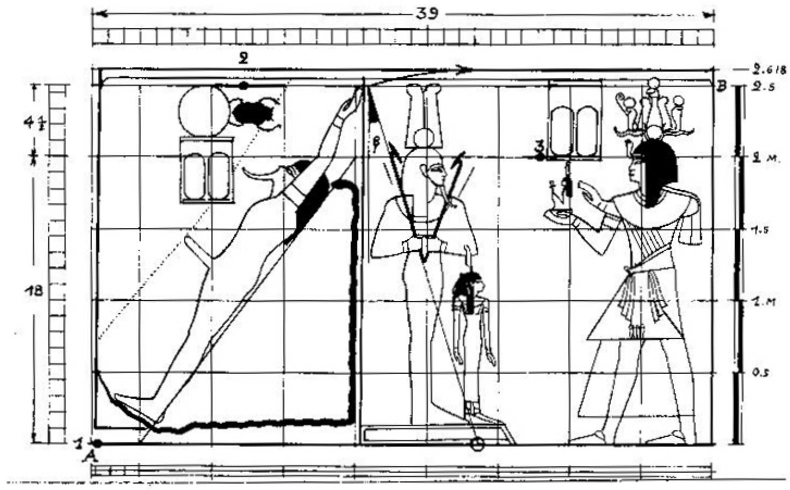
The name "Senet" means to pass through or pass beyond. So the first place to look for evidence of Senet would be the grand entryway to the temple. We begin our search with a drawing made by Lucie Lamy of a portion of an illustration that is found on the wall of the colonnade of Amen at Luxor illustrating a procession of priests bearing the Boat of Amen as they depart from the gateway at the pylon entrance to the Temple of Amen in Karnak on their way to the Temple of Amen in Luxor during the annual grand Opet Festival. "Amen" stands for the invisible Higher Self. The boat (wa*a*) symbolizes the technique of meditation used by Egyptians for crossing the "river" or "ocean" of awareness. For Egyptians the Nile River represented the dynamic and continuous flow of attention that we call consciousness. The Mediterranean Sea represented a vast existential domain of awareness that we can call psychic reality.

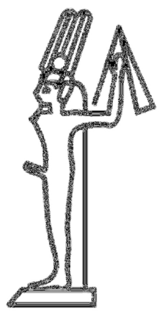
The word for portal in Egyptian is "seb*a*". The word "seb*a*" also means teaching and star. The Egyptian five-pointed star symbolized the immortal light body of a person. The Egyptians knew that everything is made of light, and that light changes shape, but never dies. Thus their meditation practice was a tool to assist a person to shift awareness away from identification with light forms as solid material bodies subject to destruction and to direct it toward identification with light forms in their true nature as pure indestructible light. If you measure the opening of the portal, you will find it has a height to width ratio of 3:1. This is the length-to-width ratio of the Senet Oracle Board to the left of the Tower. It is also the ratio of the Senet Oracle Board to the right of the Tower, but the scale is reduced and 9:3 becomes 1:1/3.

Lucie Lamy's Drawing of the Portal to the Temple of Amen (as depicted on a wall of the Colonnade of Amen at Luxor)



The next illustration is a drawing based on a mural found in the tomb of Rameses IX (KV6) at the end of the journey of the Solar Boat through the region called the Twat (the Astral Realm) as the sun prepares for rebirth to become a new day. In the illustration we find a naked ithyphallic image of pharaoh reclining stiffly against the head of a serpent that stands vertically erect with its body bent 90 degrees. Pharaoh stretches his arms straight up over his head in line with his stiff body. His ithyphallic pose is strongly suggestive of Amen's common ithyphallic pose.





Amen in His Characteristic Inthyphallic Pose

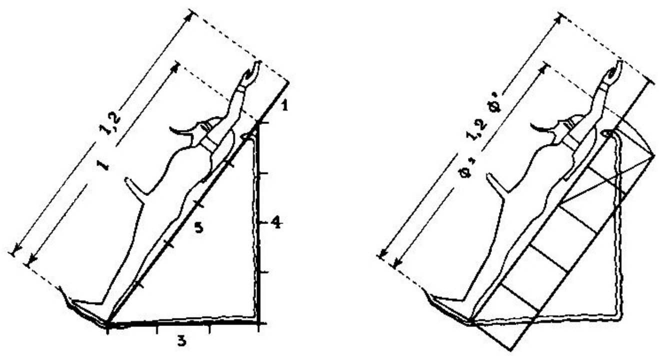
The erect phallus in the KV6 drawing divides the pharaoh's body in half between the top of his head and the bottom of his feet. On the far right of the other half of the tableau pharaoh stands wearing an elaborate "atef" crown and offers a little statue of Maat (Truth) to a standing statue of Ptah-Asar, who holds two "was" scepters at angles. The "was" in his right hand marks a diagonal to the base line, which, when rotated defines the top of the Heaven glyph as its uppermost tangent. Ptah-Asar stands on a wedge-shaped platform that means "Maat" (Truth). His vertical axis is 1 meter from the little Maat statue and 2 meters from the tableau's right side. In front of him a small figure of Maat stands, wearing her totem ostrich plume on her crown chakra. Above the entire tableau an elongated glyph for heaven (Pet) brackets the figures so that we know they form an integrated whole. Schwaller de Lubicz has added some guidelines with numbers and letters so that we can understand the dimensions of the figures and their significance. The number one at the bottom left calls attention to a special red line added after the tableau was painted so that we know this is the base line. The number two just over the scarab beetle calls attention to another special red mark that indicates the top of the tableau figures. The line also is tangent to the solar disk that the scarab pushes, indicating that the sun is about to ascend into the sky. The number three calls attention to a third red line at the bottom of the royal cartouches that extends to touch the brow chakra of the pharaoh from whose brow emerges a cobra mounted on a filet to symbolize that pharaoh's brow chakra is open and his eye of wisdom sees Truth.

Schwaller has added a grid of large squares starting at the base line and rising to the line that is tangent to the upper edge of the solar disk. Each square is half a meter on a side, indicating that the Egyptians were well aware of the meter as a unit of length. The tableau from the base line to the top of the solar disk is 2.5 meters in height. Along the left side of the drawing Schwaller adds a column of smaller squares that divide each meter length into 9 equal segments. Thus the tableau is 22.5 such small segments high. The 2-meter height corresponds to line 3 that passes through the standing pharaoh's brow chakra and also passes through the elbow of the leaning pharaoh's upraised arm, indicating that from there to the tips of his fingers at the 2.5-meter height constitutes a royal cubit.

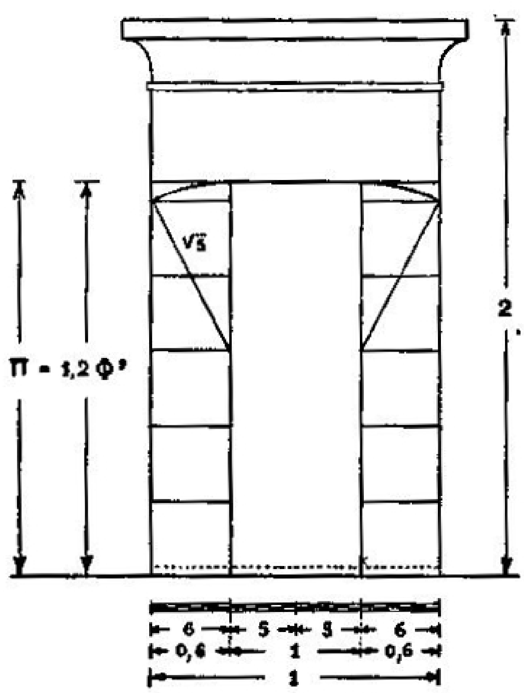
Schwaller has also drawn a diagonal line along the back of the reclining pharaoh passing along the back of his leg, his buttock, the back of his hair, and through the eye of the serpent so that we can see how the body of the pharaoh and the bent body of the serpent form the classic Pythagorean Diophantine 3, 4, 5 Triangle. This is the smallest triangle with whole number measurements of its sides that fulfills the Pythagorean relation. This alone tells us that the Egyptians knew the Pythagorean relation at least as early as Ramesside times and suggests that they taught it much later to Pythagorus during Ptolemaic times when he sojourned in Egypt. What's more, the sides of the triangle are in units of half meters, and so the hypotenuse also equals the 2.5-meter height of the tableau. It appears that the extended arm of pharaoh forms a smaller similar triangle whose hypotenuse is a royal cubit, and this will stand for 1 cubit, the pharaoh's stylized forearm, palm, and extended fingers forming the standard for that ruler.

If you look at the bottom of the reclining pharaoh's foot, you find that a vertical grid marker passes upward through the middle of the sole, a point called by the Chinese the *Yong-quan* acupoint, and considered the place where life energy enters the body from the earth. Along the base from that vertical meridian to the leftmost border of the tableau (which is defined by the leftmost edge of the Heaven glyph at the top of the tableau), we find three of the small squares. Proceeding upward from the base line, 1 meter consists of 9 rows of 3 such small squares, giving us a 9:3 mini-grid in the lower left-hand corner of the tableau (diagonal = $\sqrt{10}$). This is the Senet Oracle Board to the left of the Tower. If we add one more row of three small squares we then include the portion of the Board that is to the right of the Tower and have a perfect 10:3 Senet Oracle Board grid. If we extend the line marking the top of the tenth row of small squares to the right, we find that it passes through the eye of Maat (Truth) and into the genital area of the standing pharaoh. On the other hand, the eye of the standing pharaoh looks straight at the tip of the feather that extends from the crown chakra of the little statue of Maat (Truth).

Now we have to look at the reclining pharaoh in more detail. Schwaller has provided some small drawings that elucidate the mathematics and the metrics associated with the triangular figure. Looking at the sketch on the left, we discover that when we count the extended forearm and hand as one cubit, the hypotenuse of the 3, 4, 5 triangle becomes 5 cubits. If we then add the arm-cubit extension, we have a diagonal of 6 cubits. The ratio of 6:5 = 1.2:1. If we now turn to the sketch on the right, we find that Schwaller has enlarged the cubit marks into squares, like a Tower of 5 square blocks leaning over at a diagonal. He then draws a diagonal through the last two squares. The length of that small diagonal is √5 cubits. He then rotates the diagonal until it intersects the cubit that represents the reclining pharaoh's extended arm, extending the line above "5" by (√5 - 2) cubits (about .236 cubits). Note that in the sketches below Schwaller has shifted the baseline up so that it coincides with the snake and the heel of the reclining pharaoh. This raises the top of the 3, 4, 5 triangle along the forearm cubit by (√5 - 2). That corresponds to extending the pharaoh's finger tips to the top of the Heaven glyph, so Schwaller's sketches below are not quite drawn correctly, and "1.2" should extend beyond the fingertips by an extra (√5 - 2) that corresponds to the distance from the heel to the baseline.



If we scale the distance 5 + (√5 - 2) to φ^2, then the distance up through the finger tips to the top of Heaven becomes 1.2 φ^2. The length φ^2 is about 2.618 cubits, and thus 1.2 times that equals 3.1416, which is a very close approximation to π. Thus we have here the smallest Pythagorean Diophantine Triangle extended to produce values for φ and π.



Now we can apply this to an Egyptian doorway. Notice that the overall design in the above drawing resembles the Greek capital letter Π. The two sides of the doorway form two Towers like the legs of Baba 𓂾𓂾. Each is 5 square blocks high. At the top of each column we rotate the diagonal of the upper two blocks to its vertical high point, thus extending each column by a plinth of ($\sqrt{5}$ - 2) for a total height from the ground of π = 1.2 φ^2.

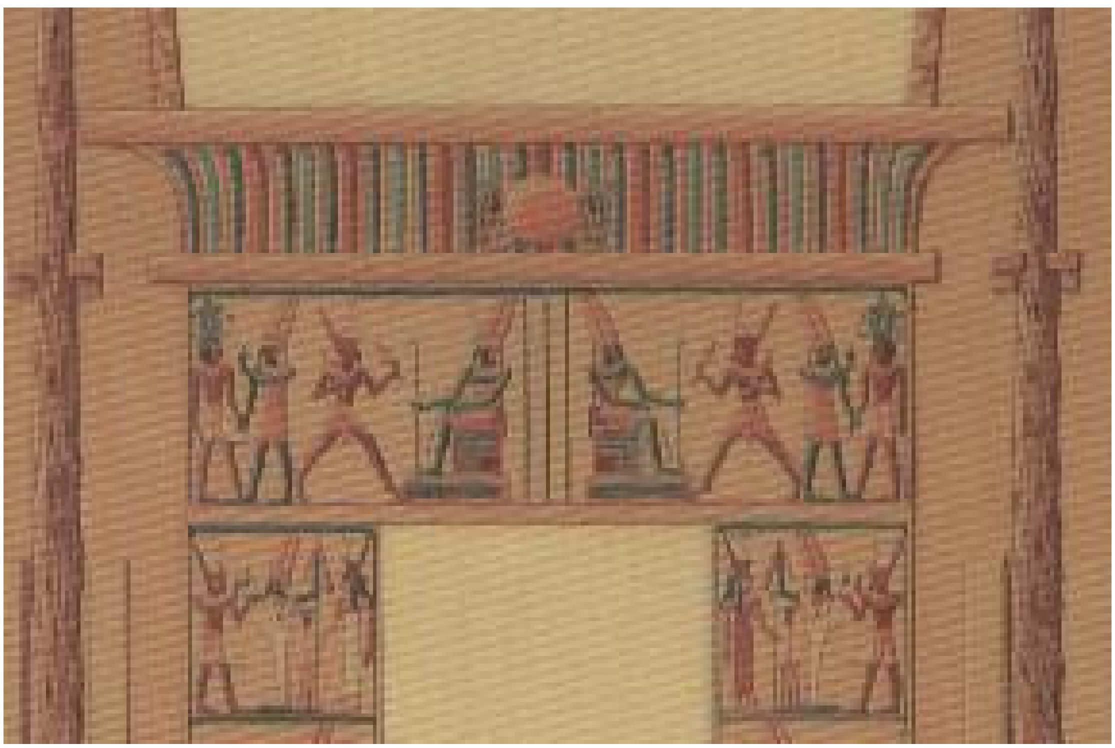
The opening of the doorway is 10 units wide, and each block is 6 units on a side. A stack of 5 such blocks totals 30 units, which gives us a 3:1 opening that is equivalent to the 9x3 grid for the Senet Oracle Board to the left of the Tower. The extra small plinth does not come out exactly to the tenth row, for a true Senet Oracle Board would be 33⅓:10, or 10:3 (rather than 31.416). So this doorway is not the same as the Karnak entrance. Lamy's drawing does not show such a plinth. To form the accurate ratio of a Senet Tarot Board, the doorway opening would be 9.4248 (i.e. 3 π) units wide and 31.416 (i.e. 10 π) units high. To form a 9/3 = 3/1 ratio, the space would have to be 10.472 (i.e. $10\pi/3$) units wide. However, the architrave over the doorway is 16.5/5 = 33.3/10, which is the proper ratio for the Senet Board.

Now we return to our starting point at the entrance to the Temple of Amen as depicted on the Amen colonnade wall at Luxor. To be certain about the drawing we can go back to check the original pylon that still stands at Karnak. This is now called Pylon Two, because another unfinished pylon was later erected outside that pylon and is now called Pylon One.

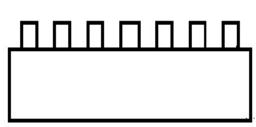
Temple of Amen, Pylon Two
(viewed from a distance across the paved courtyard)

Above is a photo of the Pylon and Portal from a distance so that you can see the scale of the entrance compared to the tiny people standing by it and the vast courtyard. Below is a detail in color. We can still make out the ornamentation faithfully copied by Lucie

Lamy and the ancient artists at Luxor from the actual Karnak Portal. Unfortunately, the architrave lintel on the remains of the portal has broken, so we can only see the two side portions of the Senet Board outline and the symmetrical images of Amen sitting in the middle on a throne are gone. From the photograph we can determine that the height-to-width ratio of the entrance doorway is 3:1, representing the root fractal form of the Senet Board that iterates at the 3:1 ratio. However, if we measure the symmetrical rectangular lintel, we find it has a 10:3 ratio, depicting a complete Senet Oracle Board outline, divided neatly in half as a pair of 5:3 rectangles. The symmetrical tableau on each half shows two figures of Amen wearing his crown with extremely tall feathers and two figures of the pharaoh. On the outside portion Amen actively blesses and clasps the hand of pharaoh who stands motionless wearing an ornate Osirian "atef" crown. On the inside portion Amen sits silently on a "Het" (Temple) throne holding the "was" (energy) and "ankh" (life) scepters while pharaoh approaches him in the dynamic wide-striding mode wearing the Red Crown and bearing a ritual implement of some sort in each hand. Ironically, the portion of the lintel showing Amen sitting on his throne has broken and now is invisible. Recall that the name "Amen" means "invisible".

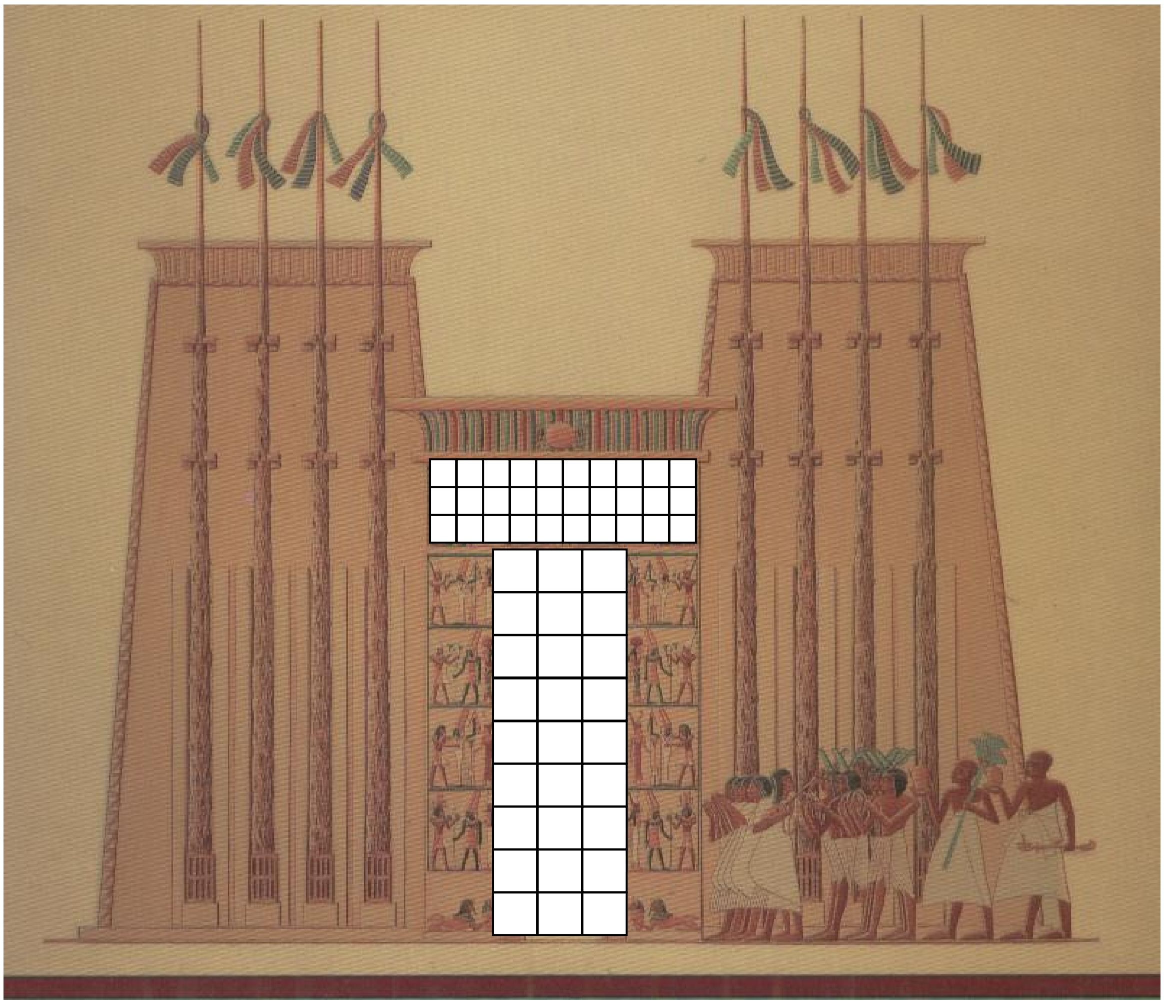


The outline of the Senet Oracle Game Board traced over the entrance to the Temple of Amen in Karnak is highly appropriate because every Egyptian knew that Amen's name was always written with the glyph for the Senet Board (Men) drawn in profile with the pawns on it and has the basic meaning of "FOUNDATION".



Men(ew)

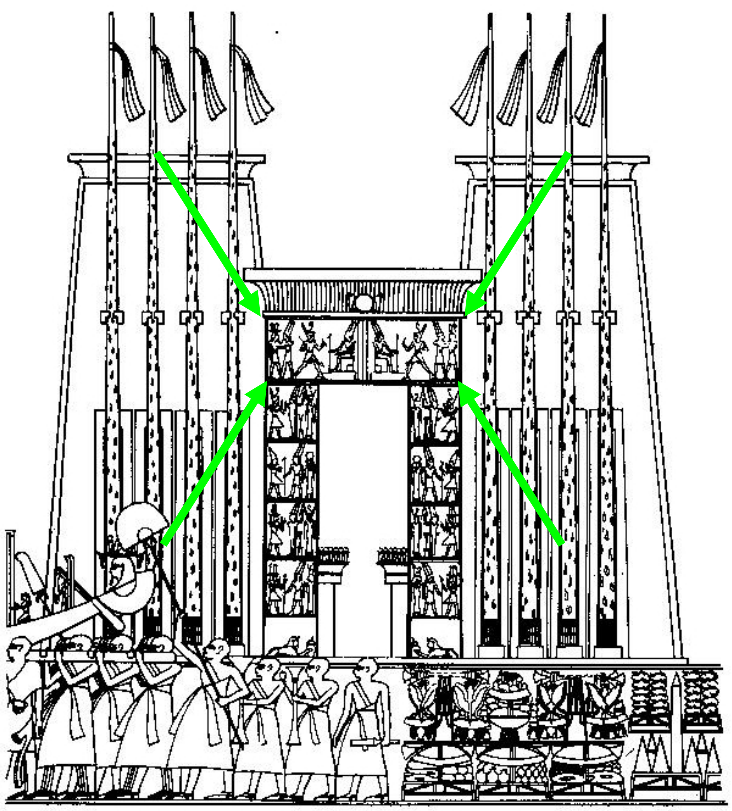
Below is a reproduction of Lucie Lamy's painting of the Portal of Pylon Two at Karnak as it was in Ramesside times and as depicted at Luxor Temple. I placed a 9:3 grid in the space of the Portal Opening and a 10:3 complete Senet Board grid above it. The scales of the two grids are different. The 9:3 grid is a fractal, showing how you can shift scales upward or downward once you enter the Portal.



From the people in the photo shown below you can tell that the actual portal is much bigger in scale than is depicted by the ancient Egyptian artists at Luxor because they wanted to be able to show both the details of the doorway and the details of the crowd of priests standing nearby in the same illustration on limited wall space. For the sake of human detail they sacrificed the immense grandeur of the portal, as if the priests and the artist were standing at some distance in front of the doorway.

The next photo shows an upclose view of Pylon Two, the entrance to Temple of Amen at Karnak, showing its present-day condition. I highlighted in black the location of the Senet Oracle Board grid outline. The column squares and the Senet Board are clearly outlined with borders in the photo.

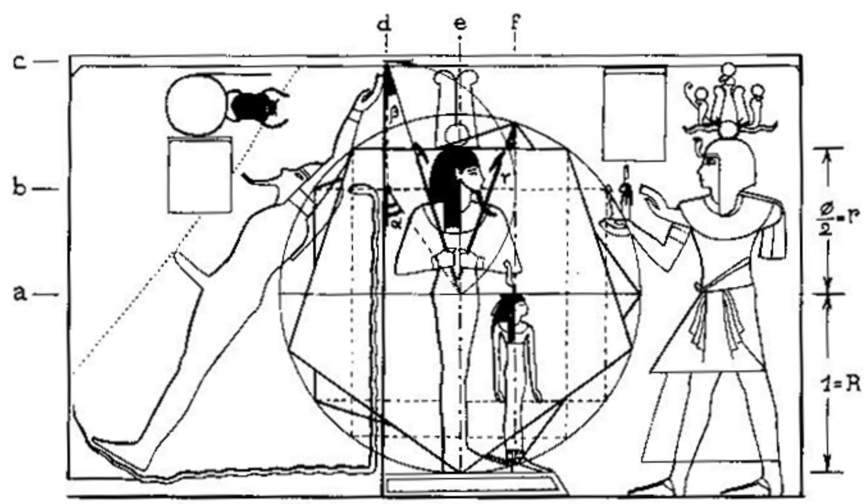
Detail of Portal Architrave with arrows showing corners of Senet Board
The figures on the door columns and remaining lintel are still visible.



Lucie Lamy's ink drawing with green arrows pointing at the Senet Board corners.

Lucie Lamy seems to have made accurate drawings of the pylon. Schwaller apparently wanted to push for the presence of *pi* and *phi* in the Amen Portal, so he added a plinth under the architrave in the outline drawing on page 24 above (reproduced from page 105 in Schwaller's **The Egyptian Miracle**). Unfortunately, the plinth is not visible in either Lamy's drawing of the pylon scene or the photo of the surviving pylon. The actual ratio of the doorway space is the fractal Senet ratio of 3:1, and the ratio of the architrave lintel tableau is the complete Senet Board ratio of 10:3. These are the traditional Senet Oracle Board ratios, unchanged throughout Egyptian history. I looked at many Egyptian portals and none were slimmer than 3:1. Many were wider.

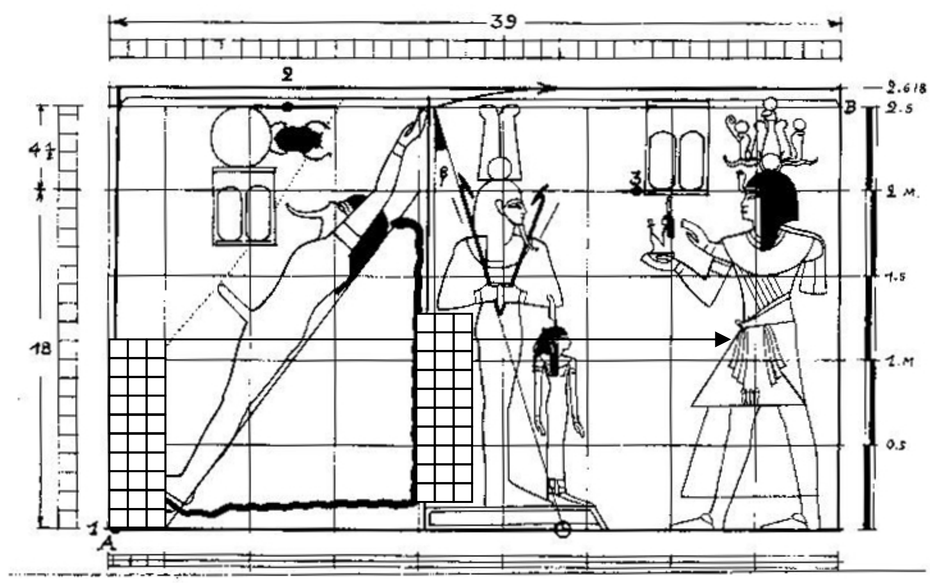
However, Schwaller is right about the triangle graphic containing the meter, the royal cubit, pi, phi, and pentagonal geometry. We also found the Senet Oracle Board hidden in it, down in the lower left-hand corner. Recall that from the triangle tableau .5236 meter (52.36 cm) equals 1 royal cubit. The tableau is 2.5 meters high, and has an extra amount extending to the top of the Heaven glyph that comes to 2.618 meters. That is φ^2 m. It is also 5 royal Egyptian cubits (5x.5236 = 2.618). The earliest surviving cubit ruler is from the time of Khufu, builder of the Great Pyramid at Giza and has the length 523.75±.25 mm, which puts it in range for 523.6 mm or $10(\sqrt{5}+3)$ cm. The Egyptian cubit is about 1.718 ft compared to 1 ft.



In this last drawing we see pentagons inscribed in a circle with its center at the hidden phallus of Ptah-Asar (Osiris). The vertical diameter (*e*) passes up through the umbilicus and the ear. The horizontal diameter of the circle, equator (*a*), extends and passes through the genitals of the three male figures. The main pentagon's top side is parallel to the tableau's rectangle and tangent to the top of Ptah-Asar's head. A rectangle is formed by dropping vertical lines from the upper tangent of the main pentagon. Two parallel lines are formed. Latitude (*b*) proceeds from the mouth of the little Maat statue, through the loop of the Ankh scepter that she holds, through the mouths of Ptah-Asar and the erect serpent and into the ear of the reclining pharaoh as if they are teaching him the secrets of life. The lower parallel line is defined by the tips of the fingers on the small standing statue of Maat. Another parallel line forms the complement to the upper pentagon tangent down near the bottom of the circle. The background pentagon is defined by the vertical axis (*f*) that runs through the small standing statue of Maat.

Where it intersects the upper arc of the circle locates the highest corner of the background pentagon. The corner to the left of the highest corner is at the ear of the reclining pharaoh. The corner to the right of the highest corner is at the horizontal diameter and points at the genital of the standing pharaoh. The lowest corner of the background pentagon is located at the ankles of the standing Maat. Schwaller labels three special angles related to Ptah-Asar and his scepters. Another important vertical meridian (*d*) is defined by the backs of the reclining pharaoh's fingers and the back of the base on which Ptah-Asar stands. Schwaller assigns the value $R = 1$ to the distance from the center of the circle to the sole of the foot of Ptah-Asar on the top surface of the Maat wedge. As a result $\varphi/2$ becomes the distance from the center of the circle to the top of the head of Ptah-Asar. The rectangle formed within lines *a*, *b*, *d*, and *e* has a diagonal with angle $\alpha = 34° 32'$. The interval *ab* is half the side of the pentagon. The interval *de* is half the circle's radius. Add the diagonal of the rectangle *a*, *b*, *d*, *e* to interval *ab* to make *ac*. The triangle with base *de* and height *ac* (taking *ac* as 3) has a hypotenuse marked by the edge of the "was" scepter in the right hand of Ptah-Asar with the length of *pi* = 3.14159. The acute angle of that triangle is marked by Schwaller as β. Extending that hypotenuse down to the baseline and up to the 2.5 meter mark makes it 2.618 (or φ^2) meters, equal to the vertical line from the baseline to the top of Heaven and equal to 5 royal cubits. The angle γ is formed by the conjunction of the line through the left-hand "was" with the vertical axis through the standing Maat at the high point of the background pentagon. The triangle formed by the left-hand "was" and the vertical axis of Maat is 1, $(2\sqrt{2})$, 3.

The height of Ptah gives the height of the pentagon. The height of Maat gives the radius of the circle. The pentagon suggests the five-pointed star that is the gateway to the secret teaching of Amen.



We can put a Senet Board in the lower left-hand corner and we can put one resting on the Maat platform under Ptah-Asar's right elbow between the snake's upright body and Ptah-

Asar's buttock. This Senet Board is 1 1/9 meter long and 1/3 meter wide. The fractal portion is exactly 1 meter by 1/3 meter.

For pictures of crowns, see:
http://www.touregypt.net/featurestories/crowns2.htm

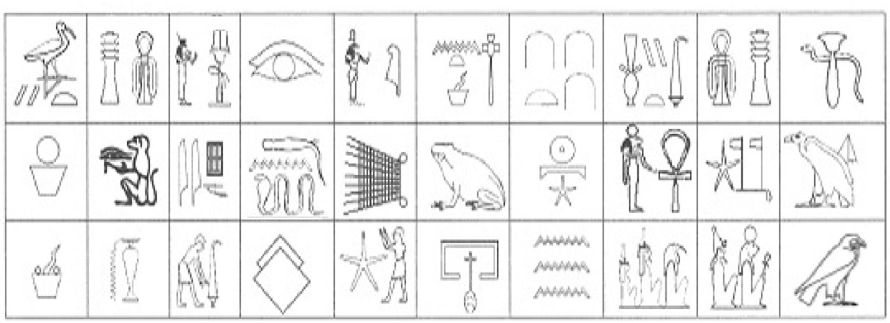
References:

Schwaller de Lubicz, R.A. **The Egyptian Miracle: An Introduction to the Wisdom of the Temple.** Translated by André and Goldian VandenBroeck. New York: Inner Traditions, 1985. (See "Man and Measure", pp. 92-105.)

Schwaller de Lubicz, R.A. **The Temple of Man: Apet of the South at Luxor**. Translated by Deborah and Robert Lawlor. Rochester, VT: Inner Traditions, 1998. (See Vol. 2, "The Master Builders' Grid", pp. 842-845.)

The Senet Game Board and the Solar-Lunar Calendar

It is fairly easy to recognize that the Senet Game Board was designed to be a perpetual calendar. The Egyptian Solar Year consisted of 12 months of 30 days each plus 5 Epagomenal Days for a total of 365 days. The Egyptian month was then divided into three dekans of ten days each. The Senet Game Board clearly is meant to be a calendar designed as a grid with thirty days divided into three weeks of ten days.



Symbols on a Senet Game Board
(Reconstructed from surviving examples and the **Senet Game Text**)

The **Senet Game Text** also clearly encodes a sequence that goes from the upper left corner to the right across the top row, then to the left across the middle row, and finally to the right across the bottom row. Square #1 belongs to Thoth who begins the New Year and the New Moon at the start of each lunar month. His curved beak represents the appearance of the first thin crescent of a new moon. The sun (symbolized by a solar disk) and the moon (symbolized by a net) appear respectively at squares 14 and 16 in the sequence. Square 15 has a large frog, and represents the time of the full moon when the sun and the moon appear on opposite horizons at dawn and dusk. On the bottom row the moon goes through a symbolic death sequence that culminates in square #27. Squares 28 through 30 represent the dark moon that is preparing for rebirth. Senet Game Boards frequently leave most of the squares blank but often leave the glyphs for the last five squares in the sequence. They represent the Five Epagomenal Days that complete the Solar Year.

The Symbols on the Senet Game Board

Square	Deity	Totem	Tarot Card
1.	Jehuty (Thoth)	Ibis	High Priest
2.	Asar (Osiris)	Pillar	Magician
3.	Net (Newet)	Altar	Star
4	Maa	Eye (vision)	Queen of Wands (fire)
5.	Ma'at	Ostrich plume	Justice
6.	Nej net B*a*?	Counsel (hearing)	Queen of Swords (air)
7.	Ma'bet	Council of 30	Judgment
8.	Senyt Ta?	Smell, Taste (tooth)	Queen of Cups (water)
9.	Thet (Aset)	Knot of Isis	High Priestess
10.	Waj (Khenty-Khard)	Papyrus	Hanged Man (child in womb)
11.	Mut (Mother Hathor)	Vulture	Empress
12.	Sah (Saa?)	Touch (finger)	Queen of Coins (earth)
13.	Sekhemet	Lioness Sphinx	Strength
14.	Ra'	Sun in Sky	Sun
15.	Heqet (Resurrection Goddess)	Frog	Wheel of Fortune
16.	Aah	Net (fishing by tides)	Moon
17.	Mehen	Serpent	Devil
18.	Pa Mery	Digging Stick	Lovers
19.	Qeftenew (Baba)	Baboon	Fool
20.	T*a*	Bowl of Bread	World
21.	B*a*	Incense	Temperance
22.	Qebhu (Qebhusenu-f)	Cooling Libation	King of Swords (Air)
23.	Mes-ta	Start Fire	King of Wands (fire)
24.	Hep?	Happy	King of Cups (water)
25.	Dewa (Dewamut-f)?	Worship of Morning Star	King of Coins (earth)
26.	Per Nefer	Embalming House	Hermit
27.	Mu	Waters	Death
28.	Shewe (Shu)	God with Plume	Emperor
29.	Tem and Ra	Tall White Crown	Tower
30.	Heru	Hawk	Chariot (Warrior)

Note: Some of the assignments may seem strange, but they are based on a reasonable reconstruction. For example, the Council of 30 is the group of judges that consider the judgment of the heart. The vulture is the symbol for Mut-Hathor, because the word "Mut" for vulture in Egyptian sounds like "mother". The Frog represents resurrection and rebirth and was a symbol of time. The net represents the moon's control of the tides. The word for bread is a homophone for World. "Per Nefer" (the beautiful house) was the place of mummification where they removed the heart of the deceased and then prepared the body for burial. The waters represent a lake of oblivion over which jackals towed the barge with the soul of the deceased. The primitive farmer's digging stick was a homophone (and metaphor) for "mer" (to desire, to love).

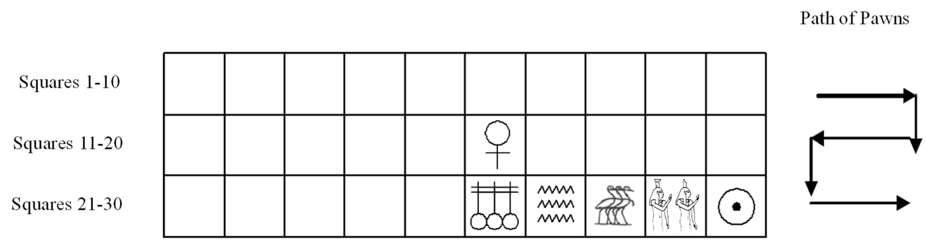
Egyptians called each square on the Senet Game Board a "Het" [House, Mansion, Temple]. Each House represented a day on the calendar. A cycle through the 30 squares on the board represented one month, and there was a deity for each day rather like the saints' days on religious calendars. (They apparently used variant sequences in different localities and times.) The Senet Game Board thus encodes travel through time and manages to be both a perpetual solar and a perpetual lunar calendar. To see how the Egyptians accomplished this we must turn to a myth preserved for us by the Greek author, Plutarch.

According to Plutarch the Egyptians developed a myth to explain how their calendar worked. Plutarch explicitly mentions the game of Senet, and once we realize that the game board is a calendar we know we must apply the math of the myth to the board. According to the myth the problem with the calendar arose when the sun god Ra in his transformation as Shu (Shewe; the Breath of Life) discovered that his children Nut (Newet, Cosmic Space) and Geb (Earth) whom he had sired with Tefnut/Sekhmet/Hathor/Mut (goddess of Love, Light, Undefined Awareness) were having a secret affair. Shu then stood between them and separated them – forming the earth's atmosphere. He then disallowed Nut from giving birth to children in any month or year. Plutarch tells us that in those ancient times the solar month and lunar month were both 30 days and the year was 360 days long. If Geb and Nut could not give birth, then life and civilization could not arise on the planet, for the nature deities necessary to facilitate organic life could not be born. In Egyptian art we often find Ra in his avatar as Shu depicted in the act of pushing Nut up and away from a reclining ithyphallic Geb. The ironic aspect of this myth is that Shu (the atmosphere) is what connects earth and cosmic space, making life on the planet possible by virtue of its insulating buffer from the cold vacuum of outer space.

Thoth (the personification of Cosmic Intelligence) had the clever ability to engineer the evolution of life and civilization on planets with the assistance of his wives Ma'at (Truth in Balance) and Sesh*a*t (Evolution). To provide the essential Egyptian deities that would be needed to get Egyptian civilization going (plants as a food source, sunlight as an energy source, fertile soil to anchor plants, stone for construction, and irrigation to nourish the plants), Thoth (probably in his disguise as Baba, the playful baboon,) made a bet with the moon that he could beat her at the game of Senet. The stake was $1/72^{nd}$ part of the light of the moon (Plutarch in his telling of the tale rounded it off to $1/70^{th}$ part, which actually comes closer to the precise fraction needed). A 1/72 part of 360 comes to exactly five days.

The numbers are important for understanding the story. The story is not myth, but math. The game of Senet was played on a rectangular chessboard with 30 squares arranged in three rows of 10 squares each. Each square represented a day, and each row was an Egyptian solar week, called by the Egyptians a **met** and called by the Greeks a **dekan**. The full set of three rows of ten squares made up a solar month of 30 days. The twelve months of a year came to 360 days. The point of the myth is to show how Thoth managed to get a year of 365 days and a month of 29.53 days from a calendar board with 30 squares.

Thoth being the most intelligent of all the gods obviously won the game and the moon was forced to give up 1/72nd of her light to add some extra days to the calendar year so that the five Egyptian national nature deities that made life possible could be born. If we divide 360 by 72, the answer is 5. The last five squares on the right side of the bottom row of the Senet board became five special squares that represented the Epagomenal Days of the short 5-day 13th month at the end of each solar year.



The 5 Epagomal Days are in the 5 squares specially illustrated on the bottom row of the game board example shown above. The symbol in the middle of the board means Life Renewed and represents the full moon on the 15th day of the month. The sun in the 30th square represents Horus as the new solar pharaoh.

If we divide 30 by 72, we get 0.416666.... We subtract that from the idealized 30-day lunar month and get 29.583333... days, which is very close to the actual lunar month of 29.53059 days. If we divide the actual solar year of 365.2425 days by the actual 5.2425 super-added days needed, then we get 69.6695278969. When we divide 30 by 69.6695278969 (which is very close to 70), we get .43060432452 (almost 1/70th part of the light of the moon in a lunar month). Subtracting this amount from 30 days gives us 29.5693956755... days, which is even closer to the "exact" lunar month of 29.53059 days than 29.583333.... days.

By this clever trick Thoth tweaked the Senet Game Board's idealized calendar of 30 days into both a perpetual solar calendar and a perpetual lunar calendar. The Egyptians alternated long and short lunar months of 29 or 30 days, depending on when the crescent of the new moon started to appear, just as, for example, the Chinese and Muslims do today in their lunar calendars.

Egyptian festivals and holidays were generally celebrated according to the lunar calendar. The solar calendar was 365 days long and slipped a day every four years, which means that the solar calendar had to be adjusted by inserting an intercalary 30-day solar month every 120 years. During the later dynasties they finally decided to add the extra quarter of a day to stop the slippage.

Astronomy with Ropes and Pegs

If the Senet Board is a calendar, then perhaps we can find some information about astronomy and celestial mechanics in the board design. We will start our exploration by introducing the Pythagorean Integer Triangle, something that Pythagoras must have

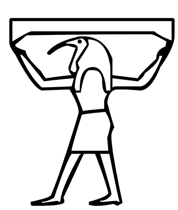
learned about when he studied in Egypt. The best-known Pythagorean Integer Triangle (PIT) has sides of 3, 4, and 5 units. According to the Pythagorean relation:
$3^2 + 4^2 = 5^2$,
$9 + 16 = 25$.
The ancients had another PIT which comes fairly close to the Senet Oracle Board dimensions. The sides of this PIT are 5, 12, and 13. The station stone rectangle at Stonehenge is an example of such a PIT. (See Robin Heath and John Michell, **The Lost Science of Measuring the Earth: Discovering the Sacred Geometry of the Ancients**, p. 60 et al.) The ratio 13/12 = 1.08333 gets fairly close to the Senet ratio value of 1.054, but the ratio of 13 / 5 = 2.6 is quite a bit too low for approximating the square root of 10.

So the 5, 12, 13 triangle seems way off from the Senet geometry until we add up the sides and find that they equal 30, which is the number of squares on the Senet Board.

After the careful measurements of the Stonehenge megalithic site by Petrie and Thom, and then through the analysis by Heath, Michell and their compatriots, with some vital assistance from astronomer Fred Hoyle, these gentlemen have cracked the secrets of Megalithic mathematics and astronomy wide open and have enabled us to discover the subtle mathematical relation between the Senet Board and Stonehenge.

Megalithic astronomically based mathematics starts with ancient men observing the motions of the sun and the moon, tracking time intervals, and extracting spatial displacements so they could understand the seasons for purposes of hunting, gathering, fishing, and planting. From these observations ancient men evolved an entire metrology. Once the ancients had worked out the system, they embodied it in various ways with stable, decay-resistant megalithic monuments and other objects. The Senet Oracle Game Board turns out to be an alternate way of presenting the same data that is recorded in the megalithic structures, but in a handy portable medium that is a game board and a sacred temple at the same time. Over time only a few of the megalithic structures have survived the ravages of mindless natural and human recycling. Fortunately in Egypt we not only have surviving megalithic structures, we also have enough surviving Senet Boards that we can reconstruct the similar megalithic principles embodied in a small portable object.

One of the most important Egyptian ritual gestures was called "stretching the cord". The Egyptians used cords of certain standard lengths to lay out plots of land and to mark the foundations for temples and other important buildings. Thoth, the progenitor of science and engineering, is often depicted in a pose where he stretches the cord to measure Heaven. Egyptians often simply showed him stretching out his hands to measure the glyph of Heaven, sometimes also represented by a strip of cloth held in his outstretched hands.



Let's follow Thoth's example and do some ancient Egyptian rope geometry. Take a length of string and mark off 30 equal units on it. Count off 5 units and peg that point on the string to the ground. Then draw out 12 more units of the string and peg the string at that point. Now you have 12 units of string pegged into a straight line and two loose ends, one of 5 units and one of 13 units. Stretch the 5 unit and 13 unit ends until they meet. Tie and peg them there. This gives you a 5,12,13 PIT. The sides of 5 and 12 units automatically will form a right angle.

So far so good, but not very amazing. The next step gets exciting. Release the 13 unit segment from its peg where it meets the 5 unit segment and slide its loose end down 2 units along the 5 unit line until it is 3 units above the 12 unit line. The 13 unit line will shorten to 12.368 units when you do this. Note that the short side of the triangle is now 3 units, which is the width of the Senet Board. However, the Board is 10 units long, not 12. Nevertheless, the length of the shortened hypotenuse gives you the number of lunations in a solar year. With a simple manipulation of a string and some pegs we have done a calculation of an important time interval in astronomical observations.

Next fold the leftover end of the former 13-unit segment of string (.632 units) back on itself, and its end defines the eclipse year of 346.6 days at the right place in the solar year. You can now use this rope triangle as a standard to make 3 ropes. The first is marked off with the 12.368 units to show the lunations per solar year. The second rope is of equal length, but you divide it into the 365.2425 days of a solar year. The third rope is shorter by .632 units and shows the 346.6 days of the eclipse year. Mark the half-way point on that rope to indicate each eclipse season. You can use these three strings like an "engineer's slide rule" to calculate new and full moons, as well as lunar and solar eclipses.

As you perhaps can see by now, the string divided into 30 equal segments is a one-dimensional equivalent to a Senet Game Board with its 30 squares. The pawns move on a zigzag path through the 30 squares, which is the same as moving past the knots on a rope. Through their study of ancient astronomy in megalithic England Heath and Michell, without realizing it, have uncovered a deeper level of geometry and mathematics hiding in the Senet Oracle Game Board of ancient Egypt.

Until I read the presentation by Heath of the Stonehenge calendar system as a simple portable rope-and-peg calendar I had never thought of taking the path of the Senet Game Board as a flexible measuring cord. Nevertheless there in the art of ancient Egypt we find Thoth holding aloft a measuring cord and stretching it taut against the sky as if to remind us that the secrets of the heavens can be captured in a piece of string. Doing the calculations this way the measurements are much more precise than Plutarch's rough calculations -- which he did not even understand were to be applied directly to the Senet Board in spite of the obvious clue about the wager over a game of Senet.

It's amazingly simple, but it immediately also gets strange, because this information is based on Earthbound humans measuring the motions and size of the Moon (and thereby knowing the size of the Earth, etc.) The weirdness arises when we ask the question why the moon is where it is and has the size it has. Is this a freak coincidence (which I highly doubt), a cosmological law of nature, or was the Moon deliberately engineered by some beings millions or billions of years ago to the size, distance, and orbital characteristics that it has? And why do we only see one side of the Moon? These are questions that have nagged at me for a long time, and they go deep into the question of what is going on in our local solar system -- especially when I see NASA photos of what looks like a huge mother ship lying on the back side of the Moon and many other lunar anomalies.

Detail of NASA photo AS15-P-9625, Apollo 15 Mission, "back" side of moon
shows what appears to be a gigantic submarine-shaped space craft marooned on the edge of a large crevise.
Naaah! It's probably just a funny shaped rock several kilometers long.

My derivation of the Egyptian origin of the name Tarot (in my book, **The Senet Tarot of Ancient Egypt**) was based on expressions in the **Litany of Ra**. The most widely used name of the game in Europe is Tarok. I believe the Egyptian origin of that name is "Da Rekh" -- That Which Bestows Knowledge. As we explore the Senet Board, we will discover that it is crammed with fascinating scientific knowledge.

Thoth stretching his sacred cord not only is the way ancient Egyptians laid out temples, it is the key to finding the two-dimensional Senet Board encoded as a one-dimensional sacred cord in the Station Stone Rectangle (SSR) and the Sacred Soli-Lunation Triangle (5, 12, 13 SSLT) as it is embodied at Stonehenge. The cords are long gone, but the stones and the pits at Stonehenge silently preserve the information. By holding the cord over his head Thoth signifies that the cord transfers celestial knowledge to earthly artifacts.

Once I had found a connection between rope geometry and the Senet Board, I discovered a simple way to convert the SSR/SSLT into what I call the TER (Triple Ennead Rectangle), and then with a subtle tweak, the Senet Oracle Board magically appears in two dimensions from the one-dimensional cord.

The Egyptian week was a 10-day decan, and 36½ such decans made a year. Each decan had a star associated with it, so the decans were called "Neteru Khabsu" (Divine Stars) or "Sebaiu Shepsu" (Honorable Star Teachers). Begin at the right angle on the SSLT and count upward and then clockwise by 10s. Starting with the 5-unit side we count 5 plus 5 along the 13 side, then 8 of the 13 side plus 2 of the 12 side, and finally the last 10 of the 12 side. Thus one trip around the SSLT clock at a day per unit is one Egyptian month of 30 days. Repeat the cycle 12 times (12 "hours" of the year) and you get a rough year of 360 days. Then count up the short side to get 5 more days (the Epagomenal Days added by Thoth) for a total of 365 days. This gives you the 365-day Senet Solar Calendar count on a rope calendar.

Next slide the 13-unit long side down by two units so that you have the 3, 12, 12.368 triangle. Then go to the other end of the 12 unit side (at the sharpest angle) and count in by 3 units, thereby reducing the 12-unit side from 12 to 9 units. Also count in 3 units from the acute apex on the 12.268 side. Press that string down and peg that point to the 9 unit point on the former 12 unit side, allowing the string to adjust into a new taut hypotenuse of what is now a Triple Ennead Triangle (TET: 3, 9, 9.486833 or square root of 90). This adjustment will pull a bit of the .632 unit hangover segment into the new hypotenuse, because you shortened 12.368 to 9.368 and the new hypotenuse is 9.486833. An extra .513167 has been pulled from the .632 hangover of the shortened 13 units. You now also have an extra loop of string that is 6 units long stretched out into two lengths of 3 units each. Swing that up into a perpendicular that is 3 units high. You now have a 3 by 9 TER with a diagonal of 9.486833, which is 3 times the square root of 10 (i.e. $3 \times 3.16227766 = 9.4868333$) that forms a TET. The extra length of 3 units in that perpendicular segment represents the 10th column on the Senet Oracle Board. One trip around the TET is 27.486833 days. Add on the 2 day units from the original 5-unit side of the SSLT and you have 29.486833, which is very close to a lunar month of 29.53059 days. If you swap the remaining hangover of .513167 for the .486833, you get 29.513167, which is about .017423 day or about 25 minutes off from an accurate lunar month. You can see how this nicely matches the old story told by Plutarch about Thoth's gamble with the Moon over a game of Senet in order to get the 5-day Epagomenal Month.

When we use the SSLT to calculate our solar year and lunar month, the number of lunations in the 12.3693168768 hypotenuse gets really close to the right length

(12.3682662283) for the lunar month (29.53059) relative to the accurate solar year (365.242199). However, the month is still too long by almost 45 minutes and the year comes out long by a little over 393 minutes. So Plutarch's report on the Senet calculation is actually more precise than the Stonehenge SSLT calculation. You can get very close, but it never comes out as a perfectly accurate integration of the two calendars. Nevertheless, the Senet Board and the story of Thoth and the Moon gives us an excellent approximation.

We can use the extra 2 units left over from the 5-unit side of the SSLT to extend the extra 3-unit loop in the Tower out to form the 10th column on the Senet Oracle Board. Then we can restretch the sacred cord. Start in the upper left corner and drop down 3 units, then turn right and proceed by 10 units. Go up 3 units, and then left 1 unit. Drop down 3 units, and finally return to the starting point with a hangover of .513167 unit. There are several ways to run the cord and you can simply adjust the cord by pulling the 2 leftover units from the original SSLT down to the peg where you originally marked the 12.368 diagonal and then using the slack to pull the 3-unit loop on the far side of the Tower out by one unit above and below to form a 1 by 3 unit rectangle.

The Hoagland Angle and the Dynamics of Rotating Spheres

After finding a way to uncover the Senet Board hiding in the SSLT, I thought to check the acute angle on the TET of the Senet Board. Using a protractor for a rough estimate, the angle looked very close to 19°. With a trig calculator it came out to 18.434948823°, which is just about 1° less than Richard Hoagland's famous 19.47°. It turns out that a triangle that is 3, square root of 72, and 9 gives the famous 19.47 degrees that has the sine value of .33333 = 1/3 = 3/9. Of course 72 is the key to pentagonal geometry since it divides 360 nicely into 5 parts as we already saw from the Plutarch story. It is also a nice **Book of Changes** number because it is the sum of the 64 hexagrams and the 8 trigrams. We add the 4 elements and 2 contrasts to get the 78 archetypes of the Tarot. This particular relationship combines powers of 2, powers of 3, tetrahedral geometry, and pentagonal geometry.

Hoagland discovered that if you place a regular tetrahedron inside a planet with the apex at a pole, the other three vertexes touch the planetary surface at 19.47° past the equator from the apex pole. When he surveyed the planets in our solar system, he found that solid planets had or still have strong volcanic activity at that latitude, and gaseous planets have large cyclonic disturbances at those latitudes. Earth has both numerous cyclonic storms and volcanoes at those latitudes. The disturbances cover an area that extends more than a degree north and south of the 19.47° latitude, so the 18.44° latitude still falls in that area.

However, if we create the Senet Spiral (see the chapter below on the Senet Spiral), and let the diagonal be tangent to the Spiral's highest point and leftmost curl, the iteration of smaller TERs extends the small rectangle on the right of the Tower upward beyond the Senet Board Rectangle (SBR) with a smaller version that goes 1/3 of a unit beyond the tip of the Tower. This gives a triangle that is 10/3, 9, 9.5974534, which gives sine = .347314, which comes to an angle of about 20.325 degrees, which is nearly a degree over

Hoagland's magical degree. As the spiral continues, it first increases the angle slightly as the next smaller TER is added, and then drops down toward the 18.44 degree angle at the tip of the Tower.

The result is that we end up with a spiral that the diagonal from the lower left corner can be tangent to at angles ranging from 20.325 degrees down to 18.44, a range of almost 2 degrees with 19.47 degrees almost right in the middle (about 19.3825 degrees).

The Senet Board and the Stonehenge Sarsen Ring

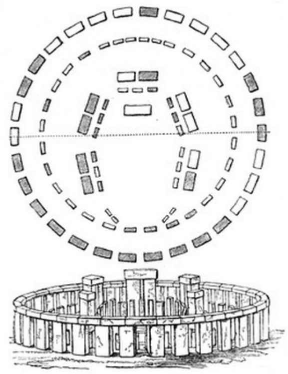
At this point we seem to have discovered how the Senet Board reveals the vortex geometry of rotating planets and a solar-lunar calendar that stays synchronized and can predict solar and lunar eclipses.

From the geometry of the Sacred Soli-Lunation Triangle (SSLT) discussed above we can also derive standard units for spatial measurement such as the foot, the royal cubit, and the Astronomical Megalithic Yard (AMY). The Sarsen Ring is a circle of 30 megalithic stones that originally formed an essential part of the Stonehenge site. Seventeen of them still stand, a few with lintels still joining them. Others lie toppled and shattered, and a few are completely missing.

The megalithic solar-lunar clock is a board with 56 (twice 28) holes arranged in a circle. These 56 holes can still be seen at Stonehenge forming a larger circle outside the Sarsen Ring. You use 1 peg for the Sun, one peg for the Moon plus two pegs for the eclipse season. You can put a peg for the Earth in the center. The Sun and Moon pegs move counterclockwise. The solar peg moves 1 hole every 13 days. The lunar peg moves 2 holes every day. The 2 eclipse season pegs are put at opposite nodes and each move clockwise 3 holes per year (once every 4 months). That is how the Stonehenge clock works. (See Richard Heath's "Proposed Itinerary for Megalithic Astronomical Development", 2009, and John Wood's **Sun, Moon, and Standing Stones**, OUP, 1978. The original idea was worked out by astronomer Fred Hoyle, **On Stonehenge**. Robin Heath further developed these ideas in **Sun, Moon, and Stonehenge**, Bluestones, 1998 and **The Lost Science of Measuring the Earth**, aka **The Measure of Albion**, 2006).

Stonehenge has another feature that links it nicely to the Senet Board. The sarsen lintel ring is made of huge megalithic stones. The ratio of the outer diameter of the ring to the inner diameter of the ring is 15/14. If we double that, we get 30/28. The outer diameter encodes the number of days in a tridecan Egyptian month, what they called the "Ma'byt", or Hall of the Thirty, which is of course the number of squares on the Senet Oracle Board.

The inner diameter of the sarsen ring encodes the minimum number of holes needed for the solar-lunar clock in order to keep track of solar and lunar time. If knowledge of eclipses is desired, a second set of holes is needed, one between each pair of the 28 holes, because the pegs for eclipses must be moved every 4 months. Note that 4 months (1/3 of a year) was the length of an Egyptian season. Alternatively I suppose one could stay with only 28 holes and move the eclipse pegs once every 8 months. However, that would result in some loss of precision.



Stonehenge Plan and Drawing

Aerial Photo of Stonehenge in Its Present State

From the above drawings and photograph it is evident that the great sarsen circle with lintels consisted of 30 megalithic stone tablets topped by lintels to form a solid ring. This is a circular rendition of the Senet Oracle Board. We see that it truly is a scientific "oracle" because it can predict future events both on earth and in the heavens.

The English Foot and Ancient Metrology

Robin Heath proposes an interesting definition of the English foot. He says, "If the English foot is made to represent the difference in time between the lunar and solar year (10.875119 days), then the megalithic yard, based on the astronomy of the lunation cycle of 29.53059 days, becomes 2.71542857 feet in length."

In other words Heath says: 29.53059 days / 10.875119 days = 2.71542857 ft. / 1 ft.

On my calculator I get 2.715426838 ft., but you get the idea. The ratio is extremely close. Thom pegged the megalithic yard at 2.72 feet, but Heath shows a much better overall correlation, although this should be checked against Thom's measurements to verify the reasonableness of correlating this idea with megalithic artifacts. Big stones that have been in place for thousands of years and possibly tampered with by humans and natural influences require careful data gathering to draw any conclusions.

Heath presents a chart on p. 34 of **The Lost Science of Measuring the Earth** containing the ratios between various important ancient measures. The measures are given relative to a modern English foot as the standard.

1.000000 English foot × 441/440 = 1.002272727 (standard Greek foot).
1.002272727 (standard Greek foot) × 176/175 = 1.008 (canonical Greek foot).
1.008 (canonical Greek foot) × 176/175 = 1.01376 (geographic Greek foot).
1.01376 (geographic Greek foot) × 15/14 = 1.08617143 (Drusian foot). (30/28 ratio)
1.08617143 (Drusian foot) × 5/2 = 2.71542857 (Astronomic Megalithic Yards) (AMY)

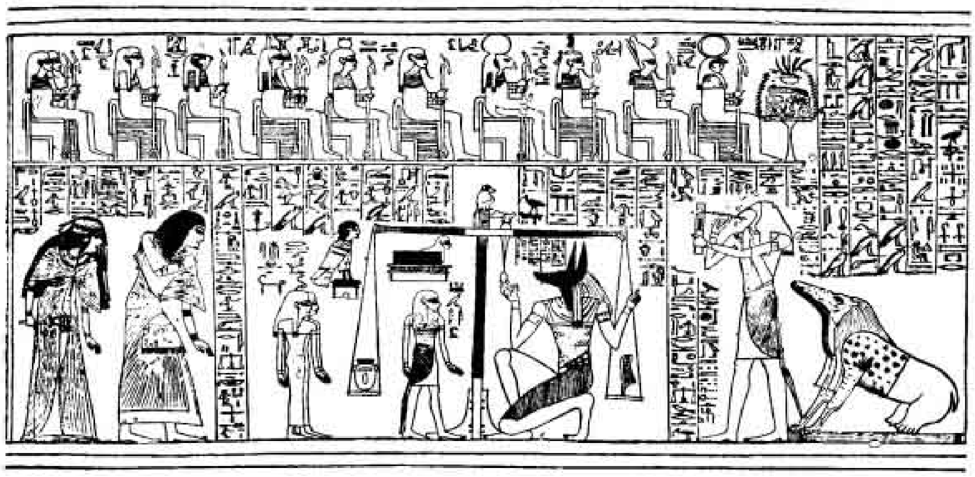
1.01376 (geographic Greek foot) × 3/2 = 1.52064 (geographic Greek cubit)
1.52064 (geographic Greek cubit) × 10/7 = 2.172342857 (geographic megalithic cubit)
2.172342857 (geographic megalithic cubit) = 2 Drusian feet (= 30/14 × geog. Gk. ft.)
2.172342857 (geographic megalithic cubit) × 5/4 = 2.71542857 (AMY)
2.172342857 (geographic megalithic cubit) × 4/5 = 1.7378743 (geographic royal cubit)
1.7378743 (geographic royal cubit) × 25/16 = 2.71542857 (AMY)
1.21499 (Egyptian remen) × 801/800 = 1.216512 (geographic Roman remen)
1.216512 (geographic Roman remen) × 12/7 = 2.0854491 (sacred geographic cubit)
2.0854491 (sacred geographic cubit) × 25/24 = 2.172342857 (geog. megalithic cubit)

The "remen" is an ancient Egyptian unit of measure equal to 5 palms or 20 fingerbreadths (about 37.5 cm). The glyph for it was an arm with the palm facing down: . The same symbol pronounced "meh" stood for the royal Egyptian cubit ("Meh Suten", the Sultan's Fullness) and equaled 7 palms and 28 fingerbreadths or about 52.5 cm (based on actual artifacts). A smaller cubit (meh nejes) was 6 palms and 24 fingerbreadths. The ratio of the "meh" to the "remen" was thus 7/5. The number 28, as we have seen, is the key to the solar-lunar calendar.

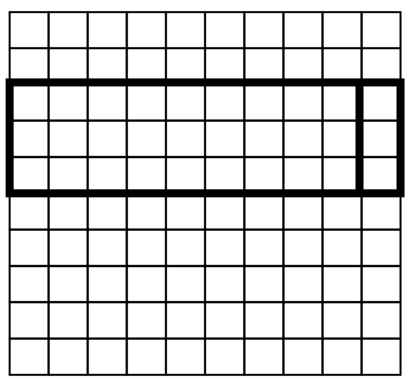
We now realize that we can take a string marked with the 28 fingerbreadths of the cubit and mark off a circle with holes at 1-fingerbreadth intervals, and this becomes a solar-lunar calendar clock. So the Egyptian royal cubit ruler was an astronomical clock as well as a tool for measuring displacement in space.

Navigating Scale with the Senet Oracle Board Spiral

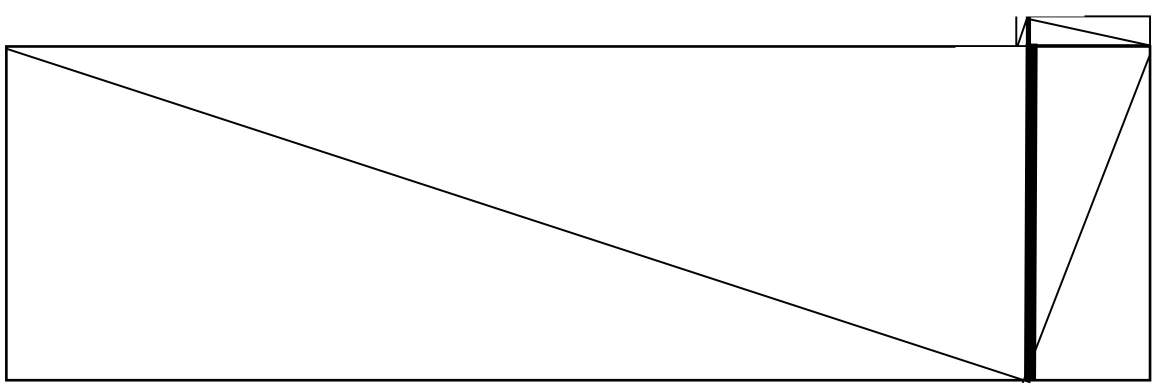
The Senet Oracle Board generates a fractal spiral. Below I show again the Weighing of the Heart Tableau. Below that I show the fractal Senet board grid, and then I have sketched the first few iterations of the fractal spiral. The spiral curls around the tip of the tower. The limit of the spiral is the tip of the tower.



Weighing the Heart Tableau



The Fractal Senet Board Grid



Fractal Senet Oracle Board Spiral (Tower)

The entire length of the first large Senet Board is 10 units, and the tower divides its length into 9 unit columns and 1 unit column. The upper row from the Tower to the left side of the Board constitutes the Ennead (Group of 9). The two rows below that join the

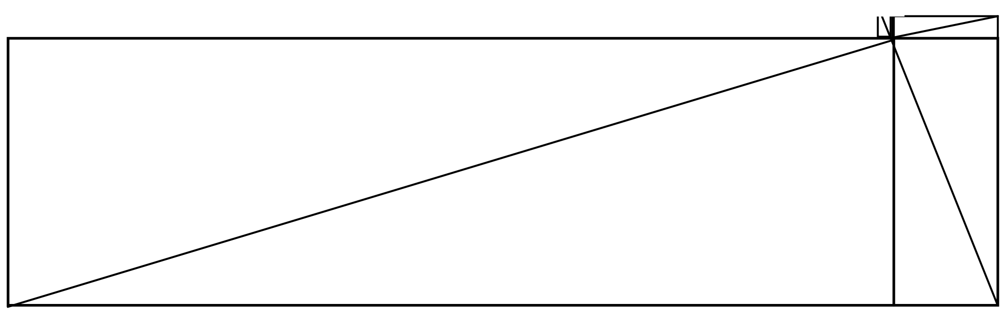
Ennead to make a Triple Ennead Rectangle (TER). The Ennead and Triple Ennead are often discussed in the **Pyramid Texts**.

On the right side of the Tower is a smaller rectangle that is similar to the Triple Ennead Rectangle, but rotated by 90 degrees. This vertical TER recapitulates the large horizontal TER, but at a smaller scale between the Houses of Ra and Thoth.

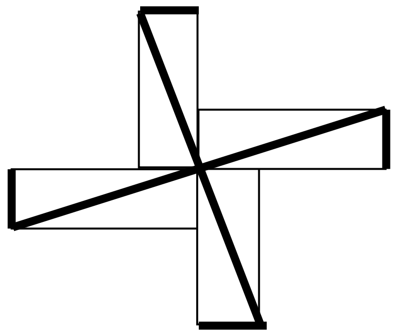
If we add an even smaller horizontal TER above the small vertical Ennead on the right side of the Tower (i.e., above the House of Ra), we make the vertical TER into a small Senet Board. This little TER extends above and to the right of the tip of the Tower. Then we add an even smaller vertical TER to the left of the small horizontal one extending it into a third, even smaller, Senet Board. The successive TERs alternate between horizontal and vertical. Each new TER is 1/9th the area of the previous TER. Each new TER also combines with the previous TER to complete another Senet Board at a smaller scale. Each smaller TER is 1/10th the area of the larger Senet Board that it completes by extending the larger TER -- just like the first little vertical TER that we found on the right side of the Tower completes the larger TER into a full Senet Board. Thus the spiral of TERs and Senet Boards recapitulates all of its dimensions at different scales.

The area of each smaller TER is 1/10th the area of the Senet Board it completes. The area of each smaller TER is 1/9th the area of its larger TER partner. The sides of a TER have a ratio of 3:1, and grow or diminish by 3x.

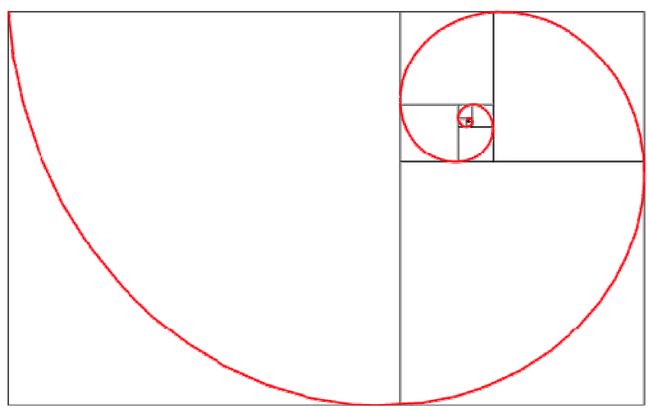
The diagonals also reduce or increase by the ratio of 3:1. The ratio of the length of each larger Senet Board is 10 times the width of the next smaller Senet Board. Thus as the Senet Board Spiral winds outward or inward, we see growth or shrinking by multiples of 10, multiples of 9, and multiples of 3, depending on how we look at the figure.



The diagonals form the spiral. The descending diagonal on the starting Ennead has a length of 3×3.162 units if we count the starting Ennead as 9 units wide and its three rows as 3 units high and represents the descent of a person into the physical world during his lifetime -- from orgasmic conception to death and judgment. Following balanced judgment Maat (Truth) and Thoth (Intelligence), a person returns to Source (Ra) in the Higher Self.

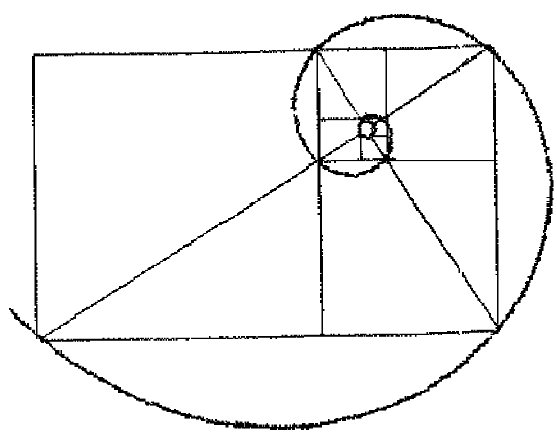


If the TERs do not scale, they can form a swastika-like structure that resembles a rotating spiral galaxy.



