ALL ROADS LEAD TO … πZZA?

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Wait, what?

Well, it all started when the Babylonians decided to think, therefore invent a preposterous way of measuring units of time. Babylonians used base 60 for their day-to-day lives, as they found it to be convenient for fractions and trading since it is divisible by a wide range of numbers (1,2,3,4,5,6,10,12,15,20,30,60). This resulted in the foundation of the most used system to date–time in sexagismal!

1 hour=60 minutes

1 min=60 seconds

However, when people standardized the modern decimal system after the Babylonians, smaller increments of time were measured in base 10:

1 second=1,000 millisecond

1 millisecond=1,000 microseconds

On the side note– why do we technically have two completely different units of time? Why did we not change the hours and minutes?!?!

Moreover, the Babylonians also defined the degree angle; their fascination with equilateral triangles led to them setting the angle between two sides to be 60°. Unfortunately, due to the degree's arbitrary nature, it is not useful when it comes to advanced mathematical topics, hence later on the degree was refined to radians through a long journey.

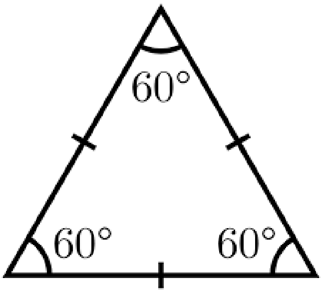
To begin with, the Babylonians found the ratio of the circumference to diameter of any circle to be constant, leading to the discovery of Pi.

$$\pi = \frac{C}{D}$$

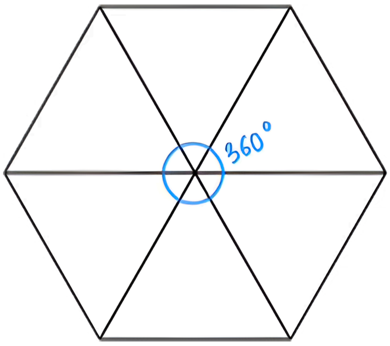
Rearranging the equation, substituting the diameter as equal to double the radius (2r), results in:

$$C = 2\pi r$$

Now assume an equilateral triangle with angle of 60°



Arranging 6 copies of the triangle in such a way to form a hexagon produces a circle constructed out of the adjacent angles.



(This method proves why a circle is 360°!)

Accordingly, each triangle contains a sector of the circle in which its arc-length is ⅙-th the circumference. For this proof, we assume a unit circle of radius=1, therefore a circumference of 2π .

Arc-length=⅙×2π =⅓π

Thus, we just proved the equivalent of **60°** to be **⅓π** ! This breakthrough allowed trigonometry to be studied in terms of radians, simplifying calculations in circular motion, engineering, and calculus.

Due to this finding, one begs the question: *if Pi is a circular property, why was it found in triangles as well? Where else does it appear?*

Pi is one of the most used mathematical constants, present in modern day engineering and architecture, as well as complex physics equations like Einstein's field equation of general relativity and Heisenberg's uncertainty principle. Just how do all these tie back to Pi? What is the hidden link among them?

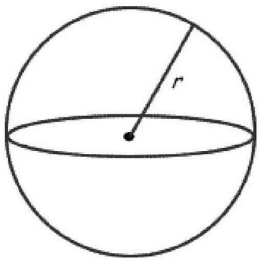
Let us explore outside earth for a little bit; when delving into the realm of cosmology, one stumbles upon the concept that our universe is isotropic and homogenous. Isotropy refers to a system that exhibits the same properties in all directions–meaning that in an isotropic system, properties are constant regardless of orientation in space.

A circle is defined as a plane figure consisting of points equidistant from a given centre–an isotropic shape. The reason Pi appears in the calculations of a circle is not because it is simply the ratio of the circumference to the diameter, rather, it is due to the circle's isotropy. In other words, Pi is a mathematical constant of rotational symmetry, hence playing a role in every other phenomena relating to curvature.

