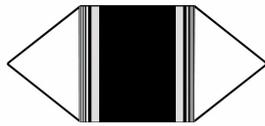


BIRTHDAY PI

π

3.14



41.8



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BIRTHDAY PI

ISBN-13: 978-1456578879
ISBN-10: 1456578871
BISAC: Education/General

www.birthday-pi.com

Printed in the U.S.A.
wwwcreatespace.com

To my grandfather

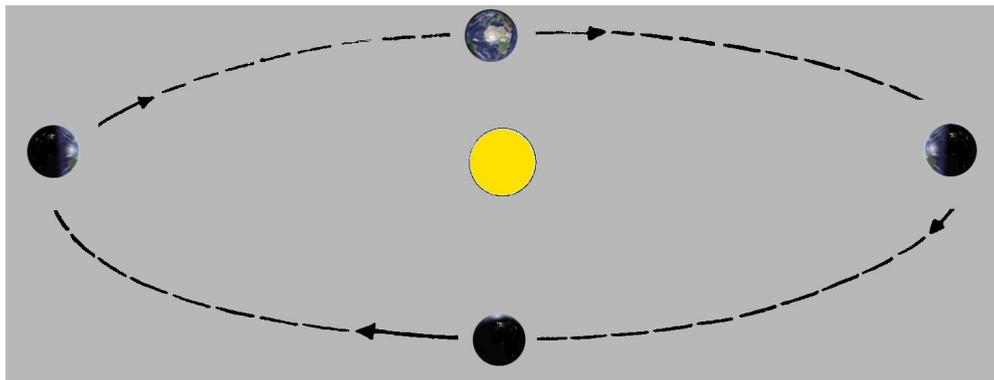
For teaching me
the value of many things
including PI

PART 1

METRONOME

IT'S YOUR BIRTHDAY!

In a year the Earth
and you make one trip
around the sun.



You and the Earth orbiting the sun.

quick question:

How many seconds is that?



quick answer:

BIRTHDAY PI!

There are

PI x 10,000,000 seconds

in one Earth orbit (year).

...pi...birthday...pi...birthday...pi...

What is PI?

PI is a special number
that relates to circles
and circular motion.



Throughout
history the
wisest minds
have always
valued PI.

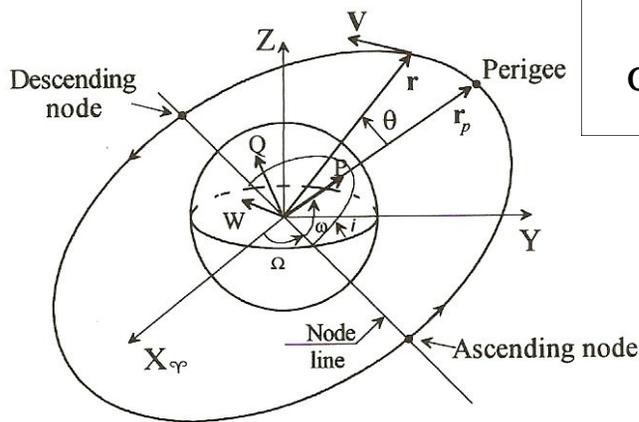
Why build PI into a system of units?

π
3.14159
265358979323
84626433832795
02884197169399375
1058209749445923078
164062862089986280
3482534211706798214808
651328230664709384460955058223
17253594081284811174502841027019385211055
59644622948954930381964428810975665933446128475648233786
7831652712019091456485669234603486104543266482133936072602491412737245
8700660631558817488152092096282925409171536436789259036001133053054882046652138414695194
15116084330572703657595919530421861173819326117931051185480744623799627495673518857527248912279381
8301194912983367336244065664308602139494639522473719070217986094370277053921717620317675238467481846766
94051320005681271452635608278577134275778960917363717872146844090122405343014654958371050722796892589235420
1995611212002196086403441815981362977477130996051870721134999998372978040951059731732816096318595024455460083026
42522382533448850526193118817101003137838752880587532083814206171776691473035982544942875546871159562863823257875937519
578187730531712208060101027876111950921142019803805272010688806327806050193381827082303019203501482080995739228994139124
9727723429131515548574244154005882933168617285880750803174637440939325060027016711900848824032830360563706010470184295556190840
76374448257977328784075364628046942590649120136770280910210475232069602409808150151251831003005976024746470267041992726020227670234761600091

PI

is an endless
transcendental
number so this may
appear like a problem
because with no limit of
digits that can make it really
difficult to write down and
calculate with even given the
inordinate obstinate attention
that math types often focus on
problems that bear only the slightest
if not trivial resemblance to real life
concerns and as such after awhile
you might want to ask why continue
reading and just joots to the next page ...

However with PI built into units, any equations that include PI will see its value “cancel out.”