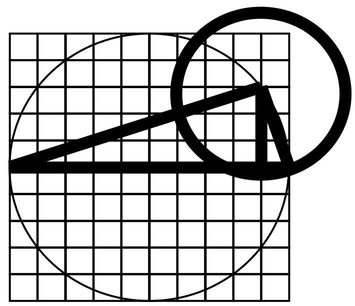
Phi Spiral

You can see from the above drawing of a phi spiral within a golden rectangle (see Wolfram Math) how this process resembles creation of the Senet Oracle Board Spiral. The length of the large rectangle in this graphic is φ. The side of the large square is 1. In descending size the second square has side = 1 / φ (i.e. φ - 1). The third square has side = 1 / φ^2. The fourth square has side = 1 / φ^3, and so on.



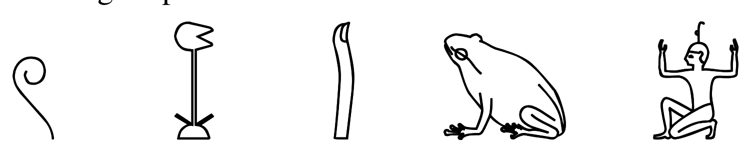
A phi spiral showing the equivalent of the 4 orthogonal rays that emanate from the Tower.

The remarkable feature of the Senet Board Spiral is that it converges on the tip of the Tower Obelisk, which is the center of the solar spark on the obelisk's pyramidion. Also it gives us nice neat multiples of 10 at each iteration instead of many irrational numbers. Of course, it is also possible to make a TER spiral that stays within the starting Senet Board the way a Phi Spiral stays within its original Golden Rectangle. However, the simple TER spiral does not make a Senet Board Spiral or neatly encode the multiples (powers) of 10.



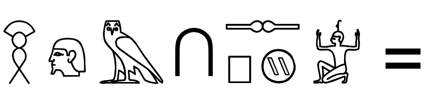
The tip of the Tower in Egyptian mythology represents the Big Bang, the concentrated point from which the universe emerges. The above drawing shows the Big Bang emanating as the Cosmic Sun from the tip of Tem's Tower. In the analogy with Menew, the ithyphallic god of procreation whose name also stands for the whole Senet Board, the tip top of the Tower is the orifice on the glans of the phallus of Tem from which the "cosmic semen" energy emanates and evolves into the physical matter of the universe. Less than half of the circle/sphere emanating from the Tower is in the Senet Board of the visible physical World.

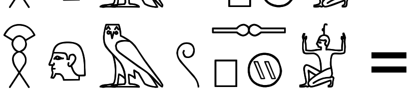
Egyptian mathematics was an ingenious combination of a base 10 and a base 2 (binary) system. The numbers from 1 to 9 were represented by notches 1, 11, 111, 1111, 11111, 111111, 1111111, 11111111, and 111111111. These could represent the columns on the Senet Board to the left of the Tower. The number 10 was written as ∩. Then the decades were simply ∩∩, ∩∩∩, ∩∩∩∩, ∩∩∩∩∩, and so on up to 100. Here are the symbols used for the higher powers of ten.

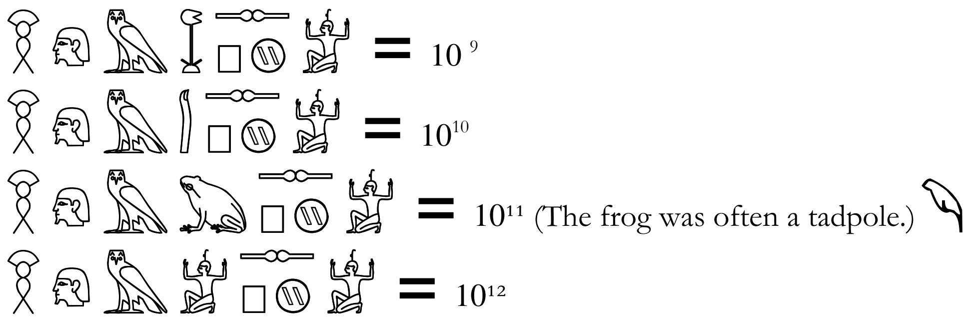


100 1,000 10,000 100,000 1,000,000

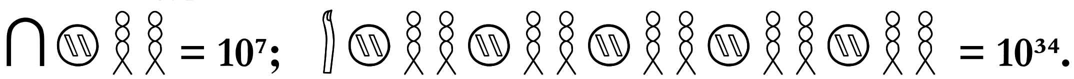
This takes us up to the sixth power of ten. To get higher powers of ten you had to multiply in various combinations. The formula for multiplication was "w*a*h tep em A sep B" (bow [or place] the head [i.e. increment] by A times B) , where A and B are the two numbers to be multiplied.

 = 10^7

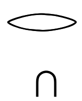
 = 10^8



Of course Egyptians often would write in hieratic and could use shorthand such as:



For fractions the Egyptians placed the lenticular mouth radical over a number to indicate its inverse. They almost entirely used only the unit numerator. Thus:



= 1/10 = (10^{-1}) and so on. A unit fraction is the reciprocal of a whole number.

We know that the Egyptians understood irrational numbers, but they may not have invented a precise notation for them. Instead they used fractional approximations, and of course understood about the square root of 2, *pi*, and *phi*. In general they understood that diagonals of rectangles usually would be incommensurate with the sides of their rectangles, often leading to rational sides and irrational diagonals or vice versa.

They also understood about scaling from the pyramid principle. The Senet Board was very special, because it embodied in geometry a simple model of how to scale by powers of 10 in either direction. The Egyptians basically preferred to work only with powers of 10 (The Senet Oracle System) and powers of 2 (The Tekhyan Min-Mut System), which we might also call the Ogdoad System of Thoth. For weights and measures as well as the operations of multiplication and division they generally used the Tekhyan Min-Mut binary methods, while for ordinary numbers they usually wrote in the base ten notation with the symbols such as I introduced above.

Macroscopic and Microscopic Wavelengths

We have begun exploring a little bit of how the Senet Oracle Board encodes information about the very large scale, beginning with the astronomy and chronometry of the Solar and Lunar interactions with Earth and extending to the dynamics of planets, solar systems, and beyond. The New Kingdom text of the **Amduat** gives evidence that the Egyptians were aware of various planets, solar systems, star systems, galactic systems, and the entire universe as a gigantic black hole in undefined awareness (see Hours 10-12.)

The Senet Spiral shows how Egyptians could expand their frame of reference from a local frame to a cosmic frame by winding outward on the spiral. Each outward step involves a 90 degree turn and a multiplication by 3 that signifies a dimensional shift and an acceleration to the speed of light in the new orthogonal dimension.

When the attention goes to the very small, we move inward on the spiral, reversing the expansion process. In their art the Egyptians represented large wavelengths as serpents and small wavelengths as ripples on water. Below is an example of the Egyptian representation of subtle energy of high frequency and small wavelength expressed as ripples on water.

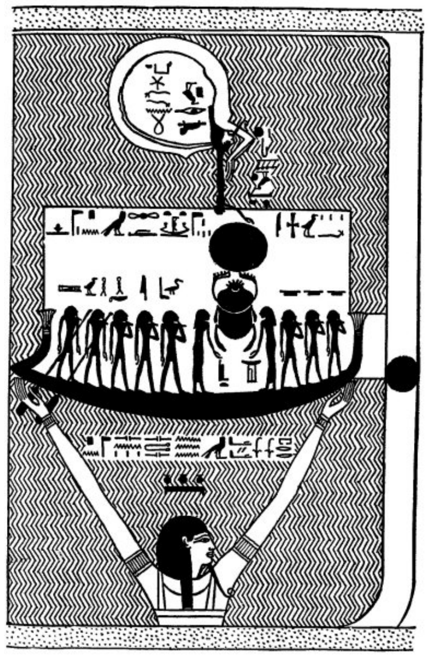
Ani and his wife drink the waters of pure high-frequency energy for immortal life.
They hold small fans in the shape of sails to symbolize the breath.

Water represented life and awareness in Egyptian symbology. The ability of water to take the shape of any container and to even take on a great variety of life forms suggested to Egyptians how awareness can take on many forms of consciousness and the various objects perceived by consciousness.

In **The Book of Pylons**, Hour Twelve, the Egyptians depict how potential energy forms into little bubbles of matter within the ocean of undefined awareness potential energy. Before displaying the graphic I quote in italics Budge's description of the tableau. What he calls the Tuat is the gap between intervals of conscious awareness with its perception of physical objects. We experience the Tuat during deep sleep, dreams, meditation, and during the phase of death between incarnations. The picture shows the transition of awakening and incarnation.

Here we see that the end of the Tuat is reached, and the boat of the sun has reached that portion of it through which he is about to emerge in the waters of Nu, and thence in the form of a disk in the sky of this world. Having passed on to the water the boat is supported by the two arms of Nu himself, or, as the text says, "These two arms come forth from the waters, and they bear up this god." The god appears in the boat in the form of a beetle, which is rolling along a disk; on the left of the beetle is Isis, and on the right Nephthys. The three beings in the front of the boat are probably the personifications of portals, and the gods to the left are SEB, SHU, HEK, HU, and SA, In the hieroglyphics at the top of the open space above the boat is written, "This god taketh up his place in the

MATETET Boat [with] the gods who are in it." Away in the waters above, or beyond the boat, is a kind of island, formed by the body of a god, which is bent round in such a way that the tips of his toes touch the back of his head. On his head stands the goddess Nut, with her arms and hands raised and stretched out to receive the disk of the sun, which the Beetle is rolling towards her; the text says, "Nut receiveth Ra." The island formed by the body of the god is said to be "Osiris, whose circuit is the Tuat."



My Notes:
The graphic is two dimensional, but Budge's use of the word "disk" really should be understood to be a sphere.

NU (NEW) is the creative urge to manifest something out of undefined awareness, which is represented in the drawing by waves of undefined potential that fill the vacuum of nothingness. New's name glyph (written over his head) is a tray that stands for Heaven on which are placed three bowls of water to suggest the defining of boundaries that give shape to the undefined waves of potential as in the three Islands of the Blessed in the pictures of Heaven. New's two arms express the dualistic contrasts that cooperate to create definition out of potential. The two arms also represent the role of an avatar to express creativity and support the process of evolution. This is standard code in the **Pyramid Texts**.

The BOAT of RA represents the Meditation of the Higher Self. The Egyptians distinguished a morning meditation and an evening meditation (ideally to be done at dawn and dusk when the sun was just passing over the horizon). This boat is the morning boat M'ANJETET (Form of Brilliance) and represents meditation done just before sunrise. The word for boat in Egyptian puns on a word for meditation. Ra is the round bubble of dynamic energy pushed by the beetle and symbolizes the Higher Self in the form of the Sun, full of life-giving energy and willing to share it with all. The beetle represents the dynamic phase of the sun that becomes active during the day.

3 PERSONIFIED GATES appear standing in the bow of the Solar Boat. They take a person from the gross level of existence to the subtler levels, from the subtler levels to the subtlest level, and from the subtlest level to the transcendental realm beyond all boundaries.

SEB (also called GEB) represents the physical world. His presence on the boat signals that the waves of potential energy are transforming into particles of matter.

SHU (SHEWE) represents the formation of gas from the particles of matter that emanate from the waves of potential. This gas becomes the breath that sustains the life of living organisms and eventually gives rise to consciousness and corresponding solid molecular structures.

HEK (HEK*A*) is the god of mantras. During meditation a person uses a mantra. When a person closes the eyes to meditate, he passes through the first portal. As the meditation progresses the mantra becomes subtler and subtler, smaller and smaller until the meditator passes through a second portal and experiences the subtlest impulse of physical sensation that is possible to sustain in consciousness. In that state all diversity unifies into a harmonious wholeness. Finally the attention passes through the third portal and transcends to the undefined waves of potential. The creation process is the opposite of this process, and once a person has experienced tracing back to the source of the whole process, he may deliberately and consciously direct the process from its inception through the three portals, and into a solid physical reality, thus identifying with New. Following the two arms of New back to his body also graphically depicts the meditation process.

HU (HEW) is the god of taste and smell. He represents the initiation of perception into the ability to distinguish between gross and subtle. Taste is a gross perception very similar to touch, and smell is a subtler aspect of taste. There is a phase shift in the manner of sensation that occurs when taste graduates to smell. That shift opens up a vast new world of subtler sensations. Thus Hew represents initiation, a phase shift of perception into a new mode of experience.

SA is the god of touch. He represents the wisdom inherent in the most primitive form of perception. The sense of touch involves interaction by means of collision, pressure, and other forms of gross physical contact. Taste is a subtler and more specialized form of touch that primarily occurs through the tongue contacting a physical substance. The higher senses are simply refinements of touch to subtler forms until sensation becomes the pure self-interaction of photons. The wisdom is that the physical world allows light to play and display its creativity through the fulfillment of reality in experience.

ASET and NEBET HET (Isis and Nephthys) are the sisters and consorts of Osiris. Respectively they represent Feeling and Bliss (Life Energy). They stand on either side of the beetle Khepera to assist in uplifting him as he pushes the sphere of Ra into the space created by the loop of Osiris. They know the truth that Osiris is an incarnation of Ra into physical form that experiences birth and death. Their arms are lifting to show they are avatars in the service of the evolution of higher consciousness in sentient beings.

NUT (NEWET) represents an empty space above the solar sphere that is prepared to receive the influx of solar energy. Newet is Cosmic Space. She is the consort of Geb (Seb) and prepares the space in which the matter he generates may reside and evolve. Stars are the first creations formed from the gas (*qi*, and *prana* energy) of SHU (SHEWE). Newet is the mother of Osiris. In the picture she is upside down in the space above Ra and reaches down to receive the energy sphere of the sun that is emanating and rising from the meditation. Newet's body forms a channel through which Ra's creative energy can flow as a beam of light.

ASAR (Osiris) is above the feet of Newet. His body is looped around so that his toes touch the back of his head. His hands are extended downward with palms facing his mother's genital region to indicate he is born from within her womb of Cosmic Space. Osiris is usually thought of as the god of the dead, for he represents the inevitable destruction and dissipation of any physical body. Yet here he demonstrates the formation of a physical body from waves of potential. With his body he demonstrates how a wave can loop around onto itself and become a closed cycle or bubble that appears to separate itself from the undefined waves of possibility by taking on a specific definition. This fundamental definition is the wavelength of the loop. The space that it defines can absorb the energy of Ra as photons and modify its vibration. Osiris at this stage can represent a subatomic particle forming in space or a fertilized egg in the womb. His body defines the Tuat (womb) of Newet.

On the right side of the drawing is a border that resembles the glyph for heaven (𓇯 pet) with a hole in its middle through which the morning boat, its occupants, and the loop-bubble of Osiris will pass to form the experience of a new life and a new day.

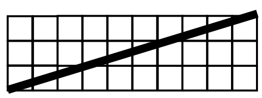
The Senet Oracle Board and the Fundamental Machines

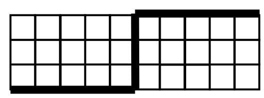
Now that we have passed through the portal into the mysterious undefined domain of Amen and his Senet Oracle Board and have had a glimpse of how we can emanate solid realities from the undefined domain of Amen, we will begin to explore some of the Egyptian wisdom about our physical world that it contains. The Great Temple of Amen is a world class marvel of engineering, and the Egyptians surely employed knowledge of the basic machines to accomplish its construction. A machine is a device that provides **mechanical advantage** in the performance of some kind of work. Mechanical advantage is the use of a physical configuration that enables a person to perform a given task more efficiently or quickly by redistributing the forces involved in the task more efficiently for the task than would be possible without the physical device.

What are the fundamental machines? Franz Reuleaux (1829-1905) made a study of over 800 types of machines and identified six devices at the foundation of these machines: inclined plane, wedge, screw, lever, pulley, and wheel with axle. He further analyzed that the first three devices involved an object sliding on a flat surface at an angle from an arbitrary "horizontal" reference surface, and the second three involved a body rotating on a pivot. The wedge is a movable inclined plane, and a screw is actually a combination of the incline and the pivot of a lever. A gear is a specialized wheel with axle. The gear teeth serve as a form of lever attached to a wheel to enhance the gripping power of the wheel rim against another object. We shall first investigate the knowledge of inclined planes that is encoded in the Senet Oracle Board.

The Inclined Plane

Earlier in our discussion I drew diagonal lines across the rectangular Senet Board. This divided the rectangle into two wedges or inclined planes. If the slope is too steep, the advantage of the ramp in assisting the lift is much reduced. It becomes like climbing a sheer cliff as opposed to walking up a gentle hill. On the other hand, if the slope is too gentle, then the length of the ramp becomes an issue. The Senet Board incline of 1:3 or 3:10 are smooth inclines. If one builds a staircase, the rise-to-tread ratio of around 17/29 ≈ .59 is considered optimal, but ranges to 7/10.6, which gives a ratio of .66. If we take the 3:10 Senet Board as a staircase with two steps, one in the domain of earth and one in the domain of heaven, then we have a ratio of 3/5 = .6, which fits nicely in the optimal range for an incline, ramp, or stair step. A rise of only 51 mm requires a tread of 523 mm to accomodate the swing of the climber's leg.





The Lever in the Senet Oracle Board

The lever was definitely a core device in Egyptian culture, because it was enshrined in the sacred text that we usually call the **Book of the Dead** and appears as a standard feature of Egyptian tomb art in the form of the Scale of Justice used to weigh the heart. The layout of the Senet Oracle Board is based on this Weighing of the Heart Tableau, and although we do not have surviving Oracle Boards that show this layout, its importance to the Senet Board is heralded in the opening phrases of the **Senet Game Text** that invoke the traditional sequence of nature deities that would appear on it. The word "lever" means to lift and expresses the common use of the device.

The lever consists of four fundamental components: a resistor, an arm, a fulcrum, and a tensor -- the latter being someone or something that pushes or pulls on the arm with effort. The fulcrum is the pivot point of the lever and requires an external object on which the lever arm rests with a small contact surface or an axle that passes through the arm. The contact surface or axle must form an axis normal to the direction of the arm's intended motion so that the motion is equatorial to the axis. Some levers are used to move things, and other levers are intended to be static and hold a system in equilibrium. The resistor is often a weight that is to be moved.

There are three possible classes of levers, that depend on the relative positions of the four key components. There is no hierarchical order in the classification and in all cases the mechanical advantage depends on the relative locations of the resistor, tensor, and fulcrum along the arm. A first class lever has the fulcrum between the resistor and the tensor. When the arm moves, the resistor and tensor move in opposite directions. The tensor and resistor push in one direction and the fulcrum pushes in the opposite direction. Examples of this type of lever are a balancing scale such as the Egyptians used, or a crowbar for lifting rocks or extracting nails. The first class lever often has the advantage of allowing the tensor to use gravity as an assistant. A second class lever has the resistor between the fulcrum and the tensor, so that both move in the same direction as the arm pivots on the fulcrum. The tensor's pull and the fulcrum's push are in the same direction while the resistor pushes in the opposite direction. A wheelbarrow is a good example of this type of lever. A third class lever has the tensor between the resistor and the fulcrum. The tensor and resistor move in the same direction. The resistor and the fulcrum push one direction and the tensor pulls in the opposite direction. A steam shovel and a human forearm are good examples of third class levers.

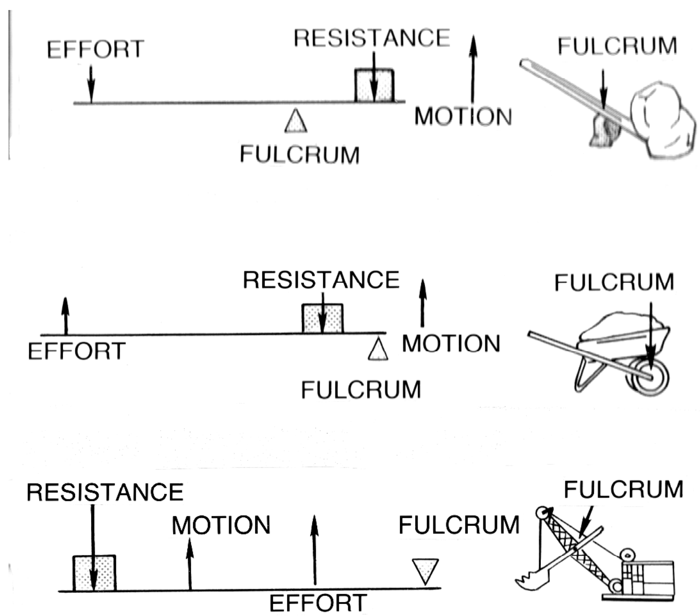
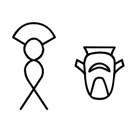


Diagram of the Three Classes of Levers
(**Wikipedia**, "Lever" article)

The Senet Oracle Board and the Judgment of the Heart Tableau

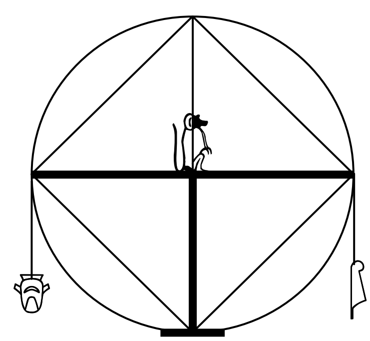
The Senet Oracle Board Sacred Geometry Mathematics and the Judgment of the Heart Tableau are closely linked, because the Egyptians used the Senet Board as an abstract model for the Tableau. In Egyptian the expression "wah ab" (place the heart) means to set one's heart on something. This was an expression for focusing attention on something considered of great value.



The glyph for placing is the same as that used for multiplication, and thus carries the idea of intensifying attention like the way a magnifying glass focuses and intensifies a beam of light. The heart glyph is what we find placed in the pan of the scale used in the Tableau. This forms the resistor weight. The other pan contains the Feather of Maat that stands for Truth, Accuracy, balance, and of course the lightness of air and the spiritual quality suggested by the image of a bird. The feather serves as the tensor and suggests minimum effort to achieve a desired goal.

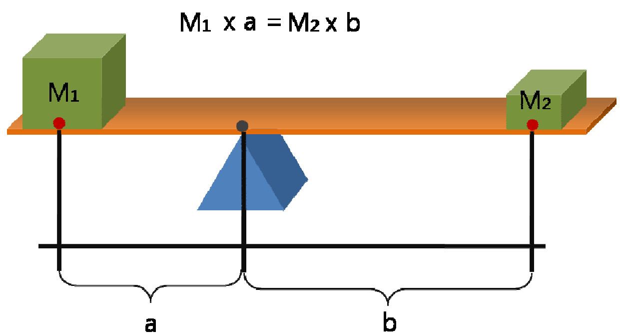
The Judgment Tableau scale is always depicted in a horizontal position of balance with an equal arm length on each side and the fulcrum in the middle. This suggests that the heart becomes as light as a feather, and is the Egyptian way of teaching people not to take life too seriously. It also teaches the art of levitation, which is that an object finds equilibrium at the level of its density. The heart is the seat of one's beliefs. Therefore, what a person sincerely and holistically believes one's self to be determines the density of the environment in which the person finds one's self existing.

In terms of the geometry we could say that the arms of the scale represent the diameter of a circle with the fulcrum of the scale being located exactly at the center. We have a circle with a cross and a 45 degree rotated square inscribed in it. In the diagram below I have highlighted the scale with darker lines and added a little base to support it. Over the fulcrum squats the little baboon Fool. Hanging from the left branch of the arm is the Heart of the Hermit, and hanging from the right branch of the arm is the Feather of Truth representing the principle of Justice, the equilibrium balance of all things in nature.



Sketch of the Scale of Truth

As a mechanical device the traditional Egyptian scale is a first class lever that demonstrates the fundamental operations of force on the relative positions of physical objects. When the arms of the scale are horizontal with the fulcrum in the middle, everything is balanced. However, if we shift the fulcrum away from the center of the arms, then the ratio of the forces changes. In order for the scale to achieve static balance and remain horizontal, the energy must be in equilibrium at all points. The fulcrum pushes up on the arm and its weights with an equal and opposite force as the gravitational force (the mass of the arm and weights combined times the gravitational acceleration) pulls down on the fulcrum.



Above is a drawing (courtesy, **Wikipedia** "Levers") of a first class lever showing the more general case of the scale depicted in the Weighing of the Heart Tableau. In this type of design the product of the distance between the centers of masses balanced on the lever arm and the fulcrum on each side of the fulcrum must be equal. The gravitational acceleration on each side is equal, so the difference is determined by the torque generated between the masses and the fulcrum. To reach equilibrium, the longer distance on one side must be matched by a corresponding larger mass on the other side.

Put in terms of the Scale of Justice, a very heavy heart can balance a very light feather as long as the heart stays close to the zero point fulcrum compared to the feather. On the other hand this means a very light feather can raise a very heavy heart as long as it gets far enough away from the fulcrum relative to the heart on the other arm. This is how the Senet Oracle Board is laid out, with the Wheel of Fortune fulcrum on square 5, the Feather of Maat's Justice on square 2, and the Hermit Heart on square 6 (counting square numbers from the right side of the bottom row).

Physicists measure mechanical devices in terms of three fundamental properties: Length (L), Time (T), and Mass (M). The product of the mass (M) times Earth's gravitational acceleration ($g = L / T^2$) times the distance L from the fulcrum gives us an expression that represents a kind of energy (E):

$$(E = M L^2 / T^2),$$

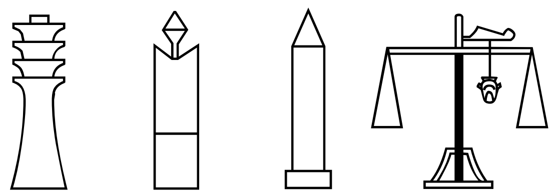
where $M L / T^2$ is the downward force of the mass and T^2 is time measured as second squared. However, the expression for g cancels out, since it is a constant component on both sides of the equation, so we only need to be concerned with the ratios of the various masses and lengths : $M_1 L_1 = M_2 L_2$. Note the reciprocal relation of these properties:

$$M_1 / M_2 = L_2 / L_1.$$

On the Senet Oracle Board we find Maat in the second House at the base of the Obelisk Tower. She wears the feather that is as light as air but also has the power of the Tower at the beginning of creation. Anubis in the third House of the bottom row kneels under the scale on the feather side, and is thus just to the left of Maat on the Oracle Board. With his left hand he holds steady the rope supporting the pan with the feather, and with his right hand he adjusts the little heart-shaped plumb bob to set the accuracy of the scale at the tongue which is right by the zero-point fulcrum. However, the baboon Fool occupies the fourth House of the bottom row and is the one who actually controls the tongue on the scale. The fifth House is Khenemew, the Potter God, who abstractly represents the

Potter's Wheel of Fortune with the pivot of the fulcrum on the stem of the scale. His horns form the arms of the scale. The lead plumb bob on the right side suggests to us a practical means by which the scale can balance a feather against a physical heart.

The heart (bottom row, sixth House) is in the left-side pan of the scale, and above it is a brick (to its right) and a little mastaba with a hawk perched on it (to its left). Both the brick and the hawk have human heads, suggesting that they represent the purpose of the body and soul of the person whose heart is being weighed. The head glyph often comes with the expression for multiplication. Two expressions are involved here: "wah tep" (bow the head) and "wah ab" (set the heart on something). "Wah" means generally to put something in place, and secondarily means to increment or increase. The Tableau shows both usages of "wah" and has the head glyph twice, suggesting the use of binary powers, whereas the ten witnessing judges sitting above on ten thrones suggest powers of ten.



Jed Pillar, Tower, Obelisk, Scale

Osiris in the middle row has a Jed-pillar as his standard totem pole and raising the Jed pillar was a ritual in the resurrection of Osiris. When we raise the pillar-tower-obelisk right over Maat's position at the second House (bottom row) instead of in the middle of the (fifth House), the fulcrum moves from the center of the Board to the boundary between the first and second columns on the right side of the Board. This means -- using the labels on the diagram of the lever -- that the length **a** becomes 9 and length **b** becomes 1. According to the lever formula, that means the feather now must weigh 9 times the weight of the heart in order to keep the lever level. Actually, the feather is really in square 2, which means it is at the fulcrum symbolized by the Tower of Tem and the Jed Pillar of Osiris. Something gets very weird. Theoretically speaking from this viewpoint Maat's feather needs an infinite force to balance the weight of any heart, no matter how heavy it is.

Of course that does not happen, because at a certain point the required force approaches the total potential force of the universe. We also must remember that this is a theoretical thought experiment in which the arms of the scale are assumed to be perfectly rigid and unbreakable. At some point the feather will reach the quantum domain lengthwise while at the same time packing exponentially huge amounts of potential energy. In fact as the Truth Feather of Maat merges into the Tower of Tem and the Pillar of Osiris, from the viewpoint of mathematical physics it acquires the energy of the Big Bang!

The Einstein-de Broglie Velocity Equation and the Scale of Justice

Einstein discovered the relationship among mass, energy, and light speed: $E = m\,c^2$, along with the quantum (particle) wave nature of light ($E = hf = hc/\lambda$), where E is energy, h is Planck's constant, f is frequency, λ is wavelength, and c is light speed. We'll come back to examine the constants h and c later in more detail.

$$E = hf = \frac{hc}{\lambda} = mc^2$$

Louis de Broglie extended the idea to describe the wave nature of particles, finding, for example, that the electron has a characteristic wavelength (λ_e) that relates to its momentum: $\lambda_e = h/p$, where h is Planck's constant and p is the particle's momentum (mass times velocity).

$E = pc = hc / \lambda$.
$m_\gamma c^2 = hc / \lambda_\gamma$, where m_γ is the virtual mass of a light particle (photon).
$m_\gamma c \lambda_\gamma = h$.
$\lambda_\gamma = h / m_\gamma c$.

The insight of de Broglie was that you could then take the mass of a particle such as an electron me and plug it into the relationship. The wavelength of the particle would be Planck's constant divided by the particle's mass times its velocity.

$\lambda_e = h / m_e v_e$, where the subscripts now represent electron properties, and v_e is the velocity of the electron.

The problem with these ideas is that the mass and energy of a particle are abstract properties. Only properties like length, velocity, and constants such as c are measureable by observation. So we re-interpret the relationship in terms of velocity alone, starting with the velocity of the particle (v_e), which we now call the "group velocity" since it is composed of a bundle of interacting waves that always move along as a totality at less than the speed of light and give the impression of a particle with mass.

$v_g = h / m_g \lambda_g$.

The phase velocity of light is $(v_p) = c = \lambda_\gamma f_\gamma$, which is the photon's wavelength times its frequency. So the phase velocity associated with an electron would be $v_{pe} = \lambda_e f_e$ and in general $v_p = \lambda_g f_g$, the phase velocity that corresponds to a particle's group velocity v_g. $E = h\,f$, and hence $E_g = h\,f_g$. Substitute $(h\,f_g / c^2)$ for the mass m_g and cancel out the h's.

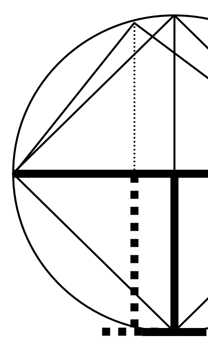
$v_g = (h / \lambda_g)(c^2 / hf_g) = c^2/v_p$.

$v_g\, v_p = c^2$.

This reciprocal relation is what I call the Einstein/de Broglie Velocity Equation.

This equation holds for any particle. The phase velocity (v_p) for the particle is a collection of waves that as a whole move faster than light. For light, the phase velocity and the group velocity both move at light speed. For particles the group and phase velocities are mutually reciprocal if we assign the value of unity to the speed of light.

The reason I mention this poorly understood relationship at this juncture is that the Einstein-de Broglie Velocity Equation $(v_g)\ (v_p) = c^2$ brings out another interesting aspect of the Scale of Justice. The Velocity Equation says that the group velocity (the slower than light speed motion of any object with mass when it is interpreted as a collection of interacting waves) times the phase velocity (the faster than light motion of an equivalent packet of waves that is associated with that mass) equals the speed of light squared. Einstein proposed that the speed of light is constant, and the physical evidence appears to support that hypothesis. He also said that any object with rest mass must move slower than light speed. However, that means the object also has associated with it an overall phase velocity that is the reciprocal of the slower speed. This non-localized superluminal phase velocity carries the same information that the localized object carries as it goes through its slower motions in the same way that 3/2 carries the same information as 2/3 but in a reciprocal format.

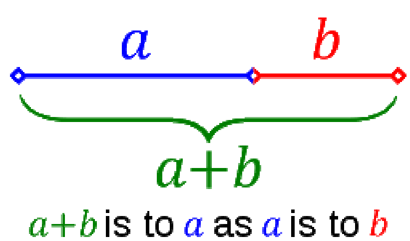


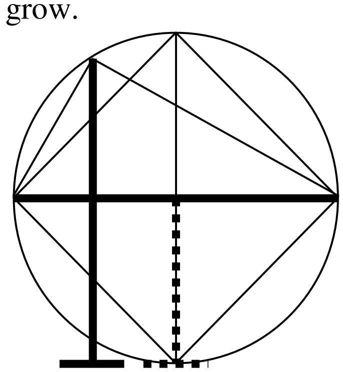
Since velocity is a ratio of distance to time and we keep time by means of a standard second, we can represent velocities simply as distances by considering all relevant velocities as various distances over the same time interval of one second. We can represent the speed of light in the equation by a vertical line drawn from the arm of the scale to the rim of a circle for which the arms of the Scale form a diameter. That vertical line is the abstract form of the Baboon Fool. The group and phase velocities become the two arms of the scale that branch out from the fulcrum and support the heart on the left and the truth on the right. In the case of the traditional drawing of the scale the two arms are of equal length with the fulcrum in the middle, so the group velocity and phase velocity are equal and equal the radius of the circle. The dotted lines show an alternative setup where the fulcrum is not in the middle.

The ratio of the triangles formed by the vertical line and the endpoints on the arm of the scale is $v_g/c = c/v_p$. The vertical line times itself therefore equals c^2, and the product of the group and phase velocities is always c^2. Therefore both the group and the phase velocity become equivalent to light speed from the baboon's viewpoint in the center as light self-interacting. However, humans generally put attention on the solid material side of life as separate from themselves. That adds mass to the heart (as a physical organ) and shifts the fulcrum to the left. The heart begins to resist the speed of light, and appears to slow down. The arm on the feather side representing the spiritual velocity then compensates by becoming longer and the spiritual energy speeds up faster than light. As a result we seem to evolve physically from a murky slowly evolving past, while our spiritual higher self energy comes back to meet us from the future and guide us back to equilibrium and unity, speeding up our evolution. On the other hand, if the physical heart-mind comes to a complete stop, the vertical line shifts to the far left end of the arm and shrinks to zero height. The phase velocity energy then becomes the entire arm of the scale. The weight of the heart and the feather both disappear, and the scale simply stands in perfect balance by itself in a virtual sphere of light.

In the Tableau a little golden baboon sits right over the center point of the scale and represents the ability to manipulate all phenomena from the viewpoint of the speed of light -- which is motionless from its own viewpoint. Everything radiates from the zero point at the fulcrum of the scale. The Heart on one side represents the Mind with its thoughts and feelings. The feather on the other side represents the Truth of one's consciousness reflected in the physical World, and tells us that the idea of solid matter is a mental concept, whereas the truth of life is pure light and superluminal spiritual energy. No matter what happens on either side of the fulcrum, the little baboon is always established in the realm of light at the zero point.

The Golden Ratio (which we met earlier as the phi spiral) is a particular subset of the Einstein-de Broglie ratio in which the relation $(a + b)/a = a/b = \varphi \approx 1.618$ holds. Many life forms make use of this fractal ratio as they grow.

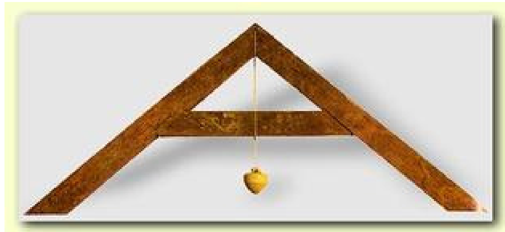




The Golden Ratio: The bold vertical line on the scale that is to the left of center is *a*, the short arm length to its left is *b*, and the long arm length to its right is *a* + *b*. The right triangles that the three line segments form in the circle are all similar. Notice that from the viewpoint of the Scale of Justice the speed of light is not fixed, but always separates the group and phase velocities.

The Pendulum (Plumb Bob)

When a scale in a state of balance is touched, the arms pivot up and down on the fulcrum forming a variation of the lever that we call the pendulum. If we rotate the balance scale 90 degrees and move the fulcrum to one end of the lever arm and the pendulum bob resistor weight to the other end of the arm, then we have the usual form of the pendulum.



Copy of an Ancient Egyptian Pendulum Plumb Bob

The static pendulum was used widely in ancient Egypt by masons and other construction engineers as a plumb bob to attain precise vertical lines and was held ninety degrees rotated from the traditional Egyptian scale. When at rest the arm of the pendulum (often attached by a string rather than a stiff arm) hangs straight down. The arm also pivots on the fulcrum when set in motion, and the Egyptians certainly noticed that the motion of a pendulum is very precise as a time keeping device. Sometimes a moving pendulum functions as a third class lever with the tensor push being somewhere along the stiff arm between the bob and the fulcrum pivot. A remarkable feature of the pendulum is that the weight of the bob and (at small angles) the amplitude of the swing do not influence the period of the pendulum swing. The period depends only on the length of the arm. $T = 2\pi \sqrt{(R / g)}$, where T is the period, R is the length of the pendulum arm, and g is the gravitational acceleration, which is 9.81 m/s^2 on our planet. For simplicity in our model we will set the length R at 1 meter, so the period T is approximately 2 seconds and the half-period is about 1 second.

Introductory physics textbooks usually have a section on what is billed as "The Simple Pendulum". However, when they describe the mechanics, it turns out that the authors only teach an approximation based on simple harmonic motion. At larger angles of pendulum swing textbooks warn that the approximation increasingly fails. The amplitude does in fact affect the period because the curve traced by the bob differs from that of simple harmonic motion, and the difference, though small at small angles, grows quite large at larger angles. Thus for timekeeping purposes the angle is kept small (less than 18° and usually between 3° and 5°), so that the approximation is fairly close and is known as the small-angle approximation. The pendulum motion changes according to $\sin \theta$ rather than θ.

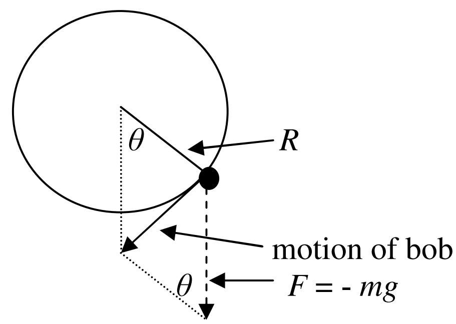
Here is a comparison of $\sin \theta$ (ratio of opposite site to hypotenuse of a right triangle relative to angle θ) and θ in radians (the ratio of the distance of the arc described over the angle θ to the radius of a circle). Notice how the distance in radians starts out almost the same as $\sin \theta$ at small angles, but as the angles grow in size, the difference becomes quite significant. The simple pendulum is not so simple.

θ	**sin θ**	**θ rad**
3°	.052336	.0523599
6°	.10453	.1047198
9°	.15643	.1570796
12°	.20791	.2094395
15°	.25882	.2617994

18°	.30902	.3141593
21°	.35837	.3665192
45°	.70711	.78539805
90°	1.000	1.5707961

We can describe the motion of a pendulum with a stiff, but massless arm in two dimensions with no losses to friction or air resistance using a differential equation:

$(d^2\theta / dt^2) = -(g/R)\sin\theta$.



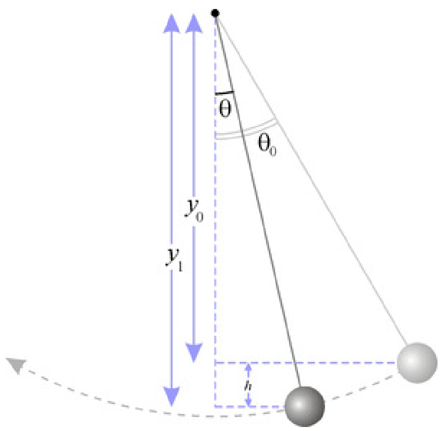
In this equation g is the acceleration caused by gravity and tends downward. R is the length of the arm, which we will set at 1 meter. The angle of displacement from vertical is θ. The motion of the bob at any moment is always along the tangent to the circular arc at the point the bob has reached along the arc, but the arm of the pendulum forces the bob to follow the circular path rather than continue along the tangent. We can represent the tangential component of the gravitational force as:

$F = -mg \sin\theta = ma$
$a = -g \sin\theta.$

Theta (θ) and the acceleration are in opposite directions, for when the bob swings to the right, it accelerates back to the left. If s is the length of the arc, we represent it in radians as $R\theta$.

The speed (NOT velocity) along the arc is then $v = ds/dt = Rd\theta/dt$.
The acceleration along the arc is then $a = d^2\theta / dt^2 = R\, d^2\theta / dt^2$.
Therefore, $d^2\theta / dt^2 = -(g/R)\sin\theta$.

We can also see the relation from the energy conservation principle. As the bob falls, it loses potential energy and gains kinetic energy. The change in potential energy is mgh, where h is the change in height of the bob. The change in kinetic energy from the bob at rest at its highest point when it starts to fall is $½mv^2$. In our frictionless pendulum no energy is lost, so $½mv^2 = mgh$, and $v = \sqrt{(2gh)}$.



from **Wikipedia**, "Pendulum (mathematics)"

We put this in terms of the arc length:

$v = R d\theta/dt = \sqrt{(2gh)}$
$d\theta/dt = R^{-1} \sqrt{(2gh)}$
$y_o = R \cos \theta_o$
$y_1 = R \cos \theta$
$h = R (\cos \theta - \cos \theta_o)$
$d\theta/dt = [(2g/R)(\cos \theta - \cos \theta_o)]\cdot$□
$a = d^2\theta/dt^2 = -(g/R) \sin \theta.$
$d^2\theta/dt^2 + (g/R) \sin \theta = 0.$ (See **Wikipedia** article for more details of the calculation.)

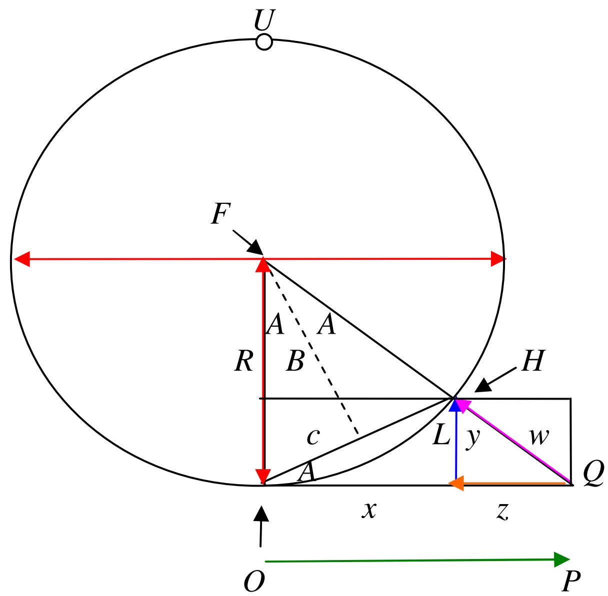
The pendulum moves according to sin θ, but scientists calculate the approximate period in terms of radians keeping the angle very small. The precise formula for the period involves adjusting by an infinite series calculated from an angle A that is half the maximum value of θ (i.e., $A = \theta_o/2$). Theoretically, a swing of 180° would result in a period $T = \infty$, but the arm is unstable when balanced over its pivot point and will fall to one side or the other.

$T = 2\pi \sqrt{(R/g)}\,(1 + (1^2/2^2)\sin^2 A + (1^2 + 3^2/2^2 + 4^2)\sin^4 A + \ldots)$

As a machine the pendulum is of interest because, barring friction, it needs only an initial push, and then it continues with its precise motion indefinitely -- fueled only by gravity. In actual practice, however, friction causes the pendulum to gradually lose its motion, although the period remains unchanged as long as the arm continues to swing within the angular range just mentioned. To keep a pendulum moving requires secondary machines, often consisting of a weight suspended from an axle by a coiled rope (or some other device) plus an escapement and various gears that will periodically kick the pendulum arm or bob and keep it at a steady amplitude while turning a set of armatures that indicate passage of time by their relative angles. As far as I know there is no evidence that the Egyptians ever built such sophisticated pendulum clocks that could be used for telling time over an extended period. For longer periods of time they used clepsydras (water clocks), gnomons (sundial staffs), and the apparent motions of stars. However, the Egyptians almost certainly used simple oscillating pendulums for short-term purposes when they needed to measure out equal units of time, for example in ritual performances, medical treatments, or rhythmic training exercises for musicians, dancers, and athletes. They also may have been used in certain ways for dowsing.

Our main interest in this section will be to study the forces involved in a pendulum to see if there is some optimal tap on the bob when it hangs vertical at rest that will give the bob maximum height for the smallest tap. For simplicity we will ignore the effects of friction. That aspect can be factored in later according to a particular physical system.

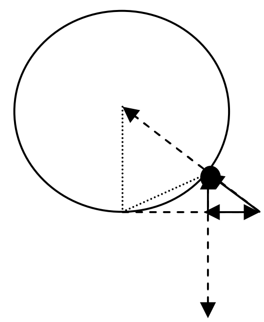
The pendulum at rest hangs motionless at the lowest point of a circle described in a vertical plane defined by a string or stiff shaft of no appreciable mass (the arm of the pendulum lever) that is attached by one end to the fulcrum that forms the center of the circle. The arm forms the radius of the circle. The static force diagram of the pendulum at rest is at equilibrium with the downward force of gravity on the bob balanced by the upward pull of the pendulum arm on the bob toward the center of the circle (red vertical arrows).



Dimensions:
R = 1 m (pendulum arm)
O = bob = 1 kg at end of arm on rim of circle.
P = tan 2A = **P**/R (horizontal equivalent of distance traveled from pushing on the bob)
H = the position of the bob at the highest point of its swing.
(2***A***) = the angle of the arc in radians formed by the bob's swing away from perpendicular resting point.
(***A***) = half of angle 2***A*** (also the angle at ***O*** between push ***P*** and resultant chord ***c***.
B = the line from the fulcrum bisecting the chord ***c***.
U = the highest possible point attainable by the bob along the circle.

If we suddenly tap the resting bob at its lowest point with a certain force ***P*** pushing it arbitrarily to the right, the bob and the arm to which it is attached will swing away from perpendicular to the horizontal ground, tracing an arc along the circle defined by the arm attached at the fulcrum center. The bob will slow down under gravity's pull and come to a stop at some point along the circle (*H*) that depends on the initial velocity imparted to the bob by our push. We can draw a chord between the point where the bob stops and the bob's starting point to represent the actual displacement of the bob, although that is not the path taken. The chord forms an angle (***A***) with the vector of the initial horizontal push ***P*** on the bob at the circle's lowest point.

Since the initial push is the only energy added to the bob, it will acquire a velocity that will then be governed only by the influences of gravity and the pull of the arm on the bob. The chord is the resultant farthest spatial displacement of the bob after the impulse, but the bob moves along an arc of the circle.



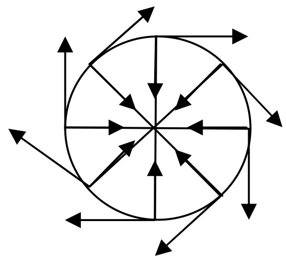
In the above simplified sketch the dashed lines along the radius from bob to fulcrum and from bob downward represent the forces that act on the bob, and the dotted chord line shows the work done on the bob. The horizontal dashed line is the tangent that represents the initial velocity after the push and the path the bob would take without the influences of the arm and gravity. The solid arrows in the little right triangle with the upper corner converging on the bob represent the change in the initial velocity that is wrought by the arm and gravity on the bob's motion. The slanted solid arrow on the hypotenuse of that triangle represents the resultant change in position from the unimpeded motion of the bob over the interval of time that is caused by the influence of gravity and the arm's pull. The horizontal and vertical solid arrows represent the x and y components of that change.

We know that the mass of the bob and the acceleration of gravity are constant. Whatever height the bob reaches from its lowest point tells us the potential energy attained when the bob comes to rest at its highest point (mgh), where m is the mass of the bob, g is gravitational acceleration, and h is the maximum height reached by the bob. That height will be determined by the kinetic energy imparted to the bob at the initial tap, since no other energy was added to the system. That kinetic energy will be $\frac{1}{2}mv^2$, where m is the mass of the bob, and v is the horizontal velocity of the bob. The force of the tap on the bob is $F = ma$, and $v = \sqrt{(2ad)}$, where a is the horizontal acceleration and d is the horizontal distance traveled due to the push. The v tells us the average horizontal velocity of the bob. Thus the kinetic energy input to the bob is mad, and must equal the potential energy mgh gained by the bob.

$mad = mgh$
$ad = gh$
$a/g = h/d$

The mass cancels out, and we know g is constant, so knowing the ratio h/d tells us the value of a/g, given any height attained by the bob.

The kinematics of this situation are clearly different from those of uniform circular motion, such as when a rock tied by a string to a rotating pole swings in a circle in a horizontal plane. In that case the tangential speed is constant and varies in direction at a constant speed. The centripetal acceleration is also constant and varies in direction at a constant speed. This makes such motion much simpler.



Clockwise Uniform Circular Motion in a Horizontal Plane

To calculate the lift ***L*** of a pendulum when the bob is set in motion by an impulse, we do as follows.

For simplicity we set $R = 1$ m. The tangent of the arc at the bob's lowest point represents the direction of the initial velocity given to the bob by the push. If the bob were a free particle, it would continue at a constant velocity in the original tangent direction indefinitely. Thus the length of that tangent would simply increase at a constant pace over time. However, the arm lifts the bob as it travels forward horizontally along the tangent of the circle described by the bob on the pendulum arm translating a portion of the horizontal impulse into vertical lift. The standard approach analyzes from the viewpoint of angle θ at the fulcrum and the right angle the arm forms with the tangent at the location of the bob wherever it happens to be on its arc path. If we draw a line through the bob at its highest point that is parallel to the original horizontal tangent that passes through the bob's lowest point in the swing, we generate a smaller triangle that is similar to the larger triangle formed by the original horizontal tangent, a line from the fulcrum through the bob's lowest point, and the line along the arm that passes through the bob at its highest point. The vertical side of the smaller triangle has a length of $R \cos \theta$, because the hypotenuse is equal to the radius R. The height of the lift L that the bob experiences from the swing is thus $L = R - (R \cos \theta) = (1 - \cos \theta)$. We know that the tangent P of the large triangle will equal $\tan \theta$. Thus the ratio of the lift from the arm's influence to the horizontal progress of the bob along the tangent line without the pull of the pendulum arm is $L / P = (1 - \cos \theta) / \tan \theta$. And this ratio tells us the ratio of the horizontal impulse of acceleration to the opposing downward acceleration of gravity. Ordinarily the two accelerations would not interfere, except that the pendulum arm translates a portion of the horizontal acceleration into upward lift against gravity as the numerator in the ratio shows.

By inspection we know that when the pendulum is vertical, there is no lift, and when it is horizontal, there is also no lift. For soft pushes the bob goes far horizontally, but rises only a tiny bit as the angle starts to shift. For hard pushes, the bob soon goes almost directly upward against gravity, which requires much more push per amount of lift in a given unit of time and the angle reduces efficiency. Somewhere in between is a maximum lift for the amount of push. We might guess it would be at 45°, but let's calculate.

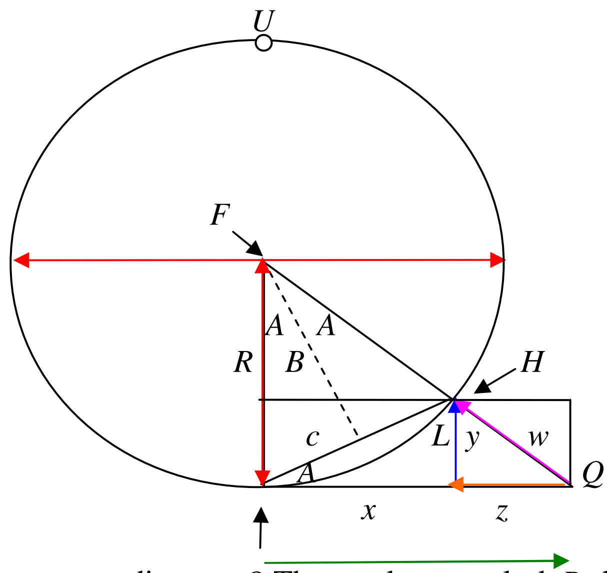
We only give the pendulum one initial push, and the average ratio changes with different pushes. To find the sweet spot in that ratio (the maximum lift per push) we will calculate the derivative of the ratio and set the result to zero.

$d(\mathrm{L/P})/d\,\theta = d[(1\text{-}\cos\theta)/\tan\theta]/d\,\theta =$
$\tan\theta\, d(1\text{-}\cos\theta) - (1\text{-}\cos\theta)d(\tan\theta)/\tan^2\theta.$
$(\sin^2\theta\cos\theta/\cos^2\theta) - (1/\cos^2\theta) + (\cos\theta / \cos^2\theta) = 0$
$\sin^2\theta\cos\theta + \cos\theta = 1$
$\sin^2\theta + \cos^2\theta = 1$
$\sin^2\theta(\cos\theta - 1) = \cos\theta(\cos\theta - 1).$
$\sin^2\theta = \cos\theta.$

This equation is satisfied approximately at 51° 49' 48" (51.83°) where $\sin\theta = .78618$ and $\cos\theta = .618$.

Here is another way of reaching the same result that will also clarify the mechanics. We will use the half angle $A = \theta/2$, which is the angle used to calculate the accurate period of a pendulum. Vector ***P*** indicates the distance the bob would move tangent to the lowest point if uninfluenced by the pendulum arm. The chord which we will label **c** will be the hypotenuse of a small right triangle with a run of *x* and a rise of ***L*** (or *y* on the *y*-axis if we place it on an *x*-*y* grid) that is similar to either of the two halves of the isosceles triangle that forms between the two radii (fulcrum *F* to bob at starting point *O* and fulcrum *F* to bob at stopping point *H*) when the chord and the angle between those two radii are bisected. (On the above diagram the triangles have sides ***R***, ***c***/2, ***B*** and ***B***, ***c***/2, ***H***-***R***).

As the bob swings to the right, the pendulum arm pulls the bob upward parallel to the y axis *OF* and backward along the bob's straight tangential path on the *x* axis. As the distance of the bob from perpendicular to the center fulcrum *F* increases along the original tangent path, the pendulum arm acts as a brake, slowing down the bob's horizontal component of progress and translating part of the motion into upward lift against gravity, so that gravity slows the upward progress until the bob stops at the furthest point it reaches along the arc defined by the chord ***c***. The triangle ***L***, ***w***, ***z*** shows the force vectors that bring the bob to its furthest point away from *OF* along the arc in this analysis. The force vectors counteract the horizontal force of the push ***P*** and the downward pull of gravity and lead to the resultant lift (***L*** = *y*) at the distance *x* along the tangent to the lowest point.



What we end up with is an energy diagram. The resultant work done by the push ***P*** is the force of the push times the actual distance traveled by the bob (chord ***c***). The pull of the pendulum arm counteracts the forward push and the downward pull of gravity and as a result lifts the bob up to the point it reaches on the arc. Chord ***c*** represents the resultant work performed on the bob.

Since $\sin A = \boldsymbol{c} / 2R$, then $\boldsymbol{c} = 2R \sin A$. We set R at 1, so we simply double the sine of angle A to get ***c*.**

Triangle ***c***, *x*, ***L*** is similar to triangle ***R***, ***B***, ***c***/2, so we can set up the following ratios.

$\boldsymbol{c} / 2\boldsymbol{R} = \boldsymbol{L} / \boldsymbol{c}$.
$\boldsymbol{L} = \boldsymbol{c}^2 / 2\boldsymbol{R}$.

Since we set $\boldsymbol{R} = 1$ to simplify the numbers, $\boldsymbol{L} = \frac{1}{2}\boldsymbol{c}^2$. This is the *y* component of the bob's motion. The chord ***c*** is the displacement of the bob as a result of the various forces acting on it. Thus it can also represent the work done by the kinetic energy that moves the bob forward by a distance *x* and upward by a lift ***L***.

We know that $\sin A$ gives half the chord length (***c***/2). We double that value to find the length of the chord. Because the triangle with sides (***L***, ***c***, *x*) also has angle *A*, the lift $\boldsymbol{L} = \frac{1}{2} c^2$. Also, since $R = 1$, therefore $\boldsymbol{P} = \tan 2A$. The ratio ***L/P*** tells us how much lift we get per a certain magnitude of push.

Now we can find a formula for this ratio ***L/P*** in terms of angle *A*. We will call that ***N***.

Since $\boldsymbol{c} = 2 \sin A$, thus $\boldsymbol{L} = 2 \sin^2 A$.
$\boldsymbol{P} = \tan 2A = (\sin 2A / \cos 2A) = (2 \sin A \cos A) / (\cos^2 A - \sin^2 A)$.
$\boldsymbol{N} = \boldsymbol{L}/\boldsymbol{P} = (\tan A)(\cos A + \sin A)(\cos A - \sin A)$
To find the sweet spot (maximum) we calculate $d\boldsymbol{N}/dA$.
$d\boldsymbol{N}/dA = (\sec^2 A)(\cos A+\sin A)(\cos A-\sin A)+(\tan A)(-\sin A+\cos A)(\cos A-\sin A)$

$+(\tan A)(\cos A+\sin A)(-\sin A-\cos A)$

$= (\cos^2 A-\sin^2 A/\cos^2 A)+(\tan A)(\cos^2 A-2\cos A\sin A+\sin^2 A)+(\tan A)(-\cos^2 A-2\cos A\sin A-\sin^2 A)$
$= 1-\tan^2 A+(\tan A\cos^2 A)-(2\tan A\cos A\sin A)+(\tan A\sin^2 A)-(\tan A\cos^2 A)-(2\tan A\cos A\sin A A)-(\tan A\sin^2 A)$.

We simplify:
$d\mathbf{N}/dA = 1 - \tan^2 A - 4\tan A \cos A \sin A = 1 - \tan^2 A - 4 \sin^2 A$.

To find the sweet spot where the slope of the function becomes flat, we set the result of differentiation = 0. Thus,

$\tan^2 A + 4 \sin^2 A = 1$.

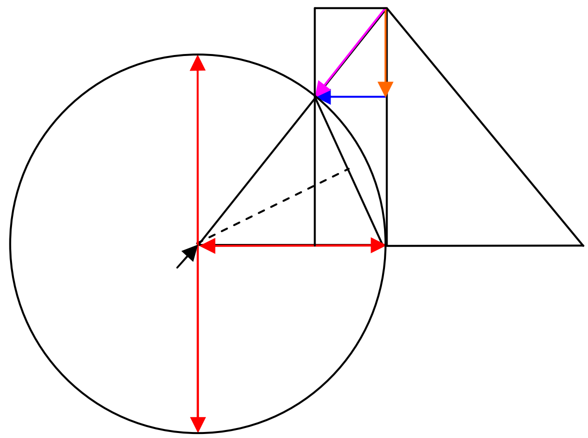
If we set $2A = 51.83°$, then $A = 25.915°$.
$\sin A = .43704$
$2 \sin A = .87408$
$\boldsymbol{L} = .3820079$
$\boldsymbol{P} = \tan 2A = 1.2721$
$\boldsymbol{L} / \boldsymbol{P} = .3002970678$. (This is the maximum lift per push.)
$\boldsymbol{P} / \boldsymbol{L} = 3.33$. (This is the minimum push per lift.)
$\tan A = .4859$
$\tan^2 A = .2360988$
$\sin A = .43704$
$\sin^2 A = .1910039616$
$4 \sin^2 A = .7640158464$
$\tan^2 A + 4 \sin^2 A = 1.0001146464$. The sweet spot is around $A = 25.915°$.

Thus the sweet spot for θ is around 51.83° (51° 49' 48"), where (est. 51° 50' 40") happens to be the angle of the Great Pyramid. The Senet Board ratio is 3/10 = .3 or 10/3 = 3.33.

The Great Pyramid, the Pendulum, and the Senet Oracle Board

Is there some connection between this pendulum ratio and the engineering of a pyramid that the ancient Egyptians discovered? The pendulum angle for maximum lift gives the displacement of the arm and bob from vertical. The pyramid angle gives the side from ground to apex relative to the horizontal ground. Thus the two angles are 90 degrees relative to each other. A pyramid is a solid mass. The greatest mass is concentrated along the vertical line downward from the apex. This is like the bob on a pendulum at its highest point in the swing being accelerated downward by gravity. The Egyptians may have discovered by experiment that at the angle of 51° the upward push of the mass of stone against the downward pull of gravity was at a minimum, giving the pyramid the least amount of structural stress.

It might seem that the optimum angle for lift to push would be 45°, but it turns out that the ratio (L/P) of lift (L) to push (P) hits a maximum at slightly over 51°, which makes A about 25.5°. The complementary angle to 51° is 39°. Half that angle is 19.5°, the angle found by Hoagland to be important in the dynamics of spinning spherical celestial bodies such as stars and planets. The rectangle formed by the ratio *L* to *P* gives us the Senet Board. If you rotate the drawing of the pendulum by 90 degrees, you will see the Great Pyramid and the Senet Board standing together. (See Appendix F for more.)



The Pendulum, the Great Pyramid, and the Senet Board

Somehow the ancient Egyptians calculated this value. We know that they experimented before they found it. They certainly used trigonometry to study geometry and to build their pyramids, but mainstream scholars believe they did not know calculus -- although we have very few surviving mathematical texts from ancient Egypt on which to base an opinion. Furthermore, the mathematics of the Eye of Horus strongly suggests that the Egyptians understood the theory of limits.

On the other hand Miles Mathis has written an article "Calculus Simplified" in which he demonstrates that it is not necessary, or even advisable, to have a theory of limits as the foundation for the differential calculus. All you need is some tables of the powers of various integers, something the ancient Egyptians and other ancient cultures were already well aware of. Here are the basic tables compiled by Mathis with some of his explanatory comments.

1	Δz	1, 2, 3, 4, 5, 6, 7, 8, 9….
2	$\Delta 2z$	2, 4, 6, 8, 10, 12, 14, 16, 18….
3	Δz^2	1, 4, 9, 16, 25, 36, 49 64, 81
4	Δz^3	1, 8, 27, 64, 125, 216, 343
5	Δz^4	1, 16, 81, 256, 625, 1296
6	Δz^5	1, 32, 243, 1024, 3125, 7776, 16807
7	$\Delta\Delta z$	1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
8	$\Delta\Delta 2z$	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
9	$\Delta\Delta z^2$	1, 3, 5, 7, 9, 11, 13, 15, 17, 19
10	$\Delta\Delta z^3$	1, 7, 19, 37, 61, 91, 127
11	$\Delta\Delta z^4$	1, 15, 65, 175, 369, 671
12	$\Delta\Delta z^5$	1, 31, 211, 781, 2101, 4651, 9031
13	$\Delta\Delta\Delta z$	0, 0, 0, 0, 0, 0, 0
14	$\Delta\Delta\Delta z^2$	2, 2, 2, 2, 2, 2, 2, 2, 2, 2

15	$\Delta\Delta z^3$	6, 12, 18, 24, 30, 36, 42
16	$\Delta\Delta z^4$	14, 50, 110, 194, 302
17	$\Delta\Delta z^5$	30, 180, 570, 1320, 2550, 4380
18	$\Delta\Delta\Delta z^3$	6, 6, 6, 6, 6, 6, 6, 6
19	$\Delta\Delta\Delta z^4$	36, 60, 84, 108
20	$\Delta\Delta\Delta z^5$	150, 390, 750, 1230, 1830
21	$\Delta\Delta\Delta\Delta z^4$	24, 24, 24, 24
22	$\Delta\Delta\Delta\Delta z^5$	240, 360, 480, 600
23	$\Delta\Delta\Delta\Delta\Delta z^5$	120, 120, 120

from this, one can predict that

24	$\Delta\Delta\Delta\Delta\Delta z^6$	720, 720, 720

And so on.

This is a table of differentials. The first line is a list of the potential integer lengths of an object, and a length is a differential. It is also a list of the integers, as I said. After that it is easy to follow my method. It is easy until you get to line 24, where I say, "One can predict that. . . ." Do you see how I came to that conclusion? I did it by pulling out the lines where the differential became constant.

7	$\Delta\Delta z$	1, 1, 1, 1, 1, 1, 1
14	$\Delta\Delta\Delta z^2$	2, 2, 2, 2, 2, 2, 2
18	$\Delta\Delta\Delta\Delta z^3$	6, 6, 6, 6, 6, 6, 6
21	$\Delta\Delta\Delta\Delta\Delta z^4$	24, 24, 24, 24
23	$\Delta\Delta\Delta\Delta\Delta\Delta z^5$	120, 120, 120
24	$\Delta\Delta\Delta\Delta\Delta\Delta\Delta z^6$	720, 720, 720

Do you see it now?

$2\Delta\Delta z = \Delta\Delta\Delta z^2$

$3\Delta\Delta\Delta z^2 = \Delta\Delta\Delta\Delta z^3$

$4\Delta\Delta\Delta\Delta z^3 = \Delta\Delta\Delta\Delta\Delta z^4$

$5\Delta\Delta\Delta\Delta\Delta z^4 = \Delta\Delta\Delta\Delta\Delta\Delta z^5$

$6\Delta\Delta\Delta\Delta\Delta\Delta z^5 = \Delta\Delta\Delta\Delta\Delta\Delta\Delta z^6$

All these equations are equivalent to the magic equation, $y' = nx^{n-1}$. In any of those equations, all we have to do is let x equal the right side and y' equal the left side. No matter what exponents we use, the equation will always resolve into our magic equation.

I assure you that compared to the derivation you will learn in school, my table is a miracle of simplicity and transparence. Not only that, but I will continue to simplify and explain. Since in those last equations we have z on both sides, we can cancel a lot of those deltas and get down to this:

$2z = \Delta z^2$

$3z^2 = \Delta z^3$

$4z^3 = \Delta z^4$

$5z^4 = \Delta z^5$

$6z^5 = \Delta z^6$

Now, if we reverse it, we can read that first equation as, "the rate of change of z squared is two times z." That is information that we just got from a table, and that table just listed numbers. Simple differentials. One number subtracted from the next. Given an *x*, we seek a *y*', where *y*' is the rate of change of *x*. And that is what we just found. Currently, calculus calls *y*' the derivative, but that is just fancy terminology that does not really mean anything. It just confuses people for no reason. The fact is, *y*' is a rate of change, and it is better to remember that at all times.

What does it *mean*? Why are we selecting the lines in the table where the numbers are constant?" We are going to those lines, because in those lines we have flattened out the curve. If the numbers are all the same, then we are dealing with a straight line. A constant differential describes a straight line instead of a curve. We have dug down to that level of change that is constant, beneath all our other changes. As you can see, in the equations with a lot of deltas, we have a change of a change of a change. . . . We just keep going down to sub-changes until we find one that is constant. That one will be the tangent to the curve. If we want to find the rate of change of the exponent 6, for instance, we only have to dig down 7 sub-changes. We don't have to approach zero at all.

We have flattened out the curve. But we did not use a magnifying glass to do it. We did not go to a point, or get smaller and smaller. We went to sub-changes, which are a bit smaller, but they aren't anywhere near zero. In fact, to get to zero, you would have to have an infinite number of deltas, or sub-changes. And this means that your exponent would have to be infinity itself. Calculus never deals with infinite exponents, so there is never any conceivable reason to go to zero. We don't need to concern ourselves with points at all. Nor do we need to talk of infinitesimals or limits. *We don't have an infinite series, and we don't have any vanishing terms.* We have a definite and limited series, one that is 7 terms long with the exponent 6 and only 3 terms long with the exponent 2.

The magic equation is just an equation that applies to all similar situations, whereas the specific equations only apply to specific situations (as when the exponent is 2 or 3, for example). By using the further variable "*n*", we are able to apply the equation to all exponents. Like this:

$$n\mathbf{z}^{n-1} = \Delta\mathbf{z}^{n}$$

And we don't have to prove or derive the table either. The table is true by definition. Given the definition of integer and exponent, the table follows. The table is axiomatic number analysis of the simplest kind. In this way I have shown that the basic equation of differential calculus falls out of simple number relationships like an apple falls from a tree.

We don't need to consider any infinite series, we don't need to analyze differentials approaching zero in any strange way, we don't need to think about infinitesimals, we don't need to concern ourselves with functions, we don't need to learn weird notations with arrows pointing to zeros underneath functions, and we don't need to notate functions with parentheses and little "*f* s", as in $f(x)$. But the most important thing we can ditch is the current derivation of the magic equation, since we have no need of it. This is important, because the current derivation of the derivative is gobbledygook.

(To see why, read the rest of the paper "Calculus Simplified" at www.milesmathis.com, paper #48. The whole paper is pretty remarkable, and Mathis has many other interesting papers on physics and mathematics at his website. All works at www.milesmathis.com are the copyright of Miles Mathis and may be reproduced for educational, non-commercial use only. I quote him at length to give you an idea of how creative and different his approach is. (For further comments, see **Appendix G**.) What Mathis describes regarding calculus is definitely something the ancient Egyptians were aware of. We just do not know how far they applied it. Maybe someday we will discover a cache of Egyptian mathematical texts and be able to throw more light on the question.)

So we are not presently able to answer with certainty the question of whether the Egyptians were able to use such elementary knowledge of numbers to solve dynamic equations (e.g. finding the rate of velocity change in accelerating systems) or extend the principles into solving differentials of trigonometric equations. In any case there is evidence that the Egyptians experimented empirically with different angles for pyramids until they found the best result from an engineering viewpoint and for aesthetic effect -- as we can see from the evolution of pyramid building that preceded Khufu's Great Pyramid and from the dimensions of that magnificent edifice.

The Senet Board Pendulum

The ancient Egyptians also encapsulated the knowledge of pendulum motion directly into their Senet Oracle Board. The Senet Board contains within it all the essentials of knowledge, both scientific and spiritual. Tutankhamen had 4 such game boards in his tomb, one for each cardinal direction so that wherever he went he would have access to the cosmic knowledge encoded in the board.

The board is a rectangular grid that is 10 squares by 3 squares. The "Tower" runs across the board at the junction between the 1st and 2nd columns on the right hand side as you face the board in divination mode. However, to see the pendulum principle, you rotate the board 90 degrees so that the "Tower" section is at the bottom. Then you put the pivot of the pendulum at the upper left corner (the square of the Lovers). It hangs all the way down to the bottom square where the lead bob of Thoth resides. Thoth's name in Egyptian means "lead", the ideal metal for pendulum bobs. Thoth records the dimensions of space and time. Just above Thoth (in this rotated position) is the square of Maat (Truth) with her Scale of Justice. The bob at rest hangs down from the Lovers through the House of Maat into the House of Thoth. Or, if you will, Thoth lies down and Maat allows his erect pendulum bob on its arm that is anchored in the Sun to swing toward her and then penetrate into and upward through her. From your viewpoint the Tower lies horizontally across the bottom of the 2nd column (that is now the 2nd row from the bottom) and represents Osiris as a dead corpse. The length of the pendulum from fulcrum to bob along the bottom row of the Board is the development of your life. Starting from the top of the rotated Board you begin your life as a pendulum clock in motionless silence at the fulcrum, then you move with a very fast oscillation, and as you go through life passing to lower positions on the board, your rhythm gradually slows down. At the bottom in the square of Thoth, you come to a stop when the friction of your resistances finally catches up to you. This coming to rest is *samadhi* or death, depending on how you look at it. Nevertheless, many want to keep going because of unfinished business. So they give the bob another push. That sends it pulsating through the square of Ra, the Sun. The bob transforms from a dull leaden orb now buried in the underground world of Thoth into the golden orb of the sun. When the bob becomes the sun and peeks out over the tip of the Tower as it traces an arc beyond the Senet Board into the sky, a ray of light beams up to the Lovers and starts a new life.

