

The Pendulum, the Pyramid, the Parthenon, and the Pound

How I became interested in the Study of Ancient Metrology

In the 1960's, While demonstrating satellite communications to the airline industry NASA asked for reports in the Metric System

we investigate the history

Queen Elizabeth I introduced the British Imperial System in the 16th century, 30 years Later, the French introduced their Metric System.

It was pendulum derived

I will never forget-the length of their new Yard (meter).

It was 993.7 mm.

55 years later, when studying Ancient Sumerian Standards of Measure, I found a Yard which was exactly 993.7 mm long

The Obvious question was - did they develop this Standards using a pendulum?

The Pendulum, the Pyramid, the Parthenon, and the Pound Background

This Ancient Standard Circa 3000 BCE was based on the length of a Pendulum
Its standard of volume, the Sila was based on 1/10 this length (Liter?)
Its standard of Weight the Mina, was based on the weight of 1/2 Sila (Pound?)

Almost no Ancient standards of length remain Today

A number of standards of Volume can be found Today

Hundreds of Ancient standards of weight and be found Today

Many are in museums where their weight is recorded to six figure accuracy

*We began our search matching only certified weights to Sample formula
like that created for the Meter*

And timing the Pendulums only from astronomical observations

*9 standards were found, each reproducible accurate to three, and four figures.
Four were based on the polar circumference of the Earth*

The Pendulum, the Pyramid, the Parthenon, and the Pound

Ancient pendulums provide the Sumerian with accurate standards of measure

The “beat” of a pendulum is the time it takes the pendulum to make one-half swing, i.e., the time from when the swinging pendulum is vertical, or the point where it would hang if at rest, through the extension of the swing to its highest point, until it swings back and reaches vertical again. The beat is determined almost exclusively by the Earth’s gravity and the length from the pendulum’s pivot point to the center of its mass.

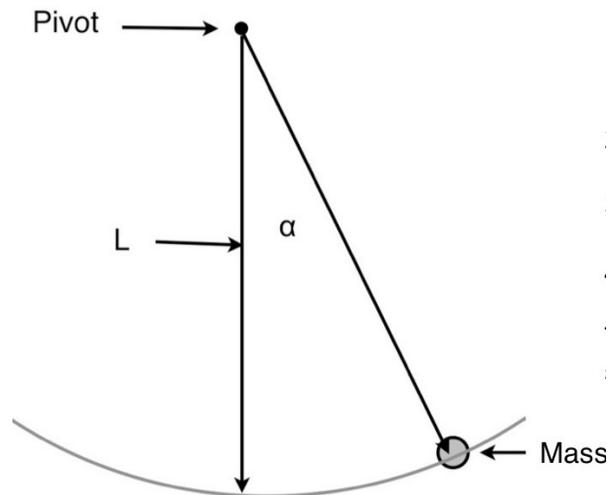


Figure 1: A Simple Pendulum

L: length of string

M: mass attached to string

Pivot: support point of string

Alpha: maximum angle of swing

The length of a pendulum is proportional to the square of the period of swing.

The period for 100 beats of a 1 meter simple pendulum is 100.384 seconds

A simple pendulum is one where the string has no weight and the ball is a point mass

The force of gravity is relatively constant anywhere on the Earth’s surface.³ Therefore, the two variables in a swinging pendulum are the *length of the string and the time of the beat*. If one of these two variables is known, the other can be determined.

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Establishing the necessary accurate intervals of time

The simplest method was to mark the interval of time it took the full Moon to move one diameter in the night sky. This interval, with the full moon near apogee, is about 121 seconds

The next method was to mark the interval of time it took the Sun's shadow to rotate through one degree west to east. This period was one Sumerian Gesh

The third (Egyptian) method was to mark an interval of time it took for a star near the equatorial plane to move 1/366 of a complete circle. (There are 366 days in a Celestial year.)

The fourth (Minoan) method was to mark an interval of time it took for the planet venus when in opposition to move 1/366 of a complete circle. (By viewing Venus when in opposition, its motion cancels out some of the apparent motion of the spinning Earth.)

Element	Solar day	Star day	Venus day
length of day	86400 sec	86164.08 sec	86560.33 sec
length of 1/360 day	240.00 sec	239.3447 sec	240.4454 sec
length of 1/366 day	236.065 sec	235.421 sec	236.504 sec

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You can build a simple pendulum to demonstrate the level of accuracy possible.