These are sample equations only and are not on the test.

$$P^2 = \left[\frac{4\pi^2}{G(m_1 + m_2)} \right] a^3$$

P = sidereal period in seconds

a = semimajor axis in meters

m₁ = mass of first object in kg

m₂ = mass of second object in kg

G = Universal gravity constant

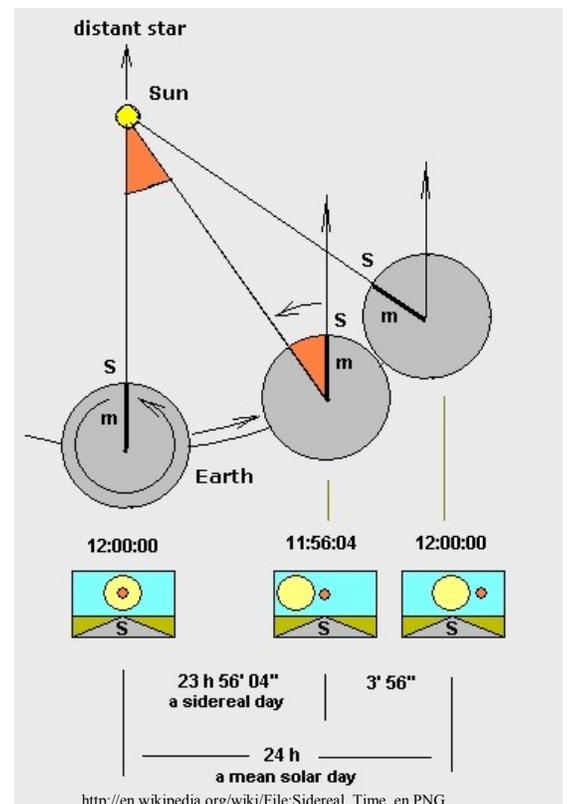
$$T^2 = (4\pi^2 / GM)r^3$$

Those solving math problems love it when that happens!

Hey wait a second!

$365 \times 24 \times 60 \times 60 = 31,536,000$
and not $31,415,926.5...?! \text{ Why?}$

There are different ways to measure seconds and days. Earth rotations are measured against a “fixed” background of stars, that “day” is 23hrs, 56mins, 4secs long (86164sec).



The Earth isn't actually a perfect sphere either. But good enough is often good enough.

Though measuring time by the stars is arguably more accurate, on Earth we prefer our “solar” day subdivided conveniently into 24 x 60 x 60 exact ticks displayed by clocks and watches.



It's good enough!

PART 2

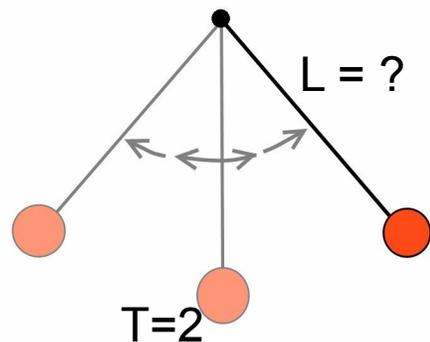
METERSTICK

What's nifty is that a definition of unit time also produces a definition of unit length using only simple methods.

For example, construct a pendulum with a time period of two seconds.

Why a period of 2 and not 1 seconds? Consider its path swinging back and forth. There are two outer points of maximum deflection and two points at the middle.

A clock mechanism located at the center will count twice per period, each time the pendulum bob passes. That's a one second clock "tick."

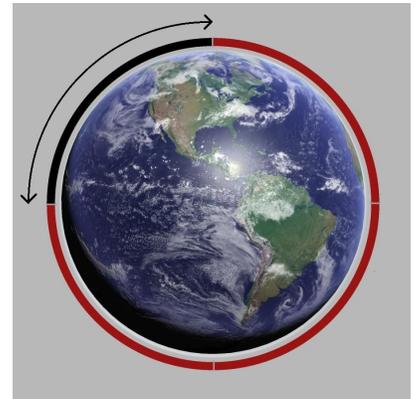


$$T = 2 \cdot \pi \cdot \sqrt{\frac{L}{g}} \quad \text{L} = \frac{T^2 g}{4\pi^2}$$


How long is this pendulum?
1 meter!

Another definition of unit length divides the Earth's circumference into millions of equal parts.

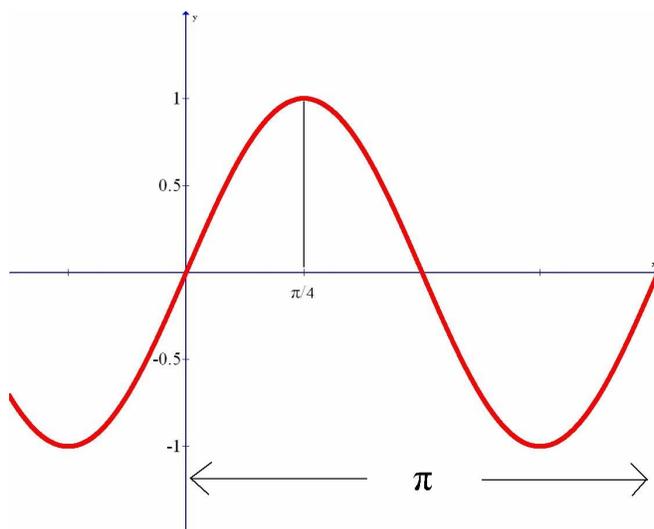
Since clocks count 86400 seconds per rotation of the equator (“exactly”) this also links our units of time and length.