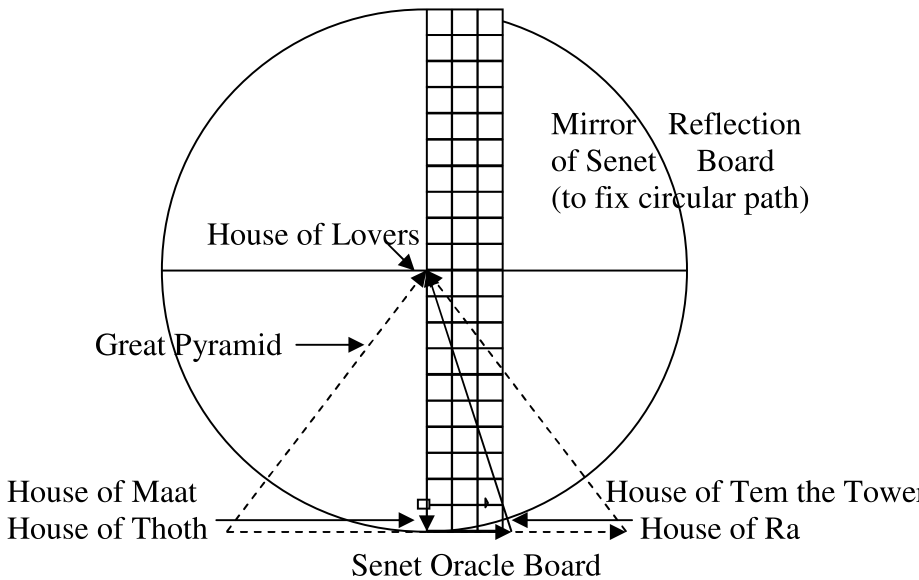
The pulse we give to the bob is a 1/3 push relative to the bob's weight. The length of the pendulum is 10 units, so we will also assign the weight of 10 to the bob. The horizontal pulse is thus 10/3 relative to the bob. That comes to a corresponding horizontal length of 3 ⅓ units, which means the vector extends beyond the square of the Sun by ⅓ of a unit. If we move up one square, the vertical length is 9 and the horizontal width is 3, and that is exactly the ratio of 1/3 push to weight, which means the triangle made when the bob is pushed follows all the geometry of our pendulum analysis, except that the angle A of course is smaller. So we have a series of similar triangles. The smallest triangle is formed by the edge of Ra's square, the place where the arm crosses the boundary between Tower and Sun, and the tip of the horizontal pulse vector and is similar to the triangle defined by the push vector, the pendulum arm at vertical position.

We push the bob so that it swings out just a bit beyond the House of Ra on the Senet Board and the arm of the pendulum crosses the adjoining outside corners of the Houses of Ra, the Sun, and Tem the Tower.

Length at extension is $\sqrt{90} + (10 - \sqrt{90}) = 9.48683298 + .513167$.
Thus .513167 is the length of the hypotenuse h of the tiny triangle that extends outside.
Angle $A = 16.6995$ degrees (about 16° 42')
$\tan A = 3/10 = .3$.
Thus $\sin A = .28735$, and $\cos a = .95783$.
Thus $x = h \sin a = .14745853745$, and $y = h \cos a = .49152674761$. Ratio $x/y = .3$.

The pendulum begins with the Solar Bob hidden like lead in the ground in the House of Thoth, Lord of Lead. The lift on the bob is about half a unit upward on the board and is just about where the sun would be for its first ray to peek over the top of the Tower and shine to the pivot point at the Lovers. It transforms from lead into gold. The shadow of the Tower at that moment coincides with the length of the pendulum. The ray of sunlight at the Lovers impregnates them with the rebirth of Osiris as Horus. As the sun passes overhead, the shadow moves down the pendulum arm at its perpendicular position. When the ray that passes from the solar pendulum bob to the Lover's corner reaches the pyramid angle, it passes through the outside corners of the Houses of Horus (the Will) and Newet (Cosmic Space), suggesting that Horus may now roam the cosmos freely with the least amount of effort (arrow with dotted line). When the sun reaches high noon, the energy flows to the Lover through the medium of the Life Force (Temperance, Nephthys). Then the sun continues its journey on the mirror image of morning as the afternoon sun, passing again through the junction of Horus and Newet, and then finally passing beyond the Tower of the West back into the House of the Sun and the underworld of Thoth.

The Great Pyramid, the Pendulum, and the Senet Oracle Board



Compare the above drawing to the drawing with the colored lines in which we identified the sweet spot. The Senet Oracle Board encodes in its dimensions the sweet spot for a pendulum, but converts it into a pendulum clock. If we really used a Senet Box to make a longcase clock, then the arm would be 8 and the push distance would be about 1, giving a tan A = .12 and an angle A of a bit under 7 degrees or even .1 with an angle of about 5 degrees. A clock maker is not interested in lift. He only wants to keep the pendulum swinging very slightly back and forth. So for him the smaller the angle the better. But the ratio of 3/10 gives us the sweet spot in the House of Horus for a pendulum able to swing freely and get the best lift per push. Viewed in this way the Senet Board becomes a gnomon, a pendulum clock, and a measuring stick.

The Origin of the Meter and the Second as Units of Measurement

During the latter half of the 17th century scientific progress began to accelerate in Europe. As a result there began to be interest in developing a more efficient system of mensuration. One of the proposals was to replace the cumbersome traditional spatial units (e.g. 1760 yards in a mile, 3 feet in a yard, 12 inches in a foot, and so on) with a consistent base-ten metric system so that calculations would be much easier. In 1668 the English architect (geometer, mathematician, physicist, and astronomer) Christopher Wren and the brilliant polymath John Wilkins -- two of the cofounders of the British Royal Society -- proposed that a new unit of length called the meter could be based upon the length of a pendulum with a half-period of one second. This was known as the "seconds pendulum".

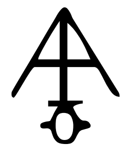
 

Bishop John Wilkins Christopher Wren

A rival proposal presented by a group of French scientists was to create a "meridian meter" to be defined as one ten-millionth of the length of an Earth meridian along a quadrant. A quadrant of the meridian would be the distance from the equator to the North Pole. Although the meridian meter proposal eventually won out at that time as the basis for the standard meter, an ordinary person in daily life is not able to derive an accurate meter by calculating the polar circumference of the earth, taking into account the globe's rotational oblateness, and then figuring a tiny fraction of a quadrant of the meridian great circle as a meter. In addition, it turned out that the calculations of the meridian meter done by the eminent French scientists were slightly off from the fraction of the earth's meridian that they intended to use as a standard, but nevertheless a standard metal bar was made to represent this arbitrarily selected spatial interval.

The seconds pendulum, on the other hand, is a very natural candidate for a measuring stick that any person in any era can easily derive -- and it seems highly probable that the Egyptians knew about it, since we have seen examples of ancient Egyptian plumb bobs and evidence in Egyptian art of using the meter as a unit of length. To make a seconds pendulum simply involves tying a small weight to the end of a string and then suspending it from the string. Stand very quietly and let the weight swing back and forth at the end of the string in a natural pendulum motion. Adjust the length of the string until the weight swings back and forth at the speed of your heartbeat for each half-period of the swing. The length of string from where you hold it to the weight will be 1 meter. Not only that, the half period will be very close to one second. Thus the meter and the second are natural units for man on this planet. (See **Wikipedia**, "Metre" article)

We know the ancient Egyptians used plumb bobs as a common tool in construction, and examples of them survive in museums. They called the plumb bob device a "khekh", and it was used as a leveler and of course to make walls plumb. Anyone using a plumb bob becomes aware that a plumb bob is also a pendulum. Since a restful heartbeat is a good representative of the second, the meter represents the length of the cord suspending an oscillating plumb bob such that its half-period swing matches the human heartbeat in a normal restful state.



"Khekh" Plumb Bob Glyph
(Note how the bob resembles the heart glyph 𓄣)

It is reasonable to assume that ancient Egyptian priests and architects were very much aware of the heart meter, and in the chapter on "Passing through the Invisible Portal" I discussed a famous example of art work identified by Schwaller de Lubicz that has in it evidence of conscious use of the meter as a unit of measure. The drawing of the Weighing of the Heart tableau (p. 10 above) shows Anubis adjusting a little plumb bob on the Scale of Justice fashioned in the shape of the glyph for the heart. If the scale is disturbed (by the little baboon sitting on the fulcrum) while in a state of balance, its arms will oscillate with a pendulum motion. If we take each arm of the scale as code for the meter interval, and the heart-shaped bob as the code for the temporal rhythm of the pendulum, then this standard picture from Egyptian sacred art nicely encodes both the meter and the second as standard units. Thoth in his baboon form was an esoteric symbol for the heart. His name Baba is a backward repetition of the word "ab" for heart in Egyptian, suggesting the periodic motion of the swinging pendulum and beating heart.

Exploring the Very Large Scale on the Senet Oracle Board

The ancient Egyptian viewpoint was cosmic and universal. The pendulum meter was easy to derive, but could only be considered a local unit, because it depended on the gravitational force of Earth and the average restful heartbeat of a human. In outer space, on other planets and in the bodies of nonhuman creatures, the definition would not hold. Also, as modern scientists soon discovered, both the heartbeat pendulum meter and the meridian quadrant meter lacked the precision as well as the universality that we require in modern science, since they varied slightly from person to person and from place to place on the planet. In the late 19th century Michelson introduced interferometry and promoted the use of light wavelengths to set the standard for a meter. The meter definition then shifted to "1,650,763.73 wavelengths of the orange-red emission line in the electromagnetic spectrum of the krypton-86 atom in a vacuum." (See **Wikipedia**, "Meter" article.) Eventually in 1983 it was decided that since the speed of light is a universal constant, the meter might as well be defined as the distance light travels in a vacuum during an interval of $(1/2.99792458\times10^8)$ s. This means that the meter is now defined in terms of the speed of light and the second, and once again the meter and the second are linked together.

NOTE: The velocity 2.99792458×10^8 m/s represents the apparently constant speed of light in free space (a vacuum) and is given the symbol *c*. For the sake of simplicity and ease of typing, I will often round that figure off to 3×10^8 m/s. I will also usually shorten the format of this number to 3e8 m/s, in which the "e" signifies that the number after it is an exponent and represents multiplication by a power of ten to that exponent. I will often use that same basic format for other very large or very small numbers.

The only problem remaining with space and time is that the second is also a local definition derived originally from the human heartbeat, the relative rotation of the Earth on its axis, and then later arbitrarily pegged to the vibration of an arbitrary atom. "Since 1967, the second has been defined to be the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom" (**Wikipedia**, "Second" article), which is a very awkward and arbitrary definition. Thus both the meter and the second are now **arbitrarily** defined in terms of light. Although I understand the logistical complications involved in adjusting mensuration standards, I feel sad that when the meter was pegged to the speed of light, it was not slightly adjusted so that there would be exactly 3e8 meters in one light-second. After the initial major discomfort of applying a tiny adjustment to the meter, life in the world of mensuration would have become much simpler.

The logical trend in the definition of dimensional units is to move from local to universal and from variable to constant. Ideally we will discover units that are universal, constant, and also easy to calibrate so that future human civilization in any part of the universe can pursue accurate mensuration under any conditions. As we continue exploring the secrets of Egyptian mensuration, we will discover what clues the Egyptians may have left us in the Senet Oracle Game Board regarding this important question. If the Board is really an Oracle, we should be able to discover such secrets of the universe precisely encoded in it.

The formula for the rest mass of a stable nucleon contains hints of these secrets, for the speed of light lurks within it. Developing a device that can reliably extract the universally constant units of 1 meter and one second from the behavior of a single proton would be very useful. Hydrogen is the most abundant element in the universe and is basically a single proton in conjunction with a single electron. Locating hydrogen rather than cesium or krypton anywhere in the universe should be a much easier task.

However, we shall need two separate tests to define the meter and the second, because the speed of light by itself is insufficient to distinguish the size of each. That is why I support the use of hydrogen or possibly helium, since helium is an inert gas. Perhaps there can be a set of alternative equivalent choices. For the purposes of this essay we will have to find procedures that would enable a megalithic culture to gain a reasonable awareness of such remarkable scientific knowledge in order to render our thesis believable.

In terms of modern notation the ideal formula for a nucleon mass is $Mn = \pi e/c$, where the mass is in terms of kilograms, π is the ratio of the circumference of a circle to its diameter (3.14159), e is the quantum unit of electrical charge (1.602e-19 C), and c is the speed of light in free space (3e8 m/s). I say that the formula is "ideal" because the values as currently defined are very slightly off from the measured values, suggesting that either there is a missing factor or one of the constants has to be adjusted. However since both e and c are different constants both containing units of meters and seconds, it should be possible to obtain measurements of both space and time from any nucleon -- for example, time from *e* and space from *c* or vice versa by appropriate ways of measuring the behaviors of charge and light speed. (We will have to deal with the problem of interpreting the electrical unit coulombs in terms of mechanical units later on.)

Access to *pi* involves only rolling a wheel one rotation and then comparing the distance rolled to the wheel's width. Thus no errors are found in *pi*. The other constants are not at human scale and thus present a much greater challenge. The 1-meter unit has to fall inevitably out of an understanding of the other units involved (*e* and *c*), although it clearly relates to the definitions of the ampere and coulomb. The second also has to be bound up in the automatic "clock" that is built into *e* and *c*.

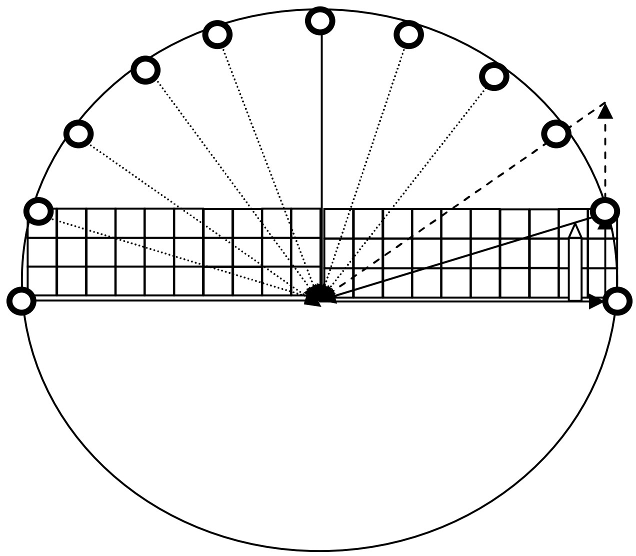
It turns out that an average day on earth can be divided nicely into 24 hours, each hour consisting of 60×60 = 3600 seconds, or a total of 86,400 seconds per day. Thus the second naturally became the ordinary small unit for measuring time because of the natural divisions of a cycle into portions divisible by 60 and 12. However, local Earth units will not do for the universe at large. Thus we must turn to quantum measurements in order to define our basic units.

The Senet Oracle Board Gnomon

On the Senet Board Oracle Layout (see below) the House of the Heart is on the closest square to the center on the left side. Khenemew works the Potter's Wheel that sits almost exactly in the center of the bottom row on the right side. The Feather of Maat is much farther over on the right side. Death adjusts the little heart-shaped lead knob, but Baba the Baboon disrupts his attention with the Eye of Wisdom that transcends all the fine balancing done during the Weighing of the Heart.

(Units on a standard Senet Board Gnomon or Pendulum clock are squares.)

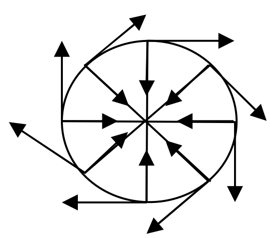
In the next drawing I have turned the pendulum clock board sideways again so we can see the progress of the sun during the day. At the Great Pyramid angle (dotted line) the ray passes diagonally through the House of Horus, Lord of the Sun, at its brightest (broken line). That period of about 6 hours from roughly 9 AM before noon to roughly 3 PM after noon is the brightest portion of the day. If we flip the figure upside down, we get the darkest portion of the night during that segment of time.



Senet Board Gnomon

As the sun moves across the sky we can slide a gnomon "tower" across the Senet Board to cast shadows at various angles. The shadows will pass through various squares on the board.

The Wheel Spinning on an Axle (Axis)



A wheel on an axle is a very efficient form of lever in which the “pendulum bob” is balanced all the way around the rim of the circle so that each push that lifts one side of the rim allows the opposite side of the rim to accelerate downward with the assistance of gravity and the torque of the arm. Once the wheel begins to spin, we only need to add little impulses to maintain the wheel's momentum against the drag of friction and any work that is extracted from the motion. The impulses can be the steps of a man or animal pulling or pushing, the motion of a piston in an engine, pushing of a fluid or gas against a series of paddles, a pulsing of magnetic fields, or anything you like. A flywheel can store a series of pulses as momentum carried by the mass of the wheel. A pulley is a lever that allows for performing continuous pulling and/or lifting work, and a set of pulleys (or gears) of various diameters can obtain and transfer a continuous mechanical advantage.

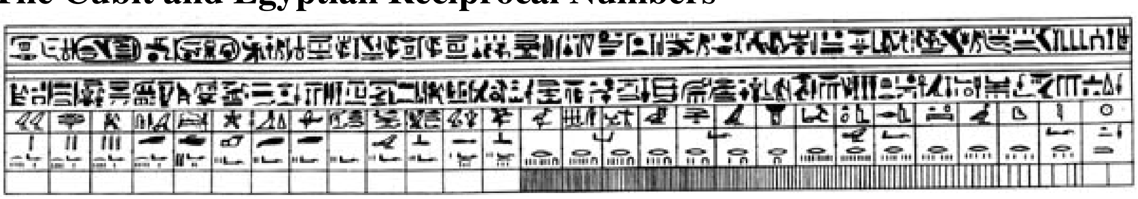
Suggested Reading
Denny, Mark. "The Pendulum Clock: a Venerable Dynamic System". **European Journal of Physics 23** (2002) 449-458. Published by Institute of Physics. (Available online at stacks.iop.org/EJP/23/449.)

Ancient Scientific Notation Encoded in the Senet Oracle Board

In order to investigate the possibility of a "cosmic metrology" encoded in the Senet Oracle Board we shall have to explore more deeply the ways Egyptians may have played with the numbers and ratios generated by the geometry of the Senet Board. We must expand our vision to discover how the Egyptians conceived of the super big and super small scales of the cosmos. In modern science the measurements we make often cover a wide range of scales and therefore require very large numbers and very small numbers. To simplify calculations, modern scientists recognize three major components to any measurement: a dimensional unit that represents the "ruler" used for the measurement, a power of ten that scales the "ruler" to the magnitude of the intended measurement, and a ratio that compares the item measured to the scale-adjusted ruler as some portion of 10 (the next order of magnitude above the scale-adjusted ruler). For example light speed is 3×10^8 meters per second (or 3e8 m/s). Meters per second (m/s) is the **dimensional unit** for velocity, 10 to the 8th power (10^8 or e8) is the **scale** of the dimensional unit for this very fast velocity, and 3 (precise modern value: 2.99792458) is the number x (such that $1 < x < 10$) by which we multiply the power of ten in order to get the **value** of the velocity of light (3×10^8 m/s) at the scale of 10^8 m/s.

What if the Egyptians had a system that worked along similar lines, but was based in geometry rather than numerical calculations? There is plenty of evidence that they used canevas grids to scale their artistic and engineering designs the way artists and engineers do today. We also know that they used a cubit ruler marked with various scales for most measurements of length.

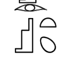
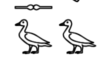
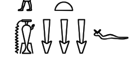
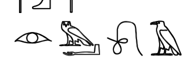
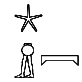
The Cubit and Egyptian Reciprocal Numbers



A Cubit Ruler
(N.B.: not drawn to actual size)

The length of an Egyptian cubit is 5 palms or 28 fingerbreadths (about .525 m). The bottom row of the above cubit ruler illustration shows the 28 fingerbreadth divisions. The first 15 fingerbreadths on the right side have finer markings that indicate fractions of a fingerbreadth: intervals of 1/2, 1/3, 1/4, 1/5, ... up to 1/16. The remaining 13 fingerbreadths have no markings in the first row. The 15 fingerbreadths on the right side of the second row from the bottom indicate the fractional numbers with a lemniscate determinative glyph ⬭ that functions like our slash for fractions, plus the appropriate denominator of the fraction written below it. The numerator is assumed to be 1 and therefore is not written.

The third row from the bottom gives the glyph(s) for the name of each fingerbreadth. Each name corresponds to an Egyptian deity. We can consider the cubit ruler itself to be an embodiment of Tem the Tower, the "extension" of Ra in the form of his "phallus", and each fingerbreadth is an avatar of Amen Ra as the Invisible Sun extended in space. The list of names begins with Ra and is followed by an Ennead list, which is a group of 9 deities, the first 6 being in the standard sequence presented in the **Book of the Dead** and on the Senet Oracle Board as attested by the opening phrase of the **Senet Game Text**: (Ra, [Tem] Shu, Tefnut, Geb, Nut), except that Tem (usually second on the list) is missing from his spot on the cubit ruler, because he plays the role of the ruler as a whole. The name Tem means "completeness" and the word for cubit (meh) means "fullness". Numbers 11-14 in the list represent the four states of the elements as they are shown on the middle row of the Senet Oracle Board.

Finger	**Deity**	**Oracle Bd**	**Tarot**	**Glyph**
0.	**Ra**	**00**	**Sun**	
[1.	**Tem**	**01**	**Tower**	 **]**
2.	**Shu (Shewe)**	**03**	**Emperor**	
3.	**Tefnut**	**04**	**Strength**	
4.	**Geb**	**05**	**World**	
5.	**Nut (Newet)**	**06**	**Star**	
6.	**Asar (Osiris)**	**19**	**Magician**	
7.	**Aset (Isis)**	**09**	**Priestess**	
8.	**Set**	**24**	**Devil**	
9.	**Nebet Het (Nephthys)**	**10**	**Temperance**	
10.	**Heru (Horus)**	**07**	**Chariot**	
11.	**Mesta**	**17**	**King of Plasmas**	
12.	**Hapy**	**15**	**King of Liquids**	
13.	**Duamut-f**	**16**	**King of Solids**	
14.	**Qebehusenu-f**	**14**	**King of Gasses**	
15.	**Jehuty (Thoth)**	**30**	**High Priest**	
16.	**Sep**	**26**	**Fortune**	
17.	**Heq**	**12?**	**Hanged Man**	
18.	**Ar-m@-w*a***	**25**	**Hermit**	
19.	**M*aa*-net-f**	**18**	**Vision**	
20.	**Ar-ren-f Jes-f**	**20**	**Hearing**	
21.	**Pehty**	**11**	**Taste**	
22.	**Sepedu**	**22**	**Judgment**	
23.	**Seba**	**13**	**Touch**	
24.	**An-heret (Onouris)**	**21?**	**Lover**	

25.	**Heru Aw*a***	**23?**	**Moon**	
26.	**Shepes**	**29?**	**Justice**	
27.	**Menew**	**27**	**Fool**	
28.	**Wew**	**28**	**Death**	
[29.	**Het Her (Hathor)**	**08**	**Empress**	**]**

From 0 to 15 on the list are unambiguous houses that are found on the Senet Oracle Board. Tem's identity as the cubit ruler itself (1) is reasonably certain, because he is missing from the part of the traditional sequence of the Ennead that does not change. (Other members vary and the sequence as a whole varies.) The identities of the remaining 13 on the list as major deities, including Hathor as the hypothetical termination unit, are not certain. "Sep" as Fortune (Shay) and "Arm@-w*a*" as the meditating Hermit ("Benew" Bird) are plausible. Either "Menew" or "Pehety" can stand for the Baboon Fool. The rest are just conjecture. There may not be any correlation of the last 13 with the Senet Board, or this list may have represented another "Senet" layout done in a linear fashion. My selection of Hathor as the end point of the ruler is pure guesswork. I consider her to be the consort of Ra-Tem.

The Egyptians, like many ancient peoples, had no concept of zero as a number. Their system of mensuration was reciprocal so that reality for them remained always in a state of unity, either explicit or implicit. Division into multiplicity, and even the diversity of deities, were all considered illusory manifestations of a single unified reality. The myth of Set dismembering Osiris into pieces that were then reassembled and brought back to life is a symbolic representation of this ancient world view. Thus the popular notion that the Egyptians were polytheistic is a misunderstanding of Egyptian culture.

The Egyptian Reciprocal Numbering System
(written with Arabic numerals)
1/9, 1/8, 1/7, 1/6, 1/5, 1/4, 1/3, 1/2, 1, 2, 3, 4, 5, 6, 7, 8, 9

The Senet Oracle Board Mensuration Encoder

My theory is that the Senet Oracle Board functions not as a ruler like the cubit stick, but as a mensuration encoder. I suggest that the basic dimensions of the Senet Board encode the universal constant ratios that are fundamental to physics and mathematics. The various different components of the board represent the various fundamental properties to be measured. The squares on the board represent orders of magnitude and are interpreted by their relative positions on the board. Operations on the board that transform its grid scale via the spiral principle discussed earlier enable it to function in the macroworld, the microworld, or the human scale according to the wishes of an artist or engineer just as the cubit ruler mensuration demonstrates. Thus a square can represent a positive exponent or a negative exponent or human scale, depending on whether you interpret it macrocosmically, microcosmically, or in terms of human events.

We will begin in the quantum microworld with a formula for the representation of a nucleon (proton or neutron) in terms of universal constants. This is an outrageous starting point that we gradually will have to justify in our discussion. How could ancient Egyptians know about the structure of subatomic particles? I will present the numbers and you decide whether or not you are willing to believe there is something to them beyond fantasy.

As I mentioned in the previous section, the basic formula for the mass of a nucleon (proton or neutron) is

$$M_p = \pi e / c,$$

where π is the ratio of the circumference to the diameter of a circle, e is 1 quantum of elementary electric charge in coulombs, and c is the speed of light in meters per second. I will round off the decimal values, assuming that the precision of the ancients, while excellent, was not quite as high as ours.

First we will fantasize a little bit.

$Mp = \pi e / c$ = (1.67e-27 kg) = (3.14) (1.6e-19 C) / (3e8 m/s).

The ratio *pi* as well as the ratios 1.67 and 3 all appear on the Senet Oracle Board Grid. The ratio 1.6 represents the $2^4 = 16$ in Egyptian binary code divided by 10, which is the base for the Egyptian decimal code and the length of the Senet Board: 1/10, 2/10, 4/10, 8/10, 16/10, ... The number 1.6 = 1 + 1/2 + 1/10, has component numbers that are all on the Senet Board, and is implied by the appearance of all the other components as constants. In other words, we can round off the charge to --

$e = Mp\, c / \pi$ = 1.6e-19 C. (We will deal with the problem of the units later in the essay.)

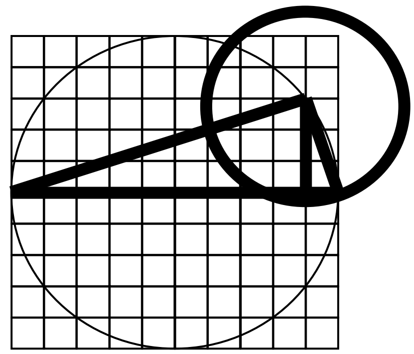
The scale for the mass of a nucleon (10^{-27}□) is suggested by the 27 houses on the macro side of the Board, because macroscopic structures are made possible by the nucleons in the form of protons and neutrons. The 30 houses that make up the whole Board suggest the scale for the mass of the electron ($9.1\times10^{-31} \approx 10^{-30}$). The scales 19 and 8 (for e and c) add up to 27, but it is not clear why they should be apportioned as they are. One possible interpretation is that the House of the Eye's Vision is on the eighth square from the left of the middle row, suggesting that light stimulates the vision of Osiris at a scale of 8. Osiris acts as the pole for the two opposite charges and Maat balances them, 9 across the top row for the heavenly negative charges and 9 across the bottom row for the earthly positive charges. The two charge ranges together plus the pole of Osiris add up to a scale of 19. The charge scale units are on either side of the neutral light scale units in the middle row.

The fundamental constant relationship of quantum mechanics is ($\hbar c$).

$(\hbar c) = (1.054\times10^{-34}\ \text{J}\cdot\text{s})\ (3\times10^{8}\ \text{m/s}) = 3.162\times10^{-26}\ \text{J}\cdot\text{m}$

The fundamental constant for scaling in base-ten physics is % r = 3.162 m. I use the % sign and call it the "oper". The r stands for one meter of displacement. In the drawing below the "oper" is encoded in the long diagonal from the tip of the Tower to the far left corner (when we give each square a length of 1/3). The number associated with spin ($\hbar$) at the smallest scale is 1.054. That ratio appears as the short diagonal from the tip of the Tower to the far right corner. The Board consists of 3 rows of squares. Thus the numbers 1.054, 3, and 3.162 all appear in the dimensions of the Senet Board.

$h = 2\,\pi\,\hbar = 6.62\times10^{-34}$ J·s. This is the engine that drives space time.



If we draw a circle with the tip of the Tower as center and the "message" of Thoth (1.054) as the radius, the circumference of the circle is 6.62. This clearly demonstrates the principle of quantum spin h and its reduced form $\hbar$.

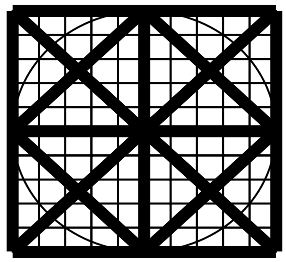
Egyptians often covered the pyramidion tips of obelisks with electrum (a naturally occurring alloy of gold and silver that also contained traces of platinum, copper, and other metals) so they would shine in the sunlight. The h-circle represents the glow of the sun reflecting off the electrum-covered pyramidion at the tip of the giant Obelisk of Tem to signal the start of a new day or a new cosmic cycle. It encodes a key value associated with the photon.

The Great Pyramid and the Golden Triangle

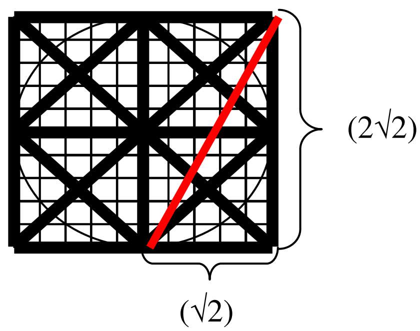
The next sketch is a top view of the Great Pyramid (GP) with the sun directly above it. The small central square symbolizes the pyramidion of the GP. The inscribed square (turned by 45 degrees) represents the pyramid of Khafra (K) scaled down a bit. The large X at the center of the figure reveals the four edges that rise from the corners to the apex of the GP. The large + at the center reveals the subtle creases at the center of each side of the pyramid that can only be seen from the air. The four smaller squares that fill the large pyramid square roughly represent the small pyramid of Menkaura (M).

If we take the side of an M-square as 1 unit, then the diagonal of the 1 unit square is √2. A diagonal from the midpoint of a GP side to a GP corner then is √5, and the triangle so defined is a Golden Triangle.

The Pyramids of Giza on the Grid

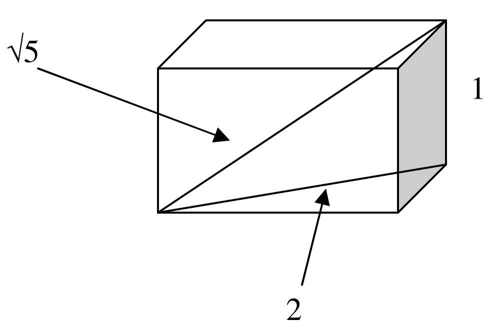


If we take a diagonal corner line of an M-square from the far corner of the big square to the apex of the M-square as 1 unit, then the length of a side of M becomes √2. The width of the GP then becomes 2√2 and a diagonal from the midpoint of a GP side to an opposite GP corner (drawn in red below) becomes √10 = 3.16227766.



$(\sqrt{2})^2 = 2$
$2\,(\sqrt{2})^2 = 8$
$2 + 8 = 10$
$\sqrt{10} = 3.16227766 =$ %

If we set the side of a small square as 1 unit, then the side of an M-square is 5 and the diagonal of an M is $\sqrt{(25 + 25)} = \sqrt{50} = 7.071 = (\sqrt{5})(\sqrt{10})$. Thus the Golden Ratio of Phi = $[(\sqrt{5} + 1) / 2]$ and the Senet Scaling Ratio of $(\sqrt{10})$ are both encoded in the GP in various ways. Wherever you find *phi* you can also find the Senet Scaling Ratio (and vice versa), since √2 is the diagonal of a square, √5 is the diagonal of a 1-by-2 rectangle, and √10 is the diagonal of a 1-by-3 rectangle as well as a (√2)-by-(2√2) rectangle.



Golden Triangle
in the
King's Chamber

We also can demonstrate this ratio with the Golden Triangle in the King's Chamber of the GP. If we take the height of the King's Chamber as 1, the diagonal of the floor becomes 2 and the diagonal from a corner of the floor to the opposite corner of the ceiling is (√5).

If we take the height of the Chamber as √2, then the floor diagonal is 2√2 and the diagonal from floor to ceiling is √10, the scaling constant of the Senet Board.

Robert Temple points out that the Ascending Passage inside the Great Pyramid also forms a Golden Triangle, the Grand Gallery forms a smaller similar Golden Triangle, and the Khafra (Chefren) pyramid casts a Golden Triangle shadow on the Great Pyramid at the winter solstice. The Grand Causeway from the Valley Temple to Khafra's Pyramid also forms a Golden Triangle. Giza apparently is laid out with Golden Triangle sacred geometry at various scales, which also means that it is fully encoded with the √10 Senet Board dimension.

Two rows of small squares on the Senet Board (⅔ of the total Board area) have a combined length of 20/3 = 6.67 (when we use the 1/3 value for the side of each small square).

The gravitational constant $G = 6.67\times10^{-11}$ m^3 / kg s^2. The geometry of the Senet Board thus reveals the ratio of the universal gravitational constant. If we consider mass to be nothing more than an acceleration of a volume (see Mile Mathis, "The Universal Gravitational Constant"), then the constant G in Newton's gravity equation becomes a dimensionless proportion, where k is the numerical product of the volume accelerations of the two interacting bodies marked by the two subscripts 1 and 2:

$$Fg = G\, M_1 M_2 / r^2 = (6.67\times10^{-11})\ (m^3 / s^2)_1\ (m^3 / s^2)_2\ r^{-2} = (6.67\times10^{-11})\ (k)\ (m/s)^4$$

In units this turns out to be a velocity squared squared. All calculations of "mass" turn out to be measurements of the relative accelerations of bodies in space, just as Kepler discovered. Newton arbitrarily assigned a new dimension of mass to those celestial motions.

$c^2 = 1 / (\varepsilon_o\, \mu_o)$, where μ_o is set at $4\,\pi\times10^{-7}$ N/A^2. (Maxwell's relation)

From the constant ratio values of ε_o, and c we can derive μ_o. With the ratio values of $\hbar$, c, G, %, and ε_o, in hand -- plus π, and the various types of Euclidean circles and spheres based on a 1 meter unit radius (circumference and area of a circle, area and volume of a sphere) we can do all of physics. The constants ε_o and μ_o represent the electric (E) and magnetic (M) properties of space that limit the transmission of EM energy to the speed of light. This suggests that what seems to be empty space is filled with an uncharged "ether" gas with a certain small density through which photons must flow as they pass between charged particles.

Armed with the numbers and relations encoded in the geometry of the Senet Board, the Great Pyramid, and the behavior of light from the sun plus the geometry of circles and spheres, it appears that we may be able to derive the physics of the entire universe. The curious question is: why does the Egyptian system happen to agree so closely with the modern metric system that we now use for scientific measurement? To find out we will have to delve further into ancient metrology and then we will see if we can answer this question as well as the problem of how the ancients might have known of and measured with considerable precision these physical relationships that are so far from our everyday scale.

The Other Cosmic Constants and their Exotic Scales

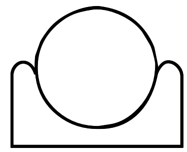
Thus far in our exploration of the Senet Oracle Board we have discovered close approximations to the ratios of the fundamental constants of modern physics. We also have suggested what determines the vast difference in scales and the interaction of the units. It seems that the large 3:9 rectangle on the Senet Board deals with the large scale of creation governed by the speed of light (*c*), and the small 1:3 rectangle deals with the small scale of creation governed by Planck's constant ($\hbar$).

Larson (1959, et al.) proposed that all physical units can be reduced to various ratios of space and time. In his view all phenomena reduce to various forms of motion expressed as the possible reciprocal relations of space (*s*) and time (*t*) distributed over a 3-dimensional space-time range. Larson was very clear that the physical world is not embedded in an abstract 3-dimensional (or 4-dimensional) space-time matrix. The various combinations of space and time make up the physical world that we can experience and measure. In his view all phenomena are nothing other than some form of motion, or what we might call flavors of change.

Thus, for example, Larson replaces the notion of mass as something solid moving through time in a background of space with an inverse velocity cubed $(t/s)^3$, a particular way in which space and time interact. He treats energy as inverse velocity (*t*/*s*). Thus we see objects under the influence of energy moving with velocity (*s*/*t*). What makes an object seem solid is energy converging from the three dimensions of space-time on a location in space-time. Such a view greatly simplifies the problem of units, but also introduces some curious problems. According to Larson, physics is the study of a reciprocal system based on a fundamental unity rather than a study of solid objects that appear mysteriously in an empty zero space. Larson, without realizing it, agrees at least in principle with the ancient Egyptians.

The ratio components of expressions for physical phenomena are calculated by multiplication and division. However, the scale and unit components are expressed as powers, so their interaction (denoted by multiplication) simply involves addition or subtraction of exponents, which greatly simplifies calculations. If we allow a Senet Board square to represent an order of magnitude in scale, then we can multiply or divide power-of-10 magnitudes simply by adding or subtracting groups of squares on the Oracle Board.

The specific triangles that fit in the Senet Board rectangle on the Cosmic Grid are only a special case of a general range of possibilities within the Solar Disk. Once we understand the system, we can choose to erect our Obelisk at any point along the semicircle that lies between the horizons defined by the "diameter" of the grid and disk. We only must not put the Tower exactly at the horizon, for then the Tower shrinks to zero size and is no longer a Tower. The two horizon points were very important in Egyptian culture, because they symbolically represented the ideal point in space time for transcending the relative. At that moment the Tower disappears from within the Solar Disk and becomes tangent to it. Symbolically this represents the meditation in which the attention enters *Samadhi* and transcends the world of thought.



The Horizon Towers as Two Mountains Framing the Solar Disk
The glyph of the sun at the horizon (a*a*khet)
reminded the Egyptions of the dawn and dusk meditation times.

We can select any point on the semicircle of the sun's arc through the sky to erect our perpendicular obelisk gnomon that spiritually reaches up to touch that arc. When we draw chords from its tip to the two horizons, the two chords will always be orthogonal to each other. The two triangles they form with the horizon also will always be similar, and thus the ratios for similar triangles always hold.

If we label the short hypotenuse A, the short diameter segment B, the obelisk C, the long diameter segment D, and the long hypotenuse E, then we discover that A/C = E/D or AD = CE. On the Senet Board example we set C = 1, so we get AD = E, which recapitulates the product of the ratios of Planck's reduced constant $\hbar$ (pronounced h-bar) and the speed of light. However, there are other ratios, such as B/C = C/D (i.e. BD = C^2). If we set C to be 1 and let it stand for the speed of light, then we have the Einstein-de Broglie Velocity Equation in which B represents a group velocity, C represents light speed, and D represents the phase velocity that corresponds to B. The group velocity (v_g) is always less than or equal to light speed (c), and its corresponding phase velocity (v_p) is always greater than or equal to light speed. The Velocity Equation: $(v_g)\ (v_p) = c^2$ is thus an example of a reciprocal relation.

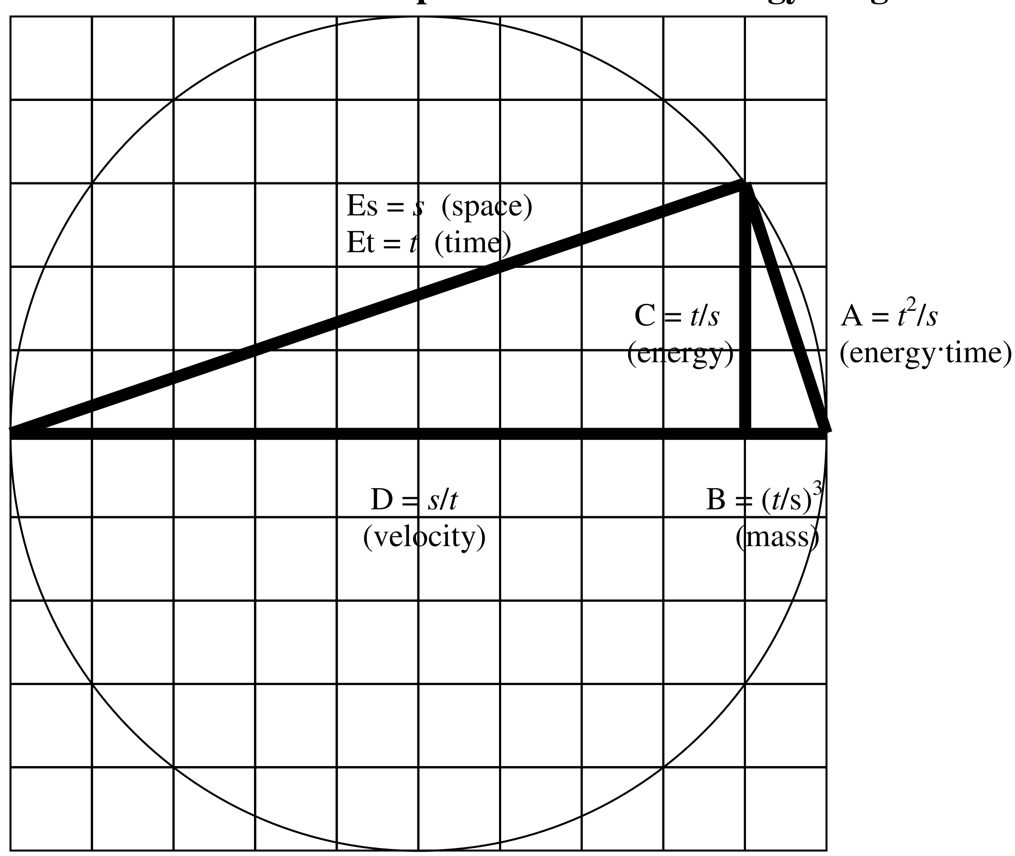
If we choose a value such as .618 for B, then D becomes 1.618 and we have the Golden Proportion. Of course we can set the Golden values for A, C, and E. If we let C = 1 and D = 2, then E becomes √5 and we have a Golden Triangle, and A becomes .5√5.

It appears that the values we derive from the Senet Board are scale independent, since we find that analogs to light speed and Planck's constant occur at the same scale in the geometry of triangles inscribed in circles when held by the Senet Board grid.

In our formula ($\hbar$ c) = (1.054e-34 J·s) (3e8 m/s) = 3.1623e-26 J·m we can convert the expression into units of space and time. Energy (J) is inverse velocity (according to Larson), so we discover from Larson's viewpoint that the product of Planck's constant and the speed of light is actually a very small quantum unit of time (t). Substituting into our similar triangle ratios, we discover that A is in units of t^2/s, D is in units of s/t, E is in units of s, and therefore, C must be in units of energy (t/s). We find that B must be in terms of mass $(t/s)^3$.

In the Senet Oracle Board physical model drawn below, A is in energy-seconds, B is in mass, C is in energy, D is in velocity, and E is displacement in space. Thus we find in the geometry of the Senet Oracle Board the eternal relationship of mass, energy, Planck's constant, and light speed. We also find that the time unit is A/C or A×D. A×D is fascinating, because it produces the same ratio number as Et (the large diagonal), but in units of time. Es×C converts directly from space into time, whereas Et×C converts into the units of A. In the drawing below space is labeled with *s* and time is labeled with *t* according to Larson's system.

The Senet Oracle Board as a Space-Time Mass-Energy Diagram



In the above chart we also find that the smallest line in the diagram is in units of mass and one square on the grid therefore must represent the smallest unit of mass. In terms of ratios we set line segment B at the value of 1/3. In terms of scale it becomes 10^{-30} (microscale) for the mass of an electron or 1 kilogram (human scale -- weight of the lead plumb bob?). The Senet Board as a whole can then equal 1 on the human scale or 10^{30} on the macroscale, the mass in kilograms of average stars (e.g. our Sun at 2×10^{30} kg).

Energy and mass are orthogonal, are the same relative leg on similar triangles, and have a 3/1 reciprocal relationship **dimensionally** -- in other words, energy is $(t/s)^1$ and mass is $(t/s)^3$. Another way of looking at it is to say that energy is $(s/t)^{-1}$ and mass is $(s/t)^{-3}$, and thus energy is 3 orders of magnitude larger than mass, but expressed as 3 **dimensions** of magnitude. And, indeed, both the line lengths and the areas are in a 3/1 ratio.

Velocity is expressed through mass. In other words we can only see velocity in the motions of objects with mass. Even the speed of light can only be measured by absorbing the light with particles that have mass. Velocity is kinetic energy. Potential energy is inverse velocity, which means that it moves "inward" or "retrogressively" in time rather than "outward" and "progressively" in space like velocity.

Mass is energy compressed as inverse velocity in three dimensions of time/space. Side A in the above diagram represents the reciprocal of acceleration and corresponds in the small triangle to the scaling principle for either space or time (the large diagonal.)

Another curious feature of the relation between mass and energy is that $E = (m\ c^2)$, as Einstein pointed out, but it is also true that $E^2 = m\ c$, which means that the light speed momentum of a mass ($p = m\ c$), and momentum in general, is the square of the energy $(t/s)^2$. Larson believes this has to do with magnetism and with electrical resistivity. According to him inverse resistivity is conductivity $(s/t)^2$. Inverse mass $(s/t)^3$ is a cubic expansion velocity that wipes out two dimensions of inverse velocity [energy squared = $(t/s)^2$] to leave behind a simple one dimensional velocity (s/t).

Inverse velocity in three dimensions compresses energy from all three dimensions into a tiny particle with a rest mass. Allowing the particle to move in one dimension reduces it from 3D energy to 2D energy with the velocity compressed as energy in only two dimensions. This manifests as momentum. What remains is an effect that causes charged particles to interact magnetically.

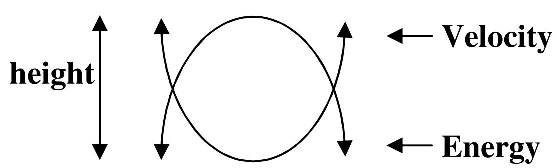
The commonly accepted phenomenon that an electron and a positron mutually annihilate and become two highly energetic gamma photons tells us that the use of *m* to represent a "fixed" rest mass is nothing more than a token for convenience in manipulating equations. However, it also disguises the true nature of mass and removes from inspection major revelations concerning the other half of the Reciprocal Universe that lurk within Einstein's famous equation. The values of *E* and *m* may vary greatly from one format to another. The following dimensional analysis from a "Larsonian" viewpoint brings out curious features of the relation between energy and mass. Remember that both energy and mass are abstractions that are not available to direct observation without physically interacting with the system being observed. Also note that in the dimensional analysis below the dimensional units are reciprocal and the ratios can differ. So, for example, *Ec* and *Ev* would have the same dimensional units but would differ in value.

$E\ c = 1$ $(t / s)\ (s / t) = 1$ $(Ec = mc^2\ c = mc^3 = (t / s)^3\ (s / t)^3 = 1)$
$E = m\ c^2$ $t / s = (t / s)^3\ (s / t)^2$
$E^2 = m\ c$ $(t / s)^2 = (t / s)^3\ (s / t)$

$c^{-3} = m$ $(t / s)^3 = (t / s)^3$
$E^3 = m$ $(t / s)^3 = (t / s)^3$

The inability to recognize that the equation $E^2 = m\ c$ is as valid as $E = m\ c^2$ comes from a lack of perspective. Potential energy (t/s) is unobservable and must be defined arbitrarily by the observer. We can only observe velocity (s/t) from a observer viewpoint in space and time. If we wish to be objective observers, the possible existence of mass and energy must be extrapolated from the observed motions of a system rather than directly observed. Thus Newton's $F = ma$ contains only one objectively observable variable: a. (And its apparent value still depends on the observer's viewpoint.)

For example, in the behavior of a pendulum, or better yet, a system with simple harmonic motion, we can observe the changes in velocity and divine that if the mass remains constant (an observer assumption), then the potential energy must be oscillating in conjunction with the velocity as the speed and direction change. But changing the mass does not change the behavior of a pendulum. Furthermore, if we push on the bob to determine its mass, we disrupt the existing motion of the pendulum. By measuring the height of the swing and how the velocity changes over time we can see how the velocity transfers to energy and energy transfers to velocity while maintaining a constant relationship (we disregard friction in this ideal example). Then we can see how potential energy and kinetic velocity are inverses of each other. If you draw a graph of the energy versus the velocity for a weight that is tossed up into the air, the velocity forms a parabola, and the energy forms an inverse parabola, so that the two exactly complement each other. The sum of the two is always constant. If the instantaneous (for very small time intervals) $E = t / s$ and the simultaneous $v = s / t$, then the product $E\ v$ is constant for that system at all time intervals.



Reciprocal Energy-Velocity System

The Problem of Measuring at Extreme Scales

We have suggested that the Senet Oracle Board as it abstractly depicts the Weighing of the Heart Tableau is a hyperdimensional scale-independent encoder of the physics and mathematics of the universe. In order for this to become believable, we must demonstrate that the Egyptians were able to **calculate experimentally** such universal constant values as the speed of light, Planck's constant, and the mass of a nucleon or electron. From light speed's scale of 10^8 meters per second to Planck's scale of 10^{-34} joule-seconds we span 42 orders of magnitude. How could the Egyptians measure dimensions at these scales without our modern sophisticated instruments?

In his book, **The Crystal Sun**, Robert Temple has given us an idea of some of the tools the Egyptians had with which to calculate values at extreme scales -- tools such as lenses and extremely long sighting tubes. Iron was a sacred metal in the Old Kingdom, and copper was known from pre-dynastic times. Let's do some experiments.

The Egyptian Mythology of Optical and Thermal Physics

The Egyptians had a deep reverence for the sun. The sun's primary life-supporting gifts to man are light and heat. It seems reasonable then that the Egyptians would have had a great interest in understanding the qualities of light and heat. With their love of precision the Egyptians would also have wanted to know as much about these two gifts as they could learn, given the state of their material civilization.

In Egyptian mythology Ra represents the sun, Hathor represents the sun's light, and a transformation of Hathor known as Sekhmet or Tefnut represents the sun's heat. Amen represents Ra's invisible quality of energy that underlies light and heat. Horus represents the notion that the sun is not an accidental phenomenon, but a deliberately created one. Thoth is the ability of the intellect to understand phenomena and to measure them accurately. Ra is the expression of intelligence that becomes the sun that we experience as the star that governs our solar system. Tem the Tower is the orthogonal principle that operates within all phenomena so that they may interact and evolve in a multidimensional framework. Maat is the principle of balance that maintains the reciprocal unity within the apparent diversity of the cosmos. The positions of these "deities" on the Senet Oracle Board help us understand their roles in the physics of ancient Egypt.

Measuring the Speed of Light

The ancient Egyptians knew that sound has a particular speed which is slower than light. It is easy to observe the lag time of a sound relative to the visual event that accompanies it when the observer's distance from the event is sufficiently far. Thus it is reasonable to imagine that the ancients might assume that light also has a characteristic speed that is faster than sound and would wish to measure it.

Our first task to convince ourselves of the ancient Egyptian technical proficiency in this matter is to make a list of what the Egyptians would need in order to calculate the speed of light via an experiment such as was performed by Hippolyte Fizeau in 1849. The items he used were available to the Egyptians even during the Old Kingdom. Fizeau sent a beam of light through the notches in a cogwheel so that it was broken into pulses that passed to a mirror 8633 meters distant. The mirror reflected the pulses back through the cogwheel. When he rotated the wheel fast enough, the speed of the wheel moved the teeth on the wheel around to block the returning pulses of light. When he increased the speed to 12.6 revolutions per second, each pulse reappeared through the next notch on the wheel. He had 720 teeth on the wheel. Fizeau then knew that the time it took for the beam to travel the distance from wheel to mirror and back to the wheel would equal the time it took for the wheel to rotate so that each light pulse passed through the next notch. The flight time of the light pulse was $2\,d\,/\,c$, where d was the distance from wheel to mirror and c was the speed of light he was seeking to measure. During that same time interval the wheel was rotating its 720 teeth and 720 notches 12.6 times per second. The period $T = (1/12.6)$ s, and the time interval it takes a tooth and a notch to move past a given point is then $T\,/\,2N$, where N is the number of teeth.

$2\ d/c = T/2N$
$c = 4dN/T$.
$c = 4\times8633$ m $\times$ 720 teeth $\times$ 12.6 $s^{-1} = 3.13\times10^8$ m/s, which is very close for such a crude method.

List of Requirements for the Experiment

1. A standard unit of time (we can call it a second). We know the Egyptians divided the day into 24 hours, because in the **Amduat** they assign 12 hours to night, so there must have been 12 hours to a day, obviously calculated from the equinox. The hour naturally divides into 60 minutes and each minute divides into 60 seconds. Thus an Egyptian day probably contained 24 hours and 86,400 seconds. They could easily calculate a second by tracking the average pulse of a person at rest, which is approximately 1 pulse per second. If they did not want to count off 86,400 pulses, they could easily measure an hour's worth of sunlight at equinox with a gnomon and bay and note that it consisted of about 3600 average heart beats. For ancient Egyptians the heart was the core of a person's being, and the heart was clearly represented as the main symbol in the iconic representation of the Weighing of the Heart Tableau. A pendulum could accurately measure the time interval.

2. Mirrors to reflect pulses of sunlight. From the earliest dynasties Egyptians already were making mirrors. Egyptians could make excellent mirrors from sheets of gold and other metals. The death mask of Tutankhamen is an example of the fine craftsmanship the Egyptians attained when working with large sheets of gold. Here is an article about the evolution of mirrors in ancient Egypt.
http://www.egyptological.com/2011/06/reflections-of-eternity-3869.

3. The Egyptian image for the sun was a disk with a little hole in the center. A stone or wooden disk with thin notches cut into its circumference (symbolizing rays of light) could be rotated at various speeds using a crank with a pulley belt that gave gear ratio. Speed of rotation could be measured by having a mark on the pulley belt that would complete a cycle every so many turns of the wheel.

4. A long shaded light channel was needed. For example, the Temple of Amen at Karnak provided such a long channel through which the Egyptians could pass pulses of sunlight when the sun was on the western horizon toward which the temple faced. ("Amen" also means "west" as well as "hidden" and "dear foundation" in Egyptian) indicating the importance the Egyptians attached to understanding the subtle and unobvious foundations of the real physical world.

Armed with these simple tools that we know they possessed, we can do some hypothetical calculating. If the length of the sighting channel was 500 meters, then a light beam's round trip down the channel and back would be 1 km = 10^3 m. The number 1000 was ritually important for Egyptians as abundantly attested in the **Pyramid Texts**. The number $10\times10\times10 = 10^3$ is nicely encoded in the Senet Oracle Board, each row of ten representing a layer of creation. A beam of light would be directed into the temple so that it passed through a notch in a large solar disk placed at or near the temple entrance at a distance of 500 meters from the inner sanctum wall. The beam broken into pulses by the notches on the disk would reflect back from a mirror hung on the inner sanctum wall and then after three such trips down the channel would pass back through another notch on the disk. The disk would then be rotated until a speed was reached at which the returning pulses of light were blocked by the teeth between the notches. When they increased the speed further, the light pulses would again as if magically pass through the notches and appear on the screen. That would indicate a time delay in the return of the reflected beam of sunlight from which they could calculate the speed of light.

The angle of the mirror would have been adjusted just enough so that when the disk was at rest the pulses returning for the last time passed through notches on the opposite side of the disk, thus removing the need for a half-silvered mirror.

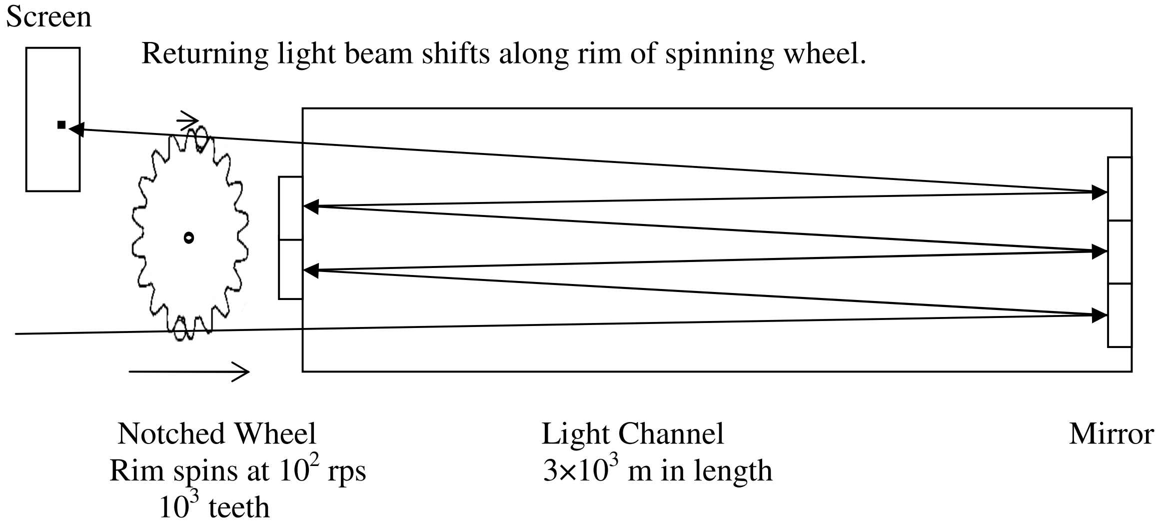
When the disk was at rest, the beam would be unbroken and would shine steadily through both notches and show up as a little bright line on a smooth flat screen made of clay or stone that was placed next to the return-beam side of the disk. When the disk began to rotate, the line of light on the screen would flicker on when the notches lined up with the beam and off when it was blocked by the teeth between the notches. As the disk turned faster, the beam would seem to shift gradually out of the second notch on its return trip through the temple and eventually would be blocked by an intervening tooth. The flickers would stop and no line of light would appear on the screen. The Egyptians could thus see a kind of "relativistic distortion" of space and time due to motion. When the disk rotated at an even faster speed, the pulses of sunlight would shift completely past the blocking teeth on their return trip and each would pass on through the next notch that had moved into position during the interval. From the rotation speed at that time interval they could calculate the speed of light.

For example, to get a strong horizontal beam of light the priests would have used a ray of sunlight when the sun was on the horizon. The light channel had to be shaded so that they could distinguish the pulses of sunlight during daylight. Let us suppose they used slightly concave mirrors to keep the beam focused and bounced it zigzag back and forth three round trips in the channel before sending it through the cogwheel again. The distance the beam traveled from going in through the wheel to going out through the wheel was thus 3×10^3 m. Let's say the number of teeth on the wheel were the ritual number 10^3, and let's say they found the rotation speed for a shift of one tooth to be about 10^2 revolutions per second, and the mark on the pulley belt cycled two times per second. They used a pendulum to measure half seconds.

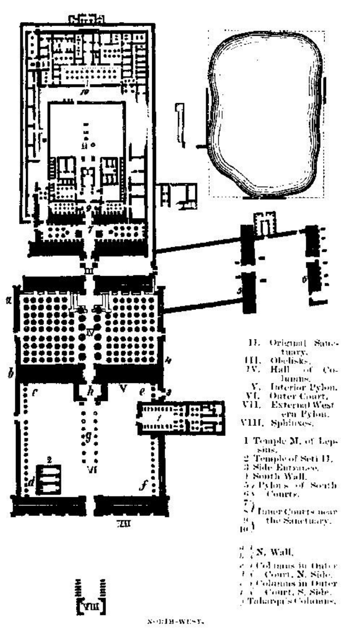
$c = (3\times10^3 \text{ m})\ (10^3 \text{ teeth})\ (10^2 \text{ s}^{-1}) = 3\times10^8$ m/s.

The Egyptians thus probably could have achieved around the same accuracy as Fizeau with their instruments, since they had sighting instruments, mirrors, and disks as well as a fascination with optical behavior.

Below is a sketch (obviously not drawn to scale) showing the basic setup for the experiment with some sample numbers that might have been found by Egyptians.



The result is that light travels at 3×10^8 m/s. Recall that the Temple of Amen at Karnak displays the outline of the Senet Oracle Board over its main entry gate and Amen's name contains the glyph for the Senet Board.



Sketch of the Temple of Amen at Karnak from <u>The Dawn of Astronomy</u> by Sir Norman Lockyer, London, 1894, p. 101. Reproduced by Robert Temple in <u>The Crystal Sun</u>, p. 337. This long sighting tube could be used to measure the speed of light with considerable accuracy.

Measuring the Charge Constant

Our next experiment is to consider how the Egyptians might have discovered electric charge. The famous experiment by which we discovered the quantization of electric charge was performed by Robert Millikan in the early years of the 20th century. Millikan discovered that he could put a small static charge on oil droplets by spraying them through an atomizer. He could then set up an electric field between two parallel horizontal metal plates. He allowed the droplets to fall through a hole in the upper plate and then adjusted the electric field until the droplets would hover in the air between the plates. By repeating the experiment many times he discovered that the charge on the droplets was always an integer multiple of 1.6×10^{-19} C, suggesting that this was the fundamental unit of charge.

We do not have evidence that the Egyptians possessed atomizers for spraying aromatic essential oils. However, we do know that they placed great importance on the raising of geese and had several names for them. The goose was the totem animal for Geb, the god of Earth. One important name for a goose was "semen", which means to make solid and contains the glyph for the Senet Board.

When harvesting a goose, the Egyptians had to pluck its feathers and in that process they would have discovered the down feathers. The down is soft and extremely lightweight. In dry weather, a common condition in Egypt, down can accumulate static charge and cling to clothing and skin. The Egyptians already venerated the ability of birds to fly, associating this with the spiritual ability to ascend to heaven. The ability of down feathers to resist falling would add to the mystique of the spiritual ability of birds to fly.

Another special material that the Egyptians associated with heaven was iron. The Egyptians first recovered iron from meteorites and thus had the idea that iron came from heaven. Other ideas associated with iron were wonderfulness, strength, and solidity. In the **Pyramid Texts** pharaoh is often described sitting on a throne of solid iron. The Egyptians probably noticed that iron had special magnetic properties. They may also have noticed how down feathers with static charge would tend to cling to magnetized iron, and this would seem to be a natural affiliation between two materials highly charged with heavenly influence.

The phenomenon of electric charge may have suggested to the Egyptians how materials come to adhere into solids. The Egyptians were one of the earliest people to develop cement, and used a form of it that was superior to that of the Romans and far superior to the Portland cement we use today. They could use very thin layers of this mortar between stones, and it would hold robustly, and it continues to function effectively in the Old Kingdom pyramids even today. The Egyptians used crushed quarry rock to make their cement, and the word comes down to us from Latin *caementum*, rough uncut quarry rock. The root of this word is traced to *caelum*, the sculptor's chisel. This word plays on *caelum*, which means "heaven" and may include the ancient Egyptian notion that iron came from the sky as well as the spiritual quality with which the sculptor endows the stone when he engraves it with his chisel. The root gets entwined with *caed* (to cut), from which we have many derivatives in English. The Greek word κοιλος (*koilos*) means hollow and probably derives from Egyptian "qar" (hole, hollow), and "qer-t" (a hollow cave, cavern, circular hole) -- a term often encountered in the spiritual texts in the sense of a spiritual source and a technical term for the "source" of the Nile. Egyptian "r" tended to become "l" in Greek, and Egyptian final "t" tended to become "s" in Greek.

The problem we face is how the Egyptians would be able to measure something that Millikan found to be $1.6e^{-19}$ C. It turns out that Millikan's experiment is always touted in the textbooks as a demonstration of the quantum nature of electric charge by measuring the smallest unit of charge. Scientists tend not to point out the significance of the other remarkable discovery that emerged from his experiment. In the physics textbooks there usually is an exercise that points out how far apart in strength gravity and electric charge are. We are taught that gravity is almost forty orders of magnitude weaker than electric charge. Gravity does not become significant in physical interactions until we reach the scale of celestial bodies such as stars, planets, and moons -- large bodies with their positive and negative electrical charges almost entirely in mutual balance. At least that is what we are told. It turns out that the forces associated with electric charge and gravity interact at all scales, and there is a crossover point on the small scale at which the two forces become equal. That crossover point turns out to be large enough to be visible to the naked eye. It occurs in any object with the mass of about 1.86×10^{-9} kg such as a small dust mote, an oil droplet, a flea, or a wisp of down. Such objects are very much within the realm of ancient Egyptian observation and measurement. In other words, Millikan could make his oil droplets hover in the air by balancing their electric charge against the force of gravity. With a little extra charge the droplets would float upward in his experiment. Here is a mathematical derivation of this reality.

Coulomb's Equation for the electric force is $Fe = e^2 / 4 \pi \varepsilon_o r^2$, where e^2 represents two fundamental electric charges interacting, ε_o is the constant permittivity of space to charge and r is the distance between the two charged bodies. The component $(1 / 4 \pi \varepsilon_o)$ is a constant usually noted as $k = 8.98775\times10^{11}$ F/m (farads per meter), but we shall have to see what the mechanical interpretation might be. In any case it reduces the passage of electromagnetic phenomena through space to the speed of light. The $4 \pi r^2$ is the area of a spherical space in which the charge is detected. Newton's equation for the gravitational force between two massive bodies is $Fg = G\ M\ m/r^2$, where G is the universal gravitational constant and M and m are two bodies with mass.

We begin by setting up the abstract ratio of the electric force (Fe) to the gravitational force (Fg) and notice that the r-component cancels out, indicating that the ratio holds at any distance and therefore at any scale, large or small.

$F_e / F_g = e^2/4 \pi \varepsilon_o G M_x^2 = 1.$

We replace M and m with M_x^2, because we are seeking two particles or objects of the same mass and the same fundamental charge that will exactly balance the electric force and the gravity forces between them. So next we will solve the equation for M_x.

$M_x = \sqrt{(e^2/4 \pi \varepsilon_o G)} = 1.86\times10^{-9}$ kg.

Surprisingly this turns out to be the "Planck mass", differing from the standard Planck mass value (m_P) by the square root of the fine structure constant as a factor.

"Standard" Planck mass: $m_P = \sqrt{(\hbar c/G)} = 2.1765\times10^{-8}$ kg.
"Unified" Planck mass: $m_{PU} = \sqrt{(\hbar c\alpha/G)} = 1.86\times10^{-9}$ kg.

I say it is "unified" because, in this formula, gravity and electric charge are unified. The remarkable thing about this formula is that it is so accessible, and the ancient Egyptians could easily observe that static charge would cause small, light objects to cling or even float in defiance of gravity. Recently NASA reports evidence that fine dust particles on the moon become charged with static electricity and levitate to form a rarified "dust atmosphere" every day under the influence of the sun's radiation and solar wind. (http://science.nasa.gov/science-news/science-at-nasa/2005/30mar_moonfountains/)

The Egyptians also would have noticed dust motes levitating in sunbeams that penetrated their dark cool temples. This is what we call Brownian movement or **pedesis** (from Greek: πήδησις "leaping"), a phenomenon named after an early 19th century botanist who studied the phenomenon. In 1905 Einstein gave the phenomenon a brilliant mathematical description. However, this motion has been noted since ancient times. The Roman writer Lucretius in a poetic essay "On the Nature of Things" (60 BC) described the motion as follows:

"Observe what happens when sunbeams are admitted into a building and shed light on its shadowy places. You will see a multitude of tiny particles mingling in a multitude of ways... their dancing is an actual indication of underlying movements of matter that are hidden from our sight... It originates with the atoms which move of themselves [i.e., spontaneously]. Then those small compound bodies that are least removed from the impetus of the atoms are set in motion by the impact of their invisible blows and in turn cannon against slightly larger bodies. So the movement mounts up from the atoms and gradually emerges to the level of our senses, so that those bodies are in motion that we see in sunbeams, moved by blows that remain invisible."

Lucretius describes the phenomenon of Brownian movement quite lucidly. From his description we know that ancient scientists were aware that matter consists of tiny particles invisible to the eye that are constantly jiggling about randomly. The particles are much smaller than visible particles, and a chance collision by one of them is not enough to have any noticeable effect on the larger particles. However, when many microscopic smaller particles happen to jiggle in the same direction against a larger particle that is visible to the unaided eye, the larger particle will also move randomly as if motivated by an unseen force.

Millikan was unable to measure directly single charges on an oil droplet in his experiments because such small droplets were subject to spontaneous Brownian movement that would mask the effects of the charge. Some believe that electric charge itself is due to bombardment of particles by a type of photon.

In any case we can be sure that the priests in the Egyptian temples were aware that dust motes, lint, and goose down could float about and cling apparently in defiance of gravity under the invisible influence of Amen Ra, energy that came from the sun. The Egyptians did not have the sophisticated mathematical tools for analyzing static charge and Brownian motion such as we have today. However, their reciprocal view of the universe allowed them to "flip" the problem from microscale to macroscale. We saw that the relationship between the electric field and the gravitational field is fundamentally scale invariant. Brownian type movement is likewise scale invariant and can occur under many different conditions and scales, macroscopic as well as microscopic.

The Problem of Hardness

This leads us to the study of how materials adhere into solids, and brings up the question of hardness, a subject very deeply understood by the ancient Egyptians, whose craftsmen excelled in working the full range of solid materials from the softest to the hardest. Because they were intent on recording their wisdom for future ages, they specialized in the ability to manipulate the hardest substances available to them: granite, diorite, basalt, and quartzite. The hardest materials should be reciprocal reflections of the charge generated by microscopic chemical bonds between charged particles.

In the early 19th century a German geologist named Friedrich Mohs devised a scale of hardness.