. I constructed a number of such pendulums using brass or steel balls and waxed flax string and found that a 944 mm pendulum would consistently swing through 100 beats in 100.00 seconds, a precision of one part in 10,000. *The Sumerians could easily reproduce this Pendulum.*

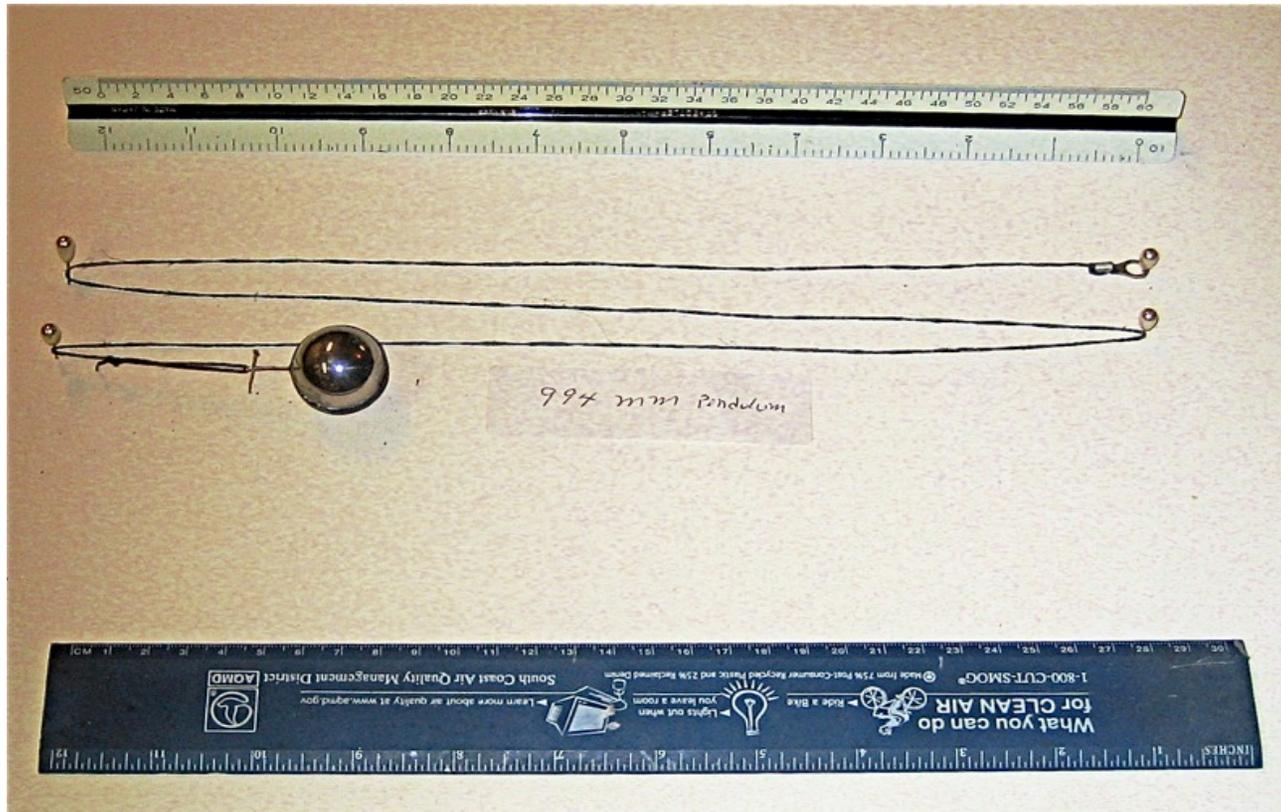


Fig.2 A 994 mm Test Pendulum

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The Five “metric standards from long ago

Name Given to Standard of Length	Pendulum Period	Length, (yard)	Volume (Liter)	Weight (1/2 kg)
P1 = Lunar Standard of Lagash	1.00833 sec	1,008.980 mm	1,027.176 ml	512.273 gm
P2 = Solar Standard of Ur	1.00000 sec	992.340 mm	977.196 ml	487.153 gm
P4 = Assyrian Foot of Babylon	0.99727 sec	987.121 mm	961.859 ml	479.508 gm
P5 = Egyptian Foot of Luxor	0.64405 sec	820.760 mm	NA	NA
P6 = Minoan Standards of Knossos	0.646186 sec	828.997 mm	569.723 ml	283.180 gm

The Sumerian “Metric” standards shown above divided the yard (Step) by 60 into “shusi” and by 10 to produce the standard unit of volume the “sila” of 1/1000 cubic yards just as in today’s liter. The standard of weight was set at 1/2 sila (Liter) of water at room temperature.

These Steps) were sometimes also divided into *Cubits of 30 shusi* each and *Feet of 20 shusi* each.

In some cultures where the primary standard length became the Foot its length was divided in into 16 fingers. The Standard Volume of one cubic foot was divided into 8 “gallons” and into 64 “pints” The Standard Weight, The Pound was that of one pint of water at room temperature.