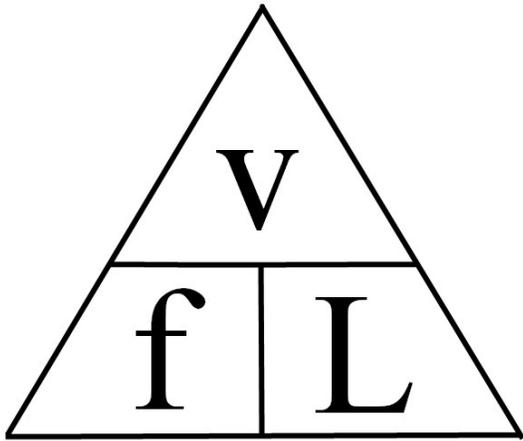
circumference = 40,000,000m
1/4 circumference = 10,000,000m
 $1/2 * \text{PI} * R_e = 10,000,000\text{m}$
(where R_e is the Earth's radius)

Yet another definition of length that relates to time is in terms of frequency.

A wave has its first maximum value $1/4$ along its wavelength. If the entire wavelength is π then $\pi/4$ represents this value.



What is the frequency of a sound wave in air with a wavelength of $\pi/4$ meters?



(Cover wave value for which you wish to solve, the correct equation remains.)

Solving for frequency (f) means speed (v) divided by wavelength (L)

v (speed of sound) = 345m/sec (room temp.)

L (Wavelength) = $\pi/4 = 0.785\text{m}$

$$f = 345 / 0.785 = 440$$

The frequency of a sound wave with a wavelength of $\pi/4$ meters is 440Hz.

This frequency is known today as the tuning frequency “Concert-A.”

π -units suggests a possible explanation for this choice.

How about that?

Just by identifying
literally with a

“pi in the sky”

- the time period of Earth's orbit -

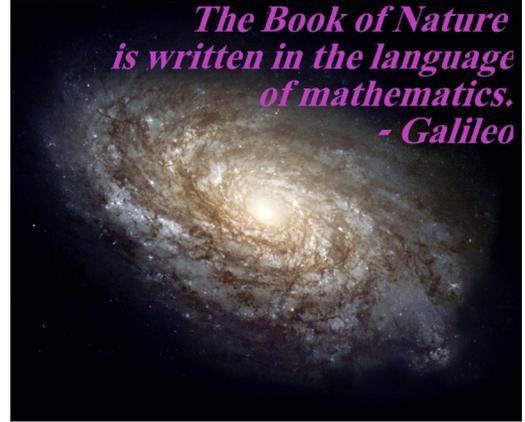
we arrive at three
different definitions of
the same unit length,
all curiously similar to the
same metric units in use today.

That's neat and
should be remembered.

PART 3

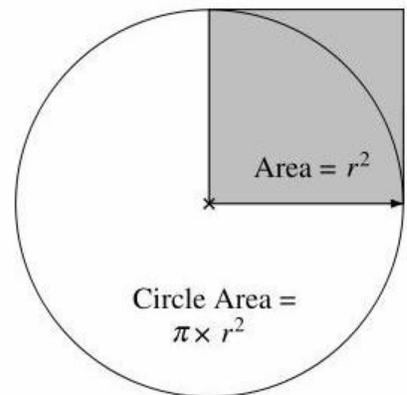
MEMORIAL

*The Book of Nature
is written in the language
of mathematics.
- Galileo*

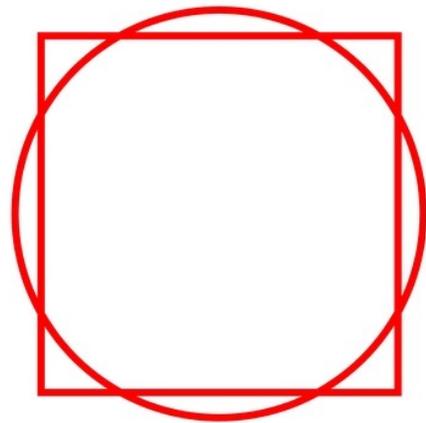
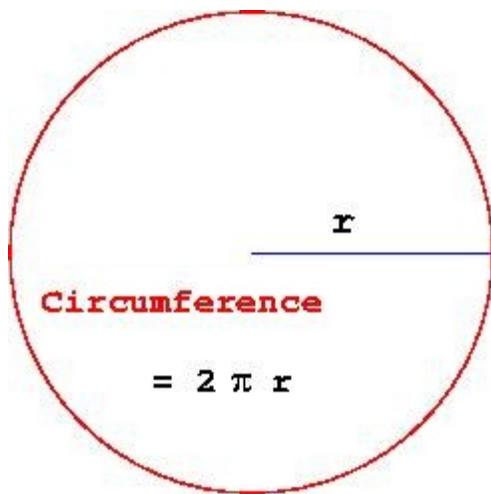


We need a way to model this information, representing it in higher language. We can use simple geometric forms.