Mohs #	Mineral	Hardness	
1.	Talc	1	
2.	Gypsum	3	
3.	Calcite	9	
4.	Flourite	21	
5.	Apatite	48	
6.	Orthoclase	72	(Feldspar)
7.	Quartz	100	
8.	Topaz	200	
9.	Corundum	400	
10.	Diamond	1600	

Pliny mentions about twenty works by Greeks on mineralogy, but only the short treatise by Theophrastus (c. 300 BC) has survived as the earliest known work on mineralogy and chemistry. Theophrastus was a student of Plato and successor to Aristotle as the leader of the Peripatetic school in Athens. During his long teaching career he wrote many essays on various scientific topics. In his essay "On Stones" he discusses the hardness of various materials and reveals knowledge of the stones and other minerals used by the Egyptians in the construction of their temples as well as the precious and semi-precious gemstones known in his era. He also mentions the ability of amber and magnetite to attract other materials and the ability of tourmaline to become charged when heated. He is very aware of the ability of some minerals to take on electric charge and attract various materials.

"It is remarkable in its powers, and so is the *lyngourion* for seals are cut from this too, and it is very hard, like real stone. It has the power of attraction, just as amber has, and some say that it not only attracts straws and bits of wood, but also copper and iron, if the pieces are thin, as Diokles used to explain."

Strabo, in his discussion of the Ligurian territory (IV, 6, 2) identifies *lyngourion* as a form of amber, and Dioscorides (II, 100; Wellmann ed., II, 81, 3) also identifies it as "this is what some people call the amber that attracts feathers," providing us with direct evidence that the ancients used amber to attract feathers such as goose down. Pliny (XXXVII, 52-53) also discusses the uses and electrostatic properties of amber, also known as *electron*. The myth that the material was solidified urine of the lynx probably derives from a yellowish transparency of the substance and the similarity of the place name of its source (Liguria) to the phrase "lynx urine". It turns out that the amber was not sourced in Liguria (northwestern Italy and the coast of Gaul), but was traded there from its real source in the Baltic region during the Roman era. We have no earlier documents to prove that Egyptians also imported amber from the Baltic, but we know that they imported many attractive minerals and gems for their artistic value.

There was a theory, attributed by Aristotle to Thales of Miletus (see Diogenes Laertius I, 1, 24 and De Anima I, w, 405A), that magnetite with its magnetic properties (i.e. lodestone called by Theophrastus "Heraclean stone") as also amber with its electrostatic properties has a soul because of its ability to move iron. Plato (Timaeus, 80C) also alludes to the attractive property of amber and in Ion (535E) the ability of lodestone to attract iron. Theophrastus is the first ancient writer whos writings survive to vaguely suggest classifying the magnetic property of lodestone with the electrostatic properties of substances like amber in terms of the similarity of the attractive influence.

Theophrastus wrote at a time that was late in the era of classical Egypt, and by that time the Egyptians had probably lost much of their ancient technological prowess. Also much of his information was secondhand rather than reporting from direct experience. Nevertheless he is a valuable resource that confirms for us that the ancient Egyptians were aware that electrostatic effects could be obtained from certain minerals, stones, and metals. He also notes their technical skill in manufacturing both natural and artificial pigments from various minerals. His mention of the Greek physician Diokles is helpful in dating the treatise.

On the hardness of stones Theophrastus has this to say: "Some stones also have the power of not submitting to treatment . . . ; for example, they cannot be cut with iron tools, but only with other stones. In general there is a great difference in the methods of working the larger stones; for some can be sawn, others can be carved, as has been stated, and others turned on a lathe, like the Magnesian stone."

Theophrastus is intrigued by the hardness of some substances that resists scratching or cutting, but yet can still be split or broken in certain ways. The ancients probably did not know about diamonds, but used corundum, often in the impure form of emery, as an abrasive for engraving hard stones such as quartz and gemstones.

Theophrastus also discusses the binding properties of certain types of gypsum used to make mortar. "Its stickiness and heat, when it is wet, are remarkable; for it is used on buildings and is poured around the stone or anything else of this kind that one wishes to fasten. After it has been pulverized and water has been poured on it, it is stirred with wooden sticks; for this cannot be done by hand because of the heat. And it is wetted immediately before it is used; for if this is done a short time before, it quickly hardens and it is impossible to divide it. Its strength, too, is remarkable; for when the stones are broken or pulled apart, the *gypsos* does not become loose, and often part of a structure falls down and is taken away, while the part hanging up above remains there, held together by the binding force. And it can even be removed and calcined and made fit for use again and again."

Theophrastus points out specifically that the cement they made in his day was harder than the stones it was used to join. Mixing the pulverized cement with water would cause it to heat up and change its chemical structure so that when it dried, it became extremely hard. It is not clear whether the material used for the mortar was gypsum (plaster of Paris) or quicklime or some other substance, although quicklime heats more in that process. These are tantalizing glimpses into the knowledge possessed by the ancients regarding the properties of minerals.

The complete work by Theophrastus in the original Greek, with an English translation and a detailed commentary by Princeton chemistry professor Earle R. Caley and Columbia classicist John F. C. Richards (with assistance from Princeton classicist Shirley H. Weber and Columbia geologist and mineralogist Thomas T. Read), is available online at http://www.farlang.com/gemstones/theophrastus-on-stones/ and can be downloaded at https://kb.osu.edu/dspace/bitstream/handle/1811/32541/THEOPHRASTUS_CALEY.pdf?sequence=1.

Basalt, dolerite, diorite, and granite are very hard igneous rocks that contain between 45% and 69% SiO_2. According to **Wikipedia** basalt is an aphanitic igneous rock that contains, by volume, less than 20% quartz and less than 10% feldspathoid and where at least 65% of the feldspar is in the form of plagioclase. Dolerite is a kind of volcanic basalt or plutonic gabbro. Diorite contains significant quartz, which makes the rock type quartz-diorite (>5% quartz) or tonalite (>20% quartz), and if orthoclase (potassium feldspar) is present at greater than ten percent the rock type grades into monzodiorite or granodiorite. Granite contains at least 20% quartz by volume.

The Egyptians often worked with such hard rocks for constructing temples, obelisks, inscriptions, and statues that were intended to last for thousands of years. They knew that there is an attractive force that holds materials together and had explored material science to the extent of developing a mortar that is better than any we use today as well as techniques for working the hardest igneous rocks with great precision and apparent ease.

Wikipedia tells us that "**hardness** is the measure of how resistant solid matter is to various kinds of permanent shape change when a force is applied." Macroscopic hardness is generally characterized by strong intermolecular bonds, but the behavior of solid materials under force is complex; therefore, there are different measurements of hardness: *scratch hardness*, *indentation hardness*, and *rebound hardness*.

Scratch hardness is determined using the Mohs scale. For instance, next to diamond (10.0 Mohs), corundum (aluminum oxide, 9.0 Mohs) is the hardest substance that occurs naturally and can scratch almost all other materials. Thus it is commonly used as an abrasive for working hard materials. Carborundum (silicon carbide SiC) is harder, but extremely rare in nature on earth (although relatively plentiful in outer space as stardust). Other than diamonds, which were probably unknown to the Egyptians, all currently known super hard materials are synthetic and either do not occur on earth naturally or only in extremely minute quantities such as traces discovered in extraterrestrial meteors.

Very Hard Materials
corundum (Al_2O_3): fairly common, less pure form known as emery.
carborundum (SiC): 3.21 g/cm^3 very rare in nature
tungsten carbide (WC): 15.63 g/cm^3 (~9 Mohs), synthetic
titanium carbide (TiC): 4.93 g/cm^3, synthetic
boron (B): 2.46 g/cm 9.5 Mohs, but does not appear naturally on earth.
boron nitride (BN): 9.5 Mohs, second only to diamond, but not found in nature.
rhenium diboride (ReB_2): close to diamond hardness, but synthetic.
stishovite (SiO_2): a synthetic polymorph of SiO_2, found only rarely in nature.
titanium diboride (TiB_2): a synthetic compound.

From this list we can see that corundum was the only very hard material readily available to the ancients. Based on our survey, we will take talc as the unit standard for hardness, corundum being 400 times harder than talc. Mohs chose his standards based on widespread availability of the materials. This meant that the scale is not linear. We use the Mohs scale because scratch testing is most suitable for hard rocks. Other test systems such as Vickers, Knoop, and so on are more suited to metals, ceramics, and other materials.

Did Ancient Egyptians Have Diamonds, Rubies, and Sapphires?

The hardest gemstone is the diamond. Rubies and sapphires are forms of corundum, a very hard naturally occurring mineral that is primarily made of aluminum oxide (Al_2O_3) and is second only to diamond in hardness. The **Australia [Diamond] Mine Atlas** reports: "The first use of diamond may have been as a talisman or charm by prehistoric humans. Diamond was highly prized as a gem stone in ancient Egypt, Babylon, Mesopotamia and India." This is a very vague statement with no references provided to back it up. Ancient Egyptians were known to use Turquoise, Carnelian, Chalcedony, Feldspar, Amethyst and Lapis lazuli. Jewelry types included amulets, necklaces, pendants, bracelets, rings, head jewelry, anklets, diadems, pectorals, and insignia. Africa is a major source of diamonds, but never in the northeastern quadrant, and not until the late 19th century when diamonds were discovered at the de Beers farm in South Africa by Dutch prospectors. So it seems that African diamonds were discovered only a little over a century ago.

The earliest diamonds known to man probably were mined in India. In Sanskrit the diamond was called *vajra*, the thunderbolt of Indra. Some believe diamonds were first introduced to the West and Egypt by Alexander the Great and his army after they campaigned in India. According to that view diamonds were not known in Egypt until the Ptolemaic period unless Arab traders brought some from India earlier -- which of course is very likely. However, I do not know of any diamond artifacts unearthed in Egypt that date from ancient times.

On the subject of gemstones Theophrastus (8) says, "Some stones are quite rare and small, such as the *smaragdos*, the *sardion*, the *anthrax*, and the *sappheiros*, and almost all those that can reasonably be cut and used as seals." The *smaragdos* was a term used more generally than just for emeralds and probably indicated any stone with a greenish tint or very hard. It probably derived from Egyptian "smery" (emery, corundum) with the connotation of "smer" (a noble title) plus "qed" (quality). *Sardion* and *anthrax* are red gemstones, the former named after the ancient city of Sardis, and the latter named after the red glow of burning charcoal.

Theophrastus (19) also mentions a stone called *adamas* or *adamantos* (αδάμαντος') by the Greeks that has been identified as the hard abrasive corundum. The Greek term literally means "unconquerable" and apparently refers to the stone's hardness. However, the Hebrew word ADM means red, and could refer to the ruby and other reddish forms of corundum. It is very possible that the Greeks learned of such precious stones and hard abrasives from the Hebrew and Phoenician traders and borrowed the word from them. There seems to be a connection to Egypt here also. The word "Atem" or "Adem" in Egyptian is the name of the form of Ra's phallus that initiates the "Big Bang" of the universe. The name came to be associated with the red glowing sun at dawn and at dusk because of the completeness of his creation as opposed to "Aten" as the disk of the sun high in the sky. Egyptian "ademayt" or "atemat" was a kind of red cloth. Those words would transliterate into Greek as "adamas". Thus we see an association of the word "adem" in Egyptian with the phallus of Ra and the color red.

Pliny (XXXVII, 60), writing in 60 B.C. about two and a half centuries after Theophrastus, mentions embedding *adamas* in iron to cut the hardest substances. Dioscorides (V, 165) mentions emery (σμυρις), which is the less pure form of corundum as a substance used for cutting and polishing precious stones. In any case I have so far not encountered any confirmed diamond artifacts surviving from the period of pre-Ptolemaic classical Egypt. Therefore, unless evidence emerges to the contrary, I will proceed on the assumption that the ancient Egyptians did not know about diamonds and were using corundum from nearby sources such as Miletus or Naxos as an abrasive harder than ordinary sand -- of which they obviously had no lack.

Hard Gemstones Mentioned in the Bible

Sapphires are mentioned several times in the Old Testament in the following passages:

Exodus 24:10, . . . And they saw the God of Israel. There was under his feet as it were a pavement of sapphire stone, like the very heaven for clearness.

Exodus 28:18, Exodus 39:11, . . . And the second row an emerald, a sapphire, and a diamond;

Job 28:6, Its stones are the place of sapphires, and it has dust of gold.

Job 28:16, It cannot be valued in the gold of Ophir, in precious onyx or sapphire.

Song of Solomon 5:14, His arms are rods of gold, set with jewels. His body is polished ivory, bedecked with sapphires.

Isaiah 54:11, "O afflicted one, storm-tossed and not comforted, behold, I will set your stones in antimony, and lay your foundations with sapphires.

Lamentations 4:7, Her princes were purer than snow, whiter than milk; their bodies were more ruddy than coral, the beauty of their form was like sapphire.

Ezekiel 1:26, And above the expanse over their heads there was the likeness of a throne, in appearance like sapphire; and seated above the likeness of a throne was a likeness with a human appearance.

Ezekiel 10:1, Then I looked, and behold, on the expanse that was over the heads of the cherubim there appeared above them something like a sapphire, in appearance like a throne.

Ezekiel 28:13, You were in Eden, the garden of God; every precious stone was your covering, sardius, topaz, and diamond, beryl, onyx, and jasper, sapphire, emerald, and carbuncle; and crafted in gold were your settings and your engravings.

The above translations are from the English Standard Version (ESV). Most likely, the stone called sapphire was actually lapis lazuli, especially when the usage draws on the blue color as in the first two passages from Ezekiel. The use of sapphire as pavement suggests its hardness. The use of sapphire for a throne, a foundation, or possibly for describing a healthy body also suggests the quality of hardness. The occurrences in Exodus suggest that the stone was known in ancient Egypt.

Of particular interest is the description in Exodus of the "Breastplate of Judgment" to be worn by Aaron. This device was adorned with twelve different gemstones set in four rows of three stones each. The stones were to symbolize the twelve tribes of Israel. The ESV version is basically the same as the King James Version (KJV). Row two in the breastplate has "an emerald, a sapphire, and a diamond" according to the ESV and KJV. The word for sapphire (*S*PYR) appears for the second stone in the second row. The Jewish Publication Society (JPS) version translates row two as "a carbuncle, a sapphire, and an emerald." A carbuncle is a deep red garnet or other red gemstone and derives from the image of a glowing coal. The Hebrew word is NPK, which is glossed as a precious stone, suggesting that all translations are pure guesswork on the part of the scholars. The root means to glisten or shine, which does not tell us much. Some think it is emerald, and others think it is a garnet. So take your pick. The third stone is translated as a diamond or an emerald. The Hebrew word for this gemstone is Y*H*LM, which is glossed by Ben-Yehuda and Strong as a diamond, probably because that is how it has come to be understood by convention. There is a possibility that it relates to Y*H*R, which means proud or haughty. It could even derive from *H*R, which means mountain.

On the other hand Y*H* is a Hebrew name for God, and the letter L in Hebrew is the sign for the phallus, suggesting the possibility of a connection between the ancient Hebrew god Yah and the Egyptian god Ra-Atem, both of whom were depicted as ithyphallic in ancient times. The idea that original man (ADM) is made in the image of God could have been a play on this tradition that the phallus is like a little man, and is also the tool that a man uses to create another man. The Hebrews added yet another dimension to the word play by saying that man was made of earth, and the word for earth in their culture was "ADM*H*", presumably indicating a reddish, iron-rich soil.

The root of the Hebrew word sapphire is "*S*P" (usually pronounced like "sef"), which means to scratch, and suggests the idea of using a very hard substance to cut a mark into a slightly less hard substance. The ability to scratch a mark into something hard and stable was the origin of record keeping. In the beginning it was simply making a scratch or a notch. The ancient Egyptian numbers from one to nine were written as notches (|, ||, |||, ||||, |||||, ...). A series of notches led to the concept of numbers and counting. Diversification of notches into other shapes gave birth to symbols for decoration and eventually the standardized identification of items in the records of notches. From this came mathematics, writing, and books. The Hebrews appended the letter "R" to "*S*P" to indicate these ideas, "*S*PYR" coming to represent a crystal hard enough to scratch notches into any other substance. The words for numbers, writing, and books in Hebrew all come from this root.

In Egyptian "sef" is a knife or sword. Used as a verb it means to cut. "*S*ep" is a mathematical term used to indicate multiplication. It generalizes as an interval or classification and takes on many meanings: a time, season, fate, occasion, opportunity, accident, condition, case, situation, kind, sort, manner, behavior, characteristic. The "*s*ep tepy" was the primeval time. It came to used for a case at law, a time of judgment, a remainder, and so on. It could also represent a segmented worm, a centipede, or the spinal column. All these meanings seem to derive from a very ancient notion of scratching or cutting marks.

There is a tradition that the sapphire represented the penetrating Eye of Horus the Hawk and the ruby represented the blood-thirsty power of Sekhmet the Lioness. The blue of the sapphire suggests the sky in which the hawk flies. The red of the ruby suggests the blood and the fiery nature of the lion's energy. Both stones are equally hard and are really the same corundum but with different impurities that contribute the coloring (chromium for the ruby and a mixture of iron and titanium for the blue sapphire). However, it is not certain how old this tradition is, and it may have arisen only during the Ptolemaic and Roman period when such stones are known to have entered Egypt.

We should also mention that the Egyptian god Set (or Setesh) represented the hardness of stone and the harshness of the desert. His name was often written with a stone radical, and both "set" and "tesh" could mean a knife for carving stone or a stone. A "tesh" was also a boundary or the boundary marker that divided territories.

The Crossover Problem

Now we come to the crux of the issue about charge. Hardness is a manifestation of electrostatic charge. When charge becomes intense enough to generate chemical bonds, a collection of atoms and molecules generally precipitates from a gas to a liquid and then to a solid. This process is governed by the amount of heat present as kinetic energy among the component particles as well as the inherent tendencies of the particles to associate into structured relationships. This involves the shapes of the component particles and the resultant distances between the charged portions.

When the attraction of the charges is very slight due to fewness of charges, fewness of particles, and/or inefficient interaction of the charges wrought by the geometry of the shapes involved, then it is possible to separate the attracting charges by pulling them apart. However, when the attraction of the charges is very strong due to a high quantity of charges and particles and/or a geometry that promotes efficient interaction of the charges, then it becomes impractical to pull the charges apart. This is especially true with hard stone that consists of charged components agglomerated into a large mass. The ancients were aware of this problem (as Theophrastus comments in section 41 of his book) and found creative ways to split extremely hard substances that could not be scratched by the stone and metal tools they generally used. Such methods involved applying heat, studying the crystal structure, finding tiny flaws or cracks, and so on.

Thus we have a compound issue. We must find the crossover point in the Egyptian reciprocal system (their standard for m/n = 1/1 = 1), and we must find where they switched from "pulling apart" (1/n) to "scratching" (m/1). Perhaps the two crossover points are identical.

The problem is further complicated by the presence of other properties such as brittleness, smoothness, flaws, impurities, irregularities, and so on.

The Secret of Ancient Egyptian Alchemy

Recently Margaret Morris published a book titled **The Great Pyramid Secret: Egypt's Amazing Lost Mystery Science Returns** (Detroit: Scribal Arts, 2010) that reveals remarkable new discoveries that have been made in material science that are beginning to explain how the ancient Egyptians created massive pyramids and temples built with huge blocks of medium-hard to very hard rock within short periods of time in an age when the only tools they had available were rock pounding balls and crude copper tools.

The mystery of the Old Kingdom pyramid construction is compounded by the absence of quarrying evidence (Old and Middle Kingdom quarrymen used pointed stone picks inadequate for quarrying blocks), no evidence of a block transport system, no efficient way to raise the blocks, and high technical perfection in the edifices that we are unable to reproduce with modern tools. Morris proposes that an emerging new technology of geopolymerization developed by Dr. Joseph Davidovits can explain how the Egyptians were able to build huge pyramids to great technical perfection without sophisticated tools and transport equipment.

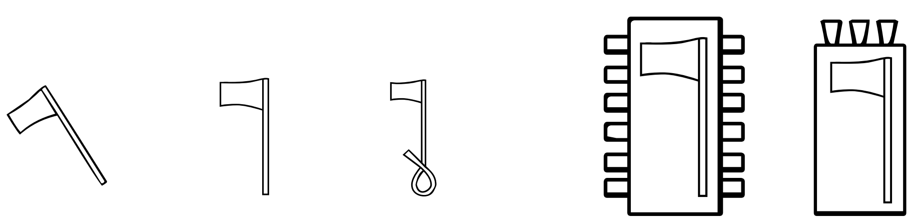
According to the theory of Davidovits and Morris the Egyptians prepared the limestone blocks by breaking up weak limestone in quarries and excavation pits into rubble with their stone picks. They then transported the rubble in baskets on donkeys. At the construction site they soaked the rubble for five to ten hours in water, during which time the weak limestone would crumble and the kaolin clay with silica and aluminum compounds would be released. Then they would add caustic soda, which they made using lime plus natron, which is mostly sodium carbonate. When the mixture set, it generated a cement or concrete that is almost exactly the same as natural limestone except that close inspection might reveal a greater jumbling than the more layered texture of usual sedimentary rock. The rock-concrete could be mixed and poured right on site and in place with a perfect fit so that no moving of heavy blocks was necessary or laborious shaping and finishing work. They could use rammers to force the water out and simple tools to shape the material before it finally hardened.

Caustic soda is sodium hydroxide (NaOH). Natron is sodium carbonate (Na_2CO_3), and lime is calcium hydroxide $Ca(OH)_2$. When natron and calcium hydroxide are combined a metathesis occurs that results in the production of calcium carbonate and sodium hydroxide.

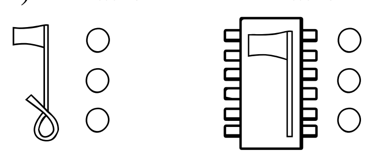
$Ca(OH)_2 + Na_2CO_3 \rightarrow CaCO_3 + 2\ NaOH$

Natron in ancient Egypt was considered a sacred and divine mineral. It is well known that the Egyptians traditionally used it for preparing mummies and as an incense ingredient. What is not understood is the extent to which they used it as a special ingredient in "megalithic" construction.

"Netra" or "nether" is the Egyptian word for natron and is the obvious origin of the English word. The Egyptian word derives from "neter", which is usually translated to mean divine or to indicate a deity and was written with a glyph that is a pictogram of an axe, but probably also represented a pole with a pennant on it such as they placed over the entrances to temples. "Neter" can be analyzed as "net-er", which would mean "that being which is beyond". Another analysis gives us "ne-ter", which would be something to be revered or worshipped or "for a time interval or season". English words such as nature, natal, and innate derive from "neter" via Latin.



neter, nejer (axe) neter (deity) netra, nether (natron) natron natron

 incense bag sachet determinative 

The three dots represent powdery material, small pellets, or particles. The glyphs that surround the neter glyph represent a wall, a fort, or other edifice. These glyphs tell us that the Egyptians used natron as a component of their construction materials as well as a component of incense. This information has been publicly available in texts and dictionaries ever since the deciphering of Egyptian hieroglyphs, but nobody to my knowledge has ever commented on why the construction and fortress determinatives are used with natron. Now we are able to understand why the Egyptians wrote natron in this way. It was a vital component in the creation of poured limestone rock concrete for the construction of temples and pyramids. For the ancient Egyptians this was a divine and sacred technology profoundly embedded in their sacred constructions.

The next question we must consider is how the Egyptians could cut, carve, engrave, transport, and erect huge granite, diorite, and basalt megaliths. We also have to deal with the fine diorite plates, bowls, and urns that apparently were turned on a potter's wheel while the geopolymer was still pliable. The Egyptians not only understood how materials bind together through electric charge, they mastered the technology of manipulating the hardness of materials through a sophisticated chemistry that did not require application of high temperatures, but relied on the use of water and special binding chemicals. Khenemew (Khnemu) is the tutelary deity of this technology and is often shown molding objects apparently made from clay on a potter's wheel. The assumption is that he is molding ordinary pottery, but he could be producing geopolymerized stoneware. There exist numerous vessels from the Old Kingdom that appear to have been folded and otherwise manipulated during their manufacture and instances of vessels apparently made of two different materials bonded together so perfectly that no traces remain of the bonding material -- for example one portion is made of graywacke and the other portion is of calcite and the two materials are flawlessly joined.

“At least one piece is so flawlessly turned that the entire bowl (about 9 inches in diameter, fully hollowed out including an undercut of the 3 inch opening in the top) balances perfectly (the top rests horizontally when the bowl is placed on a glass shelf) on a round tipped bottom no bigger than the size and shape of the tip of a hen's egg! This requires that the entire bowl have a symmetrical wall thickness without any substantial error! (With a base area so tiny - less than .15 square inches - any asymmetry in a material as dense as granite would produce a lean in the balance of the finished piece.) This kind of skill will raise the eyebrows of any machinist. To produce such a piece in clay would be very impressive. In granite it is incredible."

(Photos and text quoted from "Official Thread of the Unexplained":
http://boards.collectors-society.com/ubbthreads.php?ubb=showflat&Number=4734742&fpart=4)

The key to how the stone vessels were made is that they were "cooked" as a slurry of small fragments in a mixture of geopolymer ingredients such as kaolin, natron, and lime at a temperature of about 2000 degrees and then allowed to cool and set. While the mixture had not fully hardened, it was molded on a potter's wheel to achieve the perfect roundness and balance. Once hardened it appeared to be a piece of natural granite or diabase. Even in predynastic times the Egyptians could create imitation gems with glass paste and had unsurpassed craftsmanship in the working of flint. By the first dynasty they had mastered techniques of drilling rock crystal with sand abrasives to fashion vases and other delicate shapes as evidenced by examples found at Saqqara.

Evidence of ancient Egyptians rapidly sawing, and drilling hard rocks such as granite as if it were a soft substance suggest that the Egyptians may have worked synthetic stone with their flint and copper tools before it fully hardened. The Egyptians also could carve and inscribe such stones in the same way. We know the Egyptians used rammed earth construction. The Egyptians could use special ramming techniques applied to synthetic rock as it cooled and set to produce stonework harder than the natural rocks in the quarries from which they obtained the raw materials -- again suggesting that they may have been manufacturing much if not most of the stone they used for construction and decoration with geopolymer techniques.

The Old Kingdom pavement slabs at Giza are made of basalt. The quarry origin for this material was in the nearby Fayum at Gebel el-Qatrani, where there is an extensive basalt outcropping that was quarried extensively for use at Giza. However, it turns out that the basalt there has fractures that disallow large blocks. Furthermore, there are no tool marks at the quarry and the quarrying activity appears to be in the form of gathering highly weathered debris rather than cutting blocks. There is a seven-mile paved road -- one of the earliest paved roads in the world -- from the quarry, but no evidence on it of dragging large blocks. There are occasional piles of basalt debris that seem to be from spilled loads. All of this suggests that the Egyptians did not quarry basalt blocks but gathered basalt debris and transported it in baskets on donkeys and then used it to create geopolymerized slabs on site at Giza. The slabs at Giza have been identified as sourced from Gebel el-Qatrani, but their texture is coarser than that of the basalt there and really is a form of coarser grained diabase. Davidovitz and Morris take that as indicating the material came from Gebel el-Qatrani, but was then cold-geopolymerized into slabs rather than applying heat, with the result that the slabs have the texture of diabase, a type of rock that does not occur at all in the Fayum area. According to Morris, Davidovitz has been able to replicate the synthesis of both the coarse-grained diabase and the finer grained basalt by using, respectively, cold and hot geopolymerization processes. The rate of cooling after hot processing also has significant bearing on the final texture of the rock concrete.

Morris also believes that the sandstone slabs used for the quarry road at Gebel el-Qatrani were synthesized from local sand rather than quarried and hauled into place. The sandstone paving slabs are close fitting, without mortar, and lack any sign of tool marks. There is also no evidence that large, heavy blocks were dragged over them. The simple answer, according to Davidovitz and Morris, is that the road was used by donkeys transporting loads of highly weathered basalt debris rather than for dragging heavy blocks.

Morris also cites evidence that by the New Kingdom some of the rock-synthesizing techniques had declined to the point that inferior products resulted. Unearthed statues have been observed to crumble or dissolve under certain conditions in which natural rock of the same type would remain unchanged.

In summary, Margaret Morris has presented a strong case for synthetic rock production in ancient Egypt and backed her case up with extensive documentation from geological studies plus the experimental evidence obtained from the work of Davidovits. The truth level of these findings will be borne out as the reviving technology of geopolymerization develops. It will be possible not only to replicate (and restore) the great monuments of ancient Egypt, but also to create many amazing new modern artifacts of great use and beauty -- not only on this planet, but on the Moon, Mars, and elsewhere.

As a side note, there are claims that the photographic evidence of the Martian probes provided by NASA strongly suggest that geopolymer construction techniques have been widely used on Mars and are currently still in use there. (See Joseph P. Skipper's site http://www.marsanomalyresearch.com/ for abundant photographic evidence. For example, see report #029 with a photo of a huge nozzle spraying what looks like a geopolymer liquid goo construction material at a large project site.)

To whatever extent the Egyptians attained expertise in synthesizing their stone building materials, we know that they worked with clay, metals, and knew how to make mortar and cement as a binding agent. This suggests a range over which we can define a consistent type of measurement as opposed to the contrast between pulling substances apart and scratching substances. We can define a property called viscosity that describes the resistance of a given substance to penetration by a standard substance of maximum hardness. The range would be from zero viscosity to maximum hardness. Zero viscosity would be the standard object moving through free space. It turns out that even light moving through space experiences some drag due to the density of space. Space is not truly empty. There are always a few particles plus a lot of "virtual" energy.

Virtual energy is somewhat like potential energy, except that it does not have any preferred orientation such as gravitational potential energy. Virtual energy results from light of all different frequencies and phases coexisting in free space. It is not usually observable because the waves all cancel out. However, it becomes observable if some of the waves are blocked such as happens when two parallel plates without charge are placed very close to each other. A measureable attraction or repulsion occurs because longer wavelengths are disallowed in the narrow space between the plates. This phenomenon demonstrating the reality of virtual energy is called the Casimir effect after the scientist who first predicted it in 1947 and 1948. Since that time the effect has been observed with ever increasing precision as technology advances. Scientists developing nanotechnology find that the Casimir effect becomes a profound component in the operation of nanomachines. They have generalized the behavior of the effect for all sorts of geometries and topologies and find that for certain shape configurations the effect becomes repulsive rather than attractive. It may be possible to achieve cascading gains of the Casimir effect similar to the way scientists can amplify stimulated emissions of light to produce powerful laser beams. We may expect rapid evolution of our knowledge base and skills in this technology arena over the coming years.

We do not know how ancient Egyptians might have been able to measure the way the vacuum state of free space interacts with matter at such close nanometer ranges. However, there is a range that is available to observation with the naked eye or the eye aided by simple magnifying lenses -- which we know was available to the ancient Egyptians through the use of lenses and small bottles or vases that they already began carving from rock crystal during the Old Kingdom and predynastic times. Robert Temple (see **Crystal Sun**) suspects that elite pharaohs and priests may have used crystal lenses and bottles to kindle sacred fires with sunlight as a more dignified and refined way than the common crude method of spinning the bowdrill, and he presents considerable evidence to support his opinion.

A few pages back I mentioned the phenomenon we call Brownian motion. It is possible to observe small particles of lint and dust moving about randomly in rays of sunlight. In addition to slight air currents, the kinetic motion of smaller particles in the air buoys up these particles that have no aerodynamic qualities. In a vacuum the dust particles would fall directly to the ground unless they have been energized electrostaticly by sunlight. However, Earth's gravity is much stronger than the Moon's, so particles subject to electrostatic levitation would be much smaller than those that we observe on the Moon and very likely not visible to the human eye.

If you observe the floating dust motes carefully you will see a similarity to leaves and bits of wood floating on the surface of a pond, but of course in a three-dimensional space. From predynastic times in Egypt we find the Egyptians were building boats of papyrus reeds to travel on the Nile. They celebrated the importance of that technology by featuring stylized drawings of such boats on their very early pottery. Floating is a fascinating ability to counteract the influence of gravity. Stones do not float on water. They sink. Yet the Egyptians used barges to transport stones for constructing their pyramids and temples.

Gravity and Density

We tend to think of gravity as a force. Actually it is not a force -- it is a relaxation. It turns out that the essence of gravity is the tendency of an object to seek equilibrium in its environment. This simply means that an object will spontaneously adjust its position in an environment until it reaches an environmental density that matches the density of the object it exists as -- unless it is blocked from doing so by some other intervention. Thus the influence of gravity depends upon the belief one has about the density of the object one exists as or that one is observing or manipulating with a given density environment. This realization suggests that by redefining one's belief about the density of an object under consideration one may modify the behavior of an object. There is no particular prescribed way to do this, but it boils down to the principle that creative adjustment of point of view with regard to an object existing in an environment may significantly affect the behavior of that object in its environment. This may or may not involve physical manipulation of the object. For example, carving, transporting, lifting, and placing of a 50-ton block high up on a pyramid could be a daunting engineering challenge. Or it could simply involve a crew of men carrying some baskets of rock debris, some pails of water, some buckets of binding agent, some lumber for forms, and some simple carpentry and masonry tools to finish the job without any great strain.

The essence of "anti-gravity" is motion. There are two kinds of motion: tangential motion and density adjustment. Density adjustment is motion toward or away from a point of maximum density and depends on the relative density of an object in a density gradient. It is purely a relaxation response. Tangential motion is motion tangential to the density gradient caused by collision with a secondary object. It is a relaxation from a resistance response. The resistance response is a recoil due to the object's inability or unwillingness to allow something else to occupy its space (e.g., Pauli exclusion). The innate motion could be in the object or in the secondary object, but the resultant motion almost always has a component that is tangent to the point of maximum environmental density. The secondary object might even be at the point of maximum density, but usually is not. The resultant motion of an object may be purely tangential, purely density adjusting, or any combination of the two. As an object moves, it also may shift among several points of maximum density that will vie for equilibrium priority depending on the speed and direction of the object's motion. The entire environment is always seeking maximum equilibrium.

The upshot of this is that gravity depends on density. If there is no density, there is no gravity. To have density, there must be mass. We can interpret mass as a density (kg/m^3) times a volume (m^3). The gravitational constant G has the units of m^3/s^2 kg. We can interpret this as a frequency squared (s^{-2}) per density (kg/m^3). Multiplication represents a dynamic interaction. Thus we have something with density occupying a volume of space that we call mass. Mass must have density and it must occupy a finite volume of space. When two masses interact gravitationally, the two densities interact, as Newton's formula shows: $F_g = G\, m_1\, m_2 / r^2$. The "anti-density" in G cancels the density of one of the masses -- usually the dominant mass that contains the point of maximum density. The volumes occupied by the masses are reduced in dimension by the distance between the two centers of mass and the square of the interaction period. The distances and periods relative to each mass are equal. What remains is the acceleration of the less dense mass, which we interpret as a force exerted on it.

The Fundamental Dislocation of Mechanical and Electromagnetic Units

Now we must put some attention on the problem of finding a mechanical interpretation of the electrical units. I brought up the issue earlier when I showed how *pi* times the ratio of electric charge to the speed of light looks convincingly like the mass of a nucleon. Initially I considered that the electric permittivity of free space would be a unit of density (kg/m^3) even though it is usually disguised in the form of "farads per meter" (F/m). Electric flux varies according to the medium with which it interacts. The permittivity indicates how much flux is allowed per unit of charge in a medium. Generally the flux is maximum when the charge density is least -- i.e., in free space. However, there are cases where the charges in a medium can be polarized and lead to a permittivity greater than free space. Generally, the permittivity of free space ε_o is taken as the baseline and is multiplied by a dimensionless relative permittivity ε_r to indicate the difference from space caused by the medium.

After further consideration I realized that the photon is a particle that transfers electromagnetic energy from one charged particle to another. Although the photon is thought to vibrate as it travels through space, there is no way to directly observe such vibration. A particle emits a photon from a point in space and another particle absorbs the photon at another point in space. As far as we know an unimpeded photon in free space travels in a straight line (or a gravitational geodesic if we think in terms of general relativity). Thus we can think of the density of photons as the amount of mass-energy found in the straight line displacement between the point of emission and the point of absorption, which means we interpret this in mechanical units as kg/m.

There is also a magnetic permeability that indicates how conducive a substance is to a magnetic field. Maxwell found in his study of electromagnetism that the speed of light squared equals the reciprocal of the product of the electric permittivity and the magnetic permeability: $c_o^2 = 1 / \varepsilon_o \mu_o$. We can also write the reciprocal relation as $\varepsilon_o \mu_o c_o^2=1$. Einstein then added the relation $E^{-1} m_o c_o^2 = 1$, where m_o is the rest mass of a particle. After de Broglie discovered the wave nature of particles, a third equivalent reciprocal relation that I call the Velocity Equation was added: $v_g v_p = c_o^2$. (This latter relationship had already been noticed by Sommerfeld.)

$(E/m_o) = (\varepsilon_o \mu_o)^{-1} = v_g v_p = c_o^2$.

When the fine structure constant was discovered, it was found to have relationship with the permittivity that recalls Coulomb's equation: $\alpha = e^2 / 4 \pi \varepsilon_o \hbar c$.

By rearranging and squaring we can add this relation to our collection:

$c^2 = (e^2 / 4 \pi \varepsilon_o \hbar \alpha)^2$.

Coulomb's equation for two interacting single quantum charges is $Fe = e^2 / 4 \pi \varepsilon_o r^2$.

If you look at the **Wikipedia** discussions of permittivity and permeability, you discover that they have relative and absolute values. The relative values describe electromagnetism in the context of particular materials, but the absolute values are idealizations of a baseline for the behavior of electromagnetism in free space. Right off the bat we notice something funny. The articles say that these values of permittivity and permeability apply to the "classical vacuum", which is odd because the classical vacuum is supposed to be completely empty and therefore should provide unlimited permittivity and permeability for electromagnetic phenomena. However, the observed result is that the speed of light is finite, and Maxwell showed that electromagnetism behaves like light and for all purposes must be considered an aspect of or a way of describing light. That means the permittivity and permeability end up with finite values, which also implies that the "classical vacuum" is not completely empty, but contains a medium that used to be called the "aether". By the twentieth century the notion of an aether was jettisoned, but it never really goes away despite the pretensions of scientists, because we still use Maxwell's equations that were based on that notion.

If we try to discover how the finite values for permittivity and permeability are measured we enter a tangled tale involving the historical bootstrapping of measurement and metrology, mostly during the 19th and 20th centuries. You can't make measurements without some metrological units. You can't decide what the best units are until you take some measurements. So you end up starting with an arbitrary unit and taking some measurements to see how things fit together. Once you get deeper into things, you discover relationships that suggest revising your units. This becomes a problem, because all the measurements done before were with the old units, so the documents are in the old units, and the measurers habituated to them resist changing to a new standard.

What we find as we go deeper in research is that the physical world expresses itself in various properties such as size, duration, motion, resistance, and so on. These properties are all related in certain ways, and once we discover the most general and constant relationships, we can set these up as the baseline for metrology, because truly constant relationships hold for all times, places, and conditions in the universe. Once you know the relationships, you can set up shop anywhere and anywhen and do some hopefully simple experiments to determine the baseline units so that your research and applications will agree with those of anyone else in any other time, place, or condition. That at least sounds to me like a reasonable way of going about things.

For example, you can draw a circle with a string, make a wheel, and mark a point on its rim. If you then roll it on a flat surface, the distance on the flat surface from where the mark touches the surface to the next time the mark touches the surface will be *pi* = 3.14159 times the diameter (or *pi* times double the radius), *pi* being just an arbitrary name given to the relationship. This will work at any scale and any time or place where you can fashion a wheel and roll it on a flat surface.

The idea we are exploring in this book is that the ancient Egyptians somehow figured out these fundamental relationships of the cosmos to a fairly accurate degree and encoded them in the Senet Oracle Game Board. We are attempting to reverse engineer a plausible scenario for how they may have arrived at the numbers and relationships they designed into a game. You will have to decide how successful we are.

It turns out that our modern concepts of the electric permittivity and magnetic permeability derive from the definition of the ampere as "that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross section, and placed 1 meter apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newtons per meter of length." (The quote is from **Wikipedia**, "Vacuum Permeability".)

The decision to work from the ampere, a unit of electric current, rather than a measurement of static electrical charge derives from the problem that static charge is not really static and tends to dissipate, except for quantum charge -- which was apparently deemed too difficult to measure as a standard. It turns out that electric current is only measured indirectly by the magnetic force that it induces -- which turns out to be ORTHOGONAL to the direction of current flow and between two interacting parallel wires. As you can see from the above definition, this is also an idealized definition that can only be approximated. The vacuum magnetic permeability according to the definition then comes to be $4\pi\times10^{-7}$ H·m^{-1}. In other words, Ampere's relation gives the magnetic force as $F/\text{m} = \mu_o I^2 / 2\pi r$, where r is the distance between the interacting wires. The force (F) is in newtons, the current (I) is in amperes, and the force per meter of distance is 2×10^{-7} N/m. Solving for the vacuum permeability according to the definition of 1 ampere gives us: $\mu_o = (2\pi r)\ (2\times10^{-7}\ \text{N/m})\ /\ \text{A}^2$. This means that the vacuum permeability by definition of the ampere is $4\ \pi\ \times10^{-7}\ \text{N}\ /\ \text{A}^2$. (For more detailed discussion of the complicated historical details, see **Wikipedia**, "Vacuum Permeability".)

The newton is a mechanical force, which is necessary to be able to measure the flow of electric current. The unit of electrical current is the ampere. We want to look at the mechanical properties of charge, and we find that the unit of charge is defined as the coulomb (C) and is based on the ampere as an ampere-second (A·s). Ampere's force formula simply tells us that the ampere (A) is equal to the current I, but does not tell us what it is mechanically. It does tell us that the magnetic permeability balances out the other units in the relationship. This brings us to Maxwell's equation as a way to determine the mechanical units of charge.

The speed of light is in meters per second. Let us assume from Coulomb's static electricity equation that the electrical permittivity is a measure of density and we will put it in mechanical units as a mass per volume (kg/m^3):

$Fe = Qq\ /4\ \pi\ \varepsilon_o\ r^2$.

Then the Qq represents two interacting charges that must be each in units of kilograms per second (kg/s). If Maxwell's equation $[1\ /(\varepsilon_o\,\mu_o) = c^2]$ holds, then the mechanical units of permeability must be (ms^2/kg), because Maxwell's relationship must then give the following units: (m^3/kg) (kg/ms^2) = m^2 / s^2.

The problem here is that our scientists do not give a clear-cut mechanical unit for charge, so we must derive it from the ampere, and the ampere is only derived indirectly from a magnetic force. The magnetic force, according to Ampere's force law depends on the units of magnetic permeability. So the whole thing is circular. Miles Mathis demonstrates the nature of the problem in his article, "Electrical Charge" (pp. 29-30), where he cites as a starting point the SI units for the permeability constant ($\mu_o = 4\pi\times10^{-7}$ N/A²), and then arbitrarily suggests that we take the ampere (A) to be the same as the herz (Hz = s^{-1}). Then he substitutes the corresponding units for permeability (kg m) into Maxwell's relation ($\varepsilon_o = 1/(c^2\ \mu_o)$) to derive the permittivity units (s^2/kg m^3). Next he plugs the ε_o units into Coulomb's equation ($Fe = q_1q_2 / 4\pi\ \varepsilon_o\ r^2$). In that case all the units cancel out, leaving the charge to be what he calls a "floater" -- i.e. nothing at all. That makes an ampere become a herz, and a volt then becomes a joule. The ampere force and the coulomb force then both derive from a magnetic force interacting with the speed of light rather than from some charge. The magnetic force only arises when there is motion. Then Mathis turns around and uses the cgs system to show that charge is equivalent to mass, and mass alternatively can be in terms of length and time, which of course means motion. All of this suggests that mass only appears when there is motion, and the idea of "rest mass" is a fiction. If that sounds confusing, it is, because it is unnecessarily confusing.

Another proposal is that electric current can be treated like what it is called -- a "current". Current implies the velocity of a volume, as for example we might measure the flow of water through a pipe with a given diameter aperture. However, from the idealized definition of an electrical current as point charges flowing along an infinitely thin wire, then we do not need to consider a volume. We only have an idealized velocity (m/s) of point charges flowing along a line.

I have prepared a chart below that shows how the mechanical interpretation of electromagnetic phenomena varies significantly depending on how we define the ampere (A) in mechanical terms. In the chart "Mech" stands for a mechanical interpretation; "a" is based on taking permittivity as density (kg/m³), "b" is the approach suggested by Mathis in the above-mentioned article. Some physics textbooks provide a table that purports to show analogies between mechanical and electrical quantities. These analogies often rely on formulas that look similar in the "corresponding" mechanical and electrical situations, starting with the above-mentioned idea that electrical current resembles a liquid current and thus can be considered a velocity. You can see this "Mech c" analogy in Harris Benson, **University Physics**, p. 660. Richard Feynman has a similar chart in his **Lectures on Physics**, volume 1, p. 23-6.

The empty parentheses ( ) indicate that the unit becomes a dimensionless number indicating the scale of something with respect to some other dimension. For example, the coulomb in the "Mech b" system becomes dimensionless because the units cancel out when an ampere is a frequency and a coulomb is an ampere-second.

Unit	Symbols	SI	Mech a	Mech b	Mech c
ampere	A	A	kg/s^2	s^{-1}	m/s
coulomb	C	A·s	kg/s	( )	m
volt	V	J/C	m^2/s	kg m^2/s^2 = J	kg m/s^2 = N
herz	Hz	s^{-1}	s^{-1}	s^{-1}	s^{-1}
watt	W	J/s	kg m^2/s^3	kg m^2/s^3	kg m^2/s^3

v. permittivity	ε_o	F/m	kg/m^3	s^2/kg m^3	s^2/kg m = N^{-1}
v. permeability	μ_o	N/A^2	ms^2/kg	kg m	kg/m
ohm	Ω	V/A	m^2 s/kg	kg m^2/s	kg/s
tesla	T	N/A·m	( )	kg/s	kg/ms
weber	Wb	T·m^2 = J/A	m^2	kg m^2/s	kg m/s = p
henry	H	V·s/A = Ω·s	m^2 s^2/kg	kg m^2	kg
farad	F	C/V	kg/m^2	s^2/kg m^2 = J^{-1}	s^2/kg

In addition to the SI system that is based on the meter-kilogram-second (**mks**) mechanical units, there is the older centimeter-gram-second (**cgs**) system that uses electrostatic units to measure electric charge, current, and voltage. The statcoulomb (statC) unit of electric charge is defined as follows: if two stationary objects each carry a charge of 1 statC and are 1 cm apart, they will electrically repel each other with a force of 1 dyne, where 1 dyne equals 10^{-5} newtons. The cgs system has the advantage that the statC unit is closer to most real world systems than the very large coulomb (1 C = 2,997,924,580 statC, which rounds off to 3×10^9 statC -- basically a coulomb multiplied by ten times the speed of light). However, in the cgs system Coulomb's force law is simply the product of the two charges divided by the square of the distance between them. That means charge has the strange units of $M^{1/2}\ L^{3/2}\ T^1$, (where M = mass, L = length, T = time) which looks pretty unreal, and suggests that components are hiding in the cgs formula $Fe = q_1q_2/r^2$. Indeed, there is the question of the permittivity constant. Furthermore, the statC has to be multiplied by 4 π to serve as the coulomb of electric flux. It makes sense that a charge should be expressed in a whole unit of mass or length rather than the square root of a mass or a length until we notice that no single quantum charge exists by itself in isolation. It always has a partner with which to interact if we are to measure any charge.

The question is: which system is more in accord with reality? One of these, or something else? As I look over the chart, I am attracted to **Mech c**, the notion that an electrical current is a velocity and a voltage is a force. Also it makes some sense that a resistance (R) is a mass per second. $I = V/R$. Current is voltage divided by resistance: m/s = (kg m/s^2) (s/kg). Electric permittivity is a force that works against the transmission of electric flux and is thus somewhat like electrical resistance. Magnetic permeability is an effective mass that is dependent on the coulomb charge. It also makes some sense that mass is particularly involved with magnetism, because magnetic phenomena only appear when a charge is in motion, and mass can only be measured when something is in motion. The one apparently strange unit in this interpretation (**Mech c**) is the coulomb itself that turns out to be a meter, which is a unit of length. Larson in his Reciprocity System takes current as velocity and charge as a spatial unit -- corresponding to 1 meter in my system, but distinguishes this electric quantity from a charge flux, which he considers to be a reciprocal velocity, that is, time per space. Larson's system is rendered unfamiliar because he reduces mass to a relation between space and time. This has not been our habit, since Newton coined the notion of mass as a fundamental property. Furthermore there is the problem of whether or not there is a distinction between static charge and current charge. There is also the question of whether or not uncharged electrons may exist. Here is what Larson says on the subject.

"The truth is that this concept of an electrostatic force (*Eq*) applied to the electron mass is one of the fundamental errors introduced into electrical theory by the assumption that the electric current is a motion of electric charges. . . . Such a force would produce an accelerating rate of current flow, conflicting with the observations. In the universe of motion the moving electrons that constitute the electric current are uncharged and massless. The mass that is involved in the current flow is not a property of the electrons, which are merely rotating units of space; it is a property of the matter of the conductor. Instead of an electrostatic force, t/s^2, applied to a mass, t^3/s^3, producing an acceleration ($F/m = t/s^2 \times s^3/t^3 = s/t^2$), what actually exists is a mechanical force (voltage, t/s^2) applied to a mass per unit time, a resistance, t^2/s^3, producing a steady flow, an electric current ($V/R = t/s^2 \times s^3/t^2 = s/t$).

"Furthermore, it is observed that the conductors are electrically neutral even when a current is flowing. The explanation given for this in present-day electrical theory is that the negative* charges which are assumed to exist on the electrons are neutralized by equivalent positive* charges on the atomic nuclei. **But if the hypothetical electrostatic charges are neutralized so that no net charge exists, there is no electrostatic force to produce the movement that constitutes the current.** Thus, even on the basis of conventional physical theory, there is abundant evidence to show that the moving electrons do not carry charges. The identification of the electric current phenomena with the *mechanical* aspects of electricity that we derive from the theory of the universe of motion now provides a complete and consistent explanation of these phenomena without recourse to the hypothesis of moving charged electrons."

In Larson's discussion he clearly treats a current as a velocity, a voltage as a mechanical force (insert t^3/s^3 for the mass unit in his system), and the particle moving in the current is "merely a rotating unit of space" whose displacement in the current can be measured in meters.

For some time I have maintained that Newton's idea of mass is only to be understood as a force per acceleration ($m = F / a$). In other words, without a force applied to something that results in an observable acceleration there is no "rest mass". We can see an acceleration. A force is some form of resistance applied to an object that makes the object accelerate. There can be force on an object without acceleration in the sense of the whole object moving through space. In that case the force produces a change in pressure, volume, or temperature of the object -- in which case the acceleration is suppressed and spread out among the particles that make up the object, distorting its internal structure.

However, despite what Larson says, the idea that a charge is merely a displacement in space is a bit hard to envision. What if we say that the ampere's mechanical value is that of the newton ($kg\ m/s^2$)? Then the coulomb's mechanical value is that of momentum (kg m/s), and the volt becomes an electrical velocity, or flow of charge (m/s). Permittivity becomes mass per displacement (kg/m), and permeability becomes an "antinewton" ($s^2/kg\ m$). Electrical resistance becomes a rate of "antimass" (s/kg). The tesla (m^{-1}) and the weber (m) become reciprocal magnetic displacements. The henry becomes an "antimass acceleration" (s^2/kg) or an antinewton per meter, and the farad is simply a unit of mass like the electron or proton.

Unit	Symbols	SI	Mech d
ampere	A	A	kgm/s^2
coulomb	C	A·s	kgm/s
volt	V	J/C	m/s
watt	W	J/s	$kg\ m^2/s^3$
v. permittivity	ε_o	F/m	kg/m
v. permeability	μ_o	N/A^2	$s^2/kg\ m$
ohm	Ω	V/A	s/kg
tesla	T	N/A·m	m^{-1}
weber	Wb	$T{\cdot}m^2 = J/A$	m
henry	H	V·s/A = Ω·s	s^2/kg
farad	F	C/V	kg

From this further example of dimensional analysis of mechanical electrical units, we discover that, strange as it may seem, perhaps there is no definite anchor between electromagnetic phenomena and ordinary mechanical phenomena. We can change interpretation of the units and keep the numerical relations the same, or we can change the numerical relations along with the dimensional units as we do with cgs (centimeter-gram-second) and fps (foot-pound-second) systems.

So far in our explorations we realize that the Egyptians had a pretty good value for *pi* and probably had a reasonably good estimate of the speed of light. Since we know they used ramps and built tall structures, they also may have noticed that, when friction effects are ignored, objects fall from a height or roll down ramps at the same speeds regardless of their mass. They may not have distinguished mass from weight, but they understood the basic principles of relative density. The Greek scientist Archimedes, who lived approximately from 287-212 B.C. during the Ptolemaic era, formalized this knowledge about density with his famous principle: "the upward buoyant force exerted on a body immersed in a fluid is equal to the weight of the fluid the body displaces." Thus if a body weighs more than the fluid it displaces, it sinks, and if it weighs less, it floats. This is the density secret of gravity and was known by the ancients, certainly during Ptolemaic times, but probably the Egyptians understood the general idea much earlier. The invention of boats depends on it, and we know boats go back to predynastic times.

We might suppose that the gravitational constant actually represents the effect on density produced by the presence of particles such as protons and electrons in free space. Let's say that when matter is present we have to multiply the two constants G and ε_o to represent their interaction and then take the square root to find an average component of that interaction -- since the particle is interacting with the whole range of possible electromagnetic frequencies.

$$\sqrt{(G\,\varepsilon_o)} = \sqrt{[(6.67428\times10^{-11}\ m^3/s^2kg)(8.854187\times10^{-12}\ kg/m)]} = \sqrt{(5.90953\times10^{-22}\ m^2/s^2)} = 2.43\times10^{-11}\ m/s.$$

If we interpret the permittivity in terms of kg/m, then we end up with a very slow velocity that requires 243,000,000,000 seconds to move 1 meter. The mass of a particle has negligible influence on its gravitational acceleration when it is very small compared to a very strong gravitational field -- for example, consider various small objects in Earth's gravity. However, Newton's gravity equation tells us that with two objects interacting in free space the mass has considerable influence:

$Fg = G\,M_1\,m_2\,/r^2$.

When we calculate the ratio Fe/Fg, we are actually figuring the product ($G\,\varepsilon_o$):

$Q_1\,q_2\,r^2\,/4\,\pi\,\varepsilon_o\,r^2\,G\,M_1\,m_2$, (**The ratio of Coulomb Force to Gravity Force**).

where the upper and lower case *m*'s represent the two interacting masses and the upper and lower case *q*'s represent their respective charges. We let the forces be in equilibrium (e.g. for the floating dust motes or for two celestial bodies in a stable orbit configuration) and let the masses be unknowns. (**The distances are irrelevant!**)

$(Q_1\,q_2\,/4\,\pi\,\varepsilon_o\,GM_1\,m_2) = 1$
$(4\,\pi\,\varepsilon_o\,G)^{-1} = (M_1\,m_2/\,Q_1\,q_2)$
$\sqrt{(1/(4\,\pi\,\varepsilon_o\,G))} = \sqrt{(M_1\,m_2/\,Q_1\,q_2)}$
$\sqrt{(4\,\pi\,\varepsilon_o\,G)} = \sqrt{(\,Q_1\,q_2/M_1\,m_2)}$

I gathered the constants on one side of the equation and the variables on the other side. This means that the variables placed in these relationships always equal a universal constant. If we let the *m*'s be equal and set the *q*'s to single quantum charges ($Q_1\,q_2 = e^2$), we get what I call the Planck mass (1.86×10^{-9} kg) as the solution for *m*. That mass differs from the standard Planck mass by the square root of the fine structure constant: i.e., $\sqrt{(\hbar c/G)}$ vs. $\sqrt{(\hbar c\alpha/G)}$, where $\alpha = 7.2973525376\times10^{-3}$. We may assume that the coulomb charge is in units of (kg/s) and permittivity is in terms of density -- or we may assume that charge is in units of momentum (p = kgm/s), and permittivity is in mass per distance (kg/m), a sort of linear density. If the equation as written above is then in units of seconds, then the particles set up a physical vibration in space. The constant value according to this interpretation comes to 1.34659609×10^{20} seconds squared. The square root is 11,604,292,697 seconds, which is quite a long period for this vibration. If we use the Julian year of 365.25 days as our standard, there are 31,557,600 seconds in a year. That means our vibration has a period of about 367.71786 years, or 367 years, 262 days, and a little under 5 hours. This is just slightly over a "year of years" and given the range of scales involved is probably within a margin of error. It turns out that 4 years of years makes a Sothic cycle of 1461 years. Our rough calculation comes out somewhere between 1467 and 1470 years, depending on how we calculate the year. Who knows? There may be a connection between the electrogravity ratio constant and the Sothic cycle, which is one of the major cycles on the ancient Egyptian calendar.

" The **Sothic cycle** or **Canicular period** is a period of 1,461 ancient Egyptian years (of 365 days each) or 1,460 Julian years (averaging 365.25 days each)."

(**Wikipedia**, "Sothic Cycle")

The Sothic cycle depended on observation of Sirius, the star dedicated by the ancient Egyptians to Isis. Sirius was important for the Egyptians in that it disappeared below the horizon for a period of about 72 days (the 64 portions of the Eye of Horus plus the 8 members of the Ogdoad in the Egyptian "Book of Changes"; also the number of degrees for each point of a traditional Egyptian 5-pointed Pentacle Star that encodes the Golden Ratio and the Venus Pentacle that completes every 8 years) and then had an annual heliacal rising that heralded the annual rising of the Nile.

That of course tells us the Egyptians knew from very early times that the year is 365.25 days. They also could easily calculate this by using a gnomon in a fixed location to mark the time of its shortest shadow at noon from one year to the next. They also of course calculated it by timing the risings of stars above the horizon, particularly with attention on Sirius. A star rises about 4 minutes earlier each day, and after a year it returns to the same position at the same time. The Egyptians used heliacal risings since they did not have accurate mechanical clocks. In their decan calendar (consisting of ten-day weeks), each decan was tied to the heliacal rising of a certain star. The Sothic cycle brings up another curious coincidence, which is that the position of Sirius (Σείριος in Greek and "Sepedet" in Egyptian) in the sky is such that its heliacal risings match the Julian year that averages 365.25 days more closely than the sidereal year of 365.25636 days for stars on the ecliptic. The Julian year is geared to the rotation of the earth and its orbit around the sun.

On the other hand, if we interpret permittivity as linear density (kg/m) and the coulomb charge as momentum (kg m/s), then we end up with the square root ratio of the interacting charges and their corresponding masses that comes to a voltage that we can interpret as a velocity.

Since the electromagnetic units have never been clearly defined in terms of mechanical units of mass and length, it all depends on how you look at it. Even our units of length, time, and mass are arbitrary definitions based on our viewpoint as humans. We must pick reasonable units and work from there.

Celestial Quanta

Let's take stock of what we have discovered thus far in this section. We have discovered that the electrogravity ratio is independent of distance scale, and that there is a period or a velocity (voltage) on a celestial scale lurking in the constant portion of the ratio. This fits our plan of finding a macroscopic observational strategy by which the ancient Egyptians could arrive at an understanding of the microworld and the cosmic constants that are independent of scale -- and even in some cases of the units we assign them. We also have brought forward the notion that both the electrical and the gravitational aspects of nature occur at all scales and may work together as a team from the foundation of the cosmos. Our next step is to explore what happens when we plug the visible planets into our formula.

The ancients could track the motion of any visible planet in the night sky, and may have been able to estimate a planet's mass (or some other physical property). Even today we do not have data on the role of electric charge in the planets, so we will have to play around with what information is available and see what we can come up with.

If a "standard" Senet Oracle Board of stone or brick weighs approximately 1 kilogram, its 30 squares can represent 30 degrees of magnitude either to the smallest stable microscopic particle or to the macroscopic scale of a solar system such as ours that is capable of supporting life. The reciprocal of an approximately 10^{-30} kg electron gives us the approximate 10^{30} kg mass of our sun, which is an average mass for a star. Furthermore, the approximate 10^{-27} kg mass of a nucleon is the reciprocal of an approximate 10^{27} kg Jovian mass that marks the transition mass from a planet to a star. The Senet Board divides fractally into two similar portions: a large 3x9 section with 27 squares and a small 1x3 portion with 3 squares. The total number of squares is 30.

We assume that a planet orbiting a star (or a moon orbiting a planet) is in an overall electrogravitational equilibrium, because it stays in its orbit for extremely long periods of time (millions and even billions of years). In the 1970's Ralph Juergens came up with an Electric Sun hypothesis, claiming that most of the phenomena observed on the sun could be explained as electrical in nature. The probable truth about solar processes is that they involve something more like a combination of fusion energy and electrical energy. Since we do not have reliable electromagnetic figures for the sun, we will calculate indirectly from the estimated total power output of the sun in watts. Mathis (**The Incorporation of Light**, ch. 15, "The Hole at the Center of the Sun") estimates based on the solar wind (which contains many electrically charged particles) that about 15% of the solar power output is electrical in nature, the remaining 85% being radiation from the solar fusion process. However, regardless of the physical mechanism of the solar power output in terms of radiation and charged particle emission, it is still essentially all electromagnetic. The neutrino emissions do not interact with the Earth to any noticeable extent so we ignore that component.

We recall that the electrogravitational equilibrium formula is as follows:

$(4 \pi \varepsilon_o G) = Qq/Mm)$.

The components on the left are the electric (ε_o) and gravitational (G) constants multiplied by 4 *pi*. The components on the right represent the mass (m) and charge (q) of a planet, whereas the capital letters represent the mass (M) and charge (Q) associated with the sun. The value of the electromagnetic constant is 7.426131×10^{-21} C m^2/V kg s^2, where F = C/V, and ε_o is in units of F/m.

One rough estimate for the total power output of the sun is 3.846×10^{26} W (**Wikipedia**, "Magnitudes"), where a watt is a joule per second (J/s), which is a rate of electromagnetic energy production -- i.e., solar radiation and charged particles. However, only a tiny fraction of the total solar power output ever reaches a given planet because of the planet's small size and great distance. So we want to find out the total solar power that impacts a planet and the total planetary power that impacts its sun. We have to convert volts and coulombs into masses and mechanical movements. Furthermore, to deal with the power component, we have to modify our electrogravitational formula. To balance the units we change coulombs to watt-meters, where the watts represent the mechanical energy outputs of sun and planet per second, and the meters represent the orbit radius distance (*Or*) between the sun and the planet, averaging the slightly elliptical paths into circles. We also have to convert the masses of the sun and the planets into pure energy by multiplying them each by c^2. This gives us a modified formula:

7.426131×10^{-21} C m^2/V kg s^2 =
$(xy\ W^2)(r_p^2) / (1.998\times10^{30}\ \text{kg})(80.776\times10^{32}\ \text{m}^4/\text{s}^4)(m)$

The *m* represents the current estimated mass of the given planet, *x* is the unknown power output of the planet expressed in watts, *y* is the power of the sun upon the planet in watts, and r_p^2 is the known approximate radius of the orbit squared. First find *xy*, then x from its mass velocity and acceleration, then *y*. Results will be approximate and will depend on the accuracy of the numbers. We have no clear interpretation of electrical units in mechanical terms. However, this formula will give us a conversion of amps as newtons, coulombs as momentum, volts as velocity, and permittivity as mass per unit linear displacement (since the energy is exchanged between the centers of mass of the two bodies). **The innate tangential momentum of a celestial body is its charge. The body's mass times its gravitational acceleration (*mg*) is its amperage. A body's relative velocity at any moment gives its voltage. Permittivity makes sense "gravitationally" as the linear density between centers of mass. The sun's "radiation" is not very relevant, since most of it misses the planet.** A star could be replaced by a rock or a mass of cold gas. The observable mechanical motion of a planet in an orbit results from an interaction of its innate momentum (its mass times its tangential velocity) and its acceleration (its change in direction as it orbits the sun). We can interpret this as an exchange of power between the two bodies that affects their relationship in space. The power output of the comparatively massive sun and the momentum of the much less massive planet keep the gravitational influence minimized so that the planet does not spiral into the sun. Below is a chart with the masses plus mean orbit radius between the sun and each planet, as well as the approximate orbit radius squared.

	Mass	**Orbit Radius**	**Radius (r_p^2)**
Sun	1.9984×10^{30} kg		
Mercury	0.3301×10^{24} kg	$.579\times10^{11}$ m	$.335241\times10^{22}$ m^2
Venus	4.138×10^{24} kg	1.082×10^{11} m	1.170724×10^{22} m^2
Earth	5.9722×10^{24} kg	1.496×10^{11} m	2.24×10^{22} m^2
Mars	0.64273×10^{24} kg	2.279×10^{11} m	5.193841×10^{22} m^2
Jupiter	1898.52×10^{24} kg	7.783×10^{11} m	60.575×10^{22} m^2
Saturn	568.46×10^{24} kg	14.29×10^{11} m	204.2041×10^{22} m^2
Uranus	86.82×10^{24} kg	28.71×10^{11} m	824.2641×10^{22} m^2
Neptune	102.43×10^{24} kg	45.04×10^{11} m	2028.6016×10^{22} m^2

Next we give the momentum "charge" for the planets as their momenta (mass times velocity). Then we give the mutual accelerations of the sun and each planet. As our formula shows, the accelerations (of the sun and the planet) are encoded in the power components for each, so they must be multiplied times the momenta and each other. The solar acceleration is $a_s = G\ M_s/r_p^2$, where r_p^2 is the radial distance between the sun and the planet squared. A planet's acceleration is $a_p = G\ m_p/r_p^2$. Alternatively we can calculate the approximate planetary acceleration by assuming a circular orbit, finding the velocity (v) from the period and the radius (r_p), and then using the formula $a_p = v^2/r_p$. Since our formula is electrogravitational, it should include the total electrical and gravitational interaction of the celestial bodies. $G\ Ms = 1.33352\times10^{20}\ m^3/s^2$. In the table below I write "e" plus a positive or negative number to represent the magnitude (e.g., e20 stands for $\times10^{20}$).

Planet	Power Output (W)	Momentum (P)	Acceleration (A)
Merc to Sun	10.38e19	1.58e28	6.572e-9
Sun to Merc	11.364e25	2.8568e27	3.9778e-2
Venus to Sun	1.2399e25	1.08764e28	1.14e-3
Sun to Venus	3.41654e21	1.4483e29	2.359e-8
Earth to Sun	10.6782e26	1.7797e29	6e-3
Sun to Earth	3.01942e19	1.68166e27	1.7955e-8
Mars to Sun	1.315e19	1.592e28	8.25952e-10
Sun to Mars	1.12795e26	4.3932e29	2.5675e-4
Jupiter to Sun	5.1905e24	2.48136e31	2.0918e-7
Sun to Jupiter	7.23679e22	3.28945e27	2.2e-5
Saturn to Sun	1.05196e23	5.66186e30	1.857975e-8
Sun to Saturn	3.17e23	4.855e27	6.53e-5

Now we have a table full of numbers, but what do they mean? Mass and charge are supposed to be quantized, but these macroscopic numbers do not look very quantized. When we examined macroscopic mass, we found only a general range of values that could be subject to a variety of local conditions.

To make sense of our table of power outputs, momenta, and accelerations we must go back and re-examine our original formula. We find that when we converted charge to power and then analyzed that to be momentum times acceleration, we quietly revealed that mass has nothing to do with the whole problem. All the mass components cancel out and we are left with velocities, displacements, and accelerations -- all of which are directly observable -- unlike masses that have to be indirectly calculated.

The product of the four *pi* times the permittivity constant and the gravitational constant comes out to be a velocity squared: 7.426131e-21 m^2/s^2. Once we drop out the masses, we are left with another constant (c^4) times that velocity squared giving us a constant six dimensional velocity on one side of the equation: 6e13 m^6/s^6. The variables on the other side of the equation then consist of the planet's velocity, the sun's corresponding velocity, the planet's acceleration, the sun's corresponding acceleration, and the displacement between the two bodies squared -- all of which comes to a sixth power velocity.

We can measure the period of the planet and its average distance from the sun. From that we know the average velocity. From the tangential planetary velocity in the approximately circular orbit we can calculate an approximate planetary acceleration ($a =$

v^2/r). Armed with these we can calculate from our formula the sun's approximate corresponding velocity and acceleration. For example, for Earth's case the orbit radius is 1.49e11 m and the period T is 5.1536e7 s.

$v = 2\ \pi$ 1.49e11 m/3.1536e7 s.
v = 2.97e4 m/s.
a = (2.97e4 m/s)^2 / (1.49e11 m) = 5.92e-3 (m/s^2).

We divide Earth's velocity, acceleration, and the squared orbit radius into our constant velocity and that gives us the product of the solar velocity and acceleration, which comes to about 1.5e-11 m^2/s^3, which of course is a very small value because of the huge size of the Sun relative to the Earth. With an estimate of the solar mass we can find the solar acceleration and then the solar velocity.

The solar velocity relative to a planet is just like the swing of a lever. The much heavier weight will be near the fulcrum and the much lighter weight that moves it will be far out from the fulcrum. The light weight will move fast and far, while the heavier weight will move slowly and only a short distance.

Galileo showed that objects in Earth's gravity fall at the same rate regardless of their mass. We have shown that celestial bodies also move in their orbits without regard to their relative masses. Thus we need only pay attention to the velocity and the orbit radius. From these two we can calculate the acceleration, and that is all we need to know. We also can tell from the relationships that the acceleration and the velocity will be reciprocal, as will the velocity and the radius. Note also that we got the acceleration from the square of the velocity divided by the orbit radius. Then we multiplied by the velocity times the orbit radius. That means the orbit radius also cancels out and we merely have the product of the cubed planet velocity times the cubed solar velocity, which means we can ignore both the orbit radius and the acceleration and simply observe the relative velocities (or the ratio of the orbit radius r and the period T for each planet). So it all boils down to figuring out $v = 2\ \pi\ r\ /\ T$, which is something the ancient Egyptians were certainly capable of.

$K = v_p^3\ v_s^3$.

This is our grand equation. The planetary velocity cubed times the solar velocity cubed equals a constant $K = (4\ \pi\ \varepsilon_o\ G\ c^4)$. Also the solar velocity is simply the reciprocal of the planetary velocity scaled by the constant. Compare this to the Heisenberg relation: $\hbar <= p\ d$ (where $\hbar$ is Planck's constant, p is momentum, and d is spatial displacement); or to the Einstein - de Broglie relation: $c^2 = v_g\ v_p$ (where v_g is the group velocity and v_p is the phase velocity. The Einstein - de Broglie relation is especially relevant because it boils down to a relation between two reciprocal velocities and a constant velocity that is the speed of light squared. I suspect that the formula we just derived is simply a variant of the Einstein equation adapted to the motions of celestial bodies. Because the mass and the distance scale are irrelevant, our new formula is valid for the whole range of creation from subatomic particles up to star systems and galaxies.