The Pendulum, the Pyramid, the Parthenon, and the Pound

The four “Geodetic” standards based on the Polar circumference of the Earth

The Sumerians could not help but notice that their “Cable” of 360 Steps was just a little longer than the length of 1/360 degree on the local polar circumference of the Earth.

Accordingly they created a standard foot which was 1/1000 the length of 360 cables and adjusted the length of the step and cable to more accurately reflect the length of 1/360 degree on the locally measured polar circumference of the earth.

Name Given to Standard of Length	Pendulum Period	Length, Foot	Cable	Volume cu ft	Talent	Pound
P3 = First Geodetic foot of Lagash	0.66667 sec	317.560 mm	360 x L	32,024 ml	31,942 gm	499.094 gm
P7 = 2nd Geodetic Foot of Lagash	0.655738 sec	307.280 mm	360 x L	29.014 ml	28,929 gm	452.01 gm
P8 = Geodetic foot of Athens	0.658164 sec	307.490 mm	360 x L	29,073 ml	29,987 gm	452.93 gm
P9= Early Geodetic foot of Lagash	0.66667 sec	322.870 mm	366 x L	33,657 ml	33,568 gm	524.5 gm

The Volume of the cubic foot became an Amphora (bushel) which was divided into 8 “gallons” and 64 “pints”. The weight of a cubic foot of water became the Talent and the weight of a pint of water became the pound.

The weight of the talent was also sometimes divided into 60 Mina and 3600 shekel.

The Pendulum, the Pyramid, the Parthenon, and the Pound
Where were these standards 5000 years later

Some were in use in Ancient China and Japan

Some were in use in early England

Some were adopted by the British Imperial system

Some related to the Polar circumference of the Earth

These remain as monuments to Ancient civilizations

The Pendulum, the Pyramid, the Parthenon, and the Pound

Some were in use in Ancient China and Japan

P2, a one second pendulum, was used to establish the first French meter in 1623.

*It was also used to establish the Royal Ch'ih of the Chinese Zhou dynasty
as well as the Pied de Terre of Bordeaux France*

P3, a 2/3 second pendulum created the first Geodetic foot which later became the

*Market Foot of the Chinese Zhou Dynasty
and the the Steinbrecherfuss of Bern Austria*

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The Minoan Roots (P6) in early England and Japan

This Pendulum, a venus timed derivative of the 2/3 second pendulum was the standard in the Ancient Minoan civilization on the Island of Crete.

Their standard of weight based on 1/64 Talent came to old England where it became the 437.4 gram English Mercantile pound of the Magna Carta.

A second standard of weight based on 1/60 the weight of one Amphora of grain rather than water became the 373.24 gram English Troy pound.

The Minoan Foot traveled to Japan becoming the 303.0 mm Japanese Shaku. They also created their version of 4km in the "Ri" of 12960 Shaku which was almost exactly 1/10,000 the polar circumference of the Earth

The Pendulum, the Pyramid, the Parthenon, and the Pound

P1 Establishing the British Imperial foot and furlong

Returning to England, the P1 the Lunar Foot became the
335.28 mm Anglo Saxon Foot

In England records of land ownership were registered in
Anglo Saxon Furlongs of 600 Anglo Saxon feet
It was important that the furlong be retained.

**The Queen established the new British Foot as 1/660 of
the Anglo Saxon Furlong of 600 Anglo Saxon Feet**

The Length of this new British Imperial Foot was 304.6 mm

The Pendulum, the Pyramid, the Parthenon, and the Pound

P7 Establishing The British Imperial Pound

***Queen Elizabeth 1 Chose the French Wool Pound of
6992 grains rounded up to 7000 grains
for her new (US) British Imperial Pound.***

The French Wool Pound date back almost 2000 years to the Etruscan Pound which dates back another 1600 years to the Babylonian Octopus Talent discovered by Sir Arthur Evans in 1901 on the islands of Crete.

*The Octopus Talent is the weight of one cubic foot of water.
That foot is the Second Geodetic Foot of Lagash.*

The British Pound is related to the Polar Circumference of the Earth.

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P7 The Magnificent Octopus Talent of Babylon and the Polar Circumference of the Earth



Fig. 9 Octopus Talent Weight



Fig. 10 Octopus Amphora

This magnificent 29,000 gram Talent Weight from circa 1650 BCE may well have been commissioned to celebrate the 1000 th Anniversary of the building of the Great Pyramid at Giza. An Amphora filled with 29000 gm of water at 25° C would have a volume of 29086 ml or the volume of a 307.54 mm cube.