This is a story about birthdays but it is also about PI. Clearly we should start with a circle.



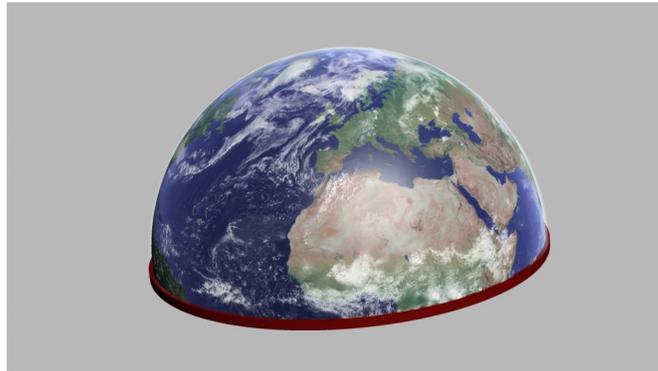
If we “square the circle” -
construct a square with
equal perimeter to the
circumference of our circle —
then our model can be oriented.



$$\frac{2 \pi r}{4} = \frac{\pi r}{2}$$

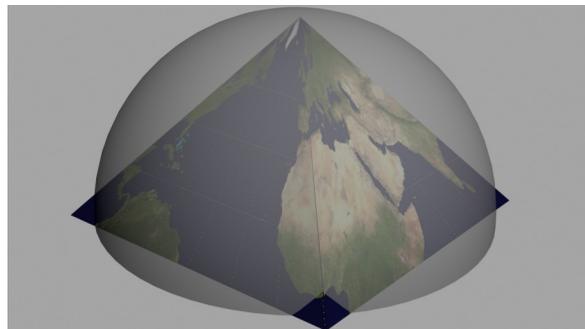
Each side of the
square is $\pi/2$ times
the radius of the circle

These forms are only two dimensional, and we need to suggest a 3D Earth. How better than to use a sphere?



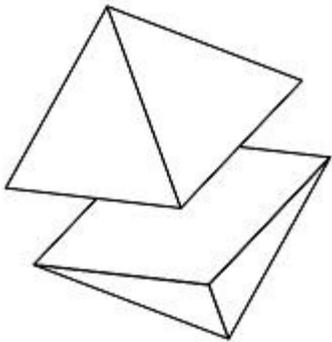
Or maybe a hemisphere (half-sphere) since this relates to circumference.

So then, how best to “square” a hemisphere?

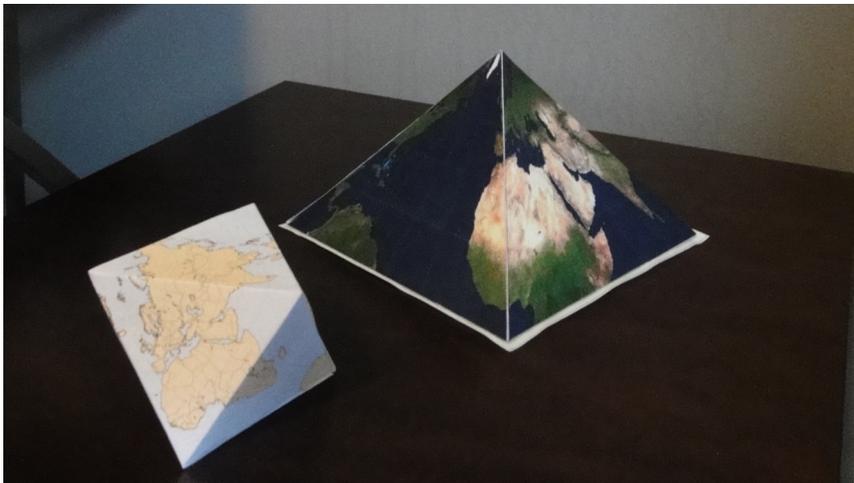


Let's choose the octahedron
(two pyramids face-to-face).

Since we're modeling a
hemisphere we'll use half
(one pyramid) with "square"
base but "spherical" height.



The base represents
the equator of the
Earth, the height
represents its polar
radius.



This design
works as a toy
but we want
something bigger.

Let's scale it up!

SCALING THE MODEL

WHAT SCALE?

We need to indicate time
so let's suggest secs/day:

$$24\text{hrs/day} * 60\text{min/hr} * 60\text{sec/min} = \\ 86400\text{sec/day}$$

$$86400/2 = 43200 \\ \text{(our half-model scale factor)}$$

HOW SQUARE?