An ancient Egyptian using his gnomon and observing the heliacal risings of stars could calculate Earth's period to within seconds or minutes. By studying the relationships of the sun, moon, and earth and their shadows he could get a good estimate of the size of our planet and its distance from the moon and sun.

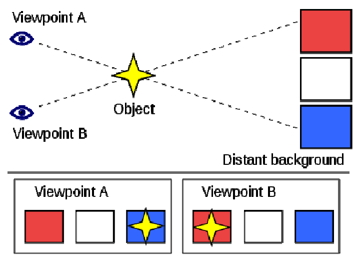
"According to Eusebius of Caesarea in the *Praeparatio Evangelica* (Book XV, Chapter 53), Eratosthenes found the distance to the sun to be σταδιων μυριαδας τετρακοσιας και οκτωκισμυριας (literally, of *stadia* myriads 400 and 80000)." This has been translated either as 4,080,000 *stadia* (1903 translation by Edwin Hamilton Gifford), or as 804,000,000 *stadia* (edition of Édouard des Places, dated 1974-1991). Using the Greek stadium of 185 to 190 meters, the former translation comes to a far too low 755,000 km whereas the second translation comes to between 148.7 and 152.8 million km (accurate within 2%)."

(**Wikipedia**, "Astronomical Unit")

[Eusebius (c. AD 263 – 339) (also called **Eusebius of Caesarea** and **Eusebius** Pamphili) was a Roman historian, exegete and Christian polemicist. (**Wikipedia**, "Eusebius")]

Our modern number for the distance between earth and sun is around 149 million km. The Places translation sounds much more accurate to me: i.e., the sum of 400 myriads of *stadia* plus 80000 myriads of *stadia* (804,000,000 *stadia*), which means the ancients really knew quite accurately the distance between earth and sun. Eratosthenes lived in 276 B.C. during the Ptolemaic period of Egypt, studied in Alexandria, and was the head librarian of the great library in Alexandria that Alexander the Great had founded when he became pharaoh of Egypt. Alexander instituted a policy that the library would collect the best available copy of every known book in the world. As head of this great center of learning in ancient Egypt, Eratosthenes certainly was no slouch at reading Egyptian and had at his fingertips all known Egyptian works on mathematics and astronomy as well as everything available in Greek and other languages of the ancient world. According to **Wikipedia** Eratosthenes was a mathematician, geographer, poet, athlete, astronomer, and music theorist -- basically an all-around well-educated man. It therefore goes without saying that he may well have gotten his ideas for how to calculate the distance between earth and sun from the records of the Egyptian astronomers that have since been lost along with the rest of the library and the original text by Eratosthenes that was cited by Eusebius. It seems strange to me that scholars admit that Eratosthenes managed all the books and documents of ancient Egypt and yet do not suggest that he may have gotten some of his ideas from the Egyptians. Unfortunately we do not know his method of figuring the distance, but it probably involved parallax measurements.

"**Parallax** is a displacement or difference in the apparent position of an object viewed along two different lines of sight, and is measured by the angle or semi-angle of inclination between those two lines. The term is derived from the Greek παράλλαξις (*parallaxis*), meaning "alteration". Nearby objects have a larger parallax than more distant objects when observed from different positions, so parallax can be used to determine distances."



(Definition and diagram
from **Wikipedia**, "Parallax")

So now let us make a new table listing only the velocity of each planet, and we will put each velocity in terms of myriads of meters per second. The cubed velocities for *Vp* are times 10^{12}. Cubed velocities for Vs^3 are at scale.

	Vp	***Vp*** ^{3}	***Vs***	***Vs*** ^{3}
Mercury	4.78725	109.713	0.817703	0.546747
Venus	3.5	42.875	1.118423	1.399
Earth	2.98	26.463592	1.313607	2.26671
Mars	2.477	15.1977	1.580359	3.946998
Jupiter	1.307	2.23268	2.995064	26.86695
Saturn	0.996	.988	3.930333	60.713866
Uranus	0.681	.31582	5.748241	189.935
Neptune	0.268	.0192488	14.606531	3116.314

From the table it is clear that the farther away a planet is from the sun, the slower it moves. The velocity is independent of the mass of the planet. If the planets were randomly created with various masses and various initial velocities, then it would appear that the planets distributed themselves according to their initial velocities, regardless of their relative sizes and physical makeup. (See lever model on previous page.)

The mean orbital velocity of the Moon is 1023 m/s. That means the cube is about 1.0706e9 $(m/s)^3$. Dividing that into our constant gives the cubed velocity of Earth relative to the Moon: 56029.6 $(m/s)^3$. The cube root of that is about 38.265 m/s, which is the reciprocal velocity of the Earth corresponding to the Moon. So the Earth moves at a much slower tangential velocity than the Moon. For the Moon the acceleration is $v^2/r = GM_E/r^2$ = 2.7e-3 m/s², whereas for Earth it is 3.809e-6 m/s².

Another situation we must consider is the possibility that the initial tangential velocity of two interacting objects is zero or so small as to be negligible. It appears that the gravity influence still holds stationary objects to the surface of a planet. We must consider density (defined as mass per volume of space). The law of densities, whose discovery for liquids is attributed to Archimedes, describes how objects can float on the earth's "hard" surface or even on liquid water. Density is an electrogravitational phenomenon. Water is made of hydrogen and oxygen, both of which are usually in the gaseous state and not very dense. Yet we can ride on water in boats made of steel. The hydrogen and oxygen bind together electromagnetically into molecules and the molecules form loosely connected strings and nets that we call water. The steel atoms bond tightly and form a material much denser than the water, but we can spread a curved sheet of steel over a large area with no pores for the water to leak through, and by means of these two ways of manipulating density (electromagnetic bonding and exaggerated surface area) the steel structure will float on the light elements hydrogen and oxygen.

In general the density of an object is to the density of its environment as the object's weight is to the weight of the environment it displaces. However, this simple ratio is distorted when electromagnetic influences in the environment strengthen or weaken the bonds between component particles. To complete our formula we must consider the case where a free particle or a bonded collection of particles with negligible velocity is introduced to a space with a gravitational influence.

The electromagnetic influence is almost 40 orders of magnitude stronger than the gravitational influence. However, it is polarized at the scale of atoms so that the electromagnetic influence can cancel in structures with many atomic components. Therefore at small scales the electromagnetic influence tends to predominate, and at large scales the gravitational influence tends to predominate. Because charge is quantized, it turns out that at extremely small scales the gravitational influence again may predominate, because matter is also quantized by the property we call mass. All matter is made up of protons, electrons, and neutrons, and each particle has an identical rest mass with all other particles of the same type.

Electrogravity Unification and Levitation

We must now consider the apparent quantization of charge, a phenomenon rediscovered in the early 20th century by Robert Millikan during his famous oil drop experiment. When a charged particle is exposed to an electric field, there is a force imposed on the particle that causes it to accelerate. Millikan set up an electric potential between two horizontally parallel plates and then allowed a static electrically charged drop of oil to fall through the space between the plates. Millikan found that he could adjust the electrical potential on the plates so that the electric field between the plates interacted with the electrically charged drop of oil so as to exactly balance the downward force of gravity on the drop. The drop would then hover motionless in the air between the two plates. The equation for this interaction is:

$$q\mathbf{E} = m\boldsymbol{g},$$

where q is the charge on the drop, $\mathbf{E}$ is the electric field, m is the mass of the drop, and $\boldsymbol{g}$ is the acceleration induced by Earth's gravity field. Millikan knew the density of the oil, and found a way to measure the volume of space occupied by the drop. The product of the density times the volume told him the drop's mass. Density is mass per volume, so density times volume tells us the mass. Gravitational acceleration near Earth's surface is $9.8\ m/s^2$.

The problem with the equation Millikan used is that physicists never explain what an electric field or a gravitational field is. All they can do is describe a "field" as something magical that happens between two objects some distance apart that can generate a physical force. A force that occurs over a distance without any clear mechanical means is usually what we call magic, and physics is not supposed to be about magic.

Based on our analysis of the mechanics of a celestial electrogravitational system, we can begin to unravel the mystery of the magic described by field theories. We found that electric charge corresponds to momentum in mechanics. This means that an object with mass is moving at a steady velocity through space. In order for that to produce a force, there must be *n* units of that momentum applied per second against some resisting body or force. In our equation the units of momentum are applied against the force of the droplet falling toward the bottom plate in the device. That force consists of the density of the droplet times the volume of the droplet times the gravitational acceleration of the droplet. The gravitational acceleration is the gravity constant times Earth's mass divided by the radius of Earth squared. We are not able to use the formula v^2/r in this case because the drop has no measurable tangential velocity relative to Earth. When the droplet hovers, there is also no vertical displacement, and therefore no vertical velocity. When the two forces ($q\mathbf{E}$ and $m\mathbf{g}$) are equal and opposite, the accelerations cancel, but the droplet still experiences the stress of the two forces pushing against each other. Depending on the density of the droplet this will tend to cause some distortion to oblateness such as you see clearly with a drop of mercury resting motionless on a level table top. The charge on the droplet must induce the electric potential on the bottom plate to emit tiny particles that strike the underside of the droplet and push it upwards, because an uncharged droplet will not be affected by the potential in the plate. The potential in the plate is also a charge that is in the opposite direction of the droplet's charge, so the two charged objects are emitting streams of particles that push mechanically against each other.

Millikan and his assistant Harvey Fletcher found that the charges on his droplets were in units of about 1.5924e-19 C. Further experiments by subsequent researchers refined the number up to around 1.602e-19 C. Mechanically we will interpret this as giving the droplet a momentum of 1.602e-19 kg m/s for each unit of charge. However, the electric field E is the voltage on the plates divided by the distance of the gap (V/d). The voltage is a velocity in our interpretation, so we begin to realize that we do not need the concept of a "field". The charge can only be measured in terms of voltage, and the voltage is measured with a voltmeter. We have discovered that we can consider a voltage to be mechanically equivalent to a velocity and a charge to be equivalent to a momentum. We only know of the "electric field" by virtue of the voltage and the charge on the droplet. Velocity (m/s) times momentum (kg m/s) equals energy (VC = J). If we move the distance of the gap between the plates over to the gravity side of the equation $qE = mg$, (where qE in electrical units and meters is C V/m) we get VC = mgd (d being the gap distance in meters), and we discover that both sides represent energy. The energy is in equilibrium. Not only that, but we can cancel out the mass on both sides, since both masses are the mass of the droplet. That means the mass of the droplet is irrelevant -- which we already knew from Galileo and from our own calculations.

We are thus left with a velocity squared on each side of the equation. On the gravity side we have the gap between the plates used for our experiment times the acceleration of gravity near Earth's surface, which is observable, measurable, and the same for all objects. On the electrical side we have a number that supposedly represents the product of the voltage potential times a certain number of elementary electrical charges. The distance between the plates is arbitrary, but fixed for the experiment. Although the charge is quantized by the number of extra electrons on the droplet, the voltage is arbitrary, so we can adjust the voltage on the electrical side of the equation so that the product of the voltage and the charge velocities exactly matches the arbitrary distance on the gravitational side times Earth's induced gravitational acceleration which is constant.

What we end up with in the equation is an interaction of velocities. On the electrical side, a fixed velocity represents the charge, and an adjustable velocity represents the voltage. On the gravitational side, we have the fixed acceleration due to Earth gravity, and the distance the droplet can travel between the plates as it accelerates. (We assume that the complexities of air resistance have been dealt with.)

A velocity is an unchanging speed of some object in a particular direction. When a second velocity interacts with the first velocity, the object accelerates. This may or may not change the direction in which the object moves, but it definitely changes the speed. In the case of the droplet, the direction does not change (other than moving up or down), but the speed changes as the object moves through the given distance, either speeding up or slowing down. If we subtract out or divide out speeds of equal size from the electrical side of the equation, no velocities remain. Since we can measure the voltage and know the distance between the parallel capacitor plates, plus we know the acceleration due to Earth gravity, we can calculate the velocity associated with the charge on the droplet that will exactly offset the gravity influence. The mass of a particular droplet does not change during the experiment. By placing a charge on a single droplet and observing its change in velocity at various known voltages we can extrapolate the quanta of velocity associated with various multiples of elementary charge on the droplet and find the value for a single unit of elementary charge. We only need to know the mass of the droplet to obtain a value for its "charge".

For example, suppose we have a droplet with a mass of about 2.4e-14 kg, and it moves at a velocity of one tenth of a millimeter per second (1e-4 m/s) between the plates when the voltage is 1962 V and the spacing between the plates is .02 m. We multiply that gap times g = 9.81 m/s^2 and get 1.962e-1 (m/s)^2. We divide by the voltage to get a "charge velocity" for the droplet of 1e-4 m/s. If we know the droplet mass (2.4e-14 kg), then we can calculate the number of elementary charges, because our charge will be:

(2.4e-14 kg)(1e-4 m/s) = 2.4e-18 kg m/s.
(2.4e-18 kg m/s) / (1.6e-19 kg m/s) = 15 elementary charges.

If we do not know the mass of the droplet, we still know the velocity and the voltage: (1962 m/s)(1e-4 m/s) = (.02 m)(9.81 m/s^2) = 1.962e-1 (m/s)^2. Knowing the elementary charge we can calculate the ratio of the mass to the number (n) of elementary charges (1.6e-15 kg/n). If the mass stays the same but the charge velocity goes to 1.6e-4 m/s, then the voltage will go to 1226.25 m/s. We also know that the ratio of elementary charges relative to the previous charge condition is 1.6/1, and if we figure out the droplet's mass, then we know it now has 24 elementary charges.

Charge on Individual Quantum Particles

The mass of an electron is 9.109e-31 kg, and if we divide the elementary charge by that mass, we get 1.7587e11 m/s, which is faster than the speed of light by several orders of magnitude. So something strange is going on here. The mass of a proton, the other most common particle with charge, is 1.673e-27 kg. Dividing the elementary charge by the proton mass gives us 9.5756e7 m/s, which is slightly less than 1/3 of light speed and makes much more sense if we imagine that the proton is emitting tiny particles. Atoms generally have electrons interacting with protons, preferably on a one-to-one basis. Although the charge on an electron is equal and opposite to the charge on a proton, the electron is about 1836 times less massive than the proton. It also appears to be a point particle, which suggests that its "mass" derives from something other than its physical "body".

My interpretation of this situation is that the proton and neutron are compound structures consisting of a complex flow of photons and antiphotons through a set of space-time nodes. The electron is really a loosely attached node in that structure. Every subatomic particle has a corresponding antiparticle, and when a particle meets its antiparticle its nodal structure quickly annihilates into a randomized collection of photons and antiphotons. The photon is the simplest subatomic particle and thus forms the ground state for all the more complex nodal configurations. Thus photons and antiphotons can associate freely without "annihilating" each other.

The only differences between a photon and an antiphoton is its direction of spin (i.e. its relative orientation in space vis-a-vis an observer) and its orientation in time. A photon moves forward in time, and an antiphoton moves backward in time (relatively speaking, of course). When a photon and its corresponding antiphoton with the same energy (frequency) associate together, the apparent temporal flow cancels out. Relative to the photon-antiphoton couplet time stands still. If a proton emits a photon that will be absorbed by an electron (or it could be vice versa), the electron emits an antiphoton that is absorbed by the proton. However, since the antiphoton runs backward in time relative to the photon, it seems that the antiphoton emerges from the proton joined to the simultaneously emitted photon and travels with it to be absorbed by the electron. An outside observer does not see the photon-antiphoton radiation unless the electron happens to be in his eye. Physicists call this radiation interaction "bremsstrahlung" (braking radiation), because it is the exchange of energy that takes place as the charge interaction causes the electron to swerve in its path by or around the much more massive proton.

Attraction at a Distance is Magic, Not Physics

Physicists have always been troubled by electromagnetic and gravitational phenomena (not to speak of the hypothetical gluonic strong force phenomena) that apparently produce attractions between objects across gaps in space with no apparent mechanical linkage. They have formulated sophisticated "field" theories to explain these mysterious influences that can occur at a distance. These theories are mathematical programs that attempt to describe the phenomena without actually explaining what really goes on. According to these theories specialized particles (such as photons) act as carriers of energy between interacting objects. With the help of our ancient Egyptian magic box we will provide an explanation that establishment physicists and the general public will no doubt immediately reject out of hand, but nevertheless we will toss it out for consideration.

All physical interactions are mechanical and are based on pushing rather than pulling (Mathis also holds this view), even when the actual motions appear to involve pulling when we observe them. Pushing is a form of resistance in which one object hardens itself and interacts with objects it considers foreign by colliding (banging against) or pushing against them. The basic property of resistance is a resistance to unity. Two objects for some reason are not willing to meld into one. The result of resistance is separation and the appearance of distance. We say that a space "exists" between separate objects.

According to the ancient Egyptian cosmology encoded in the Senet Board the universe is one thing wrapped in on itself (uni + verse). The Egyptian symbol for this is Ra, graphically represented as a circle with a dot in the center ☉, the symbol for the square in the upper right-hand corner of the Senet Oracle Board. The dot is the observer's viewpoint, and the circle around it is the environment observed and experienced by the observer. The Egyptians understood these two components as the operational mode of a single entity called awareness, a quality of being awake (Ne*h*es 𓈖𓎛𓊃). The root "ne*h*" means to be small, and connotations include escaping, separating, or winding in coils. The glyph "n" is a small vibration 𓈖, and the glyph "*h*" is a whorl or a wrapped coil 𓎛. This describes graphically the two modes of the photon -- which is the physical embodiment of awareness, as anyone can verify since all forms of awareness and perception involve electromagnetic interactions with the photon. The "s" 𓊃 is a doorbolt that locks together the two leaves of a door. The dot in the center of Ra vibrates dynamically and generates all the phenomena represented by the outer circle.

The dot is a single photon. The photon vibrates back and forth in space and time to generate the light show of our universe. The photon is motionless relative to itself. As observers made of complex light phenomena we observe photons moving at a fixed velocity of about 3e8 m/s that physicists cleverly denote with the symbol c, since the most commonly recognized form of awareness interacting with light is to "see". However, when a photon-antiphoton pair passes between a proton and an electron, it not only cancels time, it also cancels space. We perceive this as a strong tendency of the two particles to move toward each other. That apparent "attraction" simply means that some portion of the space between the two particles has been negated by the time reversal component of the couplet. As an analogy, two waves of the same frequency but opposite phase cancel. How much space is removed between the particles depends on the innate motion that already exists relative to the two particles. This can range from a slight swerve to an orbit to a coalescence that turns the proton-electron pair into a neutron. However, the innate vibrational motion of an electron is too strong for it to remain inside a free neutron, so neutrons tend to decay, transferring their electron nodes to other protons or to open space.

If two protons or two electrons interact, they are both emitting either photons (from electrons) or antiphotons (from protons). These two will not join together, but will push against each other, so the observed phenomenon will be that protons tend to repel each other and electrons also repel each other. The repulsion is due to the steady stream of photons or antiphotons that the like particles emit pushing against each other. An uncharged (electromagnetically neutral) object is transparent to a stream of photons or antiphotons.

Physicists puzzle over how an electron (or a proton) can continuously emit radiation in the form of photons and not lose any mass. The anser to the puzzle is that the flow is a circuit between oppositely charged particle nodes that constantly renews itself. All charged particles constantly emit a flow of either photons or antiphotons. Antiphotons consist of antimass, so a photon-antiphoton pair has no net mass and even cancels space. Photons alone have mass, and antiphotons alone have antimass. The emitted streams thus have momentum and like streams (i.e. noncomplementary pairs) will push against each other with a force (momentum per second) depending on how far the source particles that emit the streams are separated, which of course affects the density of the emitted particle showers. Complementary photon-antiphoton pairs cancel space between what we call oppositely charged particles. Photons versus photons increase resistance between bodies with like charge and thus increase space between bodies. Antiphotons versus antiphotons do the same. Thus complementary pairing tends to reduce the space between bodies. By analogy in society we find that the bodies of men and women tend to be drawn together into close contact because of their physical complementarity.

Gravity and the Big Bang

According to the cosmology encoded on the Senet Oracle Board, in the **Book of the Dead**, and in the **Pyramid Texts**, Ra takes the form of Tem and emits the universe in one gigantic orgasmic rush as if he is ejaculating from masturbation -- not having a female partner. Egyptians drew illustrations of this event as a giant man ejaculating seed from his phallus to form stars in all directions. The seed that he emits becomes the dense gas of the primordial universe (Shewe, Shu), which eventually begins to condense into stars that cook the heavier elements and then spit them out to form solar systems in galaxies capable of supporting life. This basic scenario fits very well with the current theory of an expanding universe that begins from a small and very dense core that explodes with a Big Bang. The dot in the center of Ra's glyph is the core, and the expanding universe is the circle around the dot. The dot is also often identified with the sacred scarab beetle Khepera, the Creator.

Of Khepera or Tem it is said: "kheper jesef" (he creates himself). This means that primordial creation is an act of resistance. In the first place it is resistance to loneliness. The Self resists the reality of unity that compels one to be alone and wants some company. The only way to do this is to separate from part of the Self and pretend that it is not merely still one Self. The interesting surprise is that all the parts look strangely similar but also different -- and sometimes quite radically different -- so different that you do not want to associate with them, much less actually BE them. Thus arises the idea of becoming "really" separate, and we give the name "space" to the distance that separates us from others, and also that handily keeps various others properly separated.

Physicists long for a unified theory, but choke up when it comes down to not only including themselves in the unified whole, but taking ultimate responsibility for it as well. Many among the general populace are more than willing to assign such responsibility to "God" and let Him or Her take care of it all so they can get on with their daily lives. The Egyptian viewpoint blows right through that. The Senet Oracle Box with all its houses emanates from Ra, and the story of Osiris is all about his "tragic" adventure in which he discovers that he is really Ra. The entire tradition of ancient Egypt is that YOU ARE OSIRIS, and therefore, YOU ARE RA. And since Ra emanated all the other gods, they are all your creations. There is no ducking of responsibility, although many Egyptians also got into the habit of handing the responsibility over to Ra and his retinue of gods and then pretending to worship them as if they were separate entities.

A simple exercise that helps a person recover the viewpoint of unity is to begin from whatever viewpoint in space and time you have right now and to expand your attention outward to more and more things, and bigger and bigger spaces. Then imagine that you have incorporated all of these objects and spaces into the concept you have of YOU. Then continue exploring to find even more objects and spaces and incorporate them into YOU. Keep going until you have incorporated all that exists or that might ever exist into YOU. (For example, see Harry Palmer's "Expansion Exercise").

Now what does this all have to do with gravity? If we accept the ancient Egyptian cosmology and/or the most widely accepted modern Big Bang cosmology of physicists, then the universe begins with a major dose of resistance to unity. Somebody really got fed up with the monotony of unity and decided to spice up reality with some variety. This required a lot of energy to push the unity apart into separate "othernesses". To get a big enough playground for a truly cosmic scale game required the creation of a lot of **space** by pushing the components of unity apart. Of course this also required a huge concentration of attention, and that made the physical universe seem very real. It also ironically put a huge primordial fixed attention energy on the unity that was resisted and thereby ensured its everlasting existence as the ultimate reality -- until and unless unity was again desired, deliberately created, fully experienced without resistance, and then just let be as an aspect of all possibilities.

Time in a fundamental sense can be measured as the relative density of things. We can arbitrarily define forward progress in time as a decreasing of density, and a backward progress of time as an increasing of density. Then we can measure the flow of cosmic time as the overall decrease in density of the universe as it spread out from the Big Bang, before which it was concentrated into a single unified and homogeneous mass of awareness. Space is linked inseparably to time, because density is defined as the amount of mass per volume of space, and the overall density of our universe is dropping. Thus we can tell time by space.

Physicists hypothesize that the phenomenon of gravity is mediated by the exchange of a particle they call the graviton. Unfortunately they have never detected such a particle. Einstein produced a theory in which he interpreted gravity as curvature of space-time due to the presence of objects with mass. This theory was on the right track but still did not really answer the question of how objects separated by empty space could be attracted. Part of the problem lies with the arbitrary definition of mass that Newton framed as a somewhat circular relation between a force and an acceleration: $m = F/a$. In other words, we only know what a force is from a mass, and we only know what a mass is from a force. The only somewhat objective component of the relationship is the acceleration, and even that is subject to unknown influences that skew the measurements -- in addition to which objects of any apparent mass fall at the same acceleration under the influence of Earth's gravitational force, so we can only distinguish the various masses when they hit something and push on it with their collisions.

Miles Mathis, Mark McCutcheon, and a few other fringe scientists have come up with unorthodox methods of flipping the attractive force of gravity into a viewpoint in which every object is conceived to be rapidly expanding. Such a theory seems ridiculous, because it begs the question of what would make everything expand like a balloon. One explanation is that the tendency of objects to be drawn toward each other is due to the expansion of the universe. Not only is space expanding, but the material objects in it are also expanding. However, if that were the case, then the Big Bang could never have happened, because all components of the core dot would always keep up expanding with each other and the overall density would never decrease, nor could it even be detected. Gravitational attraction brings about localized increase in density while the universe as a whole continues to decrease in density.

The solution to this puzzle is to recall that the Big Bang was the result of resistance, and resistance requires energy to push things apart and thereby generate space between them. We can therefore treat space as a form of matter with the least amount of material density. It contains a lot of potential energy in the form of photon and antiphoton vibrations, neutrinos, and other particles, but basically retains its form due to the initial impetus of the Big Bang. After that initial impetus, awareness began to localize into attention on areas of interest among the fragments of wholeness. This meant that the original resistance to unity no longer persisted, but also became divided into bits of local attention. Diversification is a sign of further resistance to unity. Relaxation of the original overall resistance to a unity that was no longer so evident meant that there no longer was a continuation of resistive force, but only the momentum of the initial push. The focus of attention onto islands of matter within space relaxes the push to separate them and so local islands of matter begin to coalesce into denser aggregates as the spaces between them cancel out.

The principle is that focus of attention cancels space and allows unity to be restored in the local area of focus. Attention involves exchange of photon-antiphoton pairs. This reverses the loss of density and leads to increase of density in the areas of focus. Localized focus is a natural result of the relaxation of resistance against overall unity.

Local increases of density reverse the flow of time in those areas. Integration is the opposite process to differentiation. If integration is successfully carried out over the entire universe, then time comes to a standstill and the notion of space entirely disappears. The dot and the circle are reunited.

Force is always due to something pushing against something else. That means it is a form of resistance. Mass therefore is simply another name for a resistance imposed on an object that has been pushed away and labeled as "not me" or "not mine". A person who attempts to expand his territory of influence by political or military hegemony or any other forceful means has failed to realize that he already owns everything as part of his larger Self, the Higher Self that the Egyptians called Ra. Such forceful efforts are a waste of time and energy. Rejection of something involves putting attention on it, and such focused attention anchors the "rejected" creation to the "rejector" -- thereby powerfully contradicting the original intention. Gravity is the natural return to original unity that occurs when there is a relaxation of resistance to the unity. Resistance requires excitation that generates forces. Gravity is merely the rebound to a state of least excitation that occurs with the relaxation of resistance.

Some people think of the state of unity as a condition of love. The ancient Egyptians embodied this concept in the goddess Hathor, whose name (Het Heru ) means "House of Horus". Horus is the ancient name for Ra when he was embodied as the totem of a hawk. The image derives from the way a hawk can float about in the sky on thermal drafts the way the sun seems to float across the sky during the warm day. The House is the space that lovingly embraces all the activities of Ra-Horus and incorporates them into one great Home for All. Hathor is considered to be the consort of Ra.

The process of reunification is one of relaxation of the boundaries and pressures that create the illusion of separation and diversity. Meditation is a special way of relaxing mind and body while remaining awake and alert. There are several ways of meditating. Three are immediately obvious. One is to stop physical activity, close the eyes, and reduce mental activity until it stops. The Egyptians commonly practiced this approach by using mantras or yantras while sitting quietly with eyes closed. Each square on the Senet Game Board represents a day of the month or of the year and has a set of mantras and yantras appropriate for use at that time. (For details see my book, **Mantras and Yantras of Ancient Egypt**, available at my website store dpedtech.com/MenuE or from Amazon). Another obvious technique is the expansion exercise that I described above. (See also, Harry Palmer's **ReSurfacing**, Exercise #26.) One exercise takes the attention into the dot in a relaxed manner until the dot disappears and the attention is left alone in an unbounded field of awareness. The mantra or yantra is merely a vehicle to let the attention follow a thought without getting involved with its interpretation, analysis, or relationship with other things. The other exercise expands the attention until it includes the surrounding circle (sphere) and goes out beyond the circle-sphere until the circle-sphere and the dot become one in an unbounded field of awareness. Here the things that are integrated are merely steps on the integration process and have no other interpretation. A third approach is to simply sit quietly and observe without judgment whatever occurs.

We can see from this discussion that the attractive forces of charged particles and gravitational masses are actually due to the cancellation of the mass and space that appear to be separate objects. The repulsive electromagnetic forces are due to collisions between noncomplementary particles that continue to resist and exclude each other (Pauli exclusion principle). Einstein's use of tensor calculus to describe the distortions of space-time in the presence of massive objects is basically a contorted mathematical way of describing the cancellation of space due to the relaxation of resistance between locally interacting physical bodies. The dynamics are not due to an attractive force. The distortion of space-time is due to a distortion of awareness in the observer who initiated a resistance to unity, but now abandons that and focuses attention on the relations between local objects. If anyone wishes to cancel all notions of space, simply do the expansion exercise regularly until it becomes easy to maintain the viewpoint that the notion of Self contains and is responsible for the entire universe as a tiny particle within an unbounded and timeless awareness. From that viewpoint the traditional notion of space separating a variety of distinct objects no longer exists and therefore "action at a distance" is no longer possible. The fractal structure of the Senet Oracle Board makes this quite clear.

If we take the square of Ra in the upper right hand corner of the Board as one third of the miniboard of three squares that makes up the first column, then the large square with nine houses (3×3) to the left of the miniboard becomes an expansion of Ra into the 9×3 maxiboard. We see that Ra becomes Tem, the impulse of the Big Bang resulting in Shewe, the efflux of cosmic breath that brings life to the cosmos and Tefnut the spitting forth of atoms to form solar systems capable of bearing living organisms. That is the top row of three. The middle row of three starts with Osiris, the Witnessing Observer, incarnation of Ra, and then embodies as the physical eye with its vision capability, and the King of Fire, the element that embodies the light perceived by the eye. The bottom row consists of Maat, the principle of balanced complementarity, Anepew the silence of apparent death caused by the spiraled enshrouding of light into material particles, and Qeftenu the playful baboon who juggles all the dead material bodies into a wonderful game.

The middle set of nine squares in the maxiboard corresponds to Sejem, the faculty of hearing, in the miniboard. We hear echoes of our own thoughts in the sounds of creation. The top row of the second 3×3 set consists of Geb, the material world, Newet, the space that separates and sustains the material world, and Horus, the Will that determines how we perform in the material world. The second row consists of the other three kings of the elements: earth, water, and air. These complete the solid physical world we live in and experience as sights and sounds. The bottom row consists of Khenemew the Cosmic Potter and his Potter's Wheel on which we fashion our physical body and environment through the cycles of time; Bennew, the phoenix of the heart that feels the pain of the separations we create in our world but also feels the truth of the ultimate unity of all; and Ammit, the she-devil of all the conflicting, differentiated, and apparently noncomplementary components we have created in the world.

The bottom square of the miniboard is Thoth, the master designer who conceives the order of the cosmos and quietly governs it all from beneath the surface of awareness. He is our teacher in Nature that guides us ineluctably toward our ultimate reality as unity fulfilled in bliss. In the middle of the miniboard is Sejem Lord of Hearing. He connects Thoth the High Priest with Ra the Higher Self.

The large square of nine on the left side of the maxiboard has in the top row Hathor, the spirit of unifying love, Isis, the individual's personal mission in life, and Nephthys, the embodiment of Ra's life force in the form of a beautiful woman to remind us of the importance of appreciation. The middle row consists of Saa, the Lord of Touch, teaching the wisdom of fully experiencing the physical world; Horus in the Womb, teaching us the patience to grow in skill, understanding, and appreciation; and finally the sense of taste (and smell) that teaches us to appreciate the finer aspects of our reality. The bottom row takes us from our childhood in the past to our birth into this world, and finally to our physical creation out of a pair of complementary opposites joined in loving union.

The entire process is dynamic, and boils down to velocities that shift through accelerations. We discover that the masses are not really important and only reflect whatever resistances we retain in our awareness. All velocities originate with and are remnants of accelerations due to resistances. Bodies in free space move with three dimensions of velocity. Bodies locked into free fall with no innate tangential motion have only two dimensions of velocity, and they are aligned in complementarity, discreating the space between the bodies during relaxation or increasing it during the application of resistive repulsive forces.

And now, after considerable exploration, we can identify the encoding of charge on the Senet Oracle Board. The magnitude of the proton microscale mass covers the 27 squares on the large fractal maxiboard. Light speed is encoded as the 9 squares that form its length. The charge velocity associated with the proton is 1/3 of light speed. This corresponds to the first three squares on the bottom row of the large fractal maxiboard, counting from its right corner. The 9 squares that form that third of the large fractal board encode electromagnetic phenomena. The three squares of that third's central row specifically represent the object that emits light (the torch or light beam), the organ that senses light (the eye as organ of vision), and the observer that perceives light as the witness (Osiris). The magnitude of transmission speed is ten to the eighth power. This means that all nine squares in that section are involved except for "Death" who represents the gap between photon pulses and is located beneath the eye of vision. During the gap interval, the eye sees nothing. This also tells us that the Egyptians were aware of the quantized nature of light.

We still have a final question to resolve before moving on from our consideration of charge. When we calculated the velocity for the electron's charge, we found that it is about 1836 times faster than the charge velocity of the proton, which makes it about 612 times faster than the speed of light -- which is a problem, since light always goes at light speed and electrons have rest mass and therefore are supposed to go only slower than light speed. If the electron goes faster than light, then it must move spatially rather than temporally. That means it would appear to be in several places at the same time. In this case it might seem to be in something like 1836 places at once -- which of course would make its total mass as 1836 "electrons" appear equivalent to that of a proton. This may seem funny, but physicists have never been able to account for how an electron bound in an orbit around a nucleus can manage to prevent itself from losing energy and falling into the nucleus.

This problem led to the theory of quantized energy and the formulation of a wave equation in which the electron is treated as if it were a stationary shell around the nucleus rather than a point particle rapidly swirling around the nucleus. If the electron point particle actually moves spatially many times faster than light and appears to be a virtual cloud of stationary electrons distributed in a shell-shaped space around the nucleus with the charge velocity passing simultaneously at light speed between the nucleus and each virtual electron, then the problem resolves. The pointlike nature of the electron is due to it simply representing a node or set of nodes in space time through which a stream of photon-antiphoton particles passes.

The electron's mass is encoded with the value of very close to 10^{-30} (i.e. 9.109×10^{-31}). The magnitude represents the sum of all 30 squares in microscale, and the particle is located at the square of Thoth in the lower right hand corner of the Senet Oracle Board. The electron is the smallest particle that has rest mass. The neutrino and the photon represent energy quanta and have only momentum and no rest mass or charge.

When there is an energy exchange between electrons (either bound or free), the emitting electron loses energy and the absorbing electron gains energy. The two particles move in opposite directions energywise and in space, displaying the space-creating repulsion effect of like particles interacting. This is different from the complementary photon-antiphoton exchange that takes place between a proton and an electron -- what we call particles with "opposite charge". In that case the energy between the two stays the same but some of the space between them is discreated, causing them to draw toward each other.

A charged particle and its corresponding antiparticle of the same (but opposite) rest mass also have equal and opposite charges. When they come together, they "annihilate" each other by reducing to photon-antiphoton pairs. The space between them is completely canceled, and the rest masses disappear, as do the charges.

Ra and the Universe of Light/Awareness

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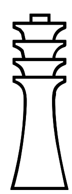
The House of Ra occupies the upper right-hand corner of the Senet Oracle Board. This is also the top square of the microscale fractal board and represents the essence of the universe and the plan for its structure. The ancient Egyptian glyph for Ra is a circle with a small circle or dot in the middle. We must understand that this symbol is a two-dimensional representation of a rotating sphere with a central axis.

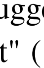
Ra is the symbol for light. He is the Higher Self and contains the cosmic plan for the unfolding of the universe. The Egyptians knew that the entire universe is nothing but light. That includes humans and all of human experience, which means that human awareness is essentially the subjective value of light, and light is the objective value of human awareness. They are one and the same thing experienced from different viewpoints. The Hebrews preserved this ancient Egyptian concept by letting "RA" mean to see, and then reversing it to get the word for light: "AR". (They later disguised the connection by adding an "U" in the middle: "AUR".

The other way in which the Egyptians depicted the sun in their art was in the form of a disk (sphere) with rays extending out from it. Sometimes the rays took the form of outstretched hands, and sometimes they were made from strings of "jed" glyphs



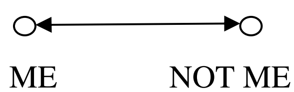
The arm-and-hand glyph means power. Rays of sunlight constantly transmit energy from the sun to the earth. That energy flowing over time is what we call power. The "jed" glyphs mean stability. A long string of such glyphs means that a ray of sunlight consists of a stream of very stable particles. These particles are what we now call "photons". If you view the "jed" glyph from above, as if it were coming toward you, you will see the glyph for Ra. The four flanges represent the four basic states of matter that evolve from light photons.

How the Physical World Manifests from Pure Light/Awareness

The problem with pure light is that it is abstract. There is really only one photon in the whole universe, and that photon happens to be YOU. The Egyptians called this being "A*a*kh" (), the subjective self as a light being of pure awareness. The bird suggests a spiritual quality, and the crest suggests the pharaoh's cloth headdress. "A*a*khet" () is the same word with a female suffix and represents the objective self as a shining apparition. The Egyptians made the glyph for "Aakhet" by simply adding shining rays to the glyph of Ra.

The appearance of many photons arises by the one photon vibrating so rapidly that to our senses it appears to be many photons in many different places at the same time rather like the way the flickering images on a television screen that are simply moving electrons give the illusion of a picture with diverse colors and shapes. Further on in our discussion we will show how this vibration becomes possible.

The problem is that light photons must find a way to agglomerate into complex structures that will give the illusion of solid reality moving and changing in a three-dimensional universe. So we will begin with the light awareness all by itself. Since there is only the one photon of awareness-light, the only thing it can do is pretend to vibrate so as to pretend that there are two "photons", one of which is "not me". Since there really is only one photon light being, it has no defined structure at this stage. Thus the vibration of pretense has no visible result that can be experienced as a reality. However, it does set the stage for what we call gravity, because, as soon as there is the slightest relaxation from the pretense, the illusion of "not me" falls back into the reality that it is only me after all. After things get more complicated and one forgets about this original pretense, the fall back becomes an inexplicable tendency for all diverse phenomena to gravitate back toward unity.



However, at this early stage, the problem is that the pretense of establishing something that is "not me" does not lead to any real experience, since ME and NOT ME are still without structure (which means that the doodle I drew above is not accurate). It does hypothetically generate two points that define a line -- the possibility of one dimension in "space".

What else can be done? The next step is for ME to rotate around NOT ME in an imaginary viewpoint shift to see if anything happens. It turns out that, relatively speaking, this is the same as NOT ME rotating around ME. It also is the same as spinning, but is very stressful, because it involves whirling around, but still has no results, since the undefined structure looks the same from all sides and that sameness is indistinguishable from nothing. The effort required for this spinning motion is the origin of electrical charge. It also adds another dimension of space, giving the abstract impression of a disc that is enshrined in the glyph for Ra.

The third type of motion is a secondary spin. The secondary spin fixes the relative motions of the primary spin and introduces a third dimension of space. It amounts to the whole disc of the primary spin rotating into that third dimension. Since there is nothing to which it can relate, the secondary spin produces an axis through the center (diameter) of the disc such as appears when you spin a coin or ring by flipping it on its edge. This third motion generates the magnetic influence that appears to emanate from the two poles of the axis. The spinning disc now resembles a spinning sphere.

We can summarize the three motions as follows: (1) a distinction between the center and the edge of a nascent circle; (2) primary rotation of the nascent circle about its center so as to define its circumference; (3) secondary rotation of the disc so as to define the rotational axis of a sphere. All this is purely an imaginary possibility within the light-awareness and does not produce any real physical phenomena.

No further rotations are possible without reference to other pre-existent systems. This leaves us with a pretended motion in a virtual three-dimensional space, but no derivable experience, because there still is nothing "solid" to see. However, we now have the three-dimensional structure that defines abstractly how light propagates as a wave in three dimensions of space. The first dimension is the ray that transmits light from a source to a receiver. It also generates the possibility of gravity in a manner we will soon describe more clearly. The second dimension is the electrical vibration due to the spin. The third dimension is the magnetic vibration that matches the electrical vibration but in yet another dimension.

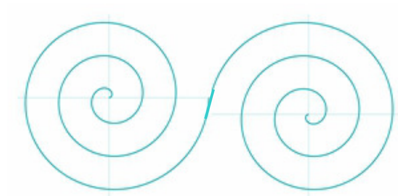
No experience of gravity is possible except through the medium of the electromagnetic interaction -- primarily through a transfer of energy via a light ray between two bodies, and secondarily through electrical and magnetic effects that accompany electromagnetic interaction. We can block local electrical and magnetic effects (localized resistance), but not gravity (nonlocalized relaxation), because it derives from the general relaxation of the primal overall resistance that occurs when awareness drops down to a very localized attention. All bodies in the universe are constantly exchanging gravity photon-antiphoton (graviton-antigraviton?) pairs in all directions that cancel out space depending on their density. Only forms of localized awareness add the electric and magnetic resistance spins to the photon-antiphoton exchanges. Another way of understanding this radiation is to think of it as the relaxation of resistance in awareness. As long as the resistance is greater than the relaxation, the universe will continue to expand. When the relaxation is greater than the resistance, the universe will begin to contract. Since perception of distance is relative to perspective, it really depends on how we look at it.

The Egyptian Glyph for Luminosity

In the Egyptian symbol for the luminosity of light we can see the three dimensions of electromagnetic radiation graphically displayed. The radiation extends out along the surface of the page in a straight line between an emitter and an absorber (perceiver not shown). The electrical circuit moves in a circle on the surface of the page with the rays extending out perpendicular to the circle's tangents. The center point marks a magnetic axis that is perpendicular to the surface of the page, similar to the modern convention in electrical drawings. The three components -- gravity, electricity, and magnetics -- are always mutually orthogonal in a three-dimensional space generated by the resistance of an observer to being merely ME in awareness. However, as yet they are still only in a virtual condition which is frustrating for a hypothetical ME identity that is trying to create some "real" experiences. We should also note that whatever the ME identity pretends to define as NOT ME is the only way in which the ME identity can define itself. Thus, what you see as a perceiver is who you are, no matter how imaginary or real it seems.

Proto-Particles

The next move generates the possibility of the first and simplest particle, but it still remains virtual. The idea of this move is to repeat the original process of pretending there is ME and NOT ME, but to start instead with the three dimensional vibration that already exists.



The above sketch shows a pair of archimedean spirals that are linked together. They schematically represent the first step of creating a physical particle using the three types of fundamental motion combined. What we see here represents a virtual electron-positron pair creation. Unfortunately it leads right away to pair annihilation and instantly returns to the undifferentiated photon state because the opposing spins exchanged between them cancel out the incipient space between them and draw the two spirals back together neutralizing the spiral motion.

Archimedes described the spirals known by his name in an essay "On Spirals" some time around 225 B.C. Conon of Samos (Κόνων, ca. 280 – ca. 220 BCE) was a Greek astronomer and mathematician. He was court astronomer to Ptolemy III Euergetes, which means he lived much of his life in Egypt. Pappus states that the spiral described by Archimedes was discovered by Conon. Conon is another example of a Greek scientist who actually worked in Egypt at the highest level with access to all of Egyptian knowledge that had been gathered together in the great library at Alexandria. Because any earlier Egyptian sources on this subject are now lost (unless new document caches are discovered), scholars give the Greeks credit for "discoveries" that very likely had been known to ancient Egyptian scientists and engineers at much earlier times. Coiling of rope neatly on a floor or a deck is a simple everyday example of an archimedean spiral. An archimedean spiral is defined mathematically as the locus of points corresponding to the locations over time of a point moving away from a fixed point with a constant speed along a line which rotates with constant angular velocity. Equivalently, in polar coordinates (r, θ) it can be described by the equation $r = a + b\theta$, with real numbers a and b. Changing the parameter a will turn the spiral, while b controls the distance between successive turnings. (This paragraph is condensed from **Wikipedia**, "Archimedean Spiral" and "Conon of Samos".)

One key principle that emerges with the electron-positron pair production is that with respect to time each member of the pair moves in an opposite direction, both in the direction of turns and in the distance from a fixed point at the spiral's center. We can even take the spiral as a kind of clock that runs at the fixed cyclotron frequency for electrons:

$f_c = qB/2\pi m$,

where f_c is the frequency, q is the electrical charge, B is a uniform magnetic field normal to the spiraling charge, and m is the mass of the particle. Period and frequency are independent of the photon particle speed, and particles with the same charge-to-mass ratio have the same cyclotron frequency in the same magnetic field.

What we are saying here is that the "external" phenomenon of an electron spiraling in an externally imposed magnetic field follows the same pattern due to charge that each photon emitted by it follows as it emerges from the point source of the particle itself. We will come back for a closer look at this "cyclotron motion" again when we examine the notion of a constant and finite speed of light.

Something is still missing from our model. There must be a way to prevent the virtual particle pair from immediately reuniting and mutually annihilating back into the photon condition. The solution is to generate a lot of confusing energy around one member of the pair as a buffer so that the two core charged particles are not able to rejoin. This is where the quarks come into the picture. A quark is a bubble of mental resistive energy placed around a positron or an electron to buffer it from merging with an electron and annihilating.

So the next move is to create a pair of chargeless buffer particles made of resistance energy and allow them to overlap so that they relax back into each other gravitationally. The result is that the density of the quark pair's mass-energy-overlap generates a small but powerful black hole that acts like "antimass". The antimass-antienergy takes on the appearance of a third particle that we will call a down quark. Stephen Hawking has shown that the smaller a black hole is, the hotter and less stable it becomes. Here is the formula he derived to describe the situation:

$T_{BH} = (1.2\times10^{26}\ \mathrm{K}\ [M/1\mathrm{g}]^{-1}$.

Here T_{BH} is the temperature of the black hole, K is degrees kelvin, M is the mass of the black hole and 1g is one gram (10^{-3} kg). The sun is 2×10^{33} g, so a black hole with that mass would have a temperature of 10^{-7} K. A black hole spits out electrons when it has a mass of around 10^{16} and a temperature of 10^{10} K.

A proton is made of two up quarks and a down quark. Rather than divide the so-called quantum of "elementary" charge among the quarks as most scientists do for no logical reason, I put one elementary positive charge with the down quark, assuming that it contains a positron at its core. The up quarks are therefore chargeless. A neutron consists of an up quark and two down quarks. The second down quark, in my analysis, has an electron at its core and thus a negative charge. A free neutron decays by emitting the electron from its negative down quark, which then becomes chargeless and is considered an up quark, so the neutron is then considered to be a proton.

According to my rough calculations, an up quark has an average mass of about 1.86×10^{-9} kg [the cosmic Planck mass = $(\hbar c\alpha/G)^{1/2}$] with an electron singularity plus momentum known as an antineutrino. Two up quarks interact dynamically and overlap to form a black hole called a "down quark" with a mass of 2.0716×10^{9} kg, two positrons (e^{++}), and the momentum of two neutrinos. The proton thus consists of two up quarks and a down quark mini black hole of antimatter. Anti-quarks are very heavy and hot black holes that are unstable. The up quarks are outside the event horizon, and each has an electron associated with it, but one usually stays outside its up quark companion. The quarks are not independent particles, but form a single dynamic system. We therefore multiply them together, dividing by the quark of the black hole. (The numbers are average outcomes.)

$(1.86\times10^{-9}\text{ kg})\ (1.86\times10^{-9}\text{ kg } e^{-}) / (2.0716\times10^{9}\text{ kg } e^{++}) + e^{-} =$
$(1.86\times10^{-9}\text{ kg})\ (1.86\times10^{-9}\text{ kg } e^{-})\ (.4827\times10^{-9}\text{ kg } e^{++}) + e^{-} = (1.67\times10^{-27}\text{ kg } e^{+}) + e^{-}.$

The mass of the black hole portion is a little over 10^{9} kg (i.e. 10^{12} g) of antimass and the temperature is thus a little over 10^{14} K. Such a black hole spits out nucleons as well as electrons and photons, which means it appears to be either a proton and an electron or a neutron. The photons account for the particle's innate motion and charge radiation. The neutrons decay into protons. In the case of a neutron the two charges mutually cancel. If the neutron is free, it emits an electron (plus an antineutrino) and decays into a proton.

$(1.86\times10^{-9}\text{ kg } e^{-})\ (1.86\times10^{-9}\text{ kg } e^{-}) / (2.0716\times10^{9}\text{ kg } e^{++}) = 1.67\times10^{-27}\text{ kg}.$ (neutron)

$e^{-} + (1.86\times10^{-9}\text{ kg})\ (1.86\times10^{-9}\text{ kg } e^{-}) / (2.0716\times10^{9}\text{ kg } e^{++}) =$
$(1.67\times10^{-27}\text{kg } e^{+}) + e^{-}.$ (proton + electron)

In case someone should object to the idea of anti-quarks associating with quarks, we note that all mesons are considered to be combinations of a quark and an anti-quark. Also, modern electronics makes use of electron holes within components that function as if they were positrons in a stable configuration with matter. To see how such a dynamic system works, you can run water into a sink from a faucet that is offset from the drain. When you reach a stable configuration in which the sink remains partially filled with water even as water exits from the drain and enters from the faucet, a vortex will form over the drain with an empty hole that extends into the drain to complement the stream of water that comes from the faucet. The hole in the vortex corresponds to a particle of anti-water embedded within the water.

The three quarks together (the water in the sink) generate a dynamic maelstrom that continually collapses into a black hole that radiates a nucleon, which is then swallowed back into the black hole and again spit back out. On average it tends to stabilize as a proton with a positive charge and an electron that circulates nearby, attracted by the proton's opposite charge. The proton complex also emits a steady stream of antiphotons, most of which are swallowed by the nearby electron. The result of this wildly dynamic process is the creation of a real atom of hydrogen.

I should mention here that the most stable configuration of this maelstrom is a cluster that we call helium, which consists of 4 nucleons and some kinetic energy. Helium is chemically inert and extremely stable. However, the usual condition that occurs in the creation of matter from the up quark Planck mass is that it spreads out faster than light, too fast to stabilize as helium and instead tends to form hydrogen atoms that in turn tend to pull together loosely to form diatomic hydrogen molecules, and occasionally include a neutron or two to produce deuterium, or tritium. The helium creation process is completed when hydrogen collects gravitationally to form stars. The high temperature and pressure within a star completes the transition into helium through what we call atomic fusion. It also sometimes overshoots the helium mark and forms heavier elements that then make possible planets, moons, and other solid material.

Let us summarize our analysis of the so-called "attractive forces" that we label as gravity, electricity, and magnetism. The universe knows only resistive forces that "push against" something else. What appears to be attraction is only the relaxation of an earlier resistance that stressed undifferentiated awareness-light into matter and space. As matter radiates, it cancels out space. This causes particles of matter to slowly aggregate together. The electric and magnetic components are much stronger, but their influence drops off much faster over distance. Thus when objects with electric charge draw near, they begin to strongly attract or repel. Attraction occurs when there is exchange of photons and antiphotons combined so as to annihilate space. Interaction of photons with photons or antiphotons with antiphotons results in repulsion. Thus electrons repel electrons, and protons repel protons.

The Aether

According to electromagnetic theory the presence of electromagnetic waves in space generates an energy density (energy per volume of space = kg/ms^2) that gives the space physical reality as consisting of mass-energy. Traditionally this was known as the "aether", but it has become unpopular to use that word, even though scientists continue to operate with calculations based on these assumptions, speaking of an electric field E and a magnetic field B. In our interpretation the electric field E has the unit property of a frequency or inverse second (s^{-1}), and the magnetic field B has the unit property of an inverse meter (m^{-1}). The energy density of the E-field is calculated to be $(\varepsilon_o/2)E^2$, and the energy density of the B-field is $(1/2\mu_o)\,B^2$. The two are equal, which means that energy flowing through space is divided equally between the two fields, as is evident from the fundamental Maxwell relationship $\varepsilon_o\ \mu_o\ c^2 = 1$. If S represents the power passing through a unit area (W/m^2) at the speed of light (c), then S is the energy density of the combined fields times c. Another way to write this is to say $S = (1/\mu_o)\,EB$. In vector notation we do the cross product of the vectors **E** and **B** so that **S** (the Poynting vector) is normal to both the field vectors, again giving us the illusion of three-dimensional space.

Thus, if we charge up a capacitor, the electric component flows down the wire to the capacitor, the magnetic component forms around the wire, and the power beams into the capacitor's gap from the space all around, normal to the wire. In other words, a capacitor is a device for sucking ambient energy into a small confined space, which is why it is sometimes called a condenser. An analogy would be the way a cold bottle of beer taken from the refrigerator condenses ambient moisture from the surrounding atmosphere onto its outer surface. The moisture on the bottle's surface is not beer leaking through the glass bottle. This tells us an environment that appears to be empty space contains ambient energy that we do not detect unless we give it an opportunity to condense or be absorbed in some way by an appropriate material structure.

The Speed of Light and the Balance of the Cosmos

The speed of light is not infinite, and this is of fundamental importance for the structure of our universe. It means there are three basic types of motion. Light (and any electromagnetic phenomenon in general) moves at the speed we call *c*, and this forms the standard for all motion. What remains is the possibility of motion slower than *c* and motion faster than *c*. Motion slower than *c* is temporal. We experience it as a single object changing position relative to other objects as measured by time (a standard repetitive cycle of temporal motion used as a clock to measure other motions). Motion faster than *c* is spatial. We experience it as what seems to be a multiplicity of identical objects found in multiple places at the same time. The fact that particles such as electrons look identical wherever we encounter them suggests that they are simply spatial clones of a single particle moving faster than light. Crystalline arrays of atoms in which each component is identical also suggest more complex superluminal (faster-than-light) motions. Our habit of seeing groups of identical particles as separate individual particles is simply our habit of perception in which we put primary attention on temporal motion rather than spatial motion.

The setting of a constant speed for all electromagnetic phenomena is one of the foundations of our universe, and it suggests that there may be only a few such constant relationships that determine the entire system by which our universe operates and from which all the diversity of phenomena flows. These basic constants would define the units of mass, energy, space, time, gravity, charge, and magnetism. Let's list them.

Constant Ratios of Geometry in Space: Circles and Spheres

$\pi = C/D = 3.14159....$ ($C = Oo$ = circumference, D = diameter)
r = radius = 1 unit = 1 meter.
$2\pi r = C = Oo$.
$\pi r^2 = Ao$. (Ao = area of unit circle)
$4\pi r^2 = As$. (As = area of unit sphere)
$(4\pi r^3)/3 = Ss$. (Ss = volume of unit sphere)

Diagonals of Rectangles with Unit Width

These are pure number ratios like π when they are compared to the unit width forming a diagonal / unit side.
$\sqrt{2}$ for length = 1 unit width.
$\sqrt{5}$ for length = 2 units width.
$\sqrt{10}$ = 3.16227766 for length = 3 units width.
(% is read "oper" and is a dimensional operator = 3.16227766... M; %/*r* = 3.16227766.)

Constant Physical Ratios

c = 3e8 m/s
$\hbar$ = 1.054e-34 J·s
G = 6.67e-11 $m^3\ kg^{-1}\ s^{-2}$
e = 1.602e-19 C
ε_o = 8.854e-12 F m^{-1}

Program for Designing a Universe

The constants must all fit together in a balanced way. To do this, all the physical constants must be expressed in terms of three mechanical properties: mass (kg = kilogram), length (m = meter), and time (s = second). Thus the joule (J) is kg m^2/s^2. The coulomb (C) is kg m/s. Then the universe of physics will match the universe of geometry. The ancient Egyptians expressed the basic constants of geometry and physics in the design of the Senet Oracle Board and they used a base ten system of calculation. First I will give the steps of the formulation, and then provide a detailed example with an analysis of how it works.

Step 1. Use the constants of geometry as factors to shift each physical constant to an exact power of 10 while maintaining the units of the physical constant unchanged.

Step 2. Identify all the fundamental physical constants that contain mass units, and organize them into all the combinations such that all the units cancel out. Disregard the ratios and scales.

Step 3. Substitute the power-of-ten versions for each of the physical constants (as derived in Step 1) into the combinations derived in Step 2.

Step 4. Total up the powers of ten and set that equal to $(\%)^2$ to the power of your total.

A Sample Universe

Step 1: The Basic Physical Constants Expressed as Powers of Ten

$c \rightarrow (c\ Ss\ /\ r\ As) = 10^8$ m/s.

$e \rightarrow (\pi\ e\ Oo\ /\ \%) = 10^{-18}$ kg m/s

$\varepsilon_o \rightarrow (\varepsilon_o As^3\ /\ Ss^2) = 10^{-9}$ kg/m

$G \rightarrow (G\ Oo\ r^2\ /\ Ss) = 10^{-10}\ m^3/s^2$ kg

$\hbar \rightarrow (\hbar\ As\ \%\ /\ Ss) = 10^{-33}$ kg m^2/s

(Note also: $\hbar c\% = 10^{-25}$ kg m^4/s^2)

Step 2: Combine Constants into Pure Numbers

$(G\ \hbar\ /\ c^3\ r^2)$

$(G\ \varepsilon_o\ /\ c^2)$

$(G\ e\ /\ c^3\ r)$

$(e\ /c\ \varepsilon_o\ r)$

$(\hbar\ /\ c\ \varepsilon_o\ r^2)$

$(\hbar\ /\ e\ r)$

Step 3: Substitute Step 1 Results for Each Physical Constant in Step 2

Pay attention to exponent signs!! These expressions are pure numbers and powers of ten.

$(G\ Oo\ r^2\ /\ Ss)\ (\hbar\ As\ \%\ /\ Ss)\ (c\ Ss\ /\ r\ As)^{-3}\ (r^{-2})$

$(G\ Oo\ r^2\ /\ Ss)\ (\varepsilon_o As^3\ /\ Ss^2)\ (c\ Ss\ /\ r\ As)^{-2}$

$(G\ Oo\ r^2\ /\ Ss)\ (\pi\ e\ Oo\ /\ \%)\ (c\ Ss\ /\ r\ As)^{-3}\ (r^{-1})$

$(\pi\ e\ Oo\ /\ \%\ r)\ (c\ Ss\ /\ r\ As)^{-1}\ (\varepsilon_o As^3\ /\ Ss^2)^{-1}\ (r^{-1})$

$(\hbar\ As\ \%\ r\ /\ Ss)\ (c\ Ss\ /\ r\ As)^{-1}\ (\varepsilon_o As^3\ /\ Ss^2)^{-1}\ (r^{-2})$
$(\hbar\ As\ \%\ r\ /\ Ss)\ (\pi\ e\ Oo\ /\ \%\ r)^{-1}\ (r^{-1})$

Step 4: Total up the powers of ten and set that equal to $(\%/r)^2 = 10$ to the power of your total.

$(G\ Oo\ r^2\ /\ Ss)\ (\hbar\ As\ \%\ /\ Ss)\ (c\ Ss\ /\ r\ As)^{-3}\ (r^{-2}) = (\%/r)^{-70}$
$10^{-10} \quad 10^{-33} \quad 10^{8} \quad = 10^{-35}$
$(G\ Oo\ r^2\ /\ Ss)\ (\varepsilon_o As^3\ /\ Ss^2)\ (c\ Ss\ /\ r\ As)^{-2} = (\%/r)^{-70}$
$10^{-10} \quad 10^{-9} \quad 10^{-16} \quad = 10^{-35}$
$(G\ Oo\ r^2\ /\ Ss)\ (\pi\ e\ Oo\ /\ \%\ r)\ (c\ Ss\ /\ r\ As)^{-3}\ (r^{-1}) = (\%/r)^{-104}$
$10^{-10} \quad 10^{-18} \quad 10^{-24} \quad = 10^{-52}$
$(\pi\ e\ Oo\ /\ \%\ r)\ (c\ Ss\ /\ r\ As)^{-1}\ (\varepsilon_o As^3\ /\ Ss^2)^{-1}\ (r^{-1}) = (\%/r)^{-34}$
$10^{-18} \quad 10^{-8} \quad 10^{9} \quad = 10^{-17}$
$(\hbar\ As\ \%\ /\ Ss)\ (c\ Ss\ /\ r\ As)^{-1}\ (\varepsilon_o As^3\ /\ Ss^2)^{-1}\ (r^{-2}) = (\%/r)^{-64}$
$10^{-33} \quad 10^{-8} \quad 10^{9} \quad = 10^{-32}$
$(\hbar\ As\ \%\ /\ Ss)\ (\pi\ e\ Oo\ /\ \%)^{-1}\ (r^{-1}) = (\%/r)^{-30}$
$10^{-33} \quad 10^{18} \quad = 10^{-15}$

Interesting Results
Using the constants of geometry with combinations of physical constants we can write each physical constant in terms of a power of ten pure number, and the Oper (Dimensional-Shift) Operator, which is the diagonal of the three-by-one rectangle on the Senet Oracle Board relative to the Board's width always can match that at any scale. The Board's length of 10 units of course gives the base ten that we can take to various powers.

Once we have set up these equations we can express various combinations of the basic physical constants entirely in terms of the constants of geometry. For example, the last formula of Step 4 can be rearranged as follows (treating $r = 1$ m as a physical constant):

$(\hbar\ r\ /\ e) = (Ss\ \pi\ Oo\ /\ As\ \%^2)\ (\%/r)^{-30} = (2\ \pi^2\ /\ 3)\ (\%/r)^{-30}\ \text{m}^2 = 6.579\times10^{-15}\ \text{m}^2.$

Many constants in physics are derived from the basic ones we have chosen. For example, the magnetic permeability of free space falls out of the relationship: $\varepsilon_o\ \mu_o\ c^2 = 1$.

Extracting Phenomena from the Equations
Each formula in Step Four of our creation process consists of two equal expressions that each have the same value as a power of ten. We have set some *n*th power of ten to be equal to the 2*n*th power of the Oper Dimensional-Shift ratio. We can represent any power of ten as a one ($10^0 = 1$) residing somewhere in an infinite string of zeroes.

. . . 0000000000000000000000000000001000000000000000000000000000000000. . .

We may extract specific properties and functions of the universe starting from this speck of unity residing in nothing. First we decide what types of properties we would like to enjoy in our universe, and what constant relationships we prefer for them to have. Then we take the properties and their constant relationships through the four steps. To see what sorts of phenomena such a universe gives rise to, we select the appropriate power-of-ten formula for what we would like to see, rearrange the factors, and simplify. For example, suppose we wish to find the simplest particle with mass that could arise in our universe. We begin by selecting the formula with the simplest ways of deriving an expression for a particle with mass: e.g., *e/c* or ε_o *r*.

$(\pi\, e\, Oo\, /\, \%)\, (c\, Ss\, /\, As)^{-1}\, (\varepsilon_o\, As^3\, /\, Ss^2)^{-1} = (\boldsymbol{\%/r})^{-34}$.

We know that $(\%)^{-34}$ corresponds to 10^{-17}. Therefore, we will insert a decimal point into our string of zeroes so that the 1 takes on that value.

000000000000000.0000000000000000100000000000000000000000000000000000. . .

Now we will reorganize our formula arranging the constants of physics to give the simplest expression of a particle with mass to the left side and putting all the remaining constants that give a particle with mass on the right side. We end up with $(\pi\, e\, /\, c)$ on one side and $(\%\ \varepsilon_o\, r)$ plus some geometry on the other side. The two numbers π = 3.14159 and % = 3.16228 are almost the same, but one is a circular ratio and the other is a diagonal ratio in a rectangle. The circular geometry amounts to the integer 6, and the Oper scaling factor is 10^{-17}.

$(\pi\, e\, /\, c) = (\%\, /\, Oo)(Ss\, /\, As)\, (\varepsilon_o\, As^3\, /\, Ss^2)\ \ (\boldsymbol{\%/r})^{-34}$.

We simplify.
$Mp = (\pi\, e\, /\, c) = (\varepsilon_o\, \%\, As^2\, /\, Oo\, Ss)\, (\boldsymbol{\%/r})^{-34} = 1.67\times10^{-27}$ kg.

On the left side of the equation appears a proton's mass ($Mp = \pi\, e\, /\, c$). On the right side of the equation we find another particle with "antimass" exactly balancing the proton that is embedded in the geometry of space and forms its complementary particle. This is what we call the "antiproton". It derives from the permittivity of free space to electricity (ε_o) interacting with the Oper D-Shift ratio, the unit radius of 1 meter and some geometry plus a scale shift. The "permittivity" is a resistance in free space that slows the speed of light and generates the effect of a mass spread out in space that is the equivalent to the particle emitting and absorbing electromagnetic radiation. If the antiproton happens to be gathered into one spot and meets a proton, the pair mutually annihilates both the mass and antimass, returning to pure photon energy with no rest mass.

$Mp\, (Oo\, Ss\, /\ \ \varepsilon_o\, As^2)\, (\boldsymbol{\%/r})^{33} = 1$.

I treat the electron as the negative pole of a proton. If the negative pole is "inside" the proton, we call the result a neutron. If it is "outside" the proton, we think of it as a separate particle and call it an electron.

Defining the Fundamental Properties of Length, Time, and Mass

From our interpretation of the electromagnetic units in terms of mechanical units we can now derive precise definitions of the fundamental mechanical properties (mass, length, time) that we can measure in terms of the constants of physics and geometry.

Length: the Meter

The meter becomes the value of the weber unit (Wb). Here is how the **Wikipedia** "Weber (Unit)" article introduces the weber, a unit of magnetic flux named for the German physicist Wilhelm Eduard Weber (1804–1891).

"The weber may be defined in terms of Faraday's law, which relates a changing magnetic flux through a loop to the electric field around the loop. A change in flux of one weber per second will induce an electromotive force of one volt (produce an electric potential difference of one volt across two open-circuited terminals).

Officially,

Weber (unit of magnetic flux) — The weber is the magnetic flux which, linking a circuit of one turn, would produce in it an electromotive force of 1 volt if it were reduced to zero at a uniform rate in 1 second.

In SI base units, the dimensions of the weber are $(kg \cdot m^2)/(s^2 \cdot A)$. The weber is commonly expressed in terms of other derived units as the Tesla-square meter ($T \cdot m^2$), volt-seconds ($V \cdot s$), or joules per ampere (J/A).

$$1 \text{ Wb} = 1 \text{ V} \cdot \text{s} = 1 \text{ T} \cdot \text{m}^2 = 1 \text{ J/A} = 10^8 \text{ Mx (maxwells)."}$$

What all this ballyhoo boils down to is that 1 Wb = 1 m, although they do not want to come out and say so, and that makes the tesla its reciprocal. The meter is also then encoded into the definition of the ampere as the current in two long parallel wires of negligible cross section and d = 1 m apart in vacuum which gives rise to a magnetic force (F_μ) per unit length (l = 1 m) on each wire of $2\pi \times 10^{-7}$ N/m. This result arises from Ampere's discovery of a force law:

$F_\mu / l = \mu_o I_1 I_2 / 2\pi d.$ (Here $\mu_o = 4\pi \times 10^{-7}$ N/A^2 = $4\pi \times 10^{-7}$ H/m.)

There is a question whether or not space is quantized. I think there is no way around it, because space has meaning only in terms of the matter that resides in it, and all matter is quantized into particles (protons and electrons), and there is a minimum distance allowed between an electron and a proton even though they want to join together and do so when conditions permit them to form into a neutron. This minimum distance is called the Bohr radius, named after Niels Bohr, the scientist who first calculated this natural displacement constant that appears to be due to inherent momentum in the electron -- which may be due to the possibility that elementary charge itself has the nature of quantized momentum. We can express the Bohr radius (a_o) as follows (where $\hbar$ is

Planck's reduced constant, α is the fine structure constant, Me is the mass of an electron, and c is the speed of light):

$a_o = \hbar / \alpha Me c = 0.529\ 177\ 208\ 59\times10^{-10}$ m.
$a_o \alpha = \hbar / Me c = 3.861\ 592\ 645\ 94\times10^{-13}$ m.

This equation reveals what is known as the reduced Compton wavelength (λ) of the electron ($\lambda = \hbar / Me c$) and is here also a radius since the electron is going around a proton at its lowest energy orbit. The non-reduced Compton wavelength (the radius multiplied by 2π) then gives the length of the orbit wavelength ($2.4263102175\pm33\times10^{-12}$ m). The fine structure constant appears in any interactions that involve electrons, and we can see how it sets up a constant relation between the Bohr radius and the reduced Compton wavelength of the electron.

⊙

"The reduced Compton wavelength is a natural representation for mass on the quantum scale. Equations that pertain to mass in the form of mass, like Klein-Gordon and Schrödinger's, use the reduced Compton wavelength. The non-reduced Compton wavelength is a natural representation for mass that has been converted into energy. Equations that pertain to the conversion of mass into energy, or to the wavelengths of photons interacting with mass, use the non-reduced Compton wavelength.

[$\lambda = h / Me c = 2\pi \hbar / Me c$].

A particle of rest mass m has a rest energy of $E = mc^2$. The non-reduced Compton wavelength for this particle is the wavelength of a photon of the same energy. For photons of frequency f, energy is given by

$E = hf = hc / \lambda = mc^2$

which yields the non-reduced Compton wavelength formula if solved for λ."
(See **Wikipedia**, "Compton wavelength".)

The above simple formula for the wavelength or Bohr radius of the electron consists entirely of constants and therefore not only gives us a universal constant of spatial displacement, it gives us a formula for the mass of the electron that is almost as simple as what we found for the proton ($Mp = \pi e / c$). Here is the formula for the electron based on the Compton wavelength ($\lambda_{ce} = 2.4263102175\pm33\times10^{-12}$ m).

$Me = h / \lambda_{ce} c$.

The ratio of the oper (%) diagonal 3.162 m to the electron's Compton wavelength (2.43×10^{-12} m) is the pure number 1.3033×10^{12}. If we multiply 1.3033 by the ratio of the diagonal of the small fractal rectangle to the side of that rectangle (the side of a single square on the Senet Board) and the square of the ratio of the length of the Board to the side of a single square, we get the well-known reciprocal of the fine structure constant, which is approximately 137. We then adjust the scale by 12 orders of magnitude.

$(\% / \lambda_{ce})(1.054)(100) \approx \alpha^{-1} (10^{12}) \approx 137.$
$\lambda_{ce} \approx 1.054\ \alpha\ \%\ (10^{-10}).$

We can now express the Compton wavelength as a factor among a cluster of constant component factors with a combined product that is a power of ten.

$10^{10} = 1.054\ \alpha\ \% / \lambda_{ce}.$

The proton Compton wavelength is $\lambda_{cp} = h / Mp\ c = 1.3214098446\times10^{-15}$ m, and is smaller than the electron's because of the larger proton mass. When we substitute the formula for the proton mass, we get a very simple expression:

$\lambda_{cp} = h / \pi\ e = 2\ \hbar / e = 1.32\times10^{-15}$ m.