This is the Length of the Second Geodetic Foot of Lagash

The Pendulum, the Pyramid, the Parthenon, and the Pound

P7 The Second Geodetic Foot and the Perimeter of the Great Pyramid

The fact that the Second Geodetic Foot of Lagash created the British Imperial Pound may seem surprising, yet this foot has more surprises in store for us.

**As frequently happens when exploring the past,
completely unexpected facts sometimes reveal themselves.**

The Sumerians as a maritime nation would have recognized that their standard “Cable” of 360 steps (yards) was just a little longer than $1/360$ of a degree on the polar circumference of the earth.

They revised the length of their foot so that 1000 of their new feet was $1/360$ degree on the polar circumference of the earth.

If you are wondering why I bring this up --The Perimeter of the great Pyramid of Giza is almost exactly 3000 Sumerian feet or one half of a Sumerian nautical mile when established at the reduced gravity in Memphis

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The Great Pyramid at Giza 2600 BCE

The Average length of each side is 230.35 meters constructed within one part in 10,000 and aligned to true north within 4 minutes of arc. Each side constructed within 0.2 minutes of arc

*The perimeter and height are 1/43,200 of the polar circumference and radius of the Earth
Accurate to 184 ppm with the Polar circumference measured at Memphis*



Geodetic Pendulum	1000 ft = 360L	3000 Feet	Description
Gravity= 9.7931630	307.197 mm	921.590 m	Geodetic pendulum in Memphis
Correction - 184 ppm	307.140mm	921.421 m	921.421 meters Petrie & Cole
1760 Royal Cubits	NA	921.421 m	One Royal Cubit = 523.535 mm

This Geodetic pendulum beat 366 time in 240 seconds (1/360 day or one Summerian Gesh

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P7 The Parthenon, the Athenian Foot ,and the Roman Mile

In the next Millennia The Octopus talent would lead to other surprises

The width of the Parthenon in Athens, Greece was accurately measured by Stuart in 1750 and later by Penrose in 1888 at 30.861 meters (100 athenian feet).

This length appeared to be almost exactly one arc second on the polar circumference of the Earth, *with an error of 9 mm out of the true measure of 30.870 meters, which was obtained in 1984 with satellite data.*



The accuracy with which the Athenian Foot predicts the Polar Circumference of the Earth has Perplexed scholars for 150 years. *This extreme accuracy was simply the product of luck.* Venus was a very important Goddess to the Minoans from which the Athenians received their standards. A Pendulum, when timed using Venus rather than the Sun, lengthened about 0.37 percent at the latitude of Athens eliminating almost all error.

***The Athenian foot was was used to develop the Roman mile.
Today we know that The polar circumference of the Earth is almost 27000
Roman miles--The Romans were all of 5.4 miles short***

Special Announcement

The Roots of Stonehenge Long-Foot Discovered

A recent article in the publication, The British Journal for the History of Mathematics by Anne Teather and others, established the length of the Long Foot at about 321.9 mm.

*The length of an early Sumerian geodetic foot was 322.9 mm
Was this the Stonehenge long-foot ?*

Proof of its existence can be found in Dr Powell's weights # 13 and #14 .This foot seems to have traveled to England where it became the long lost Long-Foot of Stonehenge.

*The true value of the stonehenge Long-foot may not be precisely 322.9 mm
or the 321.9 mm value established by the chalk drums of Folkton*

*But the search for the ancient roots of the Long-foot of the Stonehenge may,
at long last, be within our grasp.*

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Our Seven Year Search

In our search, we matched only certified weights using sample formula like that created for the Meter, Timing each Pendulum from astronomical observations, yielding nine standards each reproducible to three, and four figures accuracy.

*Four standards were based on the polar circumference of the Earth
One established the perimeter and height of the Great Pyramid and the width of the Parthenon*

much to our surprise both British Imperial and US Pounds were also related to the Polar Circumference of the Earth.

We Urge this search be expanded to other regions of the Ancient world

Conclusion

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Mr Boucher is a Retired Engineering manager and licensed California Professional Engineer.

After graduation from Yale in 1955, Mr. Boucher joined the Hughes Aircraft Company in Culver City, California where he was engaged in the design of satellites for communication, navigation and weather observation.

1969, he was chosen to be a member of the United States delegation to the first CCIR conference in Geneva to select frequency authorization for satellite communication.

After leaving the Hughes Aircraft Company in 1973 he obtained the patent for an electric powered aircraft and developed both the first electric electric powered Battlefield drone aircraft and the first high altitude solar-powered electric aircraft.

This presentation represents a five year study into the use of the pendulum by ancient civilizations to develop standards of measurement which were reported in a paper published by the author.

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