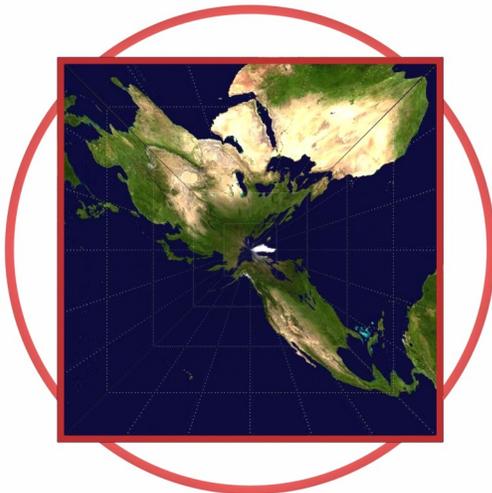
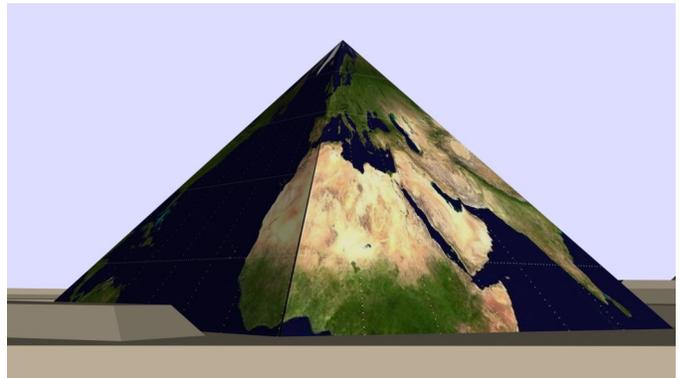
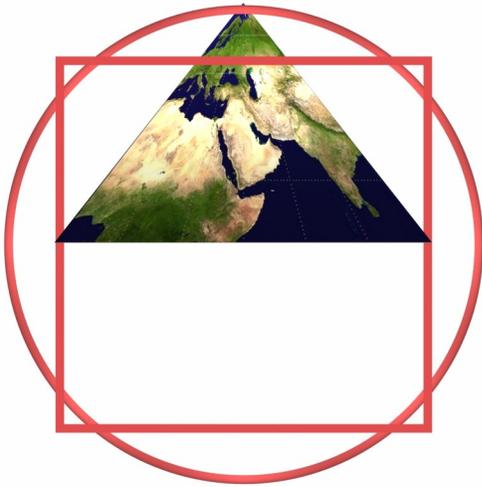
Let's make each side 440 units long.
Four sides @ 440 units = 1760 units total.
(a "unit" in this model is $\pi/6$ meters long)

HOW TALL?

To square the circle we need a height
in the proper proportion to the base.

$$\text{For a rise-to-run of } 51.5 \text{ degrees,} \\ (440/2) * \tan(51.5) = 280 \text{ units}$$

The parameters of our model
are complete. That should do it.
Let's write it down in stone
and hope no one ever forgets why.



CHECKING THE MODEL

Perimeter of Great Pyramid = 926m.

Circumference of Earth = 40,000,000m.

$40,000,000\text{m} / 43200 = 926\text{m}$ (1760 R.C.)

Height of Great Pyramid = 147m

Radius of Earth = 6,370,000m

$6,370,000 / 43200 = 147\text{m}$ (280 R.C.)

acoustic resonance found
inside Great Pyramid is 440Hz

PI is built into the structure.

So are the dimensions of
the Earth and its orbit,
and their scale is time.

Music brings it together.

AFTERWORD

Or in other words, why does this work?

It happens one kilosecond can be defined as twice the time light takes to travel from the Earth to the sun. π works its way into the orbit in that manner.

The meter pendulum works because at the Earth's surface the gravitational force is conspicuously close to π squared (meters/sec**2). That's another book.

Lots of it works because good enough is good enough. The rest works because God likes it that way.

comparison with other planets

computed quantity

$N_d \times N_s$

N_d

number of days/orbit

N_s

number of seconds/day

Mercury 0.76×10^7

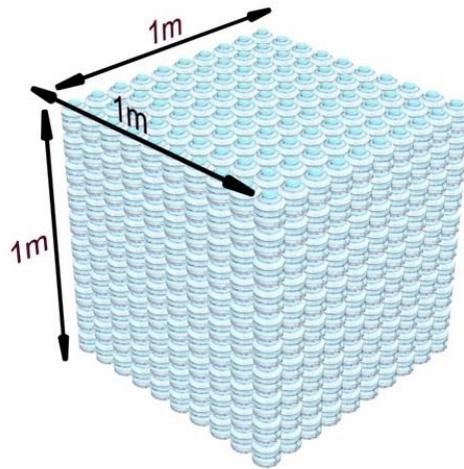
Venus 1.9×10^7

Earth $PI \times 10^7$

Mars 5.9×10^7

Jupiter 37×10^7

cubic meter of water = metric ton
metric ton = 1000 kilograms
liter of water = 1 kilogram
metric ton = 1000 water bottles