This is an elegant definition of quantized space. Since the proton is the foundation of all stable matter, it makes sense to use either the proton's Compton wavelength or the Bohr radius as a standard for length.

Time: the Second

Once we have a way of determining the meter, the second is automatically determined by the time it takes light to travel 3e8 meters, and of course any fraction of that distance will give us the corresponding fraction of a second.

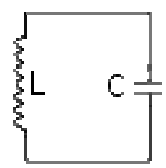
Of course it is fine to use the current standard definition: "the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom," -- provided you have a supply of cesium 133 available. Some areas of the universe may not have such supplies of cesium readily available, so a person would have to carry his own supply in order to set his clocks.

Another way to measure a second is to set up a standardized *LC* circuit. "An ***LC*** **circuit**, also called a **resonant circuit**, **tank circuit**, or **tuned circuit**, consists of an inductor, represented by the letter *L*, and a capacitor, represented by the letter *C*. When connected together, they can act as an electrical resonator, an analog of a tuning fork, storing energy that oscillates at the circuit's resonant frequency.

An *LC* circuit can store electrical energy by oscillating at its resonant frequency. A capacitor stores energy in the electric field between its plates, depending on the voltage across it, and an inductor stores energy in its magnetic field, depending on the current through it.

If a charged capacitor is connected across an inductor, charge will start to flow through the inductor, building up a magnetic field around it and reducing the voltage on the capacitor. Eventually all the charge on the capacitor will be gone and the voltage across it will reach zero. However, the current will continue, because inductors resist changes in current. The energy to keep it flowing is extracted from the magnetic field, which will begin to decline. The current will begin to charge the capacitor with a voltage of opposite polarity to its original charge. When the magnetic field is completely dissipated the current will stop and the charge will again be stored in the capacitor, with the opposite polarity as before. Then the cycle will continue in a similar way, with the current flowing in the opposite direction through the inductor.

The charge flows back and forth between the plates of the capacitor, through the inductor. The energy oscillates back and forth between the capacitor and the inductor until (if not replenished by power from an external circuit) internal resistance makes the oscillations die out. Its action, known mathematically as a harmonic oscillator, resembles a pendulum swinging back and forth, or water sloshing back and forth in a tank. For this reason the circuit is also called a **tank circuit**. The oscillation frequency is determined by the capacitance and inductance values. In typical tuned circuits in electronic equipment the oscillations are very fast, thousands to millions of times per second."



An Idealized *LC* circuit.
Quotation and Diagram from **Wikipedia**, "LC Circuit"

The oscillations of an *LC* circuit are as regular as a clock and therefore can be used to measure seconds. The natural angular frequency is $\omega_o = 1 / \sqrt{(LC)}$, where *L* is in henries (H), and *C* is in farads (F). This relates back to the speed of light in that the velocity of electromagnetic propagation through a transmission line is delayed by the effects of inductance and capacitance in the line. When we know the value of *L* and *C* per meter, then the velocity *v* of transmission in m/s is $1 / \sqrt{(LC)}$. In other words, H/m and F/m become equivalent to the permittivity and permeability, and in free space the velocity becomes *c*.

We may now ask the question: are space and time quantized? The answer is that it depends on how you look at them. Space, time, and mass are combined in various relationships in order to generate the fundamental constants of a universe. On the other hand, a ratio of space to time, such as meters per second, by itself does not inherently involve quantization. Although electromagnetic radiation theoretically can have any arbitrary frequency or wavelength, from the viewpoint of matter and energy (which involve the property of mass), its values of space and time become quantized because energy is expressed through the frequency of electromagnetic vibration, which means that at certain high frequencies radiation begins to form particles of matter, while at low frequencies it forms space. When variable phenomena form reciprocal relationships pivoting about constants, such as in the Compton relationship (wherein they pivot about Planck's constant), there is uncertainty regarding position versus momentum (i.e. charge) or energy versus time. Uncertainty is related to, but different from, quantization, and therefore the structure of a relationship disallows simultaneous precise knowledge of two of the component variables in the relationship. Uncertainty is caused by the wave nature of the electromagnetic radiation that we depend on for perception and measurement.

Mass: the Kilogram

Now we can consider how to define the kilogram, the mechanical unit of mass in the **mks** system, which is widely accepted as a standard and which we are following for the purposes of this discourse. In our interpretation of the electrical units the farad turns out to have the mechanical unit of mass. The farad is named after English physicist Michael Faraday. According to the **Wikipedia** "Farad" article:

"A farad is the charge in coulombs which a capacitor will accept for the potential across it to change 1 volt. A coulomb is 1 ampere second. Example: A capacitor with capacitance of 47 nF will increase by 1 volt per second with a 47 nA input current. . . . . The capacitance of the Earth's ionosphere with respect to the ground is calculated to be about 1 F."

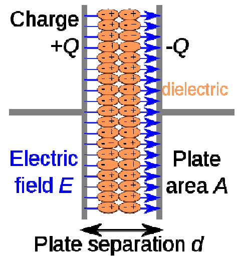
A farad (1 F) is the same as 1 kg and can be measured as the ratio C/V (coulomb per volt). Here is another way of expressing the above example of the capacitor:

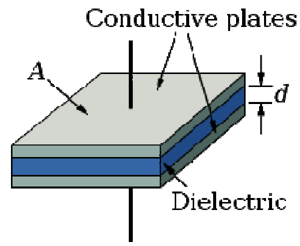
47 nA / 47 nF = 1 V/s.

The definition of the farad requires us to understand the concept of the capacitor. According to the **Wikipedia** article entitled "Capacitor":

"A **capacitor** (originally known as **condenser**) is a passive two-terminal electrical component used to store energy in an electric field. The forms of practical capacitors vary widely, but all contain at least two electrical conductors separated by a dielectric (insulator); for example, one common construction consists of metal foils separated by a thin layer of insulating film. Capacitors are widely used as parts of electrical circuits in many common electrical devices.

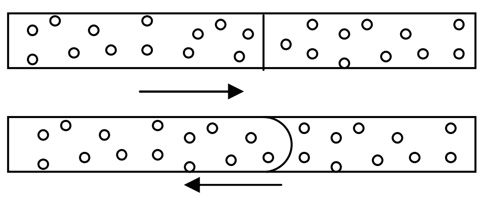
When there is a potential difference (voltage) across the conductors, a static electric field develops across the dielectric, causing positive charge to collect on one plate and negative charge on the other plate. Energy is stored in the electrostatic field. An ideal capacitor is characterized by a single constant value, capacitance, measured in farads. This is the ratio of the electric charge on each conductor to the potential difference between them."





(The ratio of charge to potential difference is in units C/V. The electrostatic field is primarily in the gap between the conductive plates, as suggested by the blue arrows in the diagram on the left.)

To understand how a capacitor generates the equivalent of mass, we can use a hydraulic analogy. Imagine a pipe sealed in the middle with an elastic membrane so that water flowing in the pipe is not able to pass through the membrane. If the water flows in one direction through the pipe, it will push against the membrane and stretch it in the direction of flow. The membrane when stretched will then push back against the water in the pipe. This is similar to the way a rock placed on a scale pushes down on the scale due to its gravitational mass. Lifting the rock to place it on the scale is like the water pushing against the membrane. The rock pushing down on the scale is like the stretched membrane pushing the water back in the pipe. It is a relaxation of a tension, but it appears to be a "weight" that results from the presence of a mass in a gravitational field.


Analogy of Water in a Pipe with a Membrane

In the capacitor diagrams shown above electric current flows along the wire and builds up an "electrostatic charge" in the space *d* between the capacitor plates. The larger the area of the conductive plates (*A*), the larger the capacitance. Also, the smaller the separation *d*, the larger the capacitance. The magnetic vibration surrounds the wire, and the energy charges and discharges into and out of the gap between the plates from the surrounding space normal to the wire's direction and parallel to the plates. Thus the analogy of water separated by a membrane in a pipe is not really very exact, and we may call the phenomenon of static charge in a capacitor "pseudomass". However, when the charge moves, it has a momentum that can be harnessed to perform work, just like the momentum of a moving mass can be harnessed to perform work.

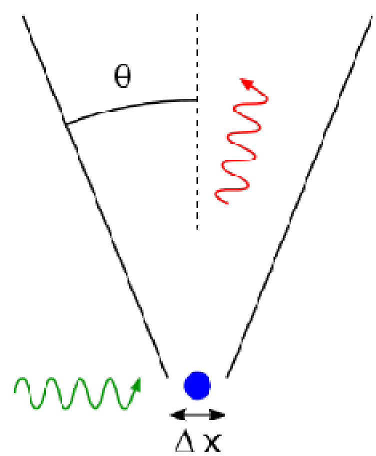
Planck's Constant and the Eye of Horus

Planck's constant emerged when physics reached the level of precision in which scientists began to discover quantum mechanical effects in their experiments. Planck discovered the constant while studying the curious behavior of thermal radiation in black bodies.

He found that he could only explain the way the heat radiated by assuming a very small constant value that caused the energy to emit in discrete quanta rather than over a continuous spectrum as expected. Planck's discovery of the constant (*h*) had to do with the thermal (heat) aspect of energy, but the constant also turned out to be a very general component of energy that guarantees the quantum nature of physics on the very small scale.

Later Einstein discovered and described the photoelectric effect. By showing how light and other electromagnetic radiation impinging on a material has an energy (frequency) threshold below which it will no longer dislodge electrons from the material no matter how strong the intensity of the light, he demonstrated that electromagnetic radiation (including light) is quantized in a form we now call photons. The role of Planck's constant shows up in the way electromagnetic energy bunches into discrete packets no finer than the value of that constant. $E = hv$, where v represents the frequency of the electromagnetic radiation. Later still, Heisenberg showed that Planck's constant describes how the interconnected properties of momentum and position or energy and cycle time can never be precisely known in both respects at once because of the vibratory nature of the electromagnetic radiation which must be used to make measurements.

$h <= \Delta p \, \Delta x$. (uncertainty of momentum and position)
$h <= \Delta E \, \Delta t$. (uncertainty of energy and period)



"Heisenberg's gamma-ray microscope for locating an electron (shown in blue). The incoming gamma ray (shown in green) is scattered by the electron up into the microscope's aperture angle θ. The scattered gamma-ray is shown in red. Classical optics shows that the electron position can be resolved only up to an uncertainty Δx that depends on θ and the wavelength λ of the incoming light." (**Wikipedia**, "Uncertainty Principle")

We must now begin our exploration of Planck's mysterious constant and how it is encoded into the Senet Oracle Board.

Since ancient times it has been known that when objects become sufficiently hot, they begin to glow with characteristic colors that depend on the temperature rather than the material that has been heated. This suggests that there is a relation between heat and light. It also suggests that the light and heat of the sun somehow transfers into materials and then radiates back out from them. On the other hand, specific materials when heated by other means also emit light that has spectral qualities that are unique to each material.

From ancient times people also observed that light from the sun could be dispersed by rain drops and mist from a fountain or waterfall into a rainbow of colors.

In his book **The Crystal Sun** Robert Temple has assembled a great deal of evidence that the ancient Egyptians and the Greeks that followed them knew a great deal about optical phenomena and were skilled at using lenses, mirrors, and other tools of the optical trade. For example, his evidence indicates that in ancient times priests used crystal or glass spheres, often filled with water to focus sunlight for lighting sacred fires in the temples.

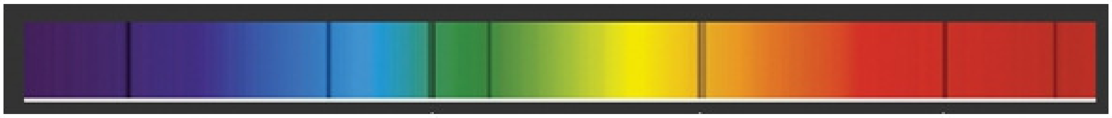
How the ancients (Roman era) used crystal spheres or spherical clear glass water bottles to light sacred fires in temples (images above and below from Temple's **The Crystal Sun**.

Temple cites passages in which the Pythagorean scholar Philolaus mentions the theory that the sun is a giant crystal in the sky that focuses the light energy of the universe and sends it to our planet. The Pythagoreans learned much of their esoteric lore from the Egyptians, so Egypt is a very likely source for the notion.

Temple also cites the obsession of the **Pyramid Text** poets with the Eye of Horus and proposes that the priests may have used the crystal and glass spheres in temple rituals as miniature models of the sun as the Eye of Horus.

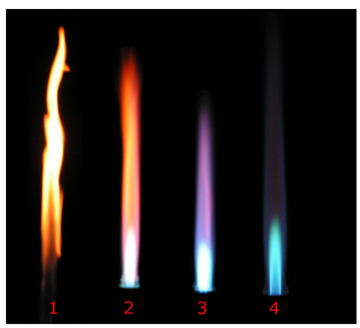
We can imagine a priest in the inner sanctum of a temple such as the Temple of Amen in Karnak waiting until the precise moment when the sun's rays penetrated into that room and then passing the beam of sunlight through an Eye of Horus crystal or a clear pyramidion crystal. He might notice at certain angles the dispersion of the sun's light into a strip of rainbow colors. If he looked closely at the rainbow spectrum of the sun, he might notice some little dark lines. We call them Fraunhofer lines in honor of the man who first studied them in modern times, although William Wollaston reported seeing them in 1802, fourteen years before Fraunhofer began studying them.

Here is a modern spectrum of sunlight showing several of the most prominent absorption lines as dark vertical bars. The absorption lines occur, because as the sunlight passes through our atmosphere that is much cooler than the radiant heat from the sun, electrons of atoms in the air absorb the sunlight at certain frequencies of its spectrum.

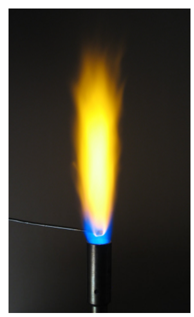


The priest could then use his Eye of Horus crystal to focus the sunbeam on an altar to ignite incense that contained a large proportion of natron (sodium bicarbonate or baking soda). Natron was a sacred mineral used in ancient Egypt for many purposes -- the preparation of mummies, as incense, toothpaste, and perhaps also as a form of soap. The name natron comes from the Egyptian word "neter" which means divine -- literally, "that which is beyond". As the priest performed the ritual, all four elements would be involved: the sunbeam passing through air, the water in the crystal eye, the mineral earth expressed by the natron, and the fire that arose from the focused light.

Here is a photo (on right) from the **Wikipedia** "Sodium" article of a flame test done on a bit of sodium held in a hot flame with low luminescence. The flame flares up with a bright yellow color which is characteristic of sodium.



1 2 3 4


Sodium Flame

The photo on the left shows the various types of flames produced by a Bunsen burner. The purplish tint to flame #3 is an artifact of the photo and should be bluish. As the air valve opens, the flame becomes tighter and bluer. The bright yellow on the right is due to the ionized sodium as the blue flame is visible below the sodium.

1. air valve closed
2. air valve nearly fully closed
3. air valve semi-opened
4. air valve maximally opened

The flame images were created by **Arthur Jan Fijałkowski** (WarX) using Open Source software and released under **GFDL**. Photos are by Garett. (GNU Free Documentation License, Version 1.2 or any later version published by the Free Software Foundation)

In this manner the priest expressed the creative energy of the sun and mastery over the four elements. He would also notice how the Eye would generate little rainbows of color from the pure beam of sunlight.

Since the sacred fire was kindled in the dark and hidden depths of the temple by the magical power of the Crystal Water Eye, it might also occur to the priest to repeat the process on a smaller scale. Once the sunbeam had passed and the fire was lit in the dark room, he might then place a canopy over the sacred glow of the natron and use the Crystal Eye to focus the captured light of Amen Ra a second time.

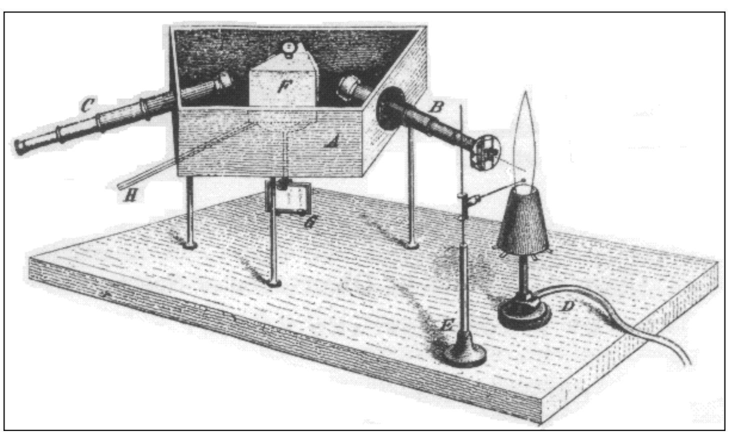
This time he would not get a perfect rainbow. He might notice that within the rainbow some bars of various colors stood out more brightly, particularly a yellow bar. He would have discovered in a very limited way what we today call an optical spectrum. Unless he could view the spectrum of the burning natron in the state of a thin gas, he would not merely see the spectral lines, but would have a more spread out spectrum. However there would be a bright yellow bar part way across the spectrum.

The sodium spectrum has bright lines at 589 nm. There are actually two lines, one at 588.995 nm and another at 589.5924 nm. The one closest to 589 nm is much brighter, and so the secondary line probably would not be noticed by the ancient Egyptians, or they may have seen them as one thicker line.

Gustav Kirchhoff and Robert Bunsen identified many elements using optical spectroscopy aided by a specially designed burner developed by Bunsen.

The Three Laws of Spectroscopy (from **Wikipedia,** "Kirchhoff" article)

1. A hot solid object produces light with a continuous spectrum.
2. A hot tenuous gas produces light with spectral lines at discrete wavelengths (i.e. specific colors) which depend on the energy levels of the atoms in the gas.
3. A hot solid object surrounded by a cool tenuous gas (i.e. cooler than the hot object) produces light with an almost continuous spectrum which has gaps at discrete wavelengths depending on the energy levels of the atoms in the gas.



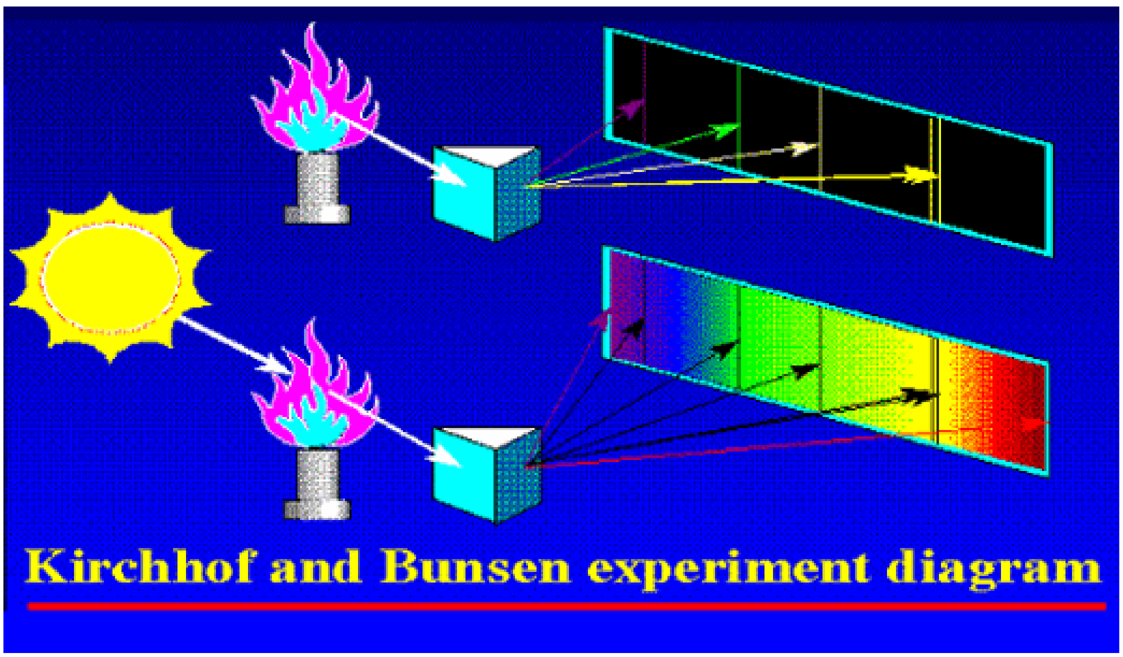
Above is a drawing of the Kirchhoff-Bunsen spectroscope. The device does not make use of anything unknown to the Egyptians. It includes a box with a blackened interior, a triangular prism, tubes with lenses for directing and observing the light, a flame, and a material to study -- e.g., natron.

Egyptian interest in the optical properties of natron would be natural because their culture focused on transformation of awareness into an immortal light body, and natron was the sacred mineral used to preserve the physical portion of the body.

Here is a key statement in the report by Kirchhoff and Bunsen on their experiments with sodium (natrium in Latin, abbreviated as Na).

"Of all spectral reactions, that of sodium is the most sensitive. Swan (**Ann.** 100, p. 311) has already drawn attention to the smallness of the sodium chloride quantity that can still produce a distinct sodium line. "

Sodium was the first example mentioned in detail by Kirchhoff and Bunsen, and they commented on the special brightness and distinctness of the golden yellow sodium line.

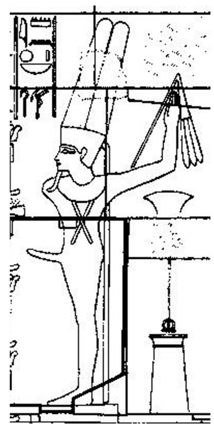


Drawing that shows the complementarity of the absorption spectrum of the sun with the emission spectrum of sodium

Amen Ra, the Sun, and the Spectral Line of Sodium

A fundamental part of the Egyptian mythology was that Osiris became the god of the night, but identified with Amen Ra, Ra being the sun, and Amen being the invisible aspect of the sun. Notice how the emission and absorption spectra are complementary with regard to the strong sodium line that glows with a golden yellow color. We know the Egyptians burned natron, because it was used as a key component of incense.

Below is an image of Amen that appears on a wall of the Temple of Man, Luxor.



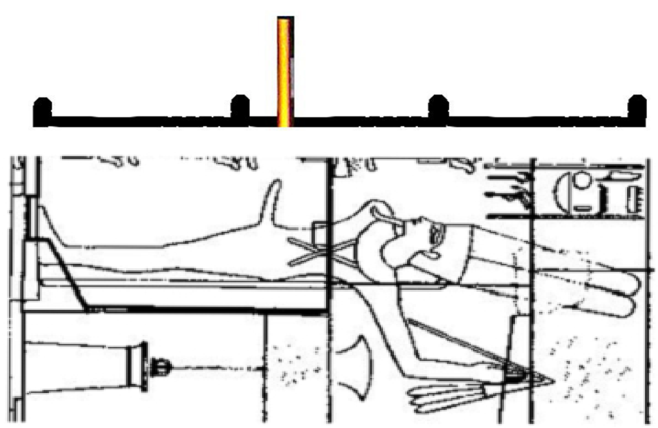
Amen holds a flail scepter with his left hand in a curious manner that is very different from the way a pharaoh holds his flail scepter. Amen's forearm is held upright so that a line from the top of the flail handle to his elbow, a line from his elbow to the bottom end of the flail handle, and the length of the flail handle form a Golden Triangle.

Amen is remarkable among Egyptian deities for his characteristic ithyphallic pose. His erect phallus and the flail suggest an abundance of life energy. The strips dangling from the flail represent rays of light, and especially the dispersed rays of colored light that pass through a triangular prism.

Amen's erect phallus represents the sacred sodium line on the solar spectrum. Osiris famously lost his phallus after he came into his earth body as a physical emanation of the sun's light. In the same way the sun's light loses its sodium line as it passes through the atmosphere to the earth.

The priest in the temple of Amen uses the Crystal Eye of Ra-Horus to ignite natron with a beam of Ra's sunlight and then uses the Crystal Eye again to manifest in the natron emission spectrum the sodium line lost from the solar absorption spectrum and thus restore the phallus of Osiris.

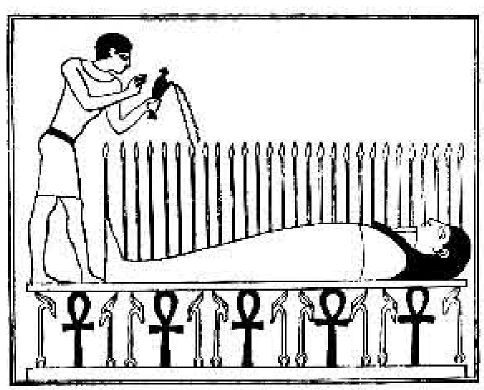
Nanometers 700 600 500 400



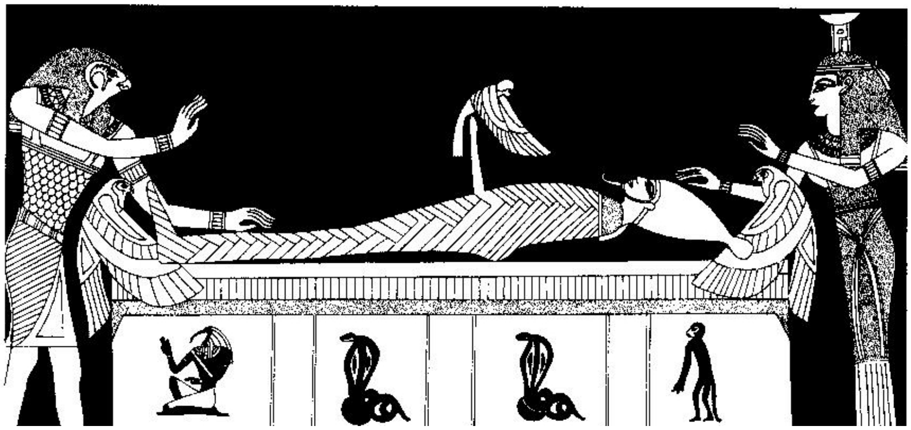
Amen rotated 90° to the position of Osiris lying on his bier
showing the relative position of the sodium line in the visible spectrum.

The above drawing shows Osiris on his bier in the pose of Awef about to reawaken as he appears in **Amduat**, Hour 6. The hawk hovering over the body is the spirit of Horus as grown Horus-Ra stands in front of kneeling Isis and watches. Seker is the missing phallus that has been destroyed. Amen Ra transforms Seker into Horus as his own incarnation. In the picture we see the 3 sons of Osiris with him (Baba disguised as Bes in the form of the male leopard bier-bed, Horus as a hawk, and Anubis as a jackal). Isis and Nephthys are at the head and foot of the bier as usual.

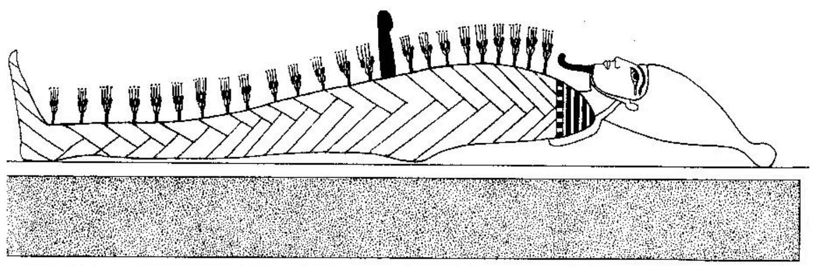
Recumbent statue of Osiris with his phallus restored.
Note the symbolic Scarab Tarot layout on his body.



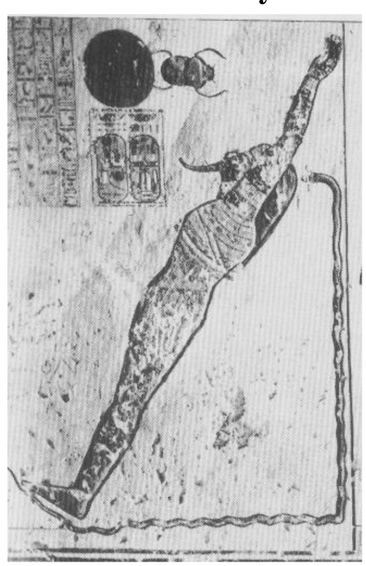
Osiris-Neper (Osiris as Corn God) from Budge, **Egyptian Ideas of the Future Life**, ch. 1.
This scene could represent a solar spectrum



The erect phallus of Seker-Osiris with the hawk of emerging Horus.
The perchng hawks at either end represent Isis and Nephthys.
Nephthys stands at the head and Horus at the foot.
On the bier we see Thoth and Baba framing the cobras Wajet and Nekhebet.
(Drawing from **Sacred Sexuality in Ancient Egypt**)

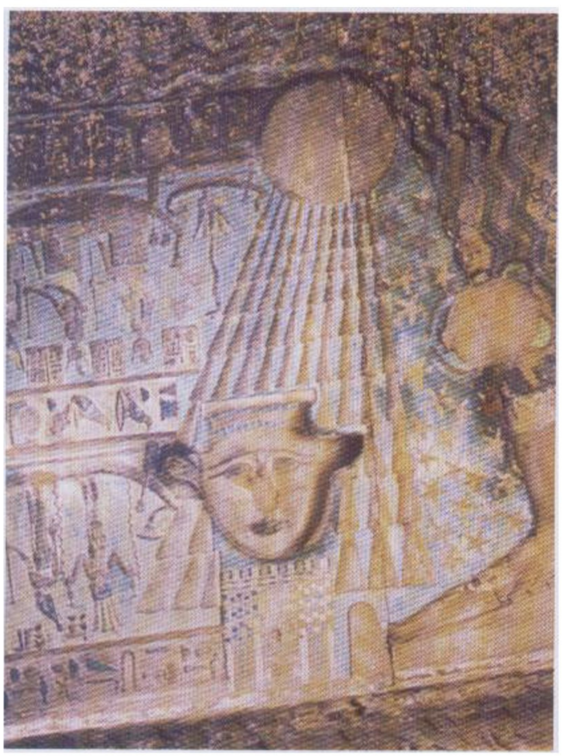


Another Osiris-Neper Corn-God solar spectrum
with the erect phallus as the bright sodium line.
(Drawing from **Sacred Sexuality in Ancient Egypt**)



The Pythagorean Serpent Triangle (3,4,5) with an ithyphallic Osiris
(phallus has been rubbed out by prudes) from the tomb of Rameses VI.

Another Osirian Pythagorean (3,4,5) Triangle
(Egyptian Museum, Cairo)



The above picture on the left shows the sun giving off digital rays of light. The face of Hathor signifies that this is the energy of light. The "particles" take the form of the "jed" pillar. This tells us they are particles that are a universal constant, and they are also of the essence of Osiris (as well as Ra and Hathor). The picture on the right shows Seshat recording digital time by inscribing notches into a palm frond. These and many other common images suggest that the Egyptians conceived of space, time, and energy as digital in nature rather than continuous and also measured them in terms of universal constants.

Measuring the Wavelength of the Sodium D-line

In order to figure out the energy of the light and Planck's constant, the Egyptians had to be able to measure the wavelength of the sodium "D-line" fairly accurately. (D is the letter that modern scientists assign to the sodium spectral line.) The problem they faced was that the visible light spectrum is all in the nanometer range. Nevertheless, the Egyptian obsession with the accurate observation of sunlight and its various optical phenomena made them aware of the problem of diffraction, since that had a direct bearing on the fine measurements they had to make when using gnomon and bay tools to determine the exact position of the sun.

They noticed that when a beam of light passed through a small slit, it caused the light to diffract. Anyone can see diffraction easily by making a thin gap between thumb and index finger. If you hold the two fingers fairly close to your eye and look at the blue sky or a lit background, you will see a series of dark lines appear in the gap like a stack of hairs. If you shine a candle light through a slit and reflect it off a CD, the disk acts as a diffraction grating. Diffraction is caused by the interference of light waves.

Christopher Dunn has closely inspected the granite sarcophagi in the Serapeum and finds that the Egyptians could "carve" in the hardest stone parallel walls to within extremely fine tolerances. See Dunn's website (www.gizapower.com) with photos of him measuring the sarcophagi and see his book, **Lost Technologies of Ancient Egypt**. With such advanced machining capabilities in the cutting of extremely hard stone, for the Egyptians to make a precise slit of submillimeter thickness, for example between two well-polished cubit rods positioned very close together, would have been no problem.

The formula for computing the wavelength of any monochromatic light is

$$\lambda = a \sin \theta$$

Lambda (λ) is the wavelength, a is the width of the slit, and *theta* (θ) is the angular position of the first minimum when a beam of sodium light encounters the slit orthogonally and passes through with diffraction producing wave interference and a spread.

For our example we set the slit width as .1mm (i.e., 10^{-4} m). We know that the wavelength is 589 nm for sodium light from simple trigonometry.

$(5.89\text{e-}7 \text{ m}) = (.1 \text{ mm}) (\sin \theta)$
$\sin \theta = .00588995 = 5.88995\text{e-}3$
$\theta = .33747°$

Of course, the Egyptians had to make use of their knowledge of wave behavior in water and the science of measuring triangle relationships (trigonometry). They would make a slit, measure the angle of the first minimum in the diffraction pattern, and then compute the wavelength to be around 589 nanometers (588.995 and 589.5924 nm). We have ample evidence that they were aware of the meter as a unit of measure, since it was the length unit of the 1-second heart pendulum, and therefore of great importance to their psychobiology of reality.

How accurately they could measure such a small angle as θ would determine how close they got to the correct wavelength. They probably had no problem getting to a resolution of a third of a degree or even finer given the accuracy with which they could align huge pyramids. They probably used a telescopic device or magnifying lens Eye of Horus to view the angle.

By measuring light speed and electromagnetic wavelengths in the visible spectrum the Egyptians were already tiptoeing into the realm of quantum mechanics that was not rediscovered until the early 20th century by Planck, Einstein and their colleagues.

The formula discovered by Einstein for the transmission of energy via photons is

$E = h\,\nu$, where h is Planck's constant and ν is the frequency of the photon radiation.

The relation of h to its reduced form is $h = 2\,\pi\,\hbar$. We express the frequency of a monochromatic beam of light in terms of the wavelength λ by the relation $\nu = c\,/\,\lambda$. The formula for the energy carried by sodium light becomes:

$E = h\,c\,/\,\lambda_{Na}$.

Planck's reduced constant has the ratio of 1.054, and light speed is 3e8 m/s. Both numbers appear on the Senet Oracle Board. The wavelength for sodium is 5.89e-7 meters. We plug these values into our equation, and calculate.

$2\,\pi\,\hbar\,c\,/\,\lambda_{Na}$.
2 (3.14159) (1.054e-34 kg m^2/s) (3e8 m/s) / (5.883e-7 m) = 3.377e-19 J = 2.108 eV.

The eV stands for 1 electron volt, a standard unit used by physicists for measuring mass, energy, and charge. The SI unit for the electron volt is the joule, and it measures an amount of energy. A single electron volt is 1.602e-19 J, which is one quantum unit of elementary electric charge times 1 volt and represents the kinetic energy gained by an electron passing through a potential difference of 1 volt. If the energy is at 1 eV, the corresponding wavelength is down in the infrared region and is not visible. So the Egyptians chose the "Golden Phallus" of the Neter at the Natron Line of 2.108 eV, because that is easily visible and is the light given off by their sacred natron when it burns. "Neter" means divine in Egyptian and is preserved in the word natron and the chemical abbreviation Na. This value is the diameter of the apex flash of the obelisk (2×1.054 = 2.108) and 2/3 of the scaling constant (3×1.054 = 3.162), which is clearly marked as the scaling line proceeds diagonally from heaven to earth across the nine vertical columns of the Ennead. The value 2.108 eV falls within the sodium line at the 5.88e-7 m to 5.89e-7 m wavelength. The circumference of the apex flash gives us the value of the non-reduced Planck constant:

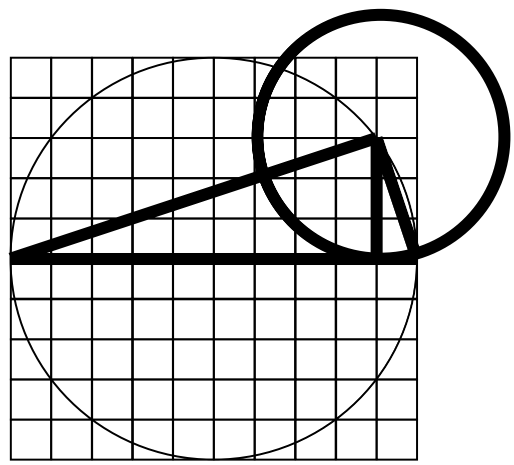
2 π 1.054e-34 kg m^2/s = 6.626e-34 kg m^2/s,

The radius of the apex flash gives the reduced value of Planck's constant, and the diameter of the apex flash gives us the value of the Natron Line in electron volts:

2.108 eV.

The value in joules (approx. 3.3773e-19 J) is very close to the ratio of the Senet Board length to width (10/3), and is only off by the fourth root of 1.054 = 1.0132.

The golden bar of natron secretly linked the physical body to the eighth chakra "a*a*kh" immortal light body. The many salts made from sodium are of interest, including ordinary table salt (NaCl), which is the essential salt in the ocean, in our bodies, and an easy way to render water an effective electrolytic solution.



The Solar Disk Flashes from the Top of the Tower of Tem
The Radius of the sphere/circle is 1.054, Given the Height of the Tower as 1 Unit
The Diameter of the sphere/circle is 2.108, the value of the Natron Line in eV.

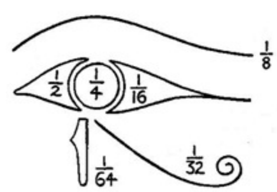
The scaling constant diagonal enters the plane of Earth at the junction between the Moon (symbol of the illusion of reflected sunlight) and the Setish demonic dragon lady, Ammet (symbol of the illusion of suffering in the physical world that eats away at the heart). As we slide down the scale from heaven to earth we encounter the smoke and mirrors of the world, although Hathor the Loving Cosmic Mother with her celestial mirror is just above the Moon to remind us that what we see is just an optical illusion reflection of our selves, and Horus, the all-powerful will is right above Ammet to remind us that we are really in charge even during the heat of what appears to be a deadly battle. The final third of the scaling constant takes us into the consummation of the Lovers, joining heaven and earth in the blissful unity from which life begins the story of growth and evolution.

As a person proceeds through life on the earthly plane, there should be a corresponding ascension on the scaling constant until the moment of Truth (Maat) is reached on earth and culminates in the apex of the obelisk with a return to Tem the Cosmic Tower and then recapitulation of union with Ra and the whole story of life in the similar triangle upheld by Thoth.

The earthly plane begins with conception, followed by gestation and birth. The next 7 houses cover infancy, adolescence, maturity, career, retirement, death, and truth (rendering of justice and return to unity). Thoth unveils the possibility of the light body through direct communion with Ra (the Cosmic Solar Source).

If you continue to ascend along the scaling line of the large triangle you enter the space above and beyond Ra. If you continue along the hypotenuse of Thoth's miniature triangle, you transcend the Senet grid and enter the invisible realm of Amen. One of the games that evolved from the Senet Board and remains very popular even today is known as Backgammon. Bak-Amen means the invisible hawk or "your mind is invisible."

In the picture on the right Thoth holds the Eye of Horus. On the left, a drawing from the **Amduat**, Hour 4 (Hour of the Heart Chakra) reveals Thoth handing the Eye to Horus. This allows Horus to focus his attention deliberately with his will to attain any knowledge or skill that he may need or desire in his heart of hearts.



Above is a drawing of the Eye of Horus (from **The Crystal Sun**, p. 441) with labels that reveal the mathematical values of the six components. This is a binary series and the sum of all the component fractions equals 63/64. A final 1/64 is invisible, but represents the continuation of the series to its limit fraction, which happens to be 1/∞ = 0. The sum total of the remaining series to the limit equals exactly 1/64. When this component is added, the Eye is whole. The mathematics of the Eye of Horus demonstrates that the Egyptians already understood the basic principles of the theory of limits and the calculus that it implies. The series 1/2, 1/4, 1/8, . . . is also a scaling constant.

The diagonal hypotenuse of the D-shift scaling constant Oper (%) resembles the slash (/) that we use to indicate ratios. Above the slash is the Ennead of Heaven. Below the slash is the Ennead of Earth. The ratio of the two equals unity: 9/9 = 1, which is the value of the Tower in the diagram. Notice how the diagonal divides the 9 x 3 rectangle into two equal triangles. If we assign a value of 1 to each triangle, then the two large triangles (Heavenly and Earthly) equal a value of 2. The little triangle of Thoth is then equal to 1/10 the size of each of the larger triangles. The sum of the Heavenly, Earthly, and Thothian triangles is 2.1, which again approximately echoes the value of the Divine Golden Natron Line energy expressed in electron volts.

Planck's Constant and the Fundamental Particles

By rearranging the expression for energy and multiplying both sides by the constant *pi* we get an excellent approximation to the rest mass of the proton (*Mp*).

$h\,\pi\,/\,2.108\text{ V }\lambda_{\text{Na}} = \pi\, e\,/c \approx Mp.$

$h\,c = 2.108\text{ eV }\lambda_{\text{Na}}.$

From the above equation we also can solve for Planck's constant in terms of constants that the ancient Egyptians theoretically could measure.

$h = 2.108\text{ eV }\lambda_{\text{Na}}\,/\,c.$

The relationship $hc = 1.987{\times}10^{-25}$ kg m^3/s^2 (or its reduced form $\hbar c = 3.162{\times}10^{-26}$) is fundamental to quantum mechanics and is encoded in the geometry of the Senet Oracle Board. We recall that the general formula for the relation between wavelength and energy is:

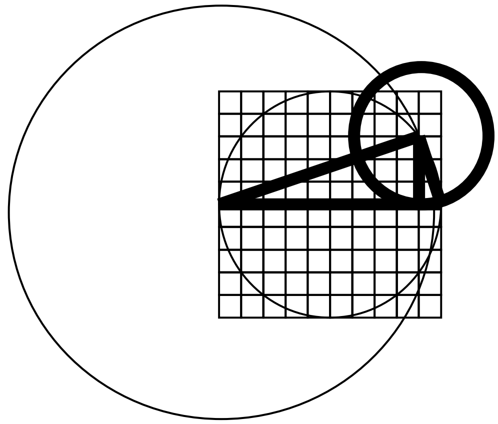
$E = h\,c\,/\,\lambda,$ where λ is the wavelength and E is the energy.

Thus energy varies inversely as the wavelength. The shorter the wavelength, the greater the energy.

Based on simple electrostatic levitation experiments with charged goose down or other materials the Egyptians probably arrived at (1 + 1/2 + 1/10) kg m/s = 1.6 kg m/s as the approximate value for a quantum charge. The Egyptians could calculate value of *c* and the wavelength *lamda* experimentally.

$2\,\pi\,3.162\,/\,5.883 \approx (10/3)\,(1.054)^{1/4}$

The value 3.162 is the maxiboard diagonal from the tip of the Tower to the lower left-hand corner of the board used as the radius of a circle that is almost 20 units in circumference (19.87), 10/3 is the ratio of the length to the width of the Senet Board, and 1.054 is the diagonal of the miniboard, which is one third the size of the maxiboard. The 5.883e-7 m wavelength is in the sodium line generated by natron at the level of precision available to ancient Egyptian engineers. The Egyptians may have arrived at the relationship $h\ c = 2.108\text{ eV }\lambda_{\text{Na}}$ by playing around with the relationships of the numbers as they are encoded in the geometry of the Oracle Board: 1.054, 1.6, 2, 3.1416, 3.162, and 5.89. They only go together in certain ways.



Large Circle Has Radius % = 3.16227766 Relative to Senet Board

The Egyptians also must have noticed the strange phenomenon that (3.1416) (3) / (1.6) ≈ 5.89, whereas (3.1416) (1.6) / (3) ≈ 1.67, which is the ratio component of the proton mass. Here we play only with the Senet Board ratios and ignore units and scale.

The mass of the electron is .511 MeV / c^2. To convert this to kg:

(.511e6) (1.602e-19 J) / (9e16 m^2 / s^2) = (9.1e-31 kg)

Compton scattering of light off an electron at "rest" has the relation $Me = h / \lambda c$, where the wavelength of a photon scattering off an electron shifts to a longer value than that of the proton. The electron's Compton Wavelength is λ = 2.43×10e-12 m. In general,

$E = m c^2$.
$E = h c / \lambda$.
$m = h / \lambda c$.

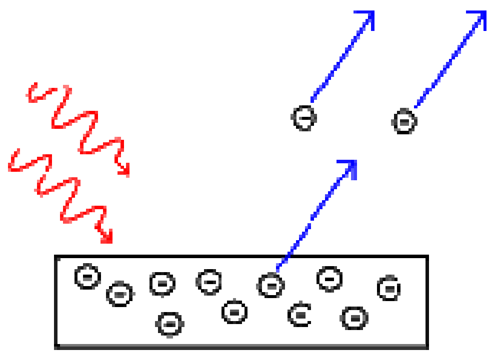
The **Wikipedia** article on the "Compton Wavelength" is so compact and relevant to what is discussed above that I quote it below (except for the references that can be found at the end of the article). For details about the fine structure constant, the Planck length, and the relation to gravity, see also my papers on **Observer Physics** and the **Wikipedia** article on "Compton Scattering".

Of great importance is recognizing how deeply pervasive the relations ($h c$), ($\hbar c$), (h / c), and ($\hbar / c$) are in the world of quantum physics. The constant interaction of the smallest constant ($\hbar$) with the largest constant (c) gives us the Oper (% = 3.162), a definition of the joule, and a fascinating unity.

$\hbar c / \% r = 10^{-26}$ J.
$\hbar c \%^{51} / r = 1$ J.
$\hbar c^2 Ss = \pi r e Oo As$.
$(\hbar c / r) (Ss / Oo As) = \pi e / c = Mp$.

Before quoting the wavelength article, here is a little chart from the "Compton Scattering" article in **Wikipedia** that shows how matter interacts with energy at different energy levels. The energy levels of radiation are determined by the wavelength.

Light–matter interaction



Low-energy phenomena: **Photoelectric effect**
Mid-energy phenomena: **Compton scattering**
High-energy phenomena: **Pair production**

The Compton Wavelength

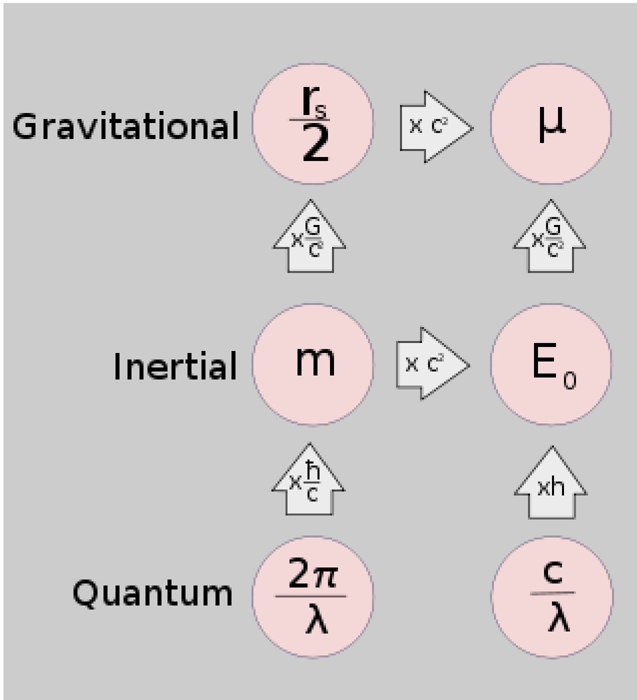
From **Wikipedia**, the free encyclopedia

The **Compton wavelength** is a quantum mechanical property of a particle. It was introduced by Arthur Compton in his explanation of the scattering of photons by electrons (a process known as Compton scattering). The Compton wavelength of a particle is equivalent to the wavelength of a photon whose energy is the same as the rest-mass energy of the particle.

The Compton wavelength, λ, of a particle is given by $\lambda = h / m c$, where h is the Planck constant, m is the particle's rest mass, and c is the speed of light. The significance of this formula is shown in the derivation of the Compton shift formula.

The CODATA 2006 value for the Compton wavelength of the electron is $2.4263102175 \pm 33 \times 10^{-12}$ m. Other particles have different Compton wavelengths.

Significance



The relation between properties of mass and their associated physical constants. Every massive object is believed to exhibit all five properties. However, due to extremely large or extremely small constants, it is generally impossible to verify more than two or three properties for any object.

- The Schwarzschild radius (r_s) represents the ability of mass to cause curvature in space and time.
- The standard gravitational parameter (μ) represents the ability of a massive body to exert Newtonian gravitational forces on other bodies.
- Inertial mass (m) represents the Newtonian response of mass to forces.
- Rest energy (E_0) represents the ability of mass to be converted into other forms of energy.
- The **Compton wavelength** (λ) represents the quantum response of mass to local geometry.

Reduced Compton wavelength

When the Compton wavelength is divided by 2π, one obtains a smaller or "reduced" Compton wavelength:

$$\lambda / 2\pi = \hbar / m c$$

The reduced Compton wavelength is a natural representation for mass on the quantum scale, and as such, it appears in many of the fundamental equations of quantum mechanics. The reduced Compton wavelength appears in the relativistic Klein–Gordon equation for a free particle:

$$\nabla^2\psi - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\psi = \left(\frac{mc}{\hbar}\right)^2\psi$$

It appears in the Dirac equation (the following is an explicitly covariant form employing the Einstein summation convention):

$$-i\gamma^\mu\partial_\mu\psi + \left(\frac{mc}{\hbar}\right)\psi = 0$$

The reduced Compton wavelength also appears in Schrödinger's equation, although its presence is obscured in traditional representations of the equation. The following is the traditional representation of Schrödinger's equation for an electron in a hydrogen-like atom:

$$i\hbar\frac{\partial}{\partial t}\psi = -\frac{\hbar^2}{2m}\nabla^2\psi - \frac{1}{4\pi\epsilon_0}\frac{Ze^2}{r}\psi$$

Dividing through by $\hbar$c, and rewriting in terms of the fine structure constant α, one obtains:

$$\frac{i}{c}\frac{\partial}{\partial t}\psi = -\frac{1}{2}\left(\frac{\hbar}{mc}\right)\nabla^2\psi - \frac{\alpha Z}{r}\psi$$

Relationship between the reduced and non-reduced Compton wavelength

The reduced Compton wavelength is a natural representation for mass on the quantum scale. Equations that pertain to mass in the form of mass, like Klein-Gordon and Schrödinger's, use the reduced Compton wavelength. The non-reduced Compton wavelength is a natural representation for mass that has been converted into energy. Equations that pertain to the conversion of mass into energy, or to the wavelengths of photons interacting with mass, use the non-reduced Compton wavelength.

A particle of rest mass m has a rest energy of $E = mc^2$. The non-reduced Compton wavelength for this particle is the wavelength of a photon of the same energy. For photons of frequency f, energy is given by

$$E = hf = \frac{hc}{\lambda} = mc^2$$

which yields the non-reduced Compton wavelength formula if solved for λ.

Limitation on measurement

The reduced Compton wavelength can be thought of as a fundamental limitation on measuring the position of a particle, taking quantum mechanics and special relativity into account. This depends on the mass *m* of the particle. To see this, note that we can measure the position of a particle by bouncing light off it - but measuring the position accurately requires light of short wavelength. Light with a short wavelength consists of photons of high energy. If the energy of these photons exceeds mc^2, when one hits the particle whose position is being measured the collision may have enough energy to create a new particle of the same type. This renders moot the question of the original particle's location.

This argument also shows that the reduced Compton wavelength is the cutoff below which quantum field theory – which can describe particle creation and annihilation – becomes important.

We can make the above argument a bit more precise as follows. Suppose we wish to measure the position of a particle to within an accuracy Δx. Then the uncertainty relation for position and momentum says that

$$\Delta x\,\Delta p \ge \frac{\hbar}{2},$$

so the uncertainty in the particle's momentum satisfies

$$\Delta p \ge \frac{\hbar}{2\Delta x}.$$

Using the relativistic relation between momentum and energy $\mathbf{p} = \gamma m_0 \mathbf{v}$, when Δp exceeds mc then the uncertainty in energy is greater than mc^2, which is enough energy to create another particle of the same type. It follows that there is a fundamental limitation on Δx:

$$\Delta x \ge \frac{1}{2}\left(\frac{\hbar}{mc}\right).$$

Thus the uncertainty in position must be greater than half of the reduced Compton wavelength $\hbar/mc$.

The Compton wavelength can be contrasted with the de Broglie wavelength, which depends on the momentum of a particle and determines the cutoff between particle and wave behavior in quantum mechanics.

Relationship to other constants

Typical atomic lengths, wave numbers, and areas in physics can be related to the Compton wavelength and the electromagnetic fine structure constant (α).

The Bohr radius is related to the Compton wavelength by:

$a_o = \lambda_e = 1 / 2 \pi \alpha.$

The classical electron radius is written:

$r_e = \lambda_e \alpha / 2 \pi.$

The Rydberg constant is written:

$R\infty = \alpha^2 / 2 \lambda_e.$

For fermions, the non-reduced Compton wavelength sets the cross-section of interactions. For example, the cross-section for Thomson scattering of a photon from an electron is equal to

$$\sigma_T = \lambda_e^2 \frac{8\pi}{3} \alpha^2,$$

For gauge bosons, the Compton wavelength sets the effective range of the Yukawa interaction: since the photon has no rest mass, electromagnetism has infinite range.

Typical lengths and areas in gravitational physics can be related to the Compton wavelength and the gravitational coupling constant (α_G which is the gravitational analog of the fine structure constant):

The Planck mass is special because the reduced Compton wavelength for this mass is equal to half of the Schwarzschild radius. This special distance is called the Planck length (l_P). This is a simple case of dimensional analysis: the Schwarzschild radius is proportional to the mass, whereas the Compton wavelength is proportional to the inverse of the mass. The Planck length is written:

$$\ell_P = \lambda_e \frac{\sqrt{\alpha_G}}{2\pi}$$

-- (End of quotation)

Below is the formula for Compton scattering (see the **Wikipedia** article on that subject):

$$\lambda' - \lambda = \frac{h}{m_e c}(1 - \cos\theta),$$

where λ is the initial wavelength, λ' is the wavelength after scattering, h is the Planck constant (non-reduced), m_e is the electron rest mass, c is the speed of light, and θ is the scattering angle.

I believe it is possible that the Egyptians were able to measure Compton scattering and obtain the Compton wavelength for the electron at rest and thus obtain the mass of the electron. The non-reduced Planck constant on the Senet Oracle Board is the circumference of the circle with its center at the tip of Tem's Tower and its radius extending from the tip of the Tower to the lower right hand corner of Thoth's House.

The light speed momentum of the electron ($m_e c$) is 2.73e-22 kg m/s, which has the magnitude order of the major arcana -- the top and bottom rows of the Oracle Board plus Osiris and Horus-in-the-Womb (Magician and Hanged Man). The constant $h / m_e c$ is 2.427e-12 m, and has the magnitude of the top row of majors plus Osiris and Horus-in-the-Womb, which means that the bottom row drops out. If the Egyptians used 6.62 for Planck's constant, 1 for the electron, and 3 for light speed, their value for the constant cluster would have been about 2.2067e-12, using 3e-22 for the electron's light speed momentum. I may be wrong, but I do not think the Egyptians thought of Planck's constant as being on the scale of 10 to the -34 magnitude. More likely they preferred to keep the magnitudes no higher than 30 and thought of the constant as the product $\hbar c$ = % *r* e-26 J, where % is 3.16227766 meters and the J stands for energy in units of joules.

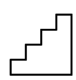
Measurement of ħ

In our discussion of electrostatic levitation we saw that $h / e = V / f$. Because $c = f \lambda$, we can substitute and rearrange to get $hc = eV\ \lambda$. The only variables are the energy in eV and the wavelength. We have shown hypothetical experiments to measure the speed of light (with a Fizeau wheel), the elementary charge (by electrostatic levitation of down), and the wavelength of a particular color of light (by measuring the angle of the first interference minimum of a beam of monochromatic light refracted through a thin slit and multiplying it times the width of the slit). All that remains is to find a way to measure the eV's -- that are twice the reduced Planck ratio (2×1.054 = 2.108) at the natron wavelength -- and an approximate value for Planck's constant emerges from the above formula. The ratio of voltage to frequency is constant and the wavelength varies inversely as the eV's.

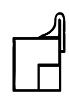
Why the voltage associated with the brightest GOLDEN spectral line of sunlight (Ra's life-giving gaze) and of sacred Natron should be one of the fundamental numbers that appears on the Senet Oracle Board AND the key ratio of the reduced Planck constant "radius" and "diameter" values (1.054 and 2×1.054 = 2.108) is a marvelous cosmic coincidence. Also once again we see Egyptian reciprocal math pivot on a constant.

The Important Role of Iron in Ancient Egypt

The ancient Egyptians considered iron to be a celestial metal, because in the early dynasties they knew of it primarily from meteorites. They believed that the floor of heaven was made of iron and the **Pyramid Texts** speak numerous times of assisting Osiris to ascend to heaven where he is greeted by his mother Newet and other heaven dwellers. To reach heaven he had to ascend on a ladder or staircase. His heavenly throne was thought to be made of iron, and the word for iron was associated with the ideas of wonder, amazement, marvel, astonishment. Compare the staircase and throne glyphs to the grid for the Senet Board. The divine thrones for the deities in the top row of the Oracle Board (as clearly shown in the Papyrus of Ani) represent the glyph for a Mansion, House, or Temple. They also nicely represent the squares on the Senet Oracle Board. **Iron is the cosmic stable plateau for matter on the Stellar Fusion Staircase.** "During their helium-burning phase, very high mass stars with more than nine solar masses expand to form red supergiants. Once this fuel is exhausted at the core, they can continue to fuse elements heavier than helium. The core contracts until the temperature and pressure are sufficient to fuse carbon (see carbon burning process). This process continues, with the successive stages being fueled by neon (see neon burning process), oxygen (see oxygen burning process), and silicon (see silicon burning process). Near the end of the star's life, fusion can occur along a series of onion-layer shells within the star. Each shell fuses a different element, with the outermost shell fusing hydrogen; the next shell fusing helium, and so forth. The final stage is reached when the star begins producing iron. Since iron nuclei are more tightly bound than any heavier nuclei, if they are fused they do not release energy—the process would, on the contrary, consume energy. Likewise, since they are more tightly bound than all lighter nuclei, energy cannot be released by fission. In relatively old, very massive stars, a large core of inert iron will accumulate in the center of the star. The heavier elements in these stars can work their way up to the surface, forming evolved objects known as Wolf-Rayet stars that have a dense stellar wind which sheds the outer atmosphere." (**Wikipedia**, "Star")

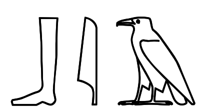


staircase

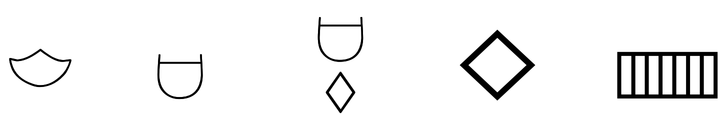


throne

The glyph for iron was "ba*a*" and was usually spelled phonetically, but also included semantic determinative glyphs.



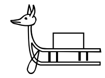
Phonetic spelling of Ba*a* (iron)



seat container? metal plate? plate metal container stone

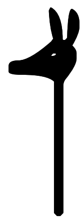
The most common determinative glyphs used with the word for iron.

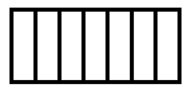
The seat glyph also can mean a pool, perhaps referencing the smelting of ore. The container glyph may represent a kind of battery used to store electrical potential. The diamond shaped glyph may represent the iron plates used to "levitate" stones by electro-gravitational technology.

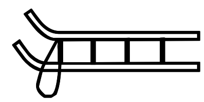


Ba*a*: wonderful, amazing, marvelous, astonishing

Divine Jackal





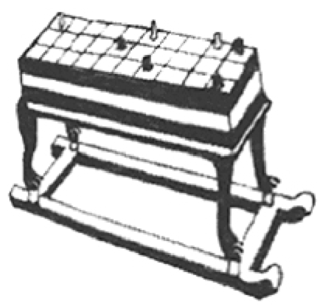


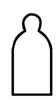
Wizard Staff (weser) Stone Sledge (tem)

Components of "wonderful":

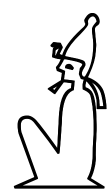
The middle glyph is the stone that was cut and hauled to build structures. The sledge was the vehicle best adapted for hauling stone over Egypt's sandy soil. The jackal-headed wizard staff was for the magical wizard technology used to lighten the load.

Senet Game Board





pawn



Tem

One of the Four Senet Game Boards Found in Tutankhamen's Tomb

The Game Board of Tutankhamen is mounted on a box that resembles a large stone block or a sarcophagus. The board encodes all the information of the universe in its 30 Houses and its sacred geometry, including a solar-lunar perpetual daily, monthly, and annual calendar. The box sits on a table whose legs resemble those of a jackal. The table stands on a sledge such as was used for hauling huge granite blocks, obelisks, and sarcophagus boxes across the sand. The sledge glyph is pronounced "tem" and means complete and all-inclusive. The box-jackal-sledge combination suggests the Egyptian glyph for wonderful, amazing. The shapes of the pawns resemble the crown of Tem the Tower.

If we assume that the Egyptians had noticed the magnetic properties of iron, then they probably were able to measure tiny charges by means of a scale. In the traditional "Weighing of the Heart" ceremony it is assumed that the Egyptians weighed a person's actual heart. The scale also may have had a different use as a very precise scientific instrument not only for measuring weights, but also for detecting electrostatic and magnetic charges. The large ostrich feather placed in one pan could represent a very small sample of down. The "heart" could be a piece of iron that could be electrostatically charged. There may have been experiments in which sunlight would cause the scale to move.

Clues to How Ancient Egyptians Transported Megalithic Blocks

It would appear that the Egyptians had a wonderful method for hauling huge stones that made the work much easier. It was so special that it became the generic term for something awesome and miraculous. Even if we assume that the Egyptians could make most of their megaliths using geopolymer chemistry, they still had to move very heavy stones from time to time.

We do not know exactly how they did it, but we can hazard some speculation, Modern MagLev technology has a variety of techniques, some of which would not be suitable for the Egyptian projects. The Egyptians would not need to make the stones float in the air. If they could reduce a 5-ton block to an effective weight of one ton or less, that would already be wonderful. They may have found a way to use the electrical properties of iron. Let us speculate. Perhaps they laid some iron plates on the ground along the path they would travel. Only a few plates would do, since they could have a team of men rotate the precious plates as the sledge passed along. The bottom of the sledge would be fitted with a special flat iron plate. Then the plates would be charged with static electricity so that they mutually repelled, which would significantly reduce the weight of the stone and the sledge resting on the lower plate. A special team of engineers would operate a portable charge generator that accompanied the stone on its journey. After a second team of workers used ropes to pull the sledge past a plate on the ground, the team of plate movers would move the plate that the sledge had already passed over to the front of the sledge and then the team in charge of charge would charge up the other plate on which the sledge now rested to prepare for the next pull. Thus the job could be accomplished with perhaps only two or three plates of the rare iron and three small teams: a charge generating team, a plate moving team, and a sledge moving team. The charging apparatus could be a pair of van de Graaff type static charge generators (or possibly a Bonetti type design). The principle would be to generate the opposite of static cling (but at very high potentials) by opposing like charges in the plate on the ground and the plate on the sledge, and thus obtaining static repulsion. The arid climate of Egypt would be suited to such a technology, since electrostatic charge is more easily generated in dry conditions.

The master engineer directing the operation may have carried a wizard baton as his symbol of authority and expertise. The head of Anepew the Death Lord on the baton signifies the gap between the plates that is critical to the function of electrostatic levitation. In this case the gap between the plates would be very small compared to the size of the apparatus. The plate on the sledge could be attached between the wooden rails.

Let us say that a block of granite weighs 2.205e4 kg (about 5 tons). The density of granite is 2.65e3 kg/m^3. The block is 2 m wide, 1 m high and 4.16 m long. The sledge weighs 500 kg including the iron plate that is 8.32 m^2 (the approximate area of the bottom of the block) and is mounted to the underside of the sledge 1 cm above the bottom of the sledge's runners. Thus the gap between the plate and the other plate under the runners is about 1 cm.

The gap between iron nuclei is 2.482e-12 m. That means there are approximately 5.125e25 iron atoms along the bottom of the sledge's iron plate. Let us say that the Egyptians could set up elementary charges on 1 out of every 8000 iron atoms. That means there are about 6.4e21 charges on the flat side of the plate -- and the value of q is around 1000 C. The value of V then must be about 2163 V to enable the workers to pull the sledge as if it had no load other than the weight of the empty sledge. If they only are able to charge up one tenth that many atoms (1 of every 80000), then they need 21630 V built up between the plates. They did not need to cancel the entire weight of the stone in order to drag it on the sledge across the plate.

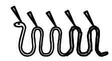
The Quantum Principle: Ladders, and Staircases, and Grids

The grid on the Senet Oracle Board suggests a digital universe, which means that space and time are quantized. The Egyptians used grids of squares to map their canonical figures to the proper scale for murals of different sizes, and of course the Senet Oracle Game Board was in the form of a grid of squares.

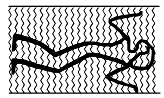
The units that we use such as the foot or meter for space and the second and day for time are not quantum units in the "established" view of nature, because they are derived from local observations and are not universal quantum units based inherently in the quantum constants. So we must dig deeper to find out what insights the Egyptians may have had into cosmic quanta.

In addition to their "grid" conception of the universe the Egyptians also had a wave interpretation of reality that they symbolized pictorially with the wavy motion of serpents and the very fine wavy lines with which they represented ripples on bodies of water. On the other hand they often showed large serpents being cut with knives into segments, suggesting a transformation from wave to particle. The ancient form of the Mehen Game Board was a coiled serpent that was divided into segments.

The coiled serpent represented a spiral that expressed the notion of varying scale and the viewpoint from which the wave interpretation melds into the particle interpretation. The segments show the particulate nature as does the round spiral as a whole.

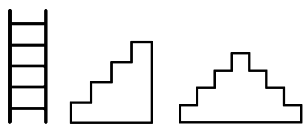


The Serpent Apep as a Quantized Wave



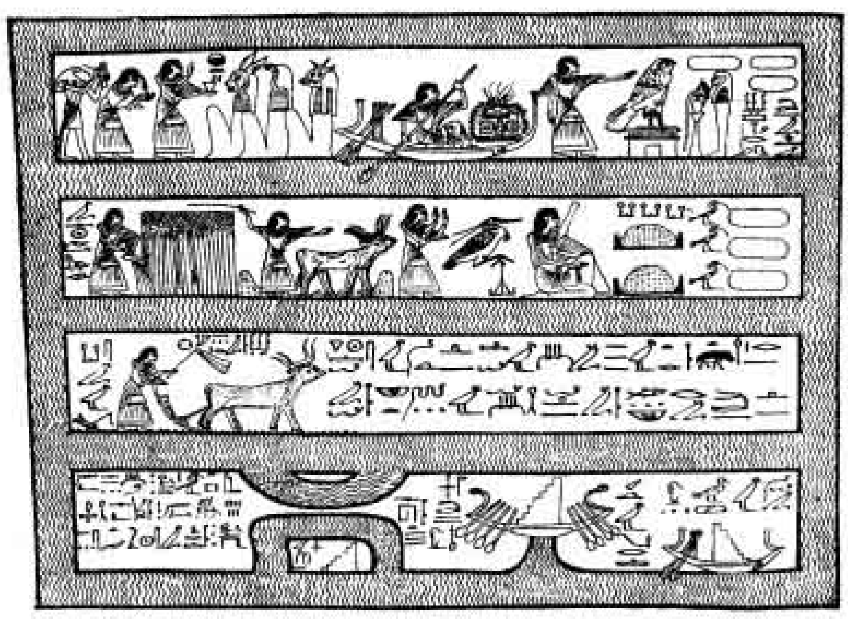
A man swimming in water characterized as ripples of energy

In addition to grids, other important symbols used by Egyptians to suggest a shift of scale by means of quantum steps were the ladder and the staircase. The former encoded one-dimensional quanta, and the latter encoded two-dimensional quantized increments. The purpose of these sacred images was to present a concrete image of spiritual ascension to higher states of consciousness. Ladders and stairs were tools for ascending to heaven in quantized steps reminiscent of the quantized steps of atomic energy shells.