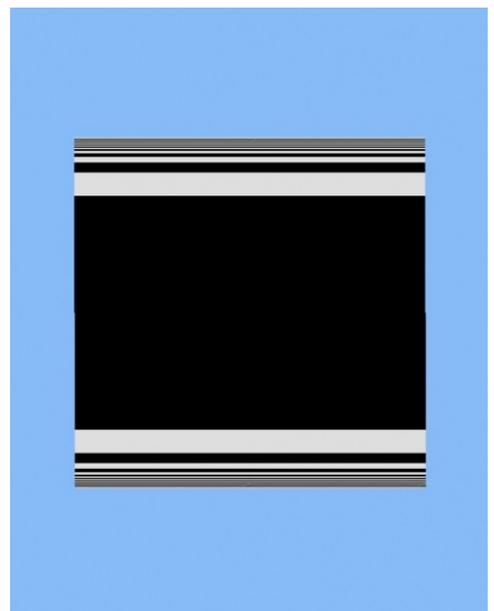
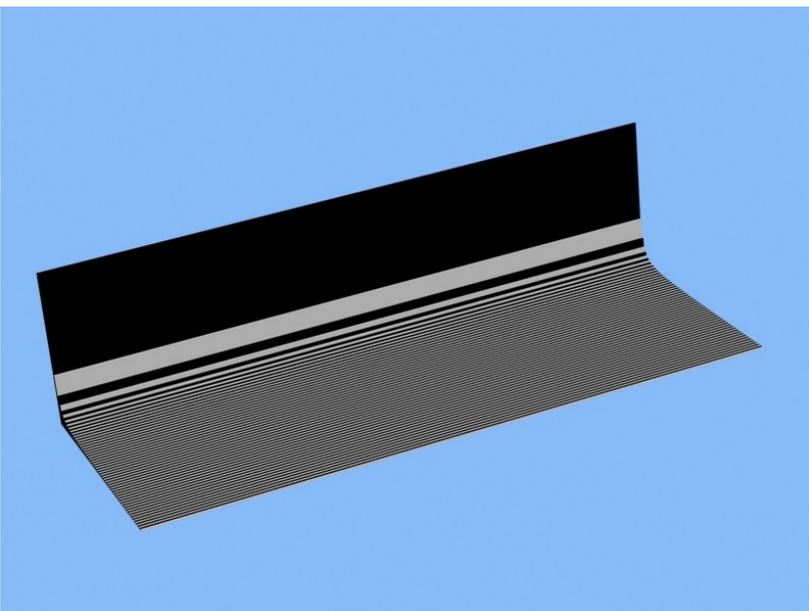