Ladder, Staircase, Step Pyramid

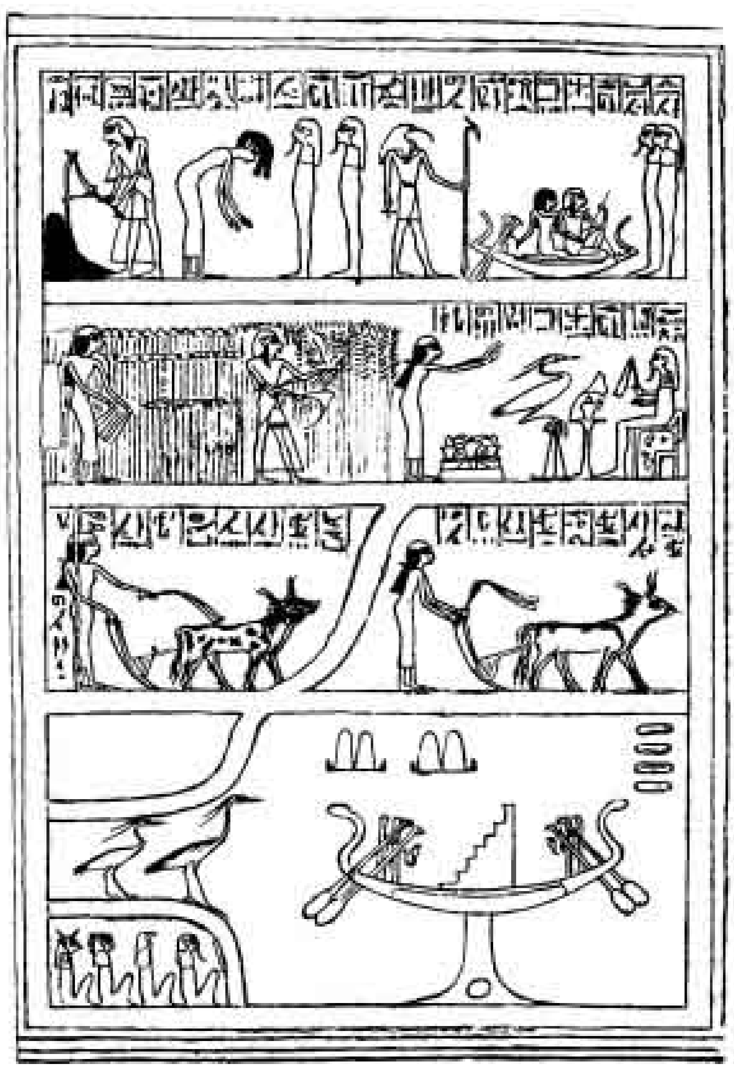
Islands of Reality in a Sea of Energy Waves

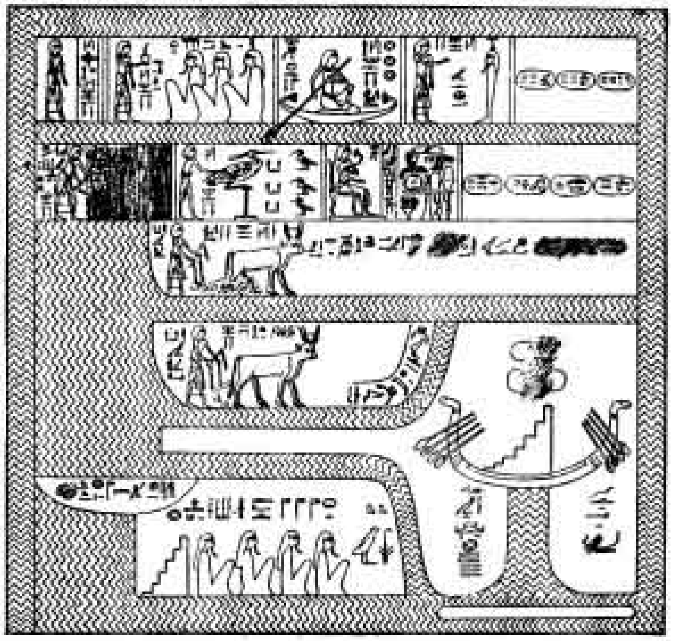


Stylized view of Egyptian Heaven Embedded as Islands in a Field of Energy Waves

Note the boat with 8 oars (for 8 chakras) and bearing the Staircase to Heaven in the lowest "island" that represents the transition phase of ascension to the Isles of the Blessed in Heaven. The lowest island in Heaven encodes the plowing of fields. In one sense this recapitulates the good actions a person did during physical life. It also suggests subtle work done in Heaven. The second island encodes the idea of reaping an abundant harvest with full granaries for all three islands of the immortal light beings who live in Heaven. The upper island depicts honoring of the archetypes of Nature and presenting of offerings to the ancestors and souls of all the inhabitants who dwell on the three islands of the blessed. In the upper left hand corner Thoth records the whole procedure. On the right side the soul is depicted as a hawk of Horus on a mastaba in front of the mummy of the body. Horus indicates that the soul is an avatar of the Invisible Higher Self Sun, Amen-Ra-Horus. Heaven is NOT the field of undefined awareness. That is represented by the wavy waters that surround the islands. These drawings clearly depict a dual viewpoint of waves and particles. We want to discover the inner connection between these two viewpoints in Egyptian science and cosmology.

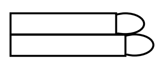
The three islands recapitulate the three rows on the Senet Oracle Board. Below are two other examples of this standard Egyptian view of the Afterworld. They each follow the same basic design with small differences in details.



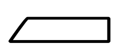


Other Examples of the Staircase to Heaven and the 3 Islands of the Blessed
The wavy environment is water, but also symbolizes the energy of light waves.

The Egyptians believed that Horus (and perhaps also Baba) helped Osiris ascend a ladder or staircase after his resurrection by means of two fingers. The two fingers together (index and middle) became a sacred amulet.

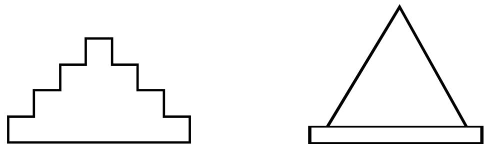


During his resurrection phase Osiris identifies with Ra as his True Higher Self. On the Senet Oracle Board the House of Death is the third square from the right on the bottom row. The House of Osiris is the second square from the right on the middle row. The House of Ra is the first square in the right corner on the top row. Thus we see on the Senet Oracle Board a miniature staircase on which Osiris ascends from death to identify with his immortal Higher Self in the form of the Sun God Ra. The ascent becomes equivalent to climbing the Tower of Tem that stands on a foundation base of Truth (Ma'at) that is often represented as a pyramid casing block and is also pronounced Ma'at. An alternate reading of the "*a*b" glyph is "mer" with the meaning of pyramid.



Ma'at Pyramid Casing Stone = Truth, Justice

Some scholars interpret the above glyph as a chisel. Sometimes the glyph is written very similar to the glyph for wedge, an edge, or an embankment. The interesting property of this casing block is that it integrates the jagged step pyramid and smooth continuous pyramid viewpoints. Perhaps this merging of discrete digital and continuous analog is Scientific Truth in the eyes of ancient Egyptians.

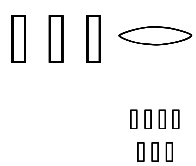


Digital Pyramid Smooth Pyramid

We have seen how the diagonals drawn on the rectangular Oracle Board have irrational values. On the other hand, if we interpret the Oracle Board as a grid, and the squares represent quantized particles, then there can be no true diagonals except in the form of staircases, just as our modern computers draw diagonals with "jaggies". This of course means that the Pythagorean Relation is no more than an estimate. Depending on how we calculate, the "diagonal" of the TER is 9 units, 12 units, or 9.486833 units in length.

π in Ancient Egypt

The simplest workaday version of *pi* for the ancients was the ratio 22 / 7. The Egyptians preferred to write only in fractions with unit numerators, so they would probably write it as 3 + 1/7.

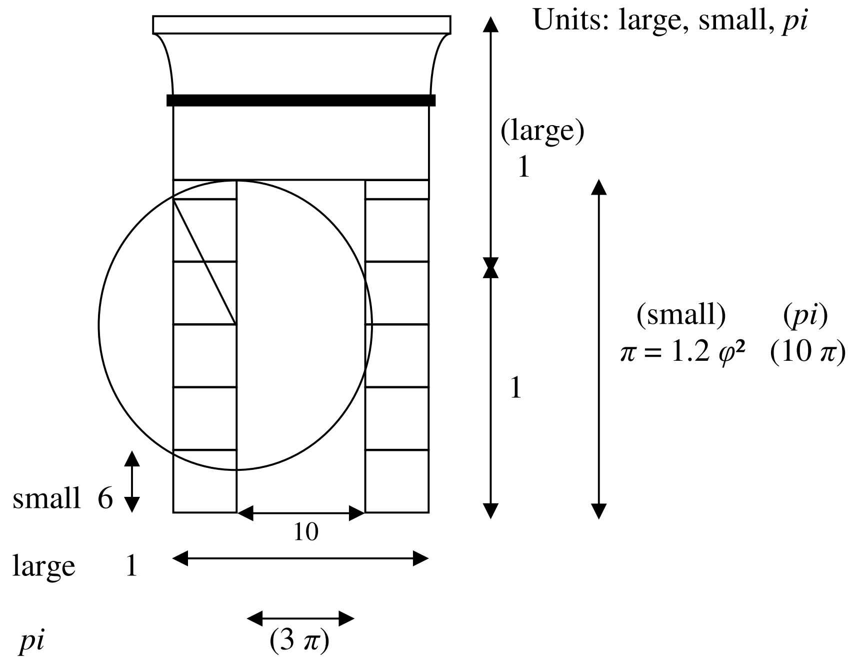


The marvelous ratio of 22/7 encodes the 22 Trump Deities and the 7 physical chakras. The eighth chakra is the light body that bridges the gap between the physical and the spiritual. The 22 Trumps include the entire top and bottom rows of the Oracle Board plus the two "eyes" of the middle row (Osiris as the Magician and Fetal Horus as the Hanged Man). The court card that corresponds to the light body is Sejem (Hearing), who is located between Thoth (High Priest) and Ra (Sun) and connects the two. When sound becomes extremely subtle, it transforms into light, which is why the Senet Tarot Court Card for the light body is the "page" of feathers (A*a*kh). The feather expresses the element of air and the reality of truth -- that the vibrations of material phenomena are lower resonances of light.

If the Egyptians wanted to approximate *pi* to 5 places 3.14159, they might write:

3 + 1/10 + 1/25 + 1/1000 + 1/2000 + 1/11111.

Other fractions using larger integers to form the rational approximation were also used (e.g. 864/275), but calculating fractions with such big numbers was quite cumbersome. It was easier and more precise for the ancients to embody *pi* in megalithic architecture.



Egyptian Megalithic Doorway Embodying *Pi*
(and shaped like the Greek letter Π)

In the above sketch of an Egyptian megalithic doorway (based on a drawing and analysis made by Schwaller de Lubicz) the outer dimensions are in a ratio of 1 large unit wide by 2 large units high. If we count each square block in the door jamb as 1 unit, then the inner height of the doorway is 3 units plus $\sqrt{5}$ units. If we count each block as 6 small units square and the inner width of the doorway as 10 small units, then the first three blocks reach a height of 18 small units and the remainder of the doorway height is 12 small units plus the additional small block that raises the height to equal the diagonal of the rectangle formed by the 2 blocks of 6 small units each. The diagonal of the 6 by 12 unit rectangle is 13.4164 units. When we add this to the 18 units, we get 31.4164. Thus the ratio of the doorway's inner height (31.4164 small units) to its inner width (10 small units) is 3.14164, which is an excellent approximation not only to *pi* but also to 1.2 φ^2. The approximation of φ is 1.618, and it is the essential component of the Golden Proportion. This is the embodiment of basic mathematics in megalithic architecture. If we let the inner width be 3×3.1416 = 9.4248 small units instead of 10 small units, then the inner doorway becomes a **Senet Oracle Board** with the dimensions of **3 pi by 10 pi!!**

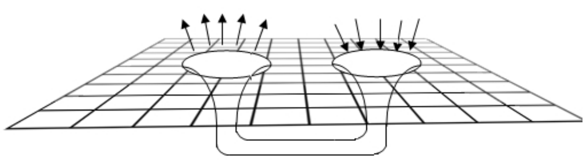
The Quantum Junction where Discrete and Continuous Merge

Black Holes and Wormholes in Ancient Egyptian Cosmology

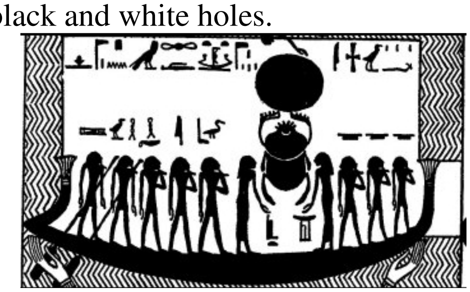
In the Senet Oracle Board, the Boat of Ra-Osiris forms the middle row and contains Osiris, the fetus to be born, the four elements, and the four senses that are all associated with the Boat of Ra. When we form the inward Senet Spiral, we start to wrap the Oracle Board onto and into itself, taking it to smaller and smaller scales. However, the spiral may not go on forever in the physical world. As the picture from the **Book of Pylons** shows, at some scale the spiral wraps up and forms the closed circle of a particle. From that point on the spiral shifts into a particle format. We want to determine when the wave converts into a particle. That is the critical quantum definition of space and time, because the process consists of light spiraling. The light must go at the constant speed of light, which means that the wavelength in space at which the particle forms will also automatically define the basic quantum unit of time. We can then translate the quantum units into whatever local units we find convenient, such as meters and seconds.

Paradoxically, because the spiral is a dynamic process, it can not stop. There must be a continuous flow. This is how the discrete and the continuous aspects of reality merge into one. The continuous flow must form a cycle that consists of the "photon" wave spiraling into a highly concentrated particle, and then passing through a phase transition in which it apparently reverses and begins to spiral outward again, returning from particle mode to the condition of a wave propagating through space.

The two hands of NEW encode how this happens. If you just look at the boat, you see the two hands as two separate particles and you may miss the fact that they are connected through the arms to the single body of NEW. This is the principle of particles and antiparticles. Every particle must have a partner antiparticle that is its reciprocal and that completes its cycle of energy flow. In his book **Starwalkers** (p. 127) William Henry compares the reed boats such as we see in the picture of the Solar Boat upheld by NEW in the graphic to hyperspatial wormholes that join black and white holes.



white hole black hole



Ra's Boat as an Hyperspatial Wormhole

The problem we face is how to determine what that Osiris particle is. We know that it must be stable, because Osiris achieves enlightenment and immortality. We also know that it must have charge, because we generate all our experiences via the photonic (electromagnetic) interaction. That tells us right away that the particle must be the electron. All our experiences consist of absorbing photons with electrons. Physical experiences involve electrons bound to atoms in our physical bodies. Psychic and spiritual experiences may involve an ability to detect interactions among free electrons via some form of quantum tunneling. But for now we will simply stick to the physical human body, develop our hypothesis, and then see how much evidence we can detect in what we have available from ancient Egyptian civilization that might support our hypothesis.

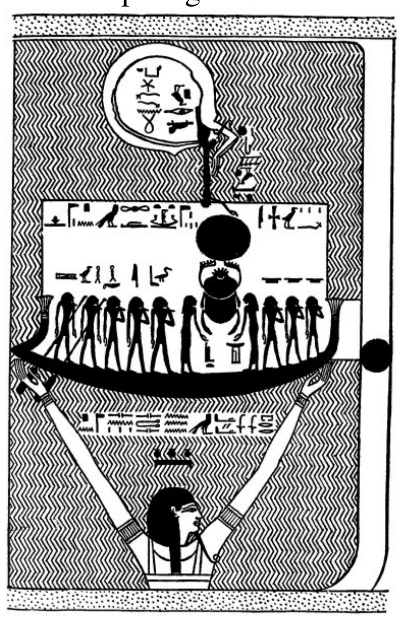
We have a problem in modern science, because there is as yet no widely accepted model for the structure of the electron even though we already know a great deal about its behavior. There are also many properties and behaviors of the electron that are not well understood at present. With this in mind we will proceed anyway to forge a hypothesis and see what we get.

All electrons are alike, which makes it easy to map them to Osiris. In ancient Egypt there was one archetypal Osiris in myth, but every individual, male or female came to be identified with Osiris. What if all electrons really are the same particle that is vibrating at a spatial frequency as well as a temporal frequency and thereby appears to distribute itself as many copies of an identical particle simultaneously throughout space in different patterns and densities?

Electrons are attracted to oppositely charged protons and form atoms and molecules. This allows for the construction of various types and configurations of matter. According to our current understanding, the most loosely (outer) bound electrons can absorb electromagnetic energy (photons) and change their energy configurations to higher states of excitation. They also can release and emit electromagnetic energy and return to lower states of excitation. This mechanism gives rise to various chemical reactions and to the possibility of conscious awareness experienced in a physical body.

However, for the electron to maintain a stable configuration in a physical system and not simply dissipate away all its energy through the charge that it gives off, there must be a cyclical flow of energy that keeps it supplied with a constant charge, even when it is not emitting electromagnetic radiation in the form of light.

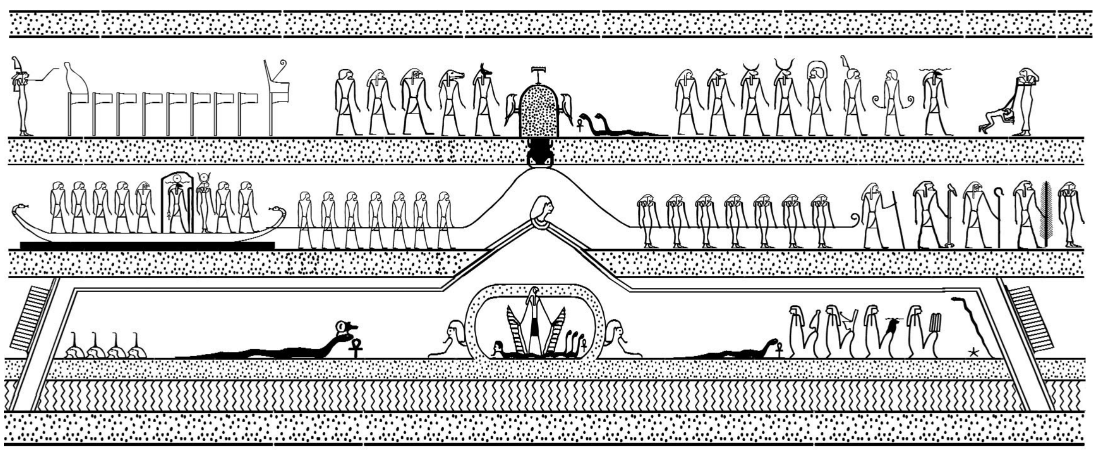
Take another look at the wave-and-loop diagram.



New is an expression of Ra. Ra becomes Tem the Tower as a huge standing man. He uplifts and spreads his arms to become New. (Notice how he also resembles Thoth stretching the cord to measure heaven.) Then he transforms into Khepera, the Sacred Scarab Beetle. Khepera pushes the disk of Ra up into the sky where it becomes the Aten flying disk. Finally through the assistance of Geb and the other gods on the boat, he becomes Osiris wrapped up like a bubble or a seed. Osiris sprouts and grows, but then dies and is dismembered. In cycles Osiris comes and goes, appears and disappears.

When New uplifts and spreads his two arms, he seems to bifurcate into two separate hands. Yet these hands are still joined to New's single body and operated by his single head.

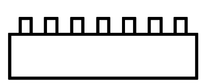
In the **Amduat** (What Happens in the Tuat), Hour Five, we find Osiris in the form of an apparently inert mound and Isis in the form of a pyramid. Khepera crawls out of the mound and lifts a rope that is towing the Boat of Ra over the pyramid of Isis.



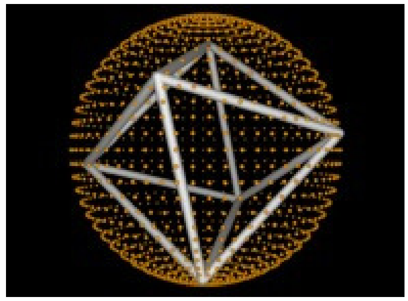
Amduat, Hour 5

Waves and Oscillations

Khepera transmits the power of Ra from Osiris into the pyramid of Isis. On the Senet Oracle Board Osiris is embedded in the Tower of Tem just as tradition says his corpse was found embedded in a tree. The energy spirals out from the electron particle at the tip of the Tower just as generative semen spurts out from the phallus of Ra in his form as the giant Tem. Osiris as a plant embodies that phallus. As the energy spirals out, it generates larger and larger versions of the Senet Board -- which of course is signified by the Oracle Game Board glyph for Menew's name, the procreative form of Amen Ra. As it reaches the large TER, it swings up into the far left corner where we find Isis and Nephthys, the two lovers of Osiris. Now we understand why the two sisters are at the far upper left on the Board, as far away from Osiris as they can be and still be on the Senet Board -- a curious feature of the layout that puzzled me for a long time. Isis represents the wife who becomes mother, and Nephthys represents the lover with her irresistible power of attraction.



Men



An Octahedral Double Pyramid Embedded in a Sphere

Suppose Isis is a positively charged particle inside a proton to which the electron is bound, and Nephthys is another positively charged particle in the same or an adjacent proton that also attracts some of the electron's electromagnetic emissions. The charge on these two women attracts the opposite charge of Osiris and draws it into them. This creates a mirror image process of an inward winding spiral that curls in the opposite direction because of the opposite charge.

The protons attract the electron emissions because they each contain within them a positron (anti-electron). The emissions from the two particles cancel the space between the particles. The outward winding spiral is like energy spiraling up one of New's arms to his hands. The inward winding spiral is like energy spiraling from New's other hand, down his arm back into his body. The point where the two arms join the body is analogous to the moment in space-time when an electron-positron pair forms out of the vacuum of undefined potential waves. Particles are always created in pairs, one of which is matter and the other of which is antimatter. Particle annihilation occurs when a particle-antiparticle pair mutually cancel.

Look again at the Egyptian drawing and you will see how Osiris is actually a white hole emitting a beam of radiation that passes through the Space of Newet to reach the black hole of the sun's disk that is supported in the embrace of Isis and Nephthys. Or you can flip it around and say that Ra's disk is the white hole that emits a beam that travels through the space of Newet and is absorbed by the loop of Osiris. The processes are equal and opposite. In any case there it is -- the fundamental process that sustains the universe and continues looping so long as the electron is kept separate from the positron.

The proton is considered to be an ensemble particle made of several components. I would tend to think of the Boat of Ra and its passengers as the proton ensemble. The three Gates are the three quarks that form to gate the proton's internal energy flow. The two ladies are the positrons. Geb, the father of Set, the Lord of solid resistant matter, is an internal electron that usually keeps Nephthys preoccupied so that most of the energy goes to Isis. The 3 Gates distort the spiral through wormholes that keep Osiris from getting too close to Isis. If the electron and positron (Osiris and Isis) physically mate, they return to the state of pure light from whence they came.

Shewe is the pattern formed by the magnetic charges of the interacting charged particles. Heka is Geb's antineutrino mantra. Hew and Sa are neutrino mantras for Isis and Nephthys.

In modern physics the radiation that passes between the orbital electron and the core positron is called *bremsstrahlung* and can be seen in cyclotrons when electrons are made to run in circles with strong electromagnets. Since the energy that curves the path of the electron comes from outside in a cyclotron, the radiation emitted by the electron goes outward and can be observed. In an atom, the magnetic energy that curves the electron path comes from in the nucleus, so the corresponding emitted radiation from the electron goes into the nucleus and is not observable from outside the atom.

As the drawing depicts the energy exchange, it goes out from the electron forward through time and passes through space. Then it goes into the positron and passes backward through time to the original moment that the electron-positron pair were created and emerged from the undefined energy potential. At the creation moment the electromagnetic radiation passes from the positron to the electron and begins spiraling outward again, picking up relative speed as it goes. When it reaches the speed of light in open space, it passes through space as energy potential and then passes through matter as motion as it winds into the positron core of the matter and backwards in time again to the creation moment. Matter and antimatter are reciprocal. Motion and energy are also reciprocal.

We know that the electron-positron is the smallest of the particle pairs that can build anything. Neutrinos, as we shall see, are not true particles, because they have no charge and do not interact with matter except as silent partners with charged particles in order to balance the uncertainty inside and outside nucleons. The electron has a scale of 10^{-30} relative to adult human size, which is about 90 kilograms give or take a few kilos. We currently peg the electron rest mass at just under 10^{-30} kg. The number thirty once again calls to mind the Senet Oracle Board and its Council of Thirty. The unit measure on the Board corresponds to mass in kilograms. The unit square is 1/30th of the area of the Board. If we take that as code for spiraling inward 30 iterations from large to small, that gives us a ratio of $1 / 10^{-30}$ a range of 30 orders of magnitude from our scale to the world of the Very Small to find the electron mass. The TER contains 27 unit squares. If each square represents an order of magnitude, then the TER gives us the scale of the proton in the world of the very small (10^{-27}). Going to the world of the very large, we find that 10^{30} kg (a positive scale of Senet Board mass) is an approximate stellar mass, and 10^{27} kg (a positive TER mass) is an approximate Jovian planetary mass.

We mentioned earlier in the book that there is a simple formula for correlating the mass of a particle with electromagnetic radiation. This is the Compton formula. Usually it is written as $\lambda = h / c\ Mx$, where lambda represents the wavelength of the wave form and Mx represents the mass of the particle phase. We can reduce Planck's constant and rearrange the formula for the electron as follows: $(2\ \pi\ \hbar\ /\ c) = \lambda_e\ Me$. We note that the part of the equation on the left is a now a constant relationship, whereas the portion on the right presents the wavelength and the mass as variables. However, once we choose a particular particle, all parts of the formula become constant. Notice also that the right hand portion has the same dimensions as the formula for the first class lever Scale of Judgment on the Senet Oracle Board.

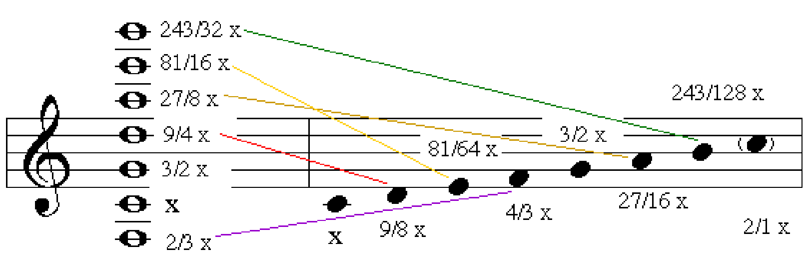
The constant portion equals 2.21×10^{-42} kg·m. The variable portion allows a range of wavelengths and masses. For example, if we choose the rest mass of an electron, we find that $\lambda_e Me = (2.426\times10^{-12}\text{ m})(9.109\times10^{-31}\text{ kg})$. Lambda more precisely is:

$$2.426\,310\,217\,5\pm33\times10^{-12}\text{ m.}$$

The Compton wavelength for a proton is 1.3214098446e-15 m, and its mass is $1.672621637\times10^{-27}$. The formula guarantees that as the mass gets larger, the Compton wavelength gets smaller, and as the mass gets smaller, the Compton wavelength gets larger. This means that the smaller mass tends to spread out over a larger space. At some point the mass is so small and the space is so large that the particle effectively has no mass and becomes equivalent to a photon vibrating in space and it no longer tends to be stable as a particle with a clearly defined rest mass.

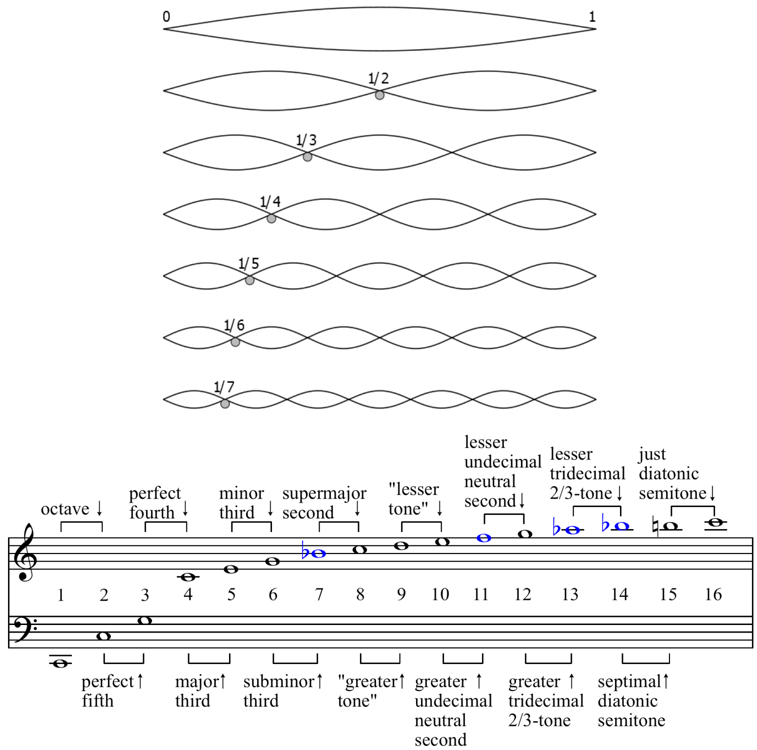
The question is: at what wavelength does a photon start to loop in on itself and form a particle? The answer is: **never**! The reason for this is that every particle ultimately remains open, because it is made of a pair of spirals, one winding outward and one winding inward. The particle is defined by the tight portion of the spiral and the wave is defined by the open portion of the spiral. The quantization of wavelengths and masses occurs due to harmonics. When a wave loops around onto itself, it can only sustain an integer number of vibrations or it will interfere with itself destructively. Thus the only stable loop waves are standing waves that form integer harmonics.

The ancient Egyptians from very early times used string instruments for making music, so they were aware of the standing waves that form when a string is stretched between two pegs and then set to vibrating. The Pythagorean school of the Greeks learned what they knew of these matters from the Egyptians. The basic ratios (1/2, 1/3, 1/4, 1/5, 1/6, 1/7, and so on) are unitary fractions of integers. You can make strings of these relative lengths and the tones they make as they vibrate will generate certain musical intervals that can be expressed as integer ratios.



Index | Pythagorean | 12 tones/oct

C	Db	D	Eb	E	F	F#	G	Ab	A	Bb	B	C
1/1	256/243	9/8	32/27	81/64	4/3	729/512	3/2	128/81	27/16	16/9	243/128	2/1



The shorter the wavelength, the higher the frequency. In the case of electromagnetic waves the energy is determined by the wavelength rather than by the amplitude of the wave. This means that a smaller wavelength has more energy than a larger wavelength and therefore has more mass. This is what our Compton formula also shows.

Neutrinos

Modern physics has found only a type of particle with no charge called the neutrino that is smaller than the electron. The neutrino has three variations (electron, muon, and tauon), all of which apparently are smaller than the electron. Each has an extremely small rest mass or perhaps only linear momentum, and the electron neutrino has the smallest mass. Because of their small size and lack of charge, neutrinos tend to pass through matter with almost no interactions and at nearly the speed of light.

Neutrinos tend to oscillate among the three variations, a feature that shows they are really only quasi-particles, without a stable definition. The estimated mass of the electron neutrino is about .04 eV / $c^2 = 7.132\times10^{-38}$ kg, but it could be even 2000 or more times smaller. At present there is no way to measure a slow-moving neutrino. Most neutrinos move at so close to the speed of light that they appear to have a much larger mass due to relativistic effects.

The small mass of the neutrino allows it to easily accelerate to speeds close to that of light, and this particular feature makes the neutrino ideally suited to preserve the conservation laws of mass-energy and spin during weak interactions at the sub-atomic level. For example, a free neutron spontaneously decays within about 15 minutes into a proton, releasing an electron and an electron antineutrino. The neutron has a mass of

$1.674927351 \times 10^{-27}$ kg. and the proton has a mass of $1.672621777 \times 10^{-27}$ kg. When the neutron decays, it loses $.002305574 \times 10^{-27}$ kg of mass. That is equal to about 23×10^{-31} kg. An electron only has a rest mass of $9.10938291 \times 10^{-31}$ kg. That leaves $13.946357 \times 10^{-31}$ kg unaccounted for. Most of that can be accounted for by assuming that a neutrino moving at nearly light speed exits the neutron along with the electron.

In addition to being a handy accounting device for maintaining conservation, the neutrino also serves to "absorb" the Heisenberg uncertainty of the electron's momentum while it is inside the neutron. Because the size of a neutron (like the proton) is in the range of 10^{-15} m, and the size of the electron tends to be in the range of 10^{-12} m, the electron needs a space with a radius 3 orders of magnitude larger than that of a neutron. Otherwise its momentum becomes very large and it will destroy the neutron -- which is what it does within about 15 minutes if there is no other nucleon around to help contain it. We can see this by simply rearranging the Compton relation to express the mass as momentum.

$$(2 \pi \hbar) = \lambda_e (Me\ c)$$

When the electron is trapped inside a nucleon, its group wave is not traveling at light speed, so *c* appears to become some relative velocity *v*. Because *Me* is constant, λ and *v* become the variables. Planck's constant acts as the pivot of the fulcrum, so that the smaller the displacement gets, the larger the velocity becomes. If the electron is confined within a nucleon space on the scale of 10^{-15} m, then its velocity is greater than the speed of light. An electron moving close to light speed in the confines of a neutron would destroy it. However, a neutrino has so little mass that it can jiggle around inside a neutron at nearly light speed and accumulate several times the mass of an electron, but not cause serious damage as long as other nucleons are around to give it a little more breathing space. In a free neutron, the internal jiggling of components gets to be too much for the neutron and it lets off steam by releasing one electron and an antineutrino.

Why is it an antineutrino and not a neutrino? The anti matter property of the neutrino also serves to cancel out some of the electron's net mass while it is in the neutron. There is a reverse beta decay seen for example in nuclear reactors in which a proton can be boosted with energy to generate a neutron plus a positron and an electron neutrino. This can also be done with energy plus an electron antineutrino to generate a neutron and a positron. The energy input has to be over 1.8 MeV.

$n^o \rightarrow p+^*, e-, v^*$ (beta decay)
$E, p+^* \rightarrow n^o, e+^*, v$ (inverse beta decay)
$E, v^*, p+^* \rightarrow n^o, e+^*$ (inverse beta decay)

I use an asterisk to indicate antiparticles and insert commas instead of plus signs so there is less confusion with the charge signs. As you can see from the formulas, the charge must be conserved. When a component changes sides in the formula, the charge changes signs. If a particle switches sides in the formula, it also changes from matter to antimatter or vice versa. The above formulas describe weak interactions, because the mass is redistributed among the particles. The notation is really not complete, because it leaves out the important quark interactions. Also there is a *WW** boson pair that mediates the interaction.

Here is my version of what goes on. It differs somewhat from the standard interpretation but seems to work fine. In my notation particles move forward in time (left to right) and antiparticles move backwards in time (right to left). There are up quarks (*u*) and down quarks (*d*). Down quarks are charged. Up quarks have no charge and can flip back and forth between particle and antiparticle with no noticeable difference, whereas the down quarks must reverse their charges. A neutron has a *d*+*, a *d*-, and a *u**. A proton has a *d*+*, a *u**, and a *u*. I will only include the leptons that are affected by the interaction and ignore the other leptons in the nucleon ensemble. Only one quark changes in this weak interaction. The *d*+* continues to flow backward in time, and a *u** continues to flow backward in time. A circle or oval represents the interaction zone where the *W* bosons appear. The *d* quark is slightly more massive than the *u* quark.

Here is beta decay.

→ *e*-
← *v**
d- → → *u*
d+* ← *d*+*
*u** ← *u**

Here is inverse beta decay.

← *e*+*
E → → *v*
u → → *d*-
d+* ← *d*+*
*u** ← *u**

Here is the other form of inverse beta decay.

E →
*v** ← ← *e*+*
u → → *d*-
d+* ← *d*+*
*u** ← *u**

Neutrino Weirdness

When a neutrino is free, it expands into a spiral that could be anywhere from a millimeter to a meter or more in radius. When it is bound, it jitters about within its tightly confined space of 10^{-15} m. Standard theory estimates the size of the neutrino by the size of the electroweak interaction zone, but that is the neutrino as it begins to release itself from bondage and escape into free space, or vice versa when it is compressed into a nucleon.

The absorption and emission of neutrinos in to and out from nucleons is analogous to the absorption and emission of photons in to and out from electrons and positrons. We may even say that it is more than an analogy, because the photon and the neutrino are both forms of electromagnetic radiation. Photons and neutrinos both lack charge. The main difference is that generally the photons are found in spin pairs and thus have spin 1, and each photon is matched together with its companion antiphoton. Neutrinos are photon pairs that have been split apart in space and time like other fermion particles so that each neutrino only has spin ½, and it has a antineutrino partner separated from it in space and time.

Photons are called bosons, because they form photon-antiphoton pairs with unit spin, and can easily coexist together. Neutrinos, electrons, and nucleons are called fermions, because they have one-half spin and must occupy separate locations in space and time, even when they are absorbed into an ensemble.

I suspect that there may be no such thing as slow neutrinos. I think of them as extremely lightweight energy springs that easily compress their jiggling energy into tiny spaces, but once in free space immediately expand and accelerate almost to light speed. Physicists use them as accounting adjusters to balance out the conservation laws, and that seems to be one of their main functions in the universe. Unlike photons, they interact very poorly with other forms of matter, which means they can easily penetrate into the cores of stars and galaxies, not to speak of the earth's small form that they pass through easily. As scientists develop the ability to measure neutrinos in indirect ways with sufficient accuracy, it may be possible to develop neutrino telescopes with a kind of neutrino vision (analogous to X-ray vision) that can peer into areas of the universe that are not accessible by ordinary electromagnetic radiation.

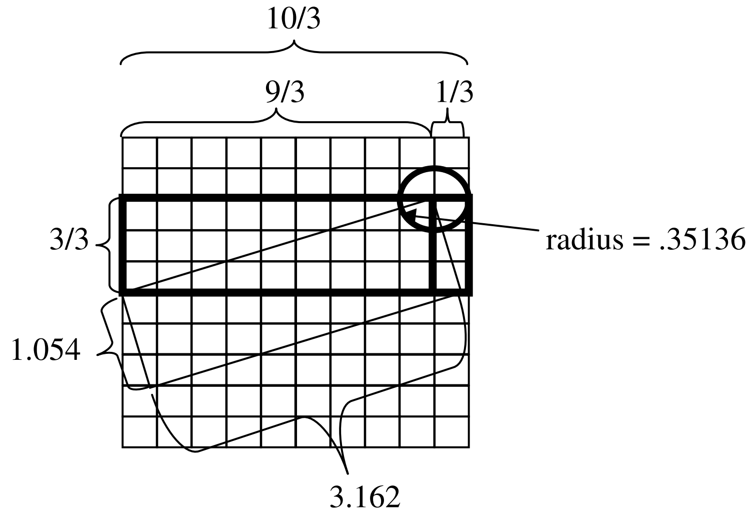
Objective material neutrinos also only occur in the left-handed form. This suggests that the material of our subjective awareness is made essentially of right-handed neutrinos, which is why we do not see them.

With this general introduction to what we know about the scale of the very small, and admitting that there is much that we do not understand about the neutrino scale due to the difficulty of studying phenomena that are so small and non-interactive with other matter, we can now make some tentative statements about the quantum values of space and time at the very small scale.

The Electron on the Senet Board

A single square on the Senet Oracle Board stands for an electron. It has a mass that is roughly 30 orders of magnitude smaller than that of a human. Like humans it has a male and female "charge". In its essence it has a body made of light that spirals in and out of its center of attention in the manner of the Senet Board Spiral. We have mentioned that the Compton formula's (λ_x Mx) component is just like the component in the lever equation that we identified as governing the physics of the Scale of Judgment for a weight on any one side of the fulcrum. The ($2 \pi \hbar / c$) portion of the Compton formula thus corresponds to the weight on the other side of the fulcrum. However, it is written with the symbols we have identified in the metrology of the Senet Oracle Board.

The expression $2\ \pi\ x$ gives the circumference of a circle with the radius x. So we want to locate a radius with the ratio value of $(\hbar / c) = 1.054/3 = 10^{1/2}/9 = .35136418446...$ on the Senet Oracle Board. The diagonal of the 1/3-by-1 miniboard is 1.054, and the diagonal of the 1-by-9/3 maxiboard rectangle is 3.162. The two diagonals are orthogonal, and form a new rectangle whose diagonal is the length of the Senet Board. The new rectangle has the dimensions of $\hbar$ by $\hbar\ c$. The Senet Board Grid cuts the $\hbar\ c$ edge into 9 equal segments. Each segment has the value of $\hbar / c$. We draw a circle centered at the tip of the Tower with a radius that extends along the $\hbar\ c$ diagonal to where it cuts the next grid line. The circumference of that circle is $(2\ \pi\ \hbar / c)$ and forms a glow of sunlight glinting on the tip of the Tower.

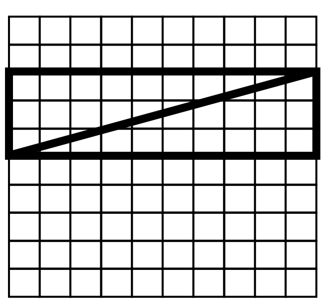


The expressions $\hbar\ c$ and $\hbar / c$ occur so often throughout the equations of quantum mechanics that physicists often apply what they call "natural units" and reduce them to the value of 1 so that they do not have to calculate them in the equations. By flattening out their equations this way they miss the deep fractal order of creation.

If you calculate the diagonal of the full Senet Board using the dimensions 10/3 by 3/3, then the **diagonal** is 3.48. If you take the square root of that, you get 1.86, which is the ratio of the Planck Mass (1.86e-9 kg), and the mass of a single quark.

$m_P = (\hbar\ c\ \alpha / G)^{1/2} = (e^2 / 4\ \pi\ \varepsilon_o\ G)^{1/2} = 1.86\times10^{-9}$ kg. (a single quark -- the Cosmic Quark)

$m_P^2 = 3.48\times10^{-18}\ kg^2$. (2 identical quarks interacting)



The Diagonal of the Senet Board is the Cosmic Electro-Gravity Quark^2!

The usual value given for the Planck mass is $(\hbar\ c\ /\ G)^{1/2}$. I have included the fine structure constant *α,* because that makes clear the connection between gravity and electromagnetic phenomena. When we substitute in the formula for the fine structure constant in terms of physical constants, it converts the Planck mass into the equilibrium point between the forces of electricity and gravity -- the condition in which $Fe = Fg$. The square root suggests that there are two particles of equal mass interacting in the expression $\hbar\ c\ \alpha\ /\ G$. Was the omission of the fine structure constant from the Planck mass deliberate obfuscation or simply that nobody noticed the elegant link between gravity and electricity at a scale that was easily accessible to the observant Egyptians?

As an exercise you might want to locate in the geometry of the Senet Oracle Board the ratio $\hbar^2 (c^2 + 1) / c^2 = 1.2345678901234$ . . . . . (See answer below.)

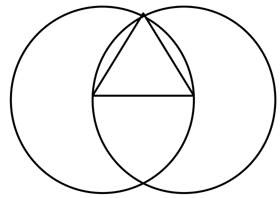
The Tower has a height of 1 unit when we take the side of a square on the board as 1/3. If you extend the Tower line downward until it intersects the downward slanting line of the 1.054 by 3.162 rectangle, you have the diagonal of the small rectangle that is 1.054 by .351364.... That diagonal is the square root of 1.2345678901234... and is equal to 1.1111111...., which is the sum of all the Egyptian power-of-ten fractions: $1/10^0 + 1/10^1 + 1/10^2 + 1/10^3 + 1/10^4 + 1/10^5$....

Here is yet another curious point. If we subtract the value of the Golden Ratio φ from 3.48 (the diagonal of the Senet Board), we get 1.86, the ratio value for the Planck mass ultimate Cosmic Quark. We discussed the Golden Ratio earlier in connection with the value of Oper and the Oper spiral on the Senet Board. Can we calculate $\varphi = (5^{1/2} + 1) / 2 \approx (1.618)$ on the Senet Board?

Let's call our unit displacement the length of a square on the board. We will start at the corner of Thoth and let his square stand for 1 unit and square #1. Then we mark off two more squares to the left (square #2 and #3) and then stretch a string from the lower right corner of square #2 to the upper left corner of square #3. That string length will be $5^{1/2}$ units. Then we hold the string at the lower corner of square #2 and pivot the other end of the string down from the upper corner of square #3 to the bottom line. This length plus the 1 unit of square #1 makes a total of $(5^{1/2} + 1)$. Then we need to bifurcate that line.

We already know that the line length $(5^{1/2})$ is longer than 1, so we swing an arc with our string pivoting from the lower left corner of square #3 and another arc pivoting from the lower right corner of square #1. The two arcs intersect above and below the line. We draw a line between the two intersections and it nicely bisects the line segment $(5^{1/2} + 1)$, giving us the length φ relative to our chosen unit of displacement.

The use of two intersecting arcs to bisect a line segment can be seen in the first proof of Euclid's **Elements**: *To construct an equilateral triangle on a given finite straight line.* In that proof Euclid constructs an equilateral triangle that looks for all the world like a pyramid emerging from two intersecting circles that form a *vesica pisces*. This is not merely a proof in geometry, it is the logo of ancient sacred geometry and is loaded with ancient wisdom.

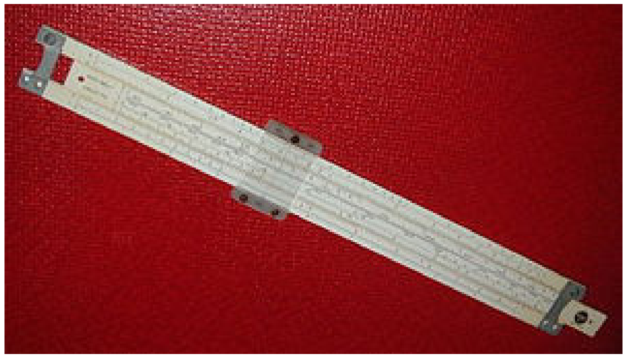


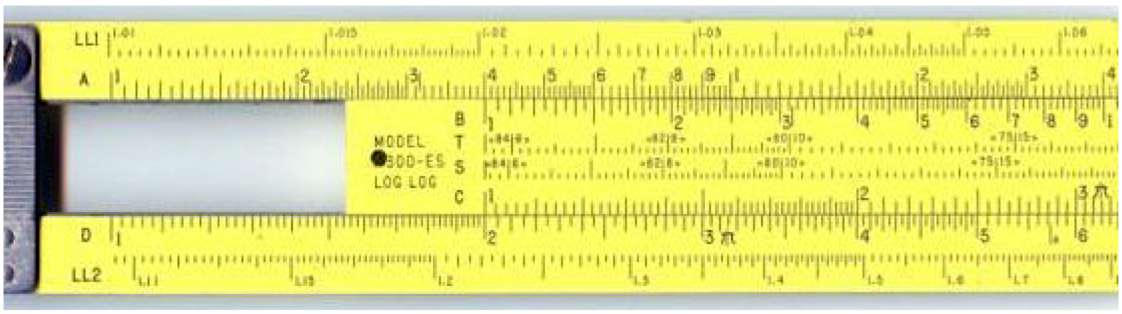
"**Euclid** (Εὐκλείδης *Eukleidēs*), fl. 300 BC, also known as **Euclid of Alexandria**, was a Greek mathematician, often referred to as the "Father of Geometry". He was active in Alexandria during the reign of Ptolemy I (323–283 BC). His *Elements* is one of the most influential works in the history of mathematics, serving as the main textbook for teaching mathematics (especially geometry) from the time of its publication until the late 19th or early 20th century. In the *Elements*, Euclid deduced the principles of what is now called Euclidean geometry from a small set of axioms. Euclid also wrote works on perspective, conic sections, spherical geometry, number theory and rigor."(from **Wikipedia**, "Euclid")

Euclid lived in Alexandria during the early Ptolemaic period and is another of the famous Greek scientists who had access to the great Egyptian Library of Alexandria as well as Egypt's foremost scientists of that era. Modern scholars give Euclid all the credit for developing the "first" systematic exposition of geometry. Euclid had access to the best and greatest of Egyptian mathematical genius that enabled the building of the Great Pyramid and the other awesome monuments of classical Egypt. As we have seen numerous times in this discourse, because the Egyptian mathematical records are for the most part lost, modern scholars give the Ptolemaic Greeks all the credit for great scientific documents that survive under the names of Greek writers but that may well be no more than translations or interpretations of traditional Egyptian material that was common knowledge to educated Egyptians of the time. On top of that they consider Egyptian mathematics and physics to have been relatively primitive, despite the fact that Egyptian architectural achievements exceeded those of the Greeks.

The Senet Game Board is an Ancient Egyptian Calculator

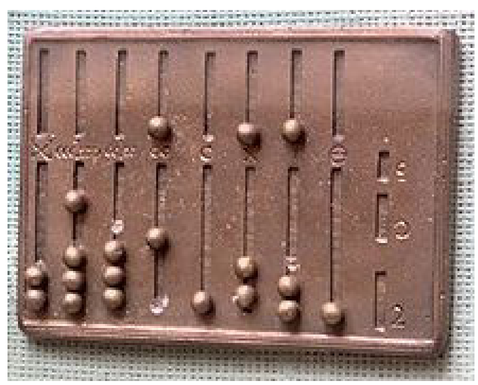
When I was in college, it was as common a sight to see engineering students packing slide rules as it also was to see gunslingers in the Cowboy Western movies packing six-guns. For those of you who have not seen one, "the **slide rule**, also known colloquially (in the US) as a **slipstick**, is a mechanical analog computer. The slide rule is used primarily for multiplication and division, and also for functions such as roots, logarithms and trigonometry, but is not normally used for addition or subtraction. . . . William Oughtred and others developed the slide rule in the 17th century based on the emerging work on logarithms by John Napier. Before the advent of the pocket calculator, it was the most commonly used calculation tool in science and engineering. The use of slide rules continued to grow through the 1950s and 1960s even as digital computing devices were being gradually introduced; but around 1974 the electronic scientific calculator made it largely obsolete and most suppliers left the business."





Above: photo of a slide rule. Below: Detail photo of a slide rule set so that each number in line D is twice the value of the corresponding number in line C. Also, line A shows the value of each number in line D squared. (Source: **Wikipedia**, "Slide rule" for the quote and photos)

What if the Senet Oracle Board was an ancient Egyptian mechanical analog computer like the slide rule or the abacus, but much simpler?

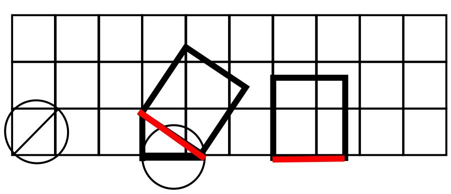



Left: modern abacus. Right: Roman abacus

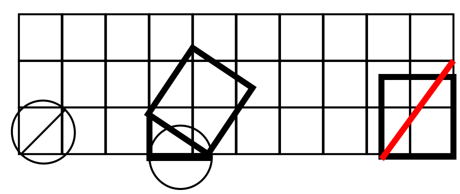
Various versions of the abacus device have been in use throughout the world for calculating since very early times. "The use of the abacus in Ancient Egypt is mentioned by the Greek historian Herodotus, who writes that the Egyptians manipulated the pebbles from right to left, opposite in direction to the Greek left-to-right method." (Source for quote and photos, **Wikipedia**, "Abacus".) Herodotus wrote as a first-hand observer who had spent time traveling and studying in ancient Egypt.

Earlier in this discourse we described a little bit of the Egyptian method of calculation. Using such a method on paper would be extremely cumbersome and used only when a mechanical calculator was not available. The use of an abacus for addition, subtraction, multiplication, and division would have been the preferred method of doing most calculations, which could then be transcribed into the Egyptian system of numbers. We have also introduced in our discussions the Egyptian cubit ruler and its system of metrology that allowed measurement at various scales. For calculating roots and logarithms, the Senet Board used together with with a cubit ruler and a piece of string would have been quite adequate. The pawns and throwing sticks could also be used.

The basic technique for square roots was to use the diagonals of rectangles. The Senet Board was very useful for calculating roots that involved irrational numbers. For that the Egyptians used the principle known to us as the Pythagorean relation for right triangles, named after Pythagoras, another smart Greek who learned many important principles of geometry in Egypt and then passed them on to the world through his students. For example, √2 is the diagonal of a single square, √5 is the diagonal of a rectangle made from two squares side by side. To get √3 we rotate the diagonal of a single square (√2) to the base line, and use the unit height of a square to generate a rectangle with sides 1 and √2. The diagonal of that rectangle is √3. To get √7, we use a rectangle with sides 2 and √3. Such calculations can be done rapidly and accurately with string on a Senet Board and a cubit ruler to measure the results. A rectangle with sides √2 and √5 also has a diagonal of √7.



Calculating √3 on the Senet Board.



Calculating √7 on the Senet Board.

The red lines represent the answers relative to a square with unit side.

Once the geometry is done on the Senet Board, the result can be converted to numerical values by calibrating the Senet Board itself or by calibrating the Senet Board to a cubit ruler and then using the cubit ruler to measure the numerical value of the displacement. The geometry is as precise as the scale at which you are working, which is why the megalithic cultures liked to work on a gigantic scale. They did not have the infrastructure to mass produce super refined instruments on the microscopic scale.

Suppose you want to do higher roots. For example, if you want to calculate the fourth root of ten ($10^{1/4}$), which is also the square root of the Oper (√%). Before we do that, we will first explore the Golden Ratio a bit more.

The ancient Egyptians as well as many other ancient cultures were aware of the interesting properties of the number we call *φ*. Since they also knew how to do the ordinary operations of arithmetic, they probably also were aware of what we call the Fibonacci numbers and their relation to *φ*. The trick for calculating is to use a variation that we now call Lucas numbers after the French mathematician Édouard Lucas who brought them to the attention of mathematicians in 1877. Of course, the Lucas numbers had always been there for anyone who liked to work with φ and apply it in practical ways.

The Fibonacci series is 0, 1, 1, 2, 3, 5, 8, 13, ... You simply add the first two terms together to get the third, and then continue by adding your latest two terms to get the next one. If you take the series a bit farther along from the first few numbers I wrote out, you will notice that the ratio of each succeeding number to its preceding number rapidly converges toward its limit which happens to be φ. For example, the ratio of the 20th to the 19th Fibonacci numbers is 6765/4181 = 1.61803396316. The problem is that φ is an irrational number, and it is much easier to work with integers while at the same time having a series in which each ratio is exactly φ, instead of a converging series of approximations. So the series of Lucas numbers simply begins with 2, which is the denominator in the defining φ ratio [($\sqrt{5}$ + 1) / 2]. Then the second term is the numerator in the ratio ($\sqrt{5}$ + 1). This guarantees that the ratio will be φ by definition. The rest of the series follows the same rule as the Fibonnaci series and has the remarkable property of being simultaneously both an additive series as well as a geometric series.

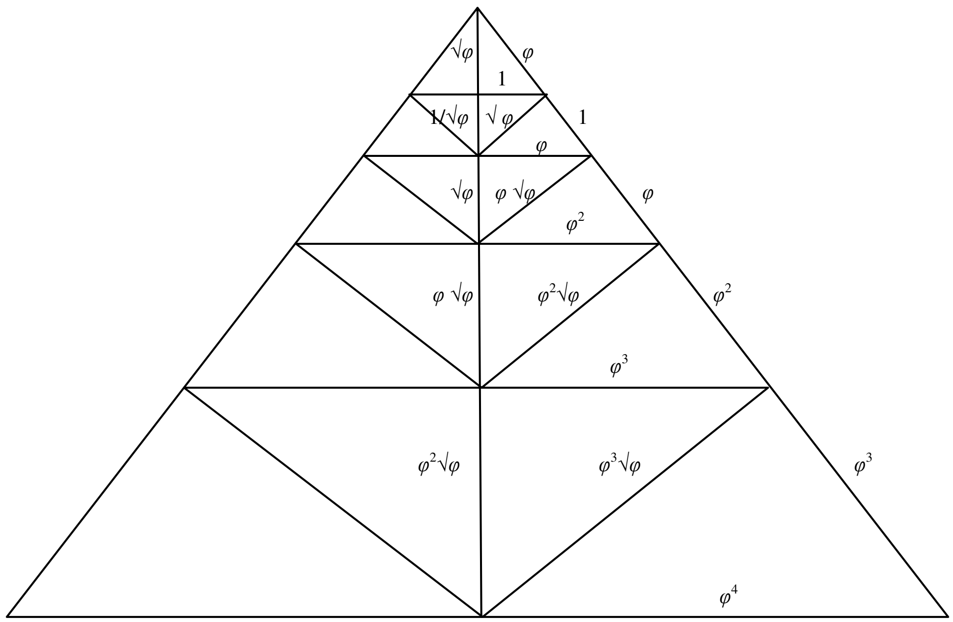
The Lucas series goes like this: 2, 1, 3, 4, 7, 11, 18, 29, 47, 76, 123, . . . and the ratios of these integers also converge on φ. (For example, the ratio of the 20th to the 19th Lucas integers is 15127/9349 = 1.61803401433.) The Lucas list corresponds to the powers of φ: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. Now we can make a list of the following series based on the ratio $\varphi = (1+ \sqrt{5}) / 2 = 1.61803398874\ldots$, and the ratio of each succeeding pair is φ.

$2+0\sqrt{5}$
$1+1\sqrt{5} = 3.23606797749$
$3+1\sqrt{5} = 5.23606797749$
$4+2\sqrt{5} = 8.47213595498$
$7+3\sqrt{5} = 13.7082039324$
$11+5\sqrt{5} = 22.1803398874$
$18+8\sqrt{5} = 35.8885438199$
....

Each member of the series is a compound of a Lucas number (the first whole number on the left) plus a corresponding Fibonacci number multiplied by $\sqrt{5}$ to form the right hand component of the sum. Also the Fibonacci number multiplied by $\sqrt{5}$ is very close to the value of the corresponding Lucas number in the compound.

The Great Pyramid of Khufu at Giza with its pyramidion was originally 146.6 m in altitude and the length of a side at the base was 230.37 m. Half the base length is then 115.185 m. The ratio 146.6 / 115.185 = 1.272735. The ideal Golden Pyramid Ratio for these dimensions would be $\sqrt{\varphi} = 1.27202$. Khufu's pyramid is amazingly close to the ideal and may be off due to slightly inaccurate estimates of the original shape or due to a slight distortion of the shape over time. None of the other pyramids come as close to this "ideal" ratio.

If we give the Benben pyramidion a base of 2, which means its half-base is $1 = \varphi^0$, then its apothem (the sloping side) is φ^1, and its altitude is $\varphi^{½}$. This is the Golden Triangle. If you then look down the body of the pyramid, you find that each succeeding "layer" has a half base and an apothem segment that becomes the next integer power of φ -- demonstrating the remarkable fractal properties of such a pyramid. Using the Lucas integers we can map back and forth between irrational and rational quantities at any power. If we continue at smaller scales inside the pyramidion, the powers become negative and thereby represent inverse ratios.



An Idealized Golden Ratio Pyramid

In other words, by using a length of string, a Senet Board grid, a cubit ruler, and a two-dimensional phi pyramid, we can calculate all sorts of powers, roots, and logarithms, perhaps not as fast as with an electronic calculator, but surely able to keep up with an engineer working a slide rule. With an abacus to boot the ancient Egyptian was at least able to keep up with a 20th century whiz.

In general $\varphi^{n+2} = \varphi^{n+1} + \varphi^{n}$.

If you take φ to a power and then add or subtract the reciprocal (add for even powers and subtract for odd powers), you get a whole number:

$\varphi^{n} + \varphi^{-n}$ = a whole number.

If you substitute the numbers 0 to 10 and so on for *n*, you get the Lucas integers.

Power: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, ...
Lucas: 2, 1, 3, 4, 7, 11, 18, 29, 47, 76, 123, ...

n:	φ^n	±	φ^{-n}	Sum = Lucas Integer
0	1	+	1	002
1	1.618033989	-	0.618033989	001
2	2.618033989	+	0.381966011	003
3	4.2360679944	-	0.236067977	004
4	6.854101966	+	0.145898034	007
5	11.090169944	-	0.090169944	011
6	17.94427191	+	0.05572809	018
7	29.034441854	-	0.034441854	029
8	46.978713764	+	0.021286236	047
9	76.013155617	-	0.013155617	076
10	122.991869381	+	0.008130619	123

This is another way of generating the Lucas series that shows how it relates to the powers of φ using good old Egyptian reciprocal math. If you run the ratios on the reciprocals backwards, you also get φ. We already know how to calculate φ on a regular Senet Board of integer unit squares. If we have another Senet Board laid out in φ units relative to your integer unit board, we can work them together. For example, if we want to find φ^4, we know that φ^2 is $\varphi + 1$, and we can calculate φ on our unit Senet Board and add 1 unit to it to get φ^2. Then we multiply this by 3 by simply marking off 3 string intervals of φ^2. Next we subtract a 1-unit interval, and lo and behold, we have an interval that is φ^4 in length. An Egyptian could do this on his Senet Board with a piece of string as fast as you can by pecking on your electronic calculator.

Now we will use φ to calculate an Egyptian approximation to $^4\sqrt{10}$. The value of φ is about 1.618. Recall that the altitude of the Benben pyramidion on our φ pyramid is $\sqrt{\varphi}$, which is about 1.272. We need to make a line segment that is $\sqrt{30}$ units long. We can do this, because we know how to get $\sqrt{10} = 3.162$ and $\sqrt{3} = 1.732$ on our Senet Board. The product of these will be $\sqrt{30} = 5.477$. The Egyptian scribe can find this several ways. He can measure his two lengths and then calculate the product arithmetically, or he can mechanically use % as his standard unit and measure off 1.732 units with his Oper unit standard string or measuring rod that he has calibrated like a meter (cubit) stick.

Once he has $\sqrt{\varphi}$ and $\sqrt{30}$, he draws a right triangle with these dimensions for its two legs. The hypotenuse is $\sqrt{(30 + \varphi)} = \sqrt{31.618}$, which is very close to the square root of 10×3.162. He measures that to be about 5.623 and then divides that by % = 3.162. He gets 5.623/3.162 = 1.7783, which is a pretty accurate approximation of $^4\sqrt{10}$, as you will see if you enter 10 on your calculator and punch the √ key twice. Our ancient scribe has found the answer using nothing more than the Benben stone on the Great Pyramid, his Senet Board, a piece of string, and some pen scratch calculations. Later we will show you yet another very simple averaging method that an Egyptian scribe could use for quickly finding square roots of any number, whole number or otherwise. For an ancient scribe, using geometry might have been faster than calculating numerically on papyrus.

Suppose we want to know the value of 3^4. We use a Senet Board 1 meter long, with each square 10 centimeters on a side. We mark off a length of 3 centimeter units 3 times on our Senet Board. This gives us a segment of 9 units. Then we mark off 9 units 3 times on the board, which takes us to 27 units. Then we mark off 27 units 3 times and get 81 units, giving us 3 to the 4th power. Simple arithmetic operations (addition, subtraction, multiplication, and division) were probably done much faster on an abacus and powers of 2 and 3 were memorized.

Dynamic Rectangles

The next drawing shows how an Egyptian could start from a single square on the Senet Board and sequentially rotate a piece of string along a row of squares to generate intervals for the square root of any integer.

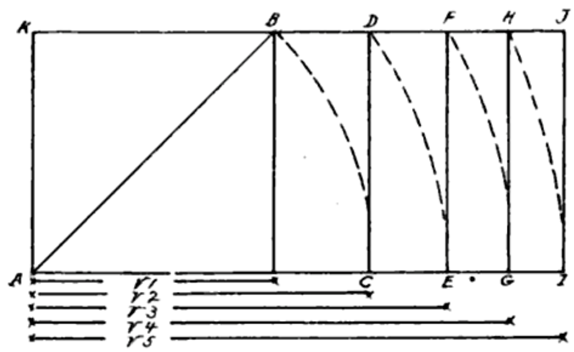


Fig. 10.

The drawing is from Jay Hambidge's 1920 illustration of the construction of root rectangles. The lengths of the horizontal sides of the original square and the four root rectangles derived from it, are respectively $\sqrt{1}, \sqrt{2}, \sqrt{3}, \sqrt{4}, \sqrt{5}$. (See, **Wikipedia**, "Dynamic Rectangles" for this and the next diagram.)

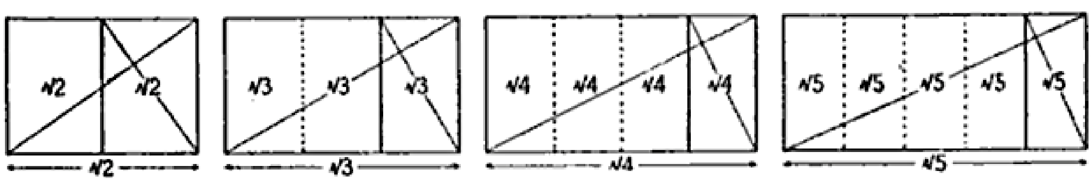
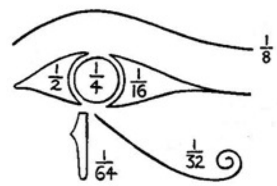


DIAGRAM V. The root rectangles and their reciprocals

Lacey Davis Caskey's 1922 illustration of the property that a root-N rectangle divides into N reciprocal rectangles of the same proportions from his beautiful book, **Geometry of Greek Vases: Attic Vases in the Museum of Fine Arts Analysed According to the Principals of Proportion Discovered by Jay Hambidge.** Caskey's book contains drawings of the elegant designs employed by the Greeks in their vases, showing how the proportions were designed according to the principles of root rectangles. This technology was no doubt pioneered much earlier by the Egyptians, who were masters at vase making.

Another Surprise! Logarithms and the Eye of Horus

For the key to understanding how the ancient Egyptians were able to do sophisticated mathematical calculations, we must have a deeper understanding of the Eye of Horus.



Mathematics of the Eye of Horus

We mentioned earlier how the fractional components of the Eye stood for the binary system of measurement used by the Egyptians. These fractions also stand for exponents. These exponents actually are roots that allow us to see deeply into the fine structure of the cosmos. The Eye shows only the first six in a continuing series of roots that converge to form Unity within Nothingness. Like *phi*, they are additive and exponential and underlie our entire mathematical system.

For a more complete and very enlightening discussion of what I am about to explain, I highly recommend you read an essay by Richard Feynman in **The Feynman Lectures on Physics**, Vol. 1 (Chapter 22, "Algebra"). Much of what I say below on this subject draws with great admiration on that essay. Feynman was a mathematical wizard, but never to my knowledge spoke about ancient Egyptian mathematics. You may also wish to look at the **Wikipedia** "Logarithm" entry.

I am going to focus for a bit on logarithms as a methodology for finding a particular exponent when given a base and a result. In our modern world we learn that John Napier introduced logarithms in the 17th century to simplify calculations. Since the principle has always existed, he may only have rediscovered what some of the ancients were quite familiar with. We will begin our discussion of the logarithm by quoting from the **Wikipedia** entry "Logarithm".

"The **logarithm** of a number is the exponent by which another fixed value, the base, has to be raised to produce that number. For example, the logarithm of 1000 to base 10 is 3, because 1000 is 10 to the power 3: $1000 = 10\times10\times10 = 10^3$. More generally, if $x = b^y$, then y is the logarithm of x to base b, and is written $y = \log_b(x)$, so $\log_{10}(1000) = 3$. . . . Tedious multi-digit multiplication steps can be replaced by table look-ups and simpler addition because of the fact — important in its own right — that the logarithm of a product is the sum of the logarithms of the factors:

$$\log_b(xy) = \log_b(x) + \log_b(y).$$

Another remarkable property of logarithms is that, once you know them for any arbitrary base, they also hold for any other base simply by means of a constant transformation."

The same article in **Wikipedia** explains this.

"The logarithm $\log_b(x)$ can be computed from the logarithms of x and b with respect to an arbitrary base k using the following formula.

$$\log_b(x) = \frac{\log_k(x)}{\log_k(b)}.$$

. . . .

Given a number x and its logarithm $\log_b(x)$ to an unknown base b, the base is given by:

$$b = x^{\frac{1}{\log_b(x)}}.$$ . . . .

Among all choices for the base b, three are particularly common. These are $b = 10$, $b = e$ (the irrational mathematical constant ≈ 2.71828), and $b = 2$. In mathematical analysis, the logarithm to base e is widespread because of its particular analytic properties explained below. On the other hand, base-10 logarithms are easy to use for manual calculations in the decimal number system:

$$\log_{10}(10x) = \log_{10}(10) + \log_{10}(x) = 1 + \log_{10}(x).$$

Thus, $\log_{10}(x)$ is related to the number of decimal digits of a positive integer x: the number of digits is the smallest integer strictly bigger than $\log_{10}(x)$. For example, $\log_{10}(1430)$ is approximately 3.15. The next integer is 4, which is the number of digits of 1430. The logarithm to base two is used in computer science, where the binary system is ubiquitous."

Here is Feynman's brief list that holds the key to the elegant palace of logarithms.

Power s	1024 s	10^s		$(10^s - 1)/s$	
1	1024	10.00000		9.00	
1/2	0512	03.16228		4.32	
1/4	0256	01.77828		3.113	
1/8	0128	01.33352		2.668	
1/16	0064	01.15478		2.476	
1/32	0032	01.074607		2.3874	
1/64	0016	01.036633		2.3445	
1/128	0008	01.018152		2.3234	211
1/256	0004	01.0090350		2.3130	104
1/512	0002	01.0045073		2.3077	053
1/1024	0001	01.0022511		2.3051	026
				↓	026
Δ/1024	Δ	1 + 00.0022486Δ	←	2.3025	
(Δ → 0)					

In our discussion we, as Feynman does, will focus on base 10, and its iterated square roots, which are binary in nature. You may notice right off the bat that Egyptian mathematics simultaneously used base 10 on the Senet Board combined with the binary system derived from the Eye of Horus fractions and exponents. They apparently knew something special about these two systems that prevented them from using the duodecimal (base 12) system except for time-keeping purposes. Other ancient cultures such as the Babylonians and Chinese also used duodecimal and/or sexagesimal (base 60) systems for tracking time, as we still do today. However, the Egyptians were special in their emphasis on the binary system, which they used widely in their standard weights and measures -- and which we in the conservative U.S. stubbornly continue to use in our liquid measures (gallon, half-gallon, quart, pint, cup, gill, half-gill, ounce, tablespoon).

Feynman reviews the way in which a generalized system of logarithms is established. He uses base 10 for our ease in following the calculations. He creates the simple table of numbers that make up the "Successive Square Roots of Ten" chart that I transcribed on the previous page.

I added some zeroes in front of numbers to keep the columns neat. Feynman points out that the value of 2.3025 actually is closer to 2.3026, but that is not critical to his discussion. The column on the left contains the components of the Eye of Horus, carrying the series four more steps. The second column from the left simply inverts the first column and shows us the reciprocal of each component of the Eye of Horus with respect to the arbitrary limit Feynman chose. He chose that limit because after ten steps the numbers in the third column become very close to unity, and they also converge on a fixed pattern that is also binary halving at each step, which means that we can then predict the whole continuing pattern in the same way we can predict the continuing series in the Benben pyramidion of the Great Pyramid. The column on the far right gives the difference between each succeeding entry in column four. After 26 the sum of all the other possible differences if we continue down the list is another 26, just like the sum of all the finer gradations of the Eye of Horus is 1/64, because the series becomes the same; each succeeding result is half the previous one. You can see this on your calculator if you pick any number and then start to hit the √ button over and over. The decimal portion after the 1 will start to become approximately 1/2 the previous value at each iteration, showing that the Eye of Horus is everywhere and sees all with its penetrating gaze. The 1 shows that, no matter how small the decimal fragment becomes, the Eye still gazes from Unity. The number 2.3025 becomes the key to establishing the natural logarithms on the base $e = 2.7183$, because $e = 10^{1/2.3025} = 10^{0.434294}$, where 0.434294 = 444.72/1024. The interesting aspect of the "natural" base e is that $\log_e (1 + n) \approx n$. That is $e^n = 1 + n$ as $n \rightarrow 0$. The number 2.3025 comes from subtracting 26 from 51, the last digits of the last item in column four (2.3051), indicating we have taken the sequence to its Eye of Horus limit. The number 444.72 = 256 + 128 + 32 + 16 + 2 + 0.72, wherein the number .72 is below 1 and comes from knowing that by making Δ small enough, we end up with 1 + 2.3025Δ for column three. So the final factor is 72% of 22511. The decimal .0022486 below column three corresponds to the 2.3025 below column four and is almost equal to .0022511, allowing for the small remaining discrepancy before the sequence converges onto the Eye of Horus halving principle. So the final factor is 1 plus 72% of .0022511 or 1.00162079. (Feynman uses .73 and gets 1.001643 as his final factor, which gives about the same result.) Look up the factors in the table and multiply all the factors to see if you get 2.7183 or something very close.

The third column lists the results from calculating the power *s* of 10, which is actually some iterated square root of 10. How would the Egyptians calculate such roots? Feynman gives a simple formula that rapidly converges on a close enough result for any practical purpose: $a' = ½ (a + N/a)$, where *N* is the number you are taking the root of, *a* is a reasonable guess, and *a* ' is an average between *a* and *N*/*a*. You start with a number, such as 10 and make a reasonable guess at its square root. For example, suppose you "guess" 3.2, which you know will give 10.24 as its square, and you know is too high. You work the formula ½ (3.2 + 3.125) = 3.1625, which is already pretty close. So you run the formula again: ½ (3.1625 + 3.16205533596) = 3.16227766 which Feynman rounds off to 3.16228, and we are done.