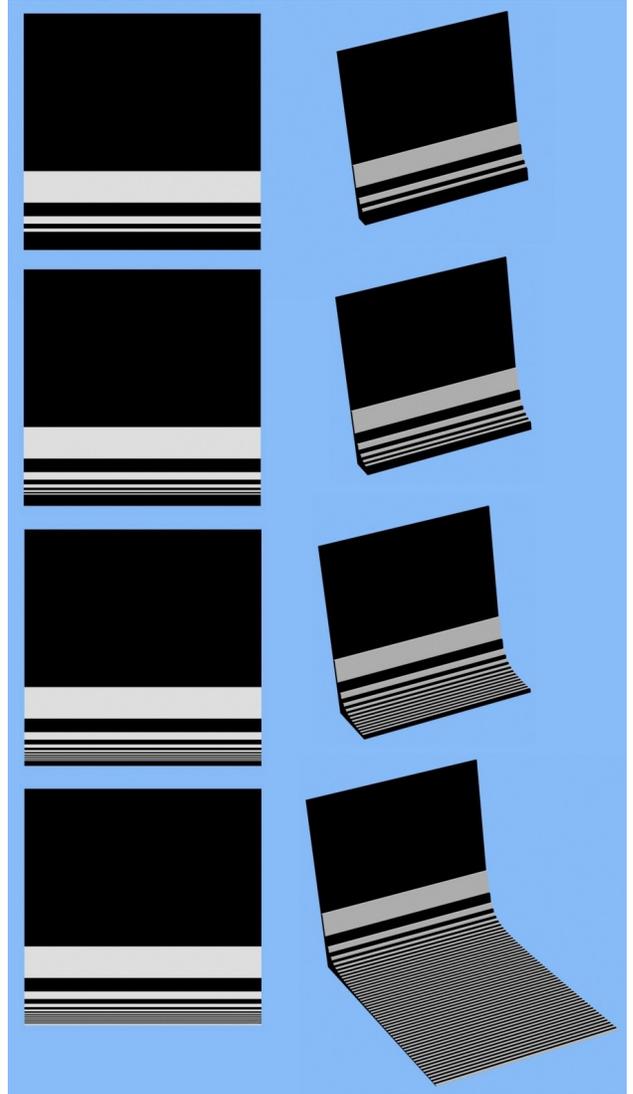
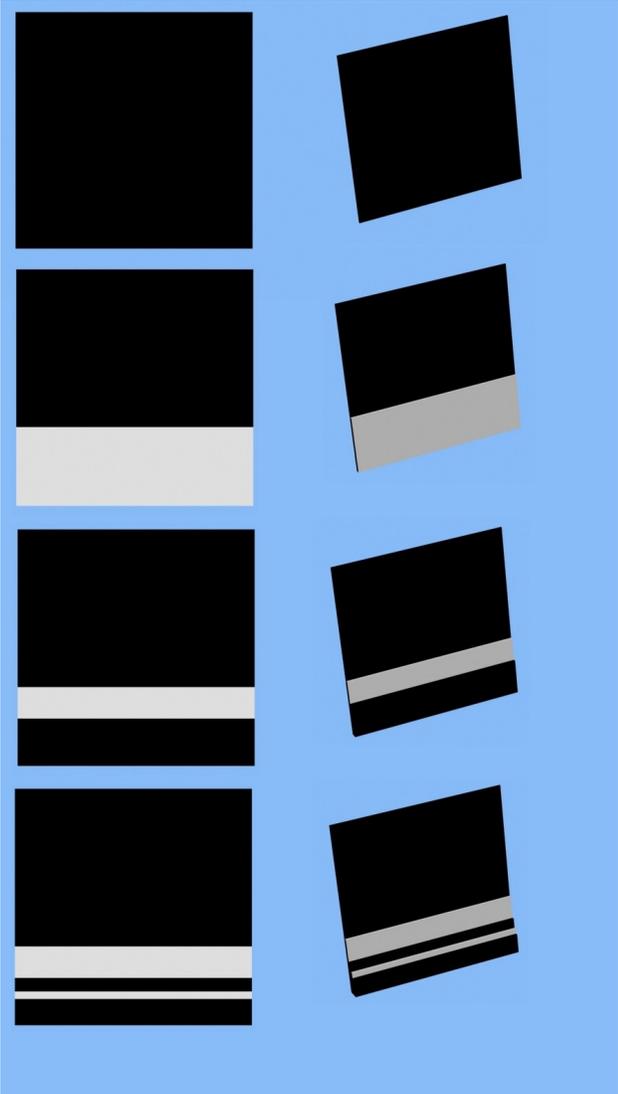
1 metric ton