An Egyptian scribe probably could construct the whole list quite fast. He would also feel running through him the amazing power of the Eye of Horus. I used modern calculation techniques and an electronic calculator, but you can see a sample in the appendix at the end of this essay of how an ancient Egyptian might calculate √10 using this method.

A Quick Way of Approximating the Roots of Ten with Fractions

The formula for approximate square roots of 10 will be that $(2^n) / (3^{n/2})$, where *n* has to be a power or root of 2.

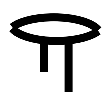
$2^{16}/3^8 = 65536 / 6561 \approx$	10.00	10^1
$2^8/3^4 = 256 / 81 \approx$	3.16	$10^{½}$
$2^4/3^2 = 16 / 9 \approx$	1.777	$10^{¼}$
$2^2/3^1 = 4 / 3 \approx$	1.333	$10^{⅛}$
$2^1/3^{½} = 2 / 1.7320508$	1.1547	$10^{1/16}$
$2^{½}/3^{¼} = 1.41421 / 1.316074$	1.0747	$10^{1/32}$
$2^{¼}/3^{⅛} = 1.1892 / 1.1472$	1.0366	$10^{1/64}$
$2^{⅛}/3^{1/16} = 1.0905 / 1.071$	1.0181	$10^{1/128}$
$2^{1/16}/3^{1/32} = 1.0443 / 1.03493$	1.00903	$10^{1/256}$
$2^{1/32}/3^{1/64} = 1.0219 / 1.0173$	1.0045	$10^{1/512}$
$2^{1/64}/3^{1/128} = 1.01089 / 1.0086$	1.00225	$10^{1/1024}$

We get an excellent approximation of the entire list of roots of 10. Enter 10 on your calculator and then press the √ key 10 times, noting the results each time. The least accurate answers using the $(2^n) / (3^{n/2})$ formula are the first two on the list. Of course, the Egyptians already knew the first two on this list, because they are enshrined in the Senet Board. The first number (10) is the length of the Senet Board. The second number ($10^{½}$) is the diagonal of a 1-by-3 rectangle. The third number on the list ($10^{¼}$) for the Egyptians would be 1 + ⅔+ 1/9, and would be the least accurate result. The fourth number ($10^{⅛}$) would be 1 + ⅓ and is already accurate to 3 decimal places. So far the approximations are all ratios of whole numbers. For the fifth number they already knew the length $3^{½}$ from the geometry of the Senet Board as we demonstrated earlier using the principle of "dynamic rectangles". To find $2 / 3^{½}$ by geometry they could first mark off $3^{½} = 1.7320508$ along the edge of the Board, noticing that it fell a bit short of the end of the second square. Next they divided the $3^{½}$ length into 10 equal portions (or 100 equal portions if they wanted greater accuracy), and then measured the interval $(2 - 3^{½})$ along the $3^{½}$ interval, noting the value in their newly scaled calibrations of that interval. They would get the value .268 / 1.732 = .1547 as the excess above 1, which they would express as something like 1 + 1/10 + 1/20 + 1/250 + 1/1280. Notice how the approximation becomes increasingly accurate as we do more iterations of the formula.

The Egyptians already knew that the eighth root of 10 was very close to 4/3 = 1.333. The quick method to approximating the sixteenth root of 10 is to multiply 4/3 by 100 to get 400/3 = 133.333.... = 133 + 1/3. The square root of that is 11.547 = 11 + 1/2 + 1/25 + 1/200 + 1/500. We then divide by 10 to find that $10^{1/16}$ = 1.1547 = 1 + 1/10 + 1/20 + 1/250 + 1/2000 + 1/5000. For $10^{1/32}$ multiply 1.1547 by 100 and take the square root of that, and you get 10.7457 = 10 + 1/2 + 1/20 + 1/25 + 1/200 + 1/2000 + 1/5000. Divide by 10 to get 1.07457 = $10^{1/32}$. Continue multiplying each root by 100, then find the square root, then divide the root by 10. At each iteration you get 1 plus a new decimal that is the previous decimal divided by a number that converges on 2. You know that the result will be 1 plus a decimal (or series of unit fractions) with increasingly smaller value.

To get the roots of 2 and 3, you may calculate using the $a' = ½ (a + N/a)$ averaging algorithm or use the simple methods we used for the roots of 10. Notice the interplay of powers of 10 and powers of 2 in this process, which is really just a variation of playing with *phi* and its reciprocal.

From the formula based on ratios of powers and roots of 2 and 3 that approximate the powers and roots of 10 we discover at least one reason why the ancient Egyptians insisted on including a special fraction glyph for 2/3 within their tradition of using only unit fractions that always had 1 as the denominator. (See **Appendix E** for more on 2/3.)



2/3

"Egyptian" Cube Roots

Once our scribe compiled his list, he could begin to do many interesting calculations. Suppose he wanted to calculate $\sqrt[3]{3}$, which happens to be 1.4422495703074083. The **Wikipedia** "Cube root" article gives a procedure to approximate cube roots on an ordinary calculator using only the multiplication and square root functions, and you can run through the little exercise that I put in **Appendix C** for the cube root of 3 or any other number just for fun if you like, but now we will see how an Egyptian scribe might do it with his Eye of Horus, Senet Board, and a bit of the string that Thoth uses for measuring Heaven.

Our scribe would set up his Senet Board and ask, "What power of 10 will give me the cube root of 3?" We can write this question with our modern algebraic notation like this:

$10^x = 3^{⅓}$.

We and our scribe then set up the following table of numbers derived by simple division:

3÷(1.77828) = (1.6870234)
1.6870234÷(2.33352) = (1.28509)
1.26509÷(1.15478) = (1.095525)
1.095525÷(1.074607) = (1.0194658)
1.0194658÷(1.018152 = (1.00129037)

We are simply factoring 3 into as many of the numbers on our Eye of Horus roots of 10 list as we can proceeding downward in order from larger to smaller factors. The last number on the list is a remainder that is smaller than anything on our list.

The nice thing about exponents is that you can add them when you multiply. So we add up all the fractions of 1024 that these factors represent and let them be the power of ten we are seeking. Notice how we are repeating the myth of reassembling the pieces of the shattered Eye of Horus as we do this.

10e[(1/1024) (256 + 128 + 64 + 32 + 8 + .5737) = 10e(488.5737/1024) = .4771227.

You will notice the funny .5737 at the end of the list of Eye pieces. This is the last small fragment. We find that by calculating Δ. We say 2.3025Δ/1024 = .00129. This .00129 is the decimal (fractional) portion of the remainder number at the end of our factoring list. Solving for Δ gives the result .5737, which then becomes our final fragment of the Eye.

We now know that $10^{.4771} = 3$. However, we want to know the cube root. So we divide the exponent on each side by three.

$10^{.4771/3} = 3^{1/3}$.
$10^{.159} = 3^{1/3}$.

We can look up the answer in a $\log_{10}$ table:

$10^{.159} = 3^{1/3} = 1.442$

(or use an anti-log calculator such as http://www.rapidtables.com/calc/math/Log_Calculator.htm.)

Sadly we do not have any surviving Egyptian $\log_{10}$ tables, which I believe must have existed but may all be lost. (Or the little list may be carved on a temple wall somewhere in hieroglyphic code and we just have not recognized it.) So our tireless scribe simply uses his Eye of Horus list and computes his answer. He multiplies: (.159)×(1024) = 162.816. He can then parse out the factors as iterated square roots of ten: 128 + 32 + 2 + 1 = 163.

(1.33352)(1.074607)(1.0045073)(1.0022511) = 1.442. Bingo, he has his answer.

Further Comments on the Possibility of Megalithic Levitation

In 1839 Becquerel investigated the effect of light on electrolytic cells and discovered the **photovoltaic effect** that demonstrates a link between light and the electronic properties of materials.

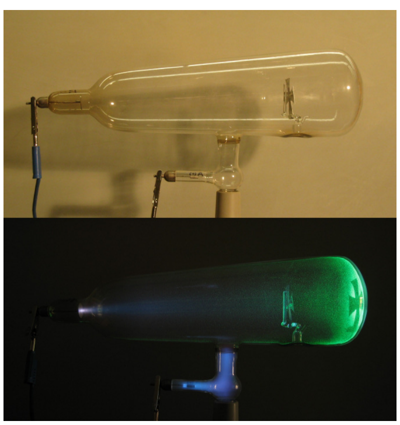
In 1873, Willoughby Smith was working on design for submarine telegraph cables. While testing the metal selenium for its high resistance properties, he discovered **photoconductivity**.

In the late 19th century Elster and Geitel studied how light influences electrified bodies and developed **photoelectric cells for measuring light intensity**.

In 1887 Heinrich Hertz observed and described the photoelectric effect and the production and reception of electromagnetic waves. He found that ultraviolet light facilitated the passage of sparks on a spark gap. Following on this discovery Hallwachs, Hoor, Righi, and Stoletov began studying how ultraviolet light effects charged bodies.

Between 1888 and 1891 Stoletov analyzed the photoelectric effect, improved the experimental apparatus, and found there is a direct proportionality between light intensity and induced photoelectric current.

In 1899 J. J. Thomson studied the behavior of ultraviolet light in a Crookes tube, a device that looks remarkably similar to the so-called Dendera "light bulb".



Crookes Tube

Dendera "Crookes Tube"

Commonly seen Egyptian "light bulb" glyphs
that represent the two shrines of northern and southern Egypt

Frank Dörnenburg has written a detailed article dismissing the idea of Egyptian light bulbs: "Electric Lights in Egypt". In his arguments he erroneously mixes issues and exaggerates scale in order to knock down this "fringe" hypothesis. I prefer to keep an open mind, although the unearthing of some "light bulb" detritus would be helpful to the fringe notion. I also find it hard to believe that Egyptians with working light bulbs would have then forgotten about them in some sort of national amnesia. It makes more sense to think of them as possibly mythicized memories of really ancient technologies that disappeared in some great catastrophe. Dörnenburg points out the Egyptians had their own technology of illuminating underground facilities such as the chambers in the Valley of Kings. They had smokeless lamps that consisted of wicks floating in olive oil. Dörnenburg further points out that in many cases temples and pyramids could be completed using daylight before the roofs were laid on. Much of the soot that is found in Egyptian sites dates from later tourists. On the other hand, that the big bulb graphics are only found in a late period temple is not an argument against antiquity. The Story of Ra and Isis survives only in a late period papyrus, but evidence in the Pyramid Texts indicates it was passed down from Old Kingdom times or earlier.

Well, it seems some electrical detritus may have finally turned up -- inside the Great Pyramid! Christopher Dunn reports that a second robot was sent up the strange shaft from the Queen's Chamber that a first robot (Upuaut I sent in by Gantenbrink) had found at the end of the shaft a limestone block with two pieces of metal protruding from it that Dunn believes were electrodes. The second robot (Gantenbrink's Upuaut II) inserted a minicamera behind the block to see what was on the other side and found that the metal pieces had loops on the other side, evidence of corrosion, and what looked like electrical conduits, detritus from conduit repair, and even ancient wiring diagrams drawn on the floor for the ancient Egyptian technicians. Check it out with photos at http://www.gizapower.com/Anotherrobot.htm. Thanks to Larry White for drawing this to my attention. We shall see how this finding evolves with future investigations and leave this issue for the moment as a questionable interpretation of strange graphics. Let us continue our survey of modern developments in the understanding of photovoltaic and photoelectric phenomena.

In 1900 Lenard discovered the ionization of gases by ultra-violet light and two years later he observed that the energy of individual emitted electrons increased with the frequency of the light.

This contradicted Maxwell's wave theory of light which predicted that the energy of electrons emitted in the photoelectric effect would be proportional to the intensity of the radiation that stimulated their emission.

In 1905 Einstein proposed to describe light as composed of discrete quanta, later named photons, rather than as continuous waves. Einstein theorized that the energy in each quantum of light was equal to the frequency multiplied by a constant, later called Planck's constant, since Planck had first proposed a constant with the same value to describe the behavior of black-body radiation. A photon above a threshold frequency that is determined by the substance with which it interacts has the required energy to eject a single electron from the substance and create the observed photoelectric effect. Einstein's discovery was a key step in the quantum revolution of physics and brought him the 1921 Nobel Prize in Physics.

Nevertheless, Einstein's concept was strongly resisted at first because the wave theory of light was in vogue and energy in physical systems was assumed to be infinitely divisible.

Einstein's work predicted that the energy of individual ejected electrons increases linearly with the frequency of the light involved. The precise relationship had not at that time been tested although by 1905 it was known that the energy of photoelectrons increases with increasing *frequency* of incident light and is independent of the *intensity* of the light.

In 1914 Robert A. Millikan **(22 March 1868 – 19 December 1953) performed experiments that showed Einstein's prediction was correct.**

The famous "oil-drop" experiment of 1908 that demonstrated the quantized charge of the electron and the photoelectric experiment (1914) that determined the ratio of electron energy to light frequency were both done by Robert A. Millikan!!! Ironically Millikan initially was trying to disprove Einstein's theory because he believed as Maxwell that light was a wave phenomenon. Millikan's two experiments were critical steps in validating the foundation of modern quantum mechanics.

The two experiments have become standard steps in the learning of quantum mechanics. Also somehow these two experiments and the associated phenomena are closely linked, although they always seem to be treated separately in the literature. The name Millikan linked them in my awareness when I noticed that he did both the critical experiments.

The next data point that fell into place for me was a little notice at the end of the **Wikipedia** article on the "photoelectric effect" that described how NASA had discovered it to be occurring naturally on the Moon at a macroscopic scale that noticeably affects the environment.

The Strange Atmosphere of the Moon

"Light from the sun hitting lunar dust causes it to become charged through the photoelectric effect. The charged dust then repels itself and lifts off the surface of the **Moon** by **electrostatic levitation**. This manifests itself almost like an 'atmosphere of dust', visible as a thin haze and blurring of distant features, and visible as a dim glow after the sun has set. This was first photographed by the **Surveyor program** probes in the 1960s. It is thought that the smallest particles are repelled up to kilometers high, and that the particles move in 'fountains' as they charge and discharge."

When I first saw the note, my thought was, "That is pretty bizarre!" Later, I suddenly realized the significance. Richard Hoagland in his book **Dark Mission** develops an elaborate theory of the political behavior of NASA, claiming massive coverups of discoveries made on the Moon and Mars. As part of his evidence he reproduces several NASA photos that reveal an apparent atmosphere on the Moon (e.g., AS17-137-20990 & AS17-134-20442 from Apollo 17). Hoagland claims the backscattering of sunlight above the lunar surface is due to massive structures made of glass rather than a gaseous atmosphere. This bothered me, because glass structures would produce an irregular pattern, whereas the atmospheric glow in the photos showed an even distribution. (Other photos do suggest some anomalous structures, but that is another issue.)

The lunar atmosphere, I now realized, is composed of electrostatically levitated lunar dust, replete with convection currents that produce subtle weather patterns.

It turns out that the lunar dust atmosphere is the result of the two Millikan experiments combined! Sunlight initiates the photoelectric effect as it strikes lunar dust, and the repulsive charges on the particles make the dust rise up against the downward pull of lunar gravity and form a temporary atmosphere that then falls back down after sunset ends the photoelectric effect. Could this be one of the secrets of building megalithic pyramids efficiently, and perhaps also the "flying saucer" formula for space travel?

I wrote down the two equations and spliced them together.

The levitation formula used in Millikan's oil-drop experiment is $qE = mg$, where q is charge, E is the electrostatic field, m is mass, and g is the local gravitational acceleration constant (on earth g is 9.8 m / s^2).

The photoelectric formula is $V / f = h / e$, where V is volts, f is frequency above the cutoff limit, h is Planck's constant, and e is the elementary quantum of electric charge.

We solve the photoelectric formula for e, and find that $e = hf / V$, and then let $q = e$ and substitute the photoelectric result for e into the levitation formula:

$$hf E / V = mg.$$

This tells us how light can make stuff levitate. On a clear earth day an electric field of about 100 N / C is directed downward at earth's surface. Here is an example from Harris

Benson, **University Physics**, p. 456, to show the electrical force on a single electron under these conditions:

$F_E = e\text{E} = (1.6\text{e-}19\ \text{C})\ (100\ \text{N} / \text{C}) = 1.6\text{e-}17\ \text{N}$. (directed upward)

On the other hand, the gravitational force on the electron is:

$Fg = mg = (9.1\text{e-}31\ \text{kg})\ (9.8\ \text{N} / \text{kg}) = 8.9\text{e-}30\ \text{N}$. (directed downward)

In this example eE is the same as $h\,f$ E / V in the combination equation that we made above, but here we are just using the charge of a single electron for $h\,f$ / V. Benson's example is to show how the electric force is much stronger than the gravitational force, so an electron can zip about in the sky and is significantly influenced only by electromagnetic forces in the environment. Thus we find that the effect of sunlight on the earth more than counteracts the effect of gravity in the case of subatomic particles.

The textbook uses an example that leads the student away from noticing the possibilities of macroscopic photoelectric effects. Just before this example (on p. 450) Benson computes the ratio of the gravitational force (Fg) to the electrostatic force (Fe) in terms of the interaction of two charged particles (an electron and a proton) to show how the two forces are separated by nearly 40 degrees of magnitude. Looked at one way, the two forces seem unrelated. Looked at another way, it should be a snap on our scale to use the electrical force to lift things beyond the influence of gravity. So why don't we do it?

Our photoelectric formula contains $E = h\,f$ as the energy of the light. For sunlight let's say the average frequency is about 1 PHz (10^{15} Hz), going up to 30 PHz if we include ultraviolet frequencies. The energy is thus about in the range of 10^{-17} J or 10^{-18} J for a single photon to whack a single electron loose. We do not want to just move electrons, we want to lift payload.

However, suppose we have a craft that has an effective photoelectric area of 9 square meters and the average insolation (solar power) per square meter is 250 W. The watt is a joule per second (W = J / s). That gives us about 2250 joules per second on the 9 m² surface.

Let's calculate for a payload of 10^3 kg. The formula is $h\,f\,\text{E} / \text{V} = m\,g$.

The fair weather field is about E = 10^2 N / C. We will solve for V.

$(2250\ \text{J} / \text{s})\ (10^2\ \text{N} / \text{C}) / (10^3\ \text{kg})\ (9.8\ \text{m} / \text{s}^2) = (23\ \text{J} / \text{C s}) = 23\ \text{V} / \text{s}$.

Then we rearrange to solve for the payload.

$(10^3\ \text{kg}) = (2250\ \text{J})\ (10^2\ \text{N} / \text{C}) / (23\ \text{V})\ (9.8\ \text{m} / \text{s}^2)$.

If the area of the plate is only one square meter, then the voltage is about 2.5 V. Interestingly, to increase the lift -- if the light energy and fair weather field remain constant-- one **reduces** the voltage. This is doing less and accomplishing more! But there are some issues that remain.

We must be sure that the frequency of our light source remains above the cutoff point for the material we are levitating. The lower visible spectrum and infrared range are not useful.

The sunlight on the metal surface generates a photoelectric effect that removes electrons from the top of the reactive plate. This is something like a crude solar panel that uses the **photovoltaic effect** (first noted in modern times by Becquerel, 1839), which is basically the same as the photoelectric effect except that the electrons are not knocked out of the atoms of the cell but are shifted to higher energy state orbits. In any case the electrons have to be captured and used to generate repulsive charges in the plates underneath the payload. (Interestingly, the "holes" where the electrons were before they moved are sort of like positron antimatter. They have positive charge.)

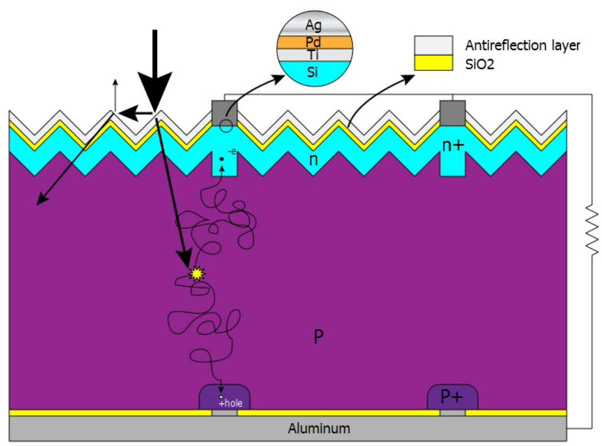


Diagram of a Modern Photovoltaic Solar Cell

Earnshaw (1839) showed that electrostatic levitation is inherently unstable because the electrons skitter around. Maxwell later proved this mathematically with the Laplace equation. You see a similar effect when you hold similar poles of magnets together. They repulse, but also easily slide and veer quickly to the side or flip unless they are held in position with a guidance system resulting in what is called pseudo-levitation. I have a dumbbell-shaped object that levitates in stable fashion for months and years whether or not it spins, bobs, or simply floats. One end of the dumbbell pivots against a small vertical pane of glass. For the Egyptians to move stone by electrostatic levitation was not a serious problem because they moved slowly and would have a crew of men steady the load by holding it taut with ropes. However, for free moving hovercraft or flying craft, computer guidance systems would be necessary to compensate for the skittering tendency.

An interesting modern approach that overcomes Earnshaw's Theorem is the Levitron, a levitating top that overcomes the problem by rapidly rotating in the permanent magnet fields underneath it and can remain stable in the air as long as it rotates. Although it is a simple mechanical solution, it would not be practical to spin huge obelisks. Nevertheless, there are many amazing new applications of electromagnetic levitation coming into use for entertainment and practical purposes.

The solar energy per volt coupled with the fair weather electric field generates an upward directed coulomb force that counter balances the downward directed force of gravity. The fair weather field generates a potential of about 100 V / m between earth's surface and the ionosphere, which is the electric field component. However, I still do not know exactly how the device would be configured, although the math looks like levitating or even flying electro-gravitational devices is feasible.

The electrically charged portion of the system must push against another solid object with charge in order to levitate. The force drops off rapidly with distance. Unless this handicap can be overcome, electromagnetic levitation will remain close to the ground.

A device like this may be able to levitate a granite block of many tons by simply borrowing the abundant energy of sunlight in the proper way. The giant sequoia trees have been able to levitate tons of water and wood into the air using the energy of sunlight for millions of years. Our Moon has been levitating its dust atmosphere for billions of years. So why shouldn't the ancient Egyptians or people in our day develop the natural levitation technology? I believe transportation of the future will use levitation technology just as Nature has made use of it for millions and billions of years.

Topics for Further Research

* It would be helpful to replicate each hypothetical scientific procedure with materials that were available to the ancient Egyptians. Replications would include the light-speed test, the spectroscopy experiments, the measurement of nanometer scale wavelengths, and the electrostatic levitation technology (using the fair weather field, photovoltaics, or electrostatic generators).

* A simple method is needed to demonstrate how the Egyptians might calculate the scale and value of Planck's constant using the sodium wavelength and a way of measuring voltage. The Egyptians from early times practiced metallurgy and were skilled in smelting ores. We know they worked with gold, copper, to some extent iron, and were making bronze. They also made pottery and did all sorts of baking. Thus we know they were skilled in the use of fire for operating ovens, kilns, and smelting furnaces. How they measured temperature and whether they explored black body radiation at high temperatures deeply enough to become aware of the quantization of energy is not very well understood and requires archaeological and technological research. Whether they had other ways of noticing the constant in their study of light is another question awaiting further research.

* Simple experiments are needed to measure the Compton wavelength of the electron and the proton in order to verify the approximate rest masses of the electron and proton could be measured by the ancients.

* We know that the Egyptians had standard weights and measures, and much of their system was based on the Eye of Horus binary fractions, but we do not know how fine the craftsmen and engineers were able to go in such measurements. One way the ancients achieved fine resolution in measurements was to use instruments built at a large scale. For example, a large Senet Board could be used to get extremely accurate measurements of irrational quantities such as square roots. Large pyramids and obelisks could be used as instruments for measuring astronomical motions and cycles of time.

We are only part way there. We have found many cosmic numbers enshrined in the sacred geometry of the Senet Board, and hints at how the ancient Egyptians might have actually understood the physics related to these numbers. Perhaps knowledge of the relation between geometry and physics was a surviving tradition from a bygone era of "Atlantean" civilization that collapsed during some great catastrophe and lost all its higher technology. Perhaps the Egyptians simply celebrated the beauty of the geometry on an intuitive level without any awareness of the underlying physical laws.

This paper as it stands is still only a rough draft that requires further research so that we may answer the above questions and further understand what the Egyptians knew. Unfortunately so much of their technical lore has been lost that we are faced with the task of reconstructing from the limited remnants that survive. Most of the perishable artifacts are long gone and we are left with whatever the archaeologists can recover from the shifting sands of Egypt.

Douglass A. White
October 25, 2012

Appendix A: Taking Square Roots with Egyptian Arithmetic

The Egyptians in early times already were quite adept at arithmetic, algebra, trigonometry, and the basics of calculus. Unfortunately only a few documents about mathematics have survived. **Wikipedia** ("Egyptian mathematics") lists for us the scanty scraps of primary documents in Egyptian that have survived.

"The earliest true mathematical documents date to the 12th dynasty (ca 1990–1800 BC). The **Moscow Mathematical Papyrus**, the **Egyptian Mathematical Leather Roll**, the **Lahun Mathematical Papyri** which are a part of the much larger collection of Kahun Papyri and the **Berlin Papyrus** all date to this period. The **Rhind Mathematical Papyrus** which dates to the Second Intermediate Period (ca 1650 BC) is said to be based on an older mathematical text from the 12th dynasty."

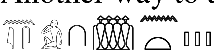
The Temple of Man (2 vols) by Schwaller de Lubicz, translated into English from French by Deborah and Robert Lawlor is a good source that discusses in detail Egyptian mathematics and its deeper meaning. The chapters "Foundation of Pharaonic Mathematics", "Pharaonic Calculation", and "Pharaonic Trigonometry" are especially useful and form the basis for Schwaller's analysis of Egyptian megalithic architecture.

In this appendix I will suggest a possible scenario by which an Egyptian scribe might calculate the square root of 10 numerically with great accuracy. The formula in modern algebraic form is $a' = ½ (a + N/a)$, where N is the number you are taking the root of, a is a reasonable guess, and a' is an average between a and N/a.

We discussed Egyptian multiplication earlier in the essay. The procedure we are using for taking the square root requires the operations of division and addition. Addition was simple in Egyptian.

 (Wah kher-k met her-s.) Place [by you] 10 over it. (Egyptian addition is like piling things.) Add 10 to whatever you already have.

Division
 (Wah-tep em khemt er gemet met.) Put 3 so that 10 is found. Divide 10 by 3.

Another way to announce division:
 (Nas met khenet khemt.) Call 10 in front of 3. (Divide 10 by 3).

From here on I will use Arabic numerals to suggest the Egyptian format. Generally speaking the Egyptians preferred to represent all fractions as unit fractions (with numerator = 1) except for occasional use of ⅔.

In the first iteration we will start with a guess of 3, which we know is a bit low.

Put 3 to find 10. (The first-guess divisor a is 3, and the dividend N is 10.)

	*1	3	
	*2	6	
	*⅓	1	Remainder
Total:	3 + ⅓	9 + 1 = 10	Quotient is 3 + ⅓ = 3.3333333....

Notes: The column on the right starts with the divisor, and doubles to find the next number. The doubling continues until the next number in the sequence exceeds the dividend. The column on the left is a binary sequence that starts with 1 and doubles to find each succeeding number. The doubling iterates the same number of times in each column. When the right-hand column is added, the sum is 9, which is 1 short of 10. We then divide the remainder of 1 by the divisor 3 to get ⅓, which we place at the bottom of the left-hand column opposite the remainder 1. The stars indicate the numbers in the list that are selected. In this case we use them all, but in other instances the sum that equals or most nearly equals the dividend does not use all components of the list. In this case our answer for the dividend 10 is the quotient 3 + ⅓. The fraction indicates the left-column remainder that is added to the quotient. Our first *a* was 3, so 3⅓ becomes our *N/a*. So we "put (3 + ⅓) over 3" and get 6 + ⅓.

Then we divide (6 + ⅓) by 2 which by inspection gives us a' = 3 + 1/6 = 3.1666666, which is much closer to √10 than 3.33333.

Next we will repeat the process, but use instead (3 + 1/6) as our new *a*.

Put 3 + 1/6 to find 10.

	*1	3 + 1/6
	*2	6 + 1/3
	*1/12 + 1/19 + 1/38	½
Totals:	3 + 1/12 + 1/19 + 1/38	9 + 1/2 + 1/3 + 1/6 = 10

The ratio ½ / (3 + 1/6) = (1/2)(6/19) = 3/19 = 2(1/19 + 1/38).
We "put 3 + 2(1/19 + 1/38) over 3 + 1/6" and get 6 + 1/6 + 2(1/19 + 1/38).
We divide by 2 and by inspection get 3 + 1/12 + 1/19 + 1/38 = 3.16228070175, which is already just about good enough -- accurate to 5 decimal places. But we will run the program one more time.

*1	3 + 1/12 + 1/19 + 1/38
*2	6 + 1/24 + 1/38 + 1/76
*1/14 + 1/24 + 1/38 + 1/76 + 1/103	9 + 1/12 + 2(1/19) + 1/24 + 1/76

1/12 + 1/24 = 1/8
1/19 + 1/38 + 1/38 + 1/76 = 9/76
3 + 1/12 + 1/19 + 1/38 = 721/228
9/76 + 1/8 = 9/38 + 1/4 = 37/76
1-37/76 = 39/76 = 117/228
(117/228)(228/721) = 117/228
(1/2)(3 + 117/721 + 3 + 3/38 + 1/12) = 3 + 117/1442 + 3/76 + 1/24
117/1442 = 1/14 + 1/103
3/76 = 1/38 + 1/76

Answer: 3 + 1/14 + 1/24 + 1/38 + 1/76 + 1/103 = 3.16227766

The Egyptians were very adept at manipulating unit fractions (fractions with the numerator 1). They also were well-versed in the process of doubling and halving. They liked to calculate this way, because it reminded them that every portion is a portion of a unified wholeness. Horus sees multiple partial values with his "damaged" Eye (the denominator) and always sees unity with his "healthy" Eye.

We are not familiar with all the tricks of the trade they used when calculating this way, so I have used some "short-cuts" to show how the process goes from a viewpoint that is more accessible to our modern view. It turns out the Egyptians also sometimes used "vulgar" fractions (with greater than unity numerators) during their calculations but then put the result in unit fractions.

Using the same process they could find the square root of 3.16227766, and then the square root of that root, and so on until they had their list of the roots of 10.

Appendix B: Methods for Calculating Egyptian Unit Fractions

(from **Wikipedia**, "Egyptian fractions")

Modern historians of mathematics have studied the Rhind papyrus and other ancient sources in an attempt to discover the methods the Egyptians used in calculating with Egyptian fractions. In particular, study in this area has concentrated on understanding the tables of expansions for numbers of the form $2/n$ in the Rhind papyrus. Although these expansions can generally be described as algebraic identities, the methods used by the Egyptians may not correspond directly to these identities. Additionally, the expansions in the table do not match any single identity; rather, different identities match the expansions for **prime** and for **composite** denominators, and more than one identity fits the numbers of each type:

- For small odd prime denominators p, the expansion $2/p = 2/(p + 1) + 2/p(p + 1)$ was used.
- For larger prime denominators, an expansion of the form $2/p = 1/A + (2A - p)/Ap$ was used, where A is a number with many divisors (such as a practical number) between $p/2$ and p. The remaining term $(2A - p)/Ap$ was expanded by representing the number $(2A - p)/Ap$ as a sum of divisors of A and forming a fraction d/Ap for each such divisor d in this sum (Hultsch 1895, Bruins 1957). As an example, Ahmes' expansion 1/24 + 1/111 + 1/296 for 2/37 fits this pattern with $A = 24$ and $(2A - p)/Ap = 11 = 3 + 8$, as $1/24 + 1/111 + 1/296 = 1/24 + 3/(24 \times 37) + 8/(24 \times 37)$. There may be many different expansions of this type for a given p; however, as K. S. Brown observed, the expansion chosen by the Egyptians was often the one that caused the largest denominator to be as small as possible, among all expansions fitting this pattern.
- For composite denominators, factored as $p\times q$, one can expand $2/pq$ using the identity $2/pq = 1/aq + 1/apq$, where $a = (p+1)/2$. For instance, applying this method for $pq = 21$ gives $p = 3$, $q = 7$, and $a = (3+1)/2 = 2$, producing the expansion $2/21 = 1/14 + 1/42$ from the Rhind papyrus. Some authors have preferred to write this expansion as $2/A \times A/pq$, where $A = p+1$ (Gardner 2002); replacing the second term of this product by $p/pq + 1/pq$, applying the distributive law to the product, and simplifying leads to an expression equivalent to the first expansion described here. This method appears to have been used for many of the composite numbers in the Rhind papyrus (Gillings 1982, Gardner 2002), but there are exceptions, notably 2/35, 2/91, and 2/95 (Knorr 1982).
- One can also expand $2/pq$ as $1/pr + 1/qr$, where $r = (p+q)/2$. For instance, Ahmes expands $2/35 = 1/30 + 1/42$, where $p = 5$, $q = 7$, and $r = (5+7)/2 = 6$. Later scribes

used a more general form of this expansion, $n/pq = 1/pr + 1/qr$, where $r = (p + q)/n$, which works when $p + q$ is a multiple of n (Eves 1953).

- For some other composite denominators, the expansion for $2/pq$ has the form of an expansion for $2/q$ with each denominator multiplied by p. For instance, 95=5×19, and 2/19 = 1/12 + 1/76 + 1/114 (as can be found using the method for primes with A = 12), so 2/95 = 1/(5×12) + 1/(5×76) + 1/(5×114) = 1/60 + 1/380 + 1/570 (Eves 1953). This expression can be simplified as 1/380 + 1/570 = 1/228 but the Rhind papyrus uses the unsimplified form.
- The final (prime) expansion in the Rhind papyrus, 2/101, does not fit any of these forms, but instead uses an expansion $2/p = 1/p + 1/2p + 1/3p + 1/6p$ that may be applied regardless of the value of p. That is, 2/101 = 1/101 + 1/202 + 1/303 + 1/606. A related expansion was also used in the Egyptian Mathematical Leather Roll for several cases.

Appendix C: Finding Cube Roots With an Electronic Calculator

(From **Wikipedia**, "Cube root")

"There is a simple method to compute cube roots using a non-scientific calculator, using only the multiplication and square root buttons, after the number is on the display. No memory is required.

- Press the square root button *once*. (Note that the last step will take care of this strange start.)
- Press the multiplication button.
- Press the square root button *twice*.
- Press the multiplication button.
- Press the square root button *four* times.
- Press the multiplication button.
- Press the square root button *eight* times.
- Press the multiplication button...

This process continues until the number does not change after pressing the multiplication button because the repeated square root gives 1 (this means that the solution has been figured to as many significant digits as the calculator can handle). Then:

- Press the square root button one last time.

At this point an approximation of the cube root of the original number will be shown in the display.

If the first multiplication is replaced by division, instead of the cube root, the fifth root will be shown on the display.

Why this method works

After raising x to the power in both sides of the above identity, one obtains:

$$x^{\frac{1}{3}} = x^{\frac{1}{2^2}\left(1+\frac{1}{2^2}\right)\left(1+\frac{1}{2^4}\right)\left(1+\frac{1}{2^8}\right)\left(1+\frac{1}{2^{16}}\right)\cdots} \quad (*)$$

The left hand side is the cube root of *x*.

The steps shown in the method give:

After 2nd step:

$$x^{\frac{1}{2}}$$

After 4th step:

$$x^{\frac{1}{2}(1+\frac{1}{2^2})}$$

After 6th step:

$$x^{\frac{1}{2}(1+\frac{1}{2^2})(1+\frac{1}{2^4})}$$

After 8th step:

$$x^{\frac{1}{2}(1+\frac{1}{2^2})(1+\frac{1}{2^4})(1+\frac{1}{2^8})}$$

etc.

After computing the necessary terms according to the calculator precision, the *last square root* finds the right hand of (*)." **(Note the use of Egyptian fractions and Eye of Horus Binary Sequence in this "modern" method.)**

Appendix D: A Peek at the Code?

In our tradition the great mathematician Euler discovered one of the truly amazing relationships in all of mathematics that combines five of the most fundamental mathematical values into one expression. From this expression came one of the most powerful mathematical tools used in the study of physics. Here it is.

$e^{i\pi} + 1 = 0$.

How does this relate to what we have been doing in this discourse? The symbol *i* in our modern notation stands for $(-1)^{½}$, and we call that strange entity an "imaginary" number. If we say $x^2 = -1$, the square root is $\pm(-1)^{½} = \pm i$. If we square *i*, we get -1, but the fourth power of *i* is +1. Values that include i are called complex numbers and take the form of a real number plus a real number times *i*. It does not matter whether *i* is considered positive or negative. So we can represent that algebraically as $x + iy$ or $x - iy$, where *x* and *y* are real numbers. We call $x - iy$ the complex conjugate of $x + iy$.

$10^{(m+in)} = 10^m\ 10^{in}$, where *m* is some real number, and *n* is some real number, and *i* is the imaginary number $(-1)^{½}$.

We thus say *in* is some complex number $x + iy$.

If $10^{in} = x + iy$, then $10^{-in} = x - iy$.

$10^{in}10^{-in} = 10^0 = 1 = (x + iy)(x - iy) = x^2 + y^2$.

We then assume that what we found for real numbers regarding very small powers holds also for complex numbers. We found that $10^{\varepsilon} = 1 + 2.3025\varepsilon$ as ε approaches 0. That means we can say $10^{in} = 1 + 2.3025\times in$ as $n\rightarrow 0$. This gives us a good approximation of 10^{in}. In his essay on "Algebra" Feynman goes on to use the wonderful $\log_{10}$ table to find that the power of 10 needed to equal i is $i(512 + 128 + 64 - 4 - 2 + 0.20)/1024$, which comes out to be $698.20i/1024$ and means that $\log_{10} i = 0.068226i$. Then he calculates successive powers of 10 to some complex power and finds that the value oscillates periodically. Since $10^{0.68i} = i$, then the fourth power of that must be i^2 squared, which means that $10^{2.72i} = +1$. The value returns to +1 at each cycle of $2.72i$ powers of 10, so $10^{3i} = (10^{2.72i})10^{.28i}$, and at about $1.36i$ powers of 10 it will have the value -1.

Of course $10^{in} = e^{iq}$, where q is a real number, and $e^{iq} = x + iy$. Feynman then substitutes for x and iy the values $\cos q$ and $i \sin q$.

$e^{iq} = x + iy = \cos q + i \sin q$.

From the above product of complex conjugates we know that $x^2 + y^2 = 1$, and therefore $\cos^2 q + \sin^2 q = 1$, which is a standard identity of trigonometry. To find the power of e that equals i we multiply $0.68226i$ by 2.3025 to get $1.5709i$, which (when our arithmetic is done more rigorously) happens to be $\pi/2 \approx 1.57079i$, or a quarter turn around a circle. If we double that (which takes us a half turn), we of course get $i\pi$, and so $e^{i\pi} = -1$, and so $e^{i\pi} + 1 = 0$, an elegant equation known as Euler's identity.

More generally, $e^{i\theta} = \cos \theta + i \sin \theta$, where the angle θ is in radians and one complete cycle is an interval of 2π. Here is **Wikipedia** on "Euler's identity".

"The identity is a special case of Euler's formula from complex analysis, which states that

$$e^{ix} = \cos x + i \sin x$$

for any real number x. (Note that the arguments to the trigonometric functions *sine* and *cosine* are taken to be in radians, and not in degrees.) In particular, with $x = \pi$, or one half turn around the circle:

$$e^{i\pi} = \cos \pi + i \sin \pi.$$

Since

$$\cos \pi = -1 \text{ and } \sin \pi = 0,$$

it follows that

$$e^{i\pi} = -1 + 0i,$$

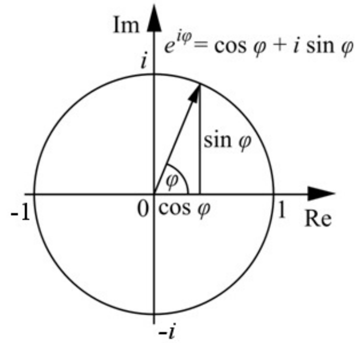
which gives the identity

$$e^{i\pi} + 1 = 0."$$

(Note five of the most important numbers: e, i, π, 1, and 0.)

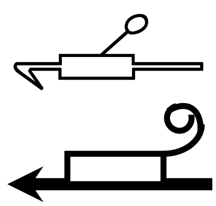
This powerful finding means that we can study all sorts of oscillations with simple exponents using Euler's magic identity that Feynman called "our jewel".

In the diagram below Re is the real dimension and Im is the imaginary dimension.



Now what does this have to do with ancient Egypt? Could the Egyptians have known about *i* and complex numbers? What if the natural base was symbolized by the pyramid glyph △, the imaginary number *i* was symbolized by the Eye of Horus 𓂀, and π, was symbolized by the disk-sphere glyph for the sun ☉?

The glyph for 1 in Egyptian was , and is generally considered to represent a harpoon. However, the interpretation of this glyph has bothered me, because it does not look right.

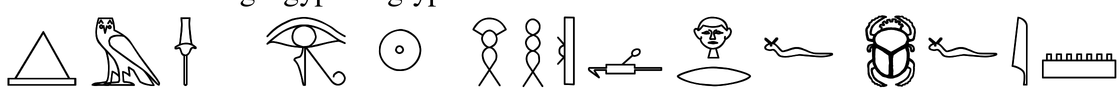


Above are two versions of the glyph, magnified so that you may see the details. The harpoon was a weapon used for spearing fish, crocodiles, or hippos -- as we can see from examples in Egyptian art. However, harpoons in the art do not have the rectangle and the spiral or loop that we find in the glyph (see drawing on p. 11). The rectangle may be some device for hurling the harpoon, and the spiral may represent a rope, since the rope glyph is very similar: . What if the rectangle represents the Senet Board, and the spiral represents the Senet Spiral and the string that was used to calculate lengths on the Board. The harpoon pole resembles the simple straight line used for the number one |.

The word for harpoon was pronounced either "w*a*@" or "m*a*@b*a*". In the first instance, if it had the "god" determinative  with it, the sense was The One, The One God. The word "w*a*@" meant oneness, unity -- and gives us the number 1. In the second instance, it usually was the determinative, and the phonetic aspect was supplied by three hooplike glyphs ∩∩∩ that represent the number 30 and are pronounced "m*a*@b*a*". This number was commonly used to refer to the council of thirty divine judges that sat in the Hall of

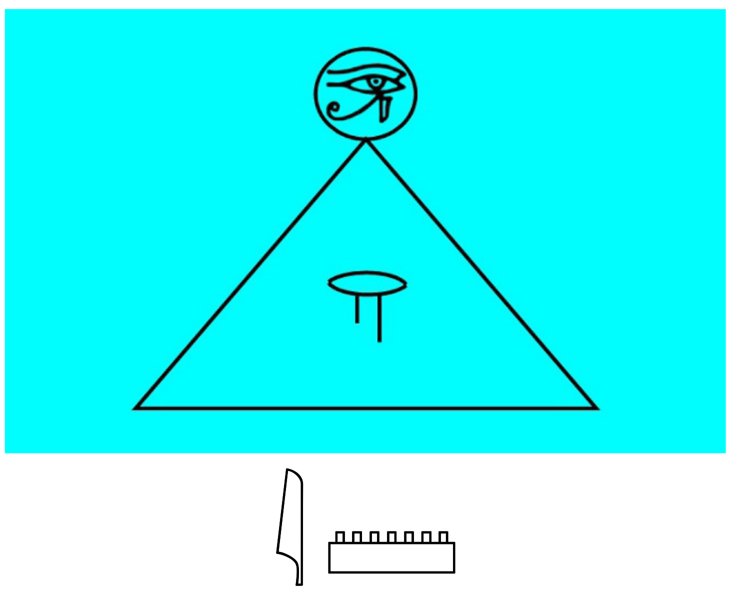
Judgment. The Senet Board contains exactly 30 squares, and each square is the house of one of the thirty divine judges. In other words, the Senet Board symbolized the thirty component natural energies that work together as one to manage an individual's life. Each member of the council of thirty is a distinct individual, but they function as a unified group, and their unifying leader is Amen, the Invisible -- whose name is the glyph that explicitly contains a drawing of the Senet Board . The glyph of the board means "foundation". The reed prefix "a" adds a sense of endearment. In addition, the word "amen" means "invisible". This is the 0. The symbol for addition in Egyptian we already saw is "wah" ().

The central image of the Judgment Tableau is the Scale of Justice that is always in balance . The glyph for power was the scepter of Sekhmet . We can now write Euler's formula using Egyptian glyphs.

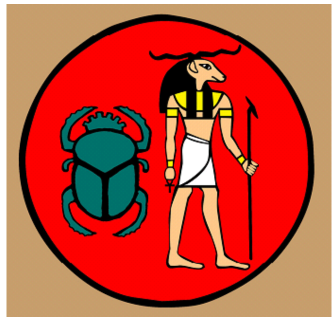


Mer em sekhem W*a*jet R*a*@ Wah W*a*@ her-f . Kheper-f Amen.
e in the power of *i* π. Put One upon it. It becomes Invisible.

"Mer" plays on another word that means "Love".



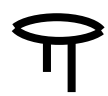
The general symbol for a complex number ($x + iy$) in Egyptian appears on the "cover" illustration of the **Litany of Ra** and is painted on the walls of many tombs in the Valley of the Kings.



x + *iy*

The solar disk represents the whole range of creation, and is the graphic equivalent of the mathematical expression of $(x + iy)(x - iy) = x^2 + y^2 = 1 = \cos^2 \theta + \sin^2 \theta$. We take the origin as the dot at the center of the glyph for Ra (☉). The scarab beetle is called Khepera and means to become. Exoterically he represents the sun during the daylight hours and a person's ability to express himself creatively in the world of physical action and material phenomena. Mathematically this is the real component x of the generalized complex number. The humanoid with the ram's head is called Awef (limbs) and represents the mind during sleep and dream states, and a person's ability to imagine ideas in his mind. Mathematically this is the imaginary component iy of the generalized complex number. The two components together make for a complete wholeness, which is represented by the number 1. This clue suggests that we may be able to interpret the **Litany of Ra** as a text on the foundations of number theory and algebra.

Appendix E: Exploring the Glyph for 2/3

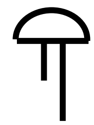


The lenticular mouth glyph stands for the letter "r" in Egyptian. When used for fractions it means "reciprocal", so whatever whole number appears under it is to be understood as transformed by the "reciprocal" sign into its reciprocal value. In the case of the fraction 2/3, the Egyptians placed two lines under the reciprocal sign, but one of them was shorter than the other. We may presume that the proper convention was that the shorter one be one half the length of the longer one, thus indicating 1 + ½, which is 3/2 in our notation. The reciprocal of 3/2 is of course 2/3. However, this neat trick presented an orthographical problem. If the scribe wrote the two lines almost the same length, or in glyphs written at a small size, it was easy to confuse reciprocal 2 (i.e. 1/2) from reciprocal 3/2 (i.e. 2/3). So they introduced another convention of using the glyph for "side" in the sense of "half". This glyph was pronounced "ges".

or

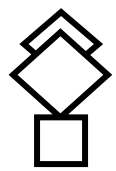
Glyphs used for "Half"

Sometimes they used the word "peseshet" (a cutting or division) to mean a half of something (𓐠), but not usually in the mathematical sense; 𓐠 𓐠 was the two halves of something. The pronunciation of the glyph for 2/3 is unknown, but we may hazard a guess that it was something like "rehep" on the model of the glyph "hep" which means to turn around, and was often used for the solstice, when the sun "turned around" (reversed its angle relative to earth's pole). The glyph  was a parasol, suggesting a shadow. At solstice the sun's shadow reversed direction halfway through the year.



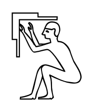
Hep

This word puns with the homophone glyph "hep" (variant: "hap") that was used as the insignia for the Nile god, the Lord of Water, the northern cardinal point, and the Apis Bull (Hep) of Memphis.



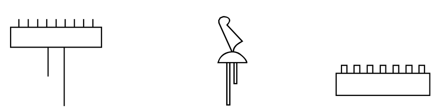
Hep, or Hap

It also punned on another homophone "hep" that means to hide, hidden.



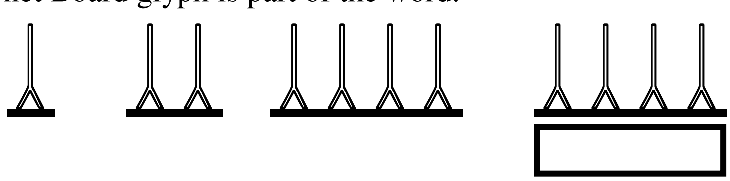
Hep

You can see the graphic connection between "hidden" and the stylized insignia for the god of the north who was "hidden". The waters of Egypt flowed to the north into the Mediterranean, which was to the north of Egypt. The north pole on Earth was inaccessibly hidden from Egypt. Two other glyphs used the two vertical lines of unequal length as a component:

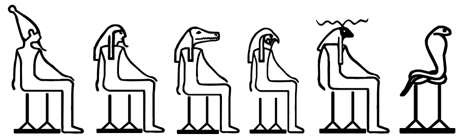


hap, hebes amen men

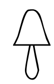
"Hap" means to hide by covering or enshrouding. "Hebes" means clothing, to put on clothing, to cover with cloth. The upper part of that glyph looks a lot like the Senet Board glyph "men" and usually had the 7 pawns on top, although occasionally it had the repeated glyph for spindles of cloth on top, which was pronounced "menekhet". This glyph was used for the cloth offerings made to the ancestors. The syllable "men" that is written with the Senet Board glyph is part of the word.



This suggests the Egyptians were playing on a connection between the pawns on the Senet Board and the cloth offerings. In the **Amduat**, Hours 8 and 9, we find deities sitting on the cloth offering glyph, which would seem to be a very uncomfortable seat.

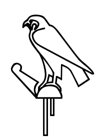


This suggests we are dealing with another complex word play. On the one hand, these are the pawns or the divine houses where the pawns rest on the Senet Board. On the other hand, there is yet another pun with the word "menekhet" that means "perfection".



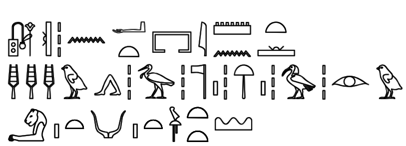
menekhet = perfection

We still have to mention the glyph for "amen", which means hidden, west, and the right side (as opposed to the left side that was identified with the east). The idea of "hidden" derives from the disappearance of the sun in the west, and they often wrote the "hep" glyph that meant hidden as a determinative for "amen" used in that sense. They spelled it phonetically using the reed and Senet Board glyphs. They used the glyph for solstice topped by a feather for the notions of west and right side. Often they included a hawk perched on top to indicate divine quality. That could be read as "Bak-Amen" (another game played on the Senet Board, the Invisible Hawk, Your Invisible Mind).

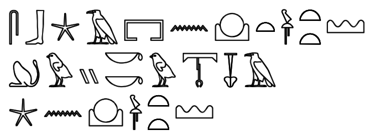


Amen

The idea of being hidden linked the glyph to Amen, The Invisible form of Ra. Ra's consort, Hathor, was also often called Amenet, and the realm in which the sun and its light became invisible (i.e. night) was called Amenetet. The **Amduat** text is a detailed description of that Invisible Realm -- the Light that is not visible but can be cognized --, which is why the proper title of the work by which it announces itself is **Book of the Hidden Chamber** (or **Book of the Hidden Realm** Sesh ne @*a*t Amenet), and its contents describe the B*a*iu (thoughts), Neteru (natural archetypes), Shewut (shadows = subconscious entities), A*a*khu (Light Beings), and Aru (actions) that begin at the West (amen), the Seba (Stargate) of the A*a*khet Amenetet (Western Horizon = Samadhi of the Invisible Realm) and culminate in the Unifying Darkness, which is the Stargate of the Western Horizon.



Sesh en @*a*t Amenet
@h@u B*a*iu, Neteru, Shewu, A*a*khu, Aru;
H*a*t wep Amenetet,



Seba en Aakhet Amenetet,
Pehuy Keku Sem*a*,
Seb*a* en A*a*khet Amenetet.

In this extended title we find the Senet Board glyph, the shadow glyph, and the hidden-west glyph along with play on the Light Beings and the Samadhi Horizon and the image of a Stargate Portal that is the entrance to the Invisible World. Furthermore, the lion glyph (solar symbol) is cut in half, and the front half and the rear half both combine (or find equilibrium = Sem*a*) at the Stargate, since that phrase about the Portal is repeated so we know it is the Alpha and Omega of the whole book combined into a single moment-point in time-space.

Appendix F: The Plumb Bob Pendulum and Cosmic Architecture

In the early 1970s I met the creative inventor, Itzhak Bentov, and had the pleasure of being a guinea pig for one of his experiments in which he was exploring certain aspects of human hearing. Later, after his untimely death in 1979, I read his book, **Stalking the Wild Pendulum** in which he points out a wild property of the pendulum that is not usually discussed in physics texts.

It is obvious to most observers that the bob on a pendulum swings back and forth under the influence of gravity. A swinging pendulum accelerates as it swings downward and moves fastest when it reaches its lowest point. As it moves upward in the swing, it slows. When it reaches its highest point, the bob stops for a moment and then reverses direction to begin another downward swing. Bentov calls attention to the moment when the rising bob comes to a full stop at its highest point in preparation to begin its downward swing in the direction from whence it has just swung upward. At that moment the bob hovers motionless in the air and apparently is neither rising nor falling. It would seem that it must come to a full or nearly full stop before changing directions.

Bentov then points out that if the motion of the bob goes toward zero, the position of the bob must be extremely precise. However, according to Heisenberg's quantum mechanical principle of uncertainty, the relationship between the change in momentum and the change in position of an object is reciprocal and governed by Planck's constant. (Recall that momentum is mass times velocity.) As the bob slows to its pause, the smaller the change in position, the greater the change in momentum. Therefore, if the change in position is nearly zero, the change in momentum must become nearly infinite. That means the bob in that moment of pause somehow magically whishes off to who knows where with a fantastically huge momentum. Once the downward swing begins, the bob immediately drops that huge momentum and returns to the simple momentum of a bob swinging on a pendulum arm. Bentov teases us with this puzzling superluminal situation but does not explain why it might be true and quite simple to understand.

The problem of the pendulum bob's momentary "wildness" becomes very general when we realize that any time an object stops moving under any circumstances, its position appears to become very precise, which means according to Heisenberg's "quantum mechanics" that its momentum must become much larger and less precise. On the surface such an idea seems absurd, because we can see that a pendulum bob at rest is clearly not moving visibly and therefore should not have any visible momentum.

Actually the situation is not as wild as it seems. For example, imagine that the pendulum is in a grandfather clock. When the clock winds down, the pendulum bob comes to rest at its lowest point. Then the bob comes into equilibrium with the entire clock apparatus and the case in which it hangs. The clock stops "telling time", and the pendulum with the whole clock case shifts into equilibrium with its relatively nonmoving environment that includes the room in which the clock stands as well as the house that contains the room and the planet on which the house sits.

The pendulum bob at rest is no longer a distinct object moving about in the local environment of a clock case. It has come into equilibrium with that entire environment that is relatively at rest with it, but that has its own momentum. The planet spins on its axis and orbits around the sun, while the solar system moves around galactic center far out in a galactic arm. The mass of the locally motionless bob is no longer its localized mass, nor is its motion the localized swinging of the bob. The bob's mass has expanded to identify with the mass of a planet and its motion has expanded to become the motion of a planet.

Of course, now we can turn the whole thing around and look at it another way. Once we can see that the momentum of the bob at rest has identified with the mass-velocity momentum of the entire planet, we now have a precise definition of the expanded momentum of the bob. Once we define the bob's momentum in this way, the bob becomes extremely unlocalized and uncertain in its position. The bob could be any equivalent blob of matter anywhere in the planet as long as it is relatively at rest with the whole system (and not a bird flying or you walking around.)

Of course, we can think of the planet as a pendulum bob swinging around the sun. As such it is a very precise clock. However, if we know exactly where the planet is with respect to the sun at any moment, then, with this new viewpoint, we lock the planet into an equilibrium position with regard to the sun and the momentum of that system immediately expands to a much larger field of celestial motions.

If we continue in this fashion, we simply allow a relatively local system to come into positional equilibrium with its larger environment, and then find how the momentum (mass-velocity) automatically expands to a much larger domain. Then we precisely define the shape and position of that larger domain and explore the even greater expanded momentum domain that comes to attention. Then we define that domain's positional context and discover its larger momentum context, and so on. With a few iterations of this exercise the whole universe dissolves into uncertainty. The result is that you have to decide for yourself where you are and what if anything you are existing as and possibly doing.

The ancient Egyptians primarily used the pendulum mechanism as a motionless plumb bob in balanced equilibrium to aid in constructing solid stone monuments that would express as perfectly as possible the timeless, effortless, nonlocal, and universal qualities of silent rest. The Great Pyramid is the archetype of ancient Egypt's transcendental meditation during which an alert observer effortlessly reduces the scale of thoughts until the momentum of consciousness expands beyond all limitations to the silent awareness that underlies all of creation. As the energy scale reduces, the scale of time expands to identify with eternity. $\Delta p\ \Delta x \geq h$; $\Delta E\ \Delta t \geq h$. We have an interesting reciprocal game.

Appendix G: Extending Mathis' Simplified Calculus

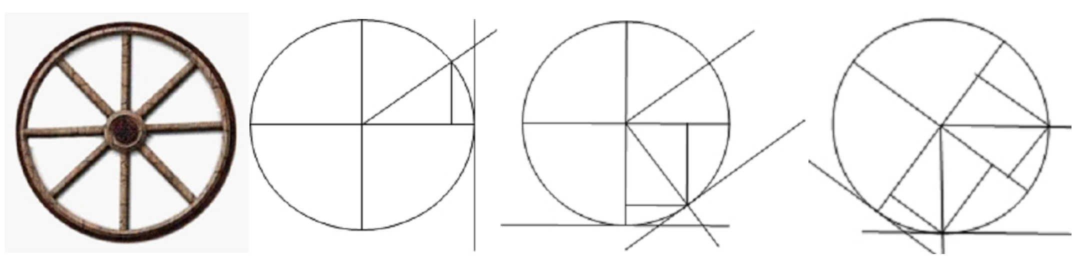
Critics have rightly pointed out that the "simplified calculus" described by Mathis breaks down when applied to negative exponents, trigonometric equations, and natural logarithms. I would like to suggest that we may only need to adjust our viewpoint slightly to include these forms of calculus without having to consider infinitesimal limits.

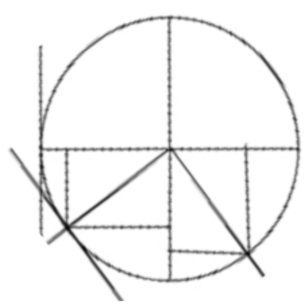
Negative Exponent Equations

The basic negative exponent example has the form $y = 1/x$, which is just $xy = 1$, a reciprocal hyperbolic relation like the Velocity Equation with $c = 1$. This is equivalent to the always balanced Egyptian Scales of Justice (see my discussion of the Scales). When the Scales are balanced, we know that the "instantaneous velocity" is zero, thus giving access to the derivative. The formula is $M_2L_2 = M_1L_1$, and you can set it up so that a standard $M_1L_1 = 1$, and then you have $M_2L_2 = xy = 1$.

Trigonometric Relations

Trigonometric equations are based on the unit circle, which is simply a wheel for the ancients.





The standard differentiation of $f(x) = \sin x$ is $f'(x) = \cos x$. We have a unit circle $x^2 + y^2 = 1$. Then the limit as θ goes to 0 for $\cos\theta$ is 1, and the limit as θ goes to 0 for $\sin\theta$ is 0.

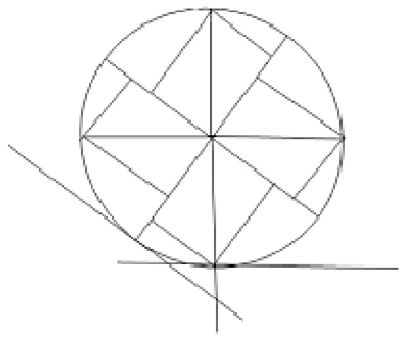
The trig functions are ratios of the various pairs of sides of a right triangle with an acute angle. The simplest way to represent these is with a unit (radius = 1) circle. That way for any point on the circle the sine gives that point's *y* value above or below 0 and the cosine gives that point's *x* value above or below 0. A circle is a closed curve, and the derivative of a point on the curve should be the tangent line at that point on the curve. Each trig function is already a ratio of two straight lines that indicates a slope. On a unit circle the tangent (tan) indicates the tangent line relative to a particular angle and can be expressed as the ratio of sine to cosine. Or we can take the interval from the tangent point on say the x axis to where an extension of the radius at an angle to the x axis intercepts the tangent line relative to the unit radius. If the circle is sliding along that tangent line, that is the "instantaneous velocity" at the tangent point. If the circle is rolling like a wheel along the tangent line, then it is the "instantaneous velocity" of the center of the circle. If the circle rolls at a constant rate, the velocity of the center is also constant.

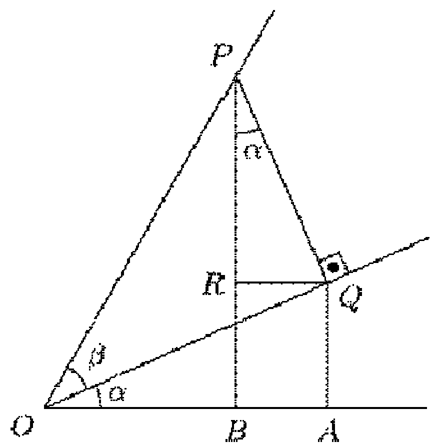
For the ancients, the mechanical version of the rolling circle is the wheel. A wheel on a wagon or a chariot rests on the ground, and flat ground represents a line tangent to the circle. If a line is extended from the axle out past the rim (to the right as we face the wheel) at any angle less than 90 degrees, then the "tangent" value is the distance from where the line touches the ground to where the rim touches the ground compared to the length of a spoke (axle center to edge of rim). If a peg is placed at the rim where the line crosses it, and the wheel is then rotated 90 degrees counter clockwise (until the vertical spoke points level to the right) and a weight is hung by a string from a peg on the rim, then the weight hangs down crossing the horizontal spoke at the point on it marking the sine along the string and the cosine along the spoke.

Suppose we place the wheel with the *x* axis touching the ground and then roll it to the right a distance less than a quarter of a turn. The center of the wheel moves forward parallel to the ground at a constant velocity as the wheel turns. The direction of center point motion is thus always parallel to the tangent line of the wheel touching the ground, no matter how far the wheel turns, and this tells us the velocity of the entire wheel as it rolls along the ground. As the wheel turns, the angle (we'll call it A) made by the line from center to tangent point relative to the *x* axis changes, and sin A and cos A also change accordingly. Also the line through the center that is always parallel to the tangent line changes accordingly. The radius (r) from center to tangent point is always the diagonal of the rectangle formed by (sin A)(cos A), and r is set at unity. When the angle rotates an additional 90 degrees, the sine-cosine rectangle also rotates by 90 degrees into the next quadrant. Thus the sine and cosine swap places. The sine becomes the cosine, but the cosine becomes the sine with the sign changed since it is now on the other side of the center point (origin).

The addition rules of trig confirm this. We will call the 90-degree shift angle B. We get $\sin(A+B) = \sin A \cos B + \cos A \sin B$. The 90-degree value for cosine is 0 and the 90-degree value for sine is 1. So the result of the transformation is from sin A to cos A. Then also $\cos(A+B) = \cos A \cos B - \sin A \sin B = -\sin A$. This of course is what the derivatives of sine and cosine are. Thus we have the derivative for any value of the sine or cosine without infinitesimalizing to limits, and we have a clear understanding of how it relates to a tangent point on a curve and a constant velocity. This is so much simpler than the otherwise necessary division of 0 by 0 using the "ghosts of departed quantities" as Berkeley so aptly described them.

The sketch below shows rotation by additional 90 degree steps into the third and fourth quadrant. The oscillating nature of sine and cosine are obvious.





Sketch of an angle sum proof in trigonometry
(See **Wikipedia**)

Draw a horizontal line (the *x*-axis); mark an origin O. Draw a line from O at an angle α above the horizontal line and a second line at an angle β above that; the angle between the second line and the *x*-axis is $\alpha + \beta$.
Place P on the line defined by $\alpha + \beta$ at a unit distance from the origin.
Let PQ be a line perpendicular to line defined by angle α, drawn from point Q on this line to point P. ∴OQP is a right angle.
Let QA be a perpendicular from point A on the *x*-axis to Q and PB be a perpendicular from point B on the *x*-axis to P. ∴ OAQ and OBP are right angles.
Draw QR parallel to the *x*-axis.
Now angle $RPQ = \alpha$ (because $OQA = 90 - \alpha$, making

$RQO = \alpha, RQP = 90 - \alpha$, and finally $RPQ = \alpha$)

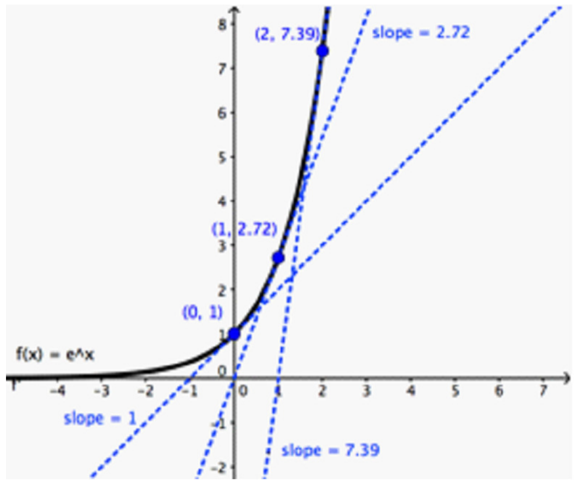
$$RPQ = \frac{\pi}{2} - RQP = \frac{\pi}{2} - (\frac{\pi}{2} - RQO) = RQO = \alpha$$
$$OP = 1$$
$$PQ = \sin\beta$$
$$OQ = \cos\beta$$
$$\frac{AQ}{OQ} = \sin\alpha$$, so $AQ = \sin\alpha\cos\beta$
$$\frac{PR}{PQ} = \cos\alpha$$, so $PR = \cos\alpha\sin\beta$
$$\sin(\alpha+\beta) = PB = RB + PR = AQ + PR = \sin\alpha\cos\beta + \cos\alpha\sin\beta$$

By substituting $-\beta$ for β and using Symmetry, we also get:
$$\sin(\alpha-\beta) = \sin\alpha\cos-\beta + \cos\alpha\sin-\beta$$
$$\sin(\alpha-\beta) = \sin\alpha\cos\beta - \cos\alpha\sin\beta$$

Another simple "proof" can be given using Euler's formula known from complex analysis: Euler's formula is:
$$e^{i\varphi} = \cos\varphi + i\sin\varphi$$
Although it is more precise to say that Euler's formula entails the trigonometric identities, it follows that for angles α and β we have:
$$e^{i(\alpha+\beta)} = \cos(\alpha+\beta) + i\sin(\alpha+\beta)$$
Also using the following properties of exponential functions:
$$e^{i(\alpha+\beta)} = e^{i\alpha}e^{i\beta} = (\cos\alpha + i\sin\alpha)(\cos\beta + i\sin\beta)$$
Evaluating the product:
$$e^{i(\alpha+\beta)} = (\cos\alpha\cos\beta - \sin\alpha\sin\beta) + i(\sin\alpha\cos\beta + \sin\beta\cos\alpha)$$
Equating real and imaginary parts:
$$\cos(\alpha+\beta) = \cos\alpha\cos\beta - \sin\alpha\sin\beta$$
$$\sin(\alpha+\beta) = \sin\alpha\cos\beta + \sin\beta\cos\alpha$$

Natural Logarithms

The unique property of the natural logarithm base *e*, where $y = e^x$ is that $de^x/dx = e^x$. The result of that relation is that **for every x value, the slope at that point is equal to the y value.**



If $\boldsymbol{y = \ln x}$, then $\boldsymbol{e^y = x}$. Differentiate both sides with respect to x: $\boldsymbol{e^y\, dy/dx = 1}$. Then substitute x in for $\boldsymbol{e^y}$ and get $\boldsymbol{x\, dy/dx = 1}$. Divide both sides by x to get: $\boldsymbol{dy/dx = 1/x}$. If $\boldsymbol{f(x) = \ln x}$, then $\boldsymbol{f\,'(x) = 1/x}$. No limits are needed for this method.

Now we take $\boldsymbol{e^x = y}$. By definition $\ln(e^x) = x$ for all x. We convert our starting expression to natural logs: $\ln(e^x) = \ln(y)$, and then substitute: $x = \ln(y)$. We take the derivative of x and the derivative of y with respect to x and get: $1 = dy/dx\,(1/y)$, since we already found that if $\boldsymbol{f(x) = \ln x}$, then $\boldsymbol{f\,'(x) = 1/x}$. Next we multiply both sides by y, getting $y = dy/dx$. Finally we substitute $\boldsymbol{e^x}$ for y and get our final result: $\boldsymbol{e^x = d\, e^x /dx}$.

Appendix H: Selected Books and Products by Dr. White

(For Those Ready to Go "Deeper")
Published by Delta Point Educational Technologies
Available at www.dpedtech.com

The Senet Tarot Oracle Deck of Ancient Egypt. English edition: $20.00.

Crimson Velvet Tarot Card Bag with Golden Eye of Wisdom. Price: $6.95.

Senet Tarot Deck and Bag: Price $25.00. **(With Book included: $29.00)**

Digital Books:
A. **The Senet Tarot of Ancient Egypt.** Parts I and II. (Part I FREE) Part II Price: $5.00

B. **The Pyramid Texts: Avatar Wizards of Eternity.** Intro. + 5 volumes, Price: $45.00.

C. **The Litany of Ra (Tarok Naipe)**. Price: $19.95.

D. **A Tour of Atlantis, or What Happens in the Astral Realm.** 3 parts. (Amduat). $5 ea.

E. **The Senet Game Text of Ancient Egypt**. Price: $5.95.

F. **The Story of Ra and Isis**. Price: $4.95.

G. **Mantras and Yantras of Ancient Egypt**. Price: $7.80.

H. **The Holistic Change Maker (The Book of Changes)**. Price: $19.95.

I. **Popcorn Time: Enlightenment for Everybody.** Price: $2.99.

J. **The Yoga Sutras of Patanjali: An Enlightened Translation and Commentary.** Price: $6.00.

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So long, and thanks for all the Wales.