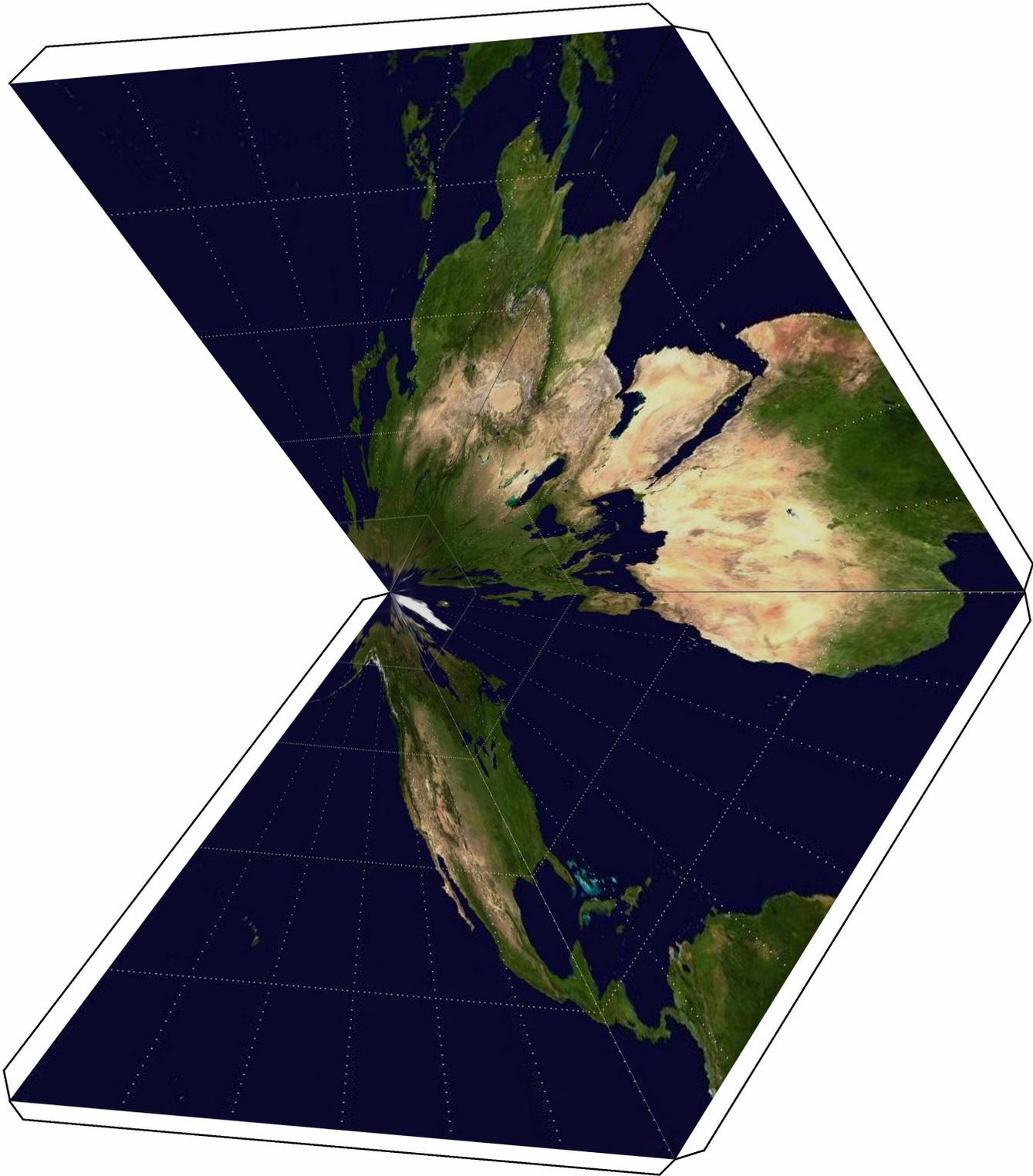
H₂O

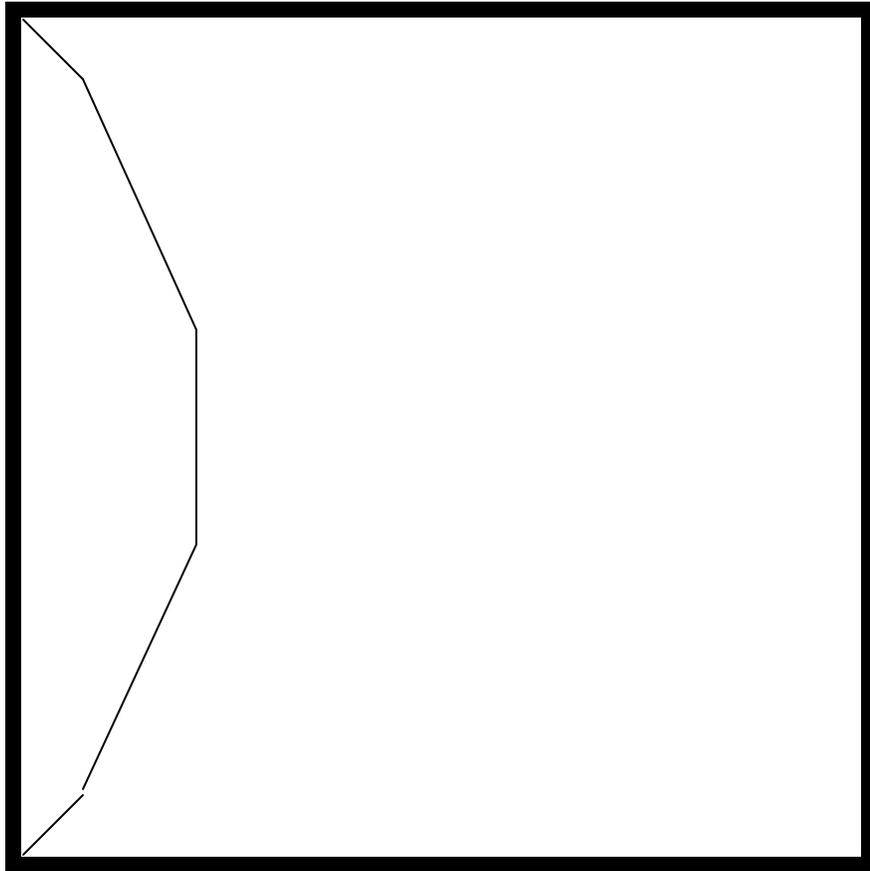
Earth mass = 6.0×10^{24} kg
pyramid mass = 6.0×10^9 kg

One million, billion pyramids
equals the mass of the Earth.

The Great Pyramid masses about
the same as 6 billion bottles of water,
around one for everybody on Earth.







Trim octaglobe from paper. Cut tabs no closer than outline.

Fold octaglobe along pole-to-equator edges. Align then crease.

Fold octaglobe glue tabs inwards along map borders. Align then crease.

Practice assembly by aligning octaglobe to base square.

Glue one basetab along edge of base square.

Seal octaglobe then glue remaining basetabs

Use cotton swab to touch-up glue on tab and target areas.

Let octaglobe dry then trim base as desired.