For instance, consider the mentioned Einstein's field equation:

$$G_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

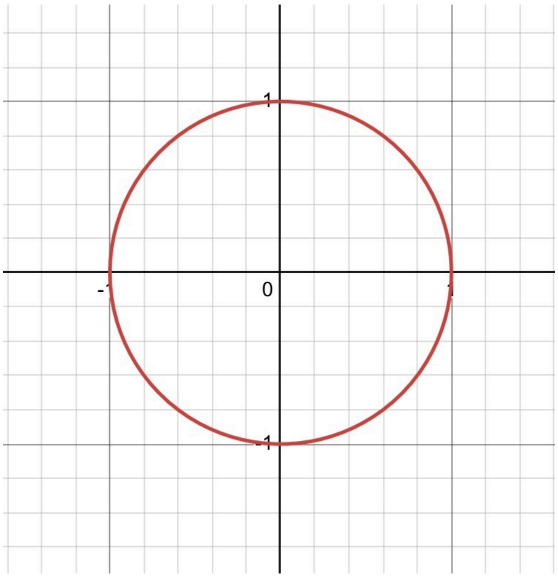
Pi is present not just as a constant, but also as a systemic necessity.



When integrating the surface area of a sphere, it results in $4\boldsymbol{\pi} r^2$, where 4π is the total amount of direction in a 3-dimensional space. Gravity acts in all directions uniformly, and modelling it acting on a point mass leads to the previous result.

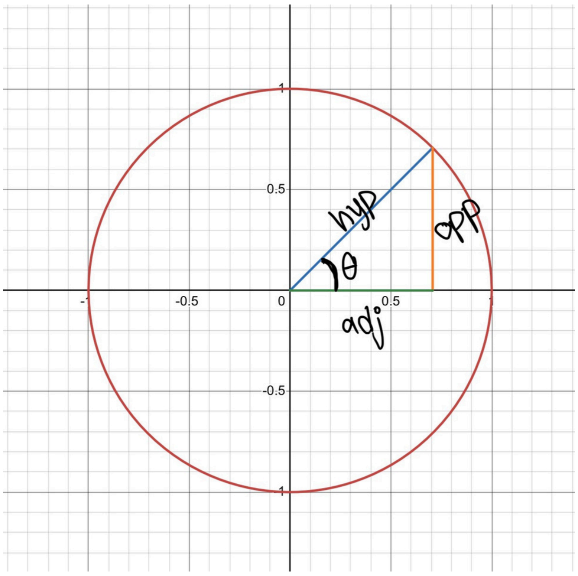
Another example of the emergence of Pi is in waves, where trigonometric functions such as sine and cosine result from the unity of triangles and circles.

Consider a unit circle with centre **(0,0)** lying on the Cartesian Coordinate plane.



We can construct a right-angled triangle within the circle, where the hypotenuse is the radius. This allows for the use of the Pythagorean theorem: $\mathbf{x^2+y^2=r^2}$, where:

$$\mathbf{r=1 \Rightarrow r^2=1 \Rightarrow x^2+y^2=1}$$



(This is actually where the equation of the circle originated!)

To calculate angle **θ** we can use either:

$$\sin(\theta) = \frac{opposite}{hypotenuse} = \frac{y}{r} = \frac{y}{1}$$

Or

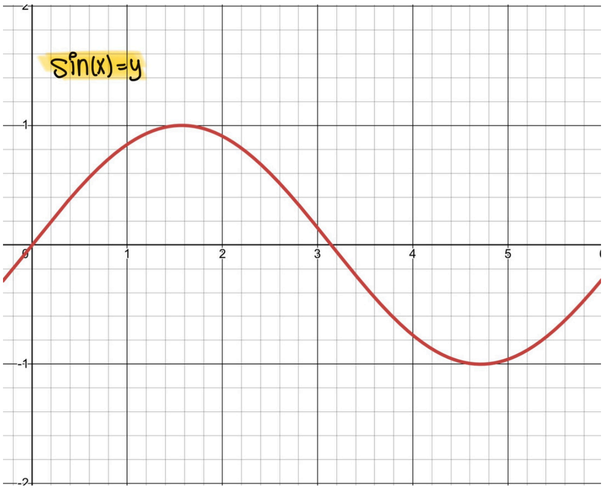
$$cos(\theta) = \frac{adjacent}{hypotenuse} = \frac{x}{r} = \frac{x}{1}$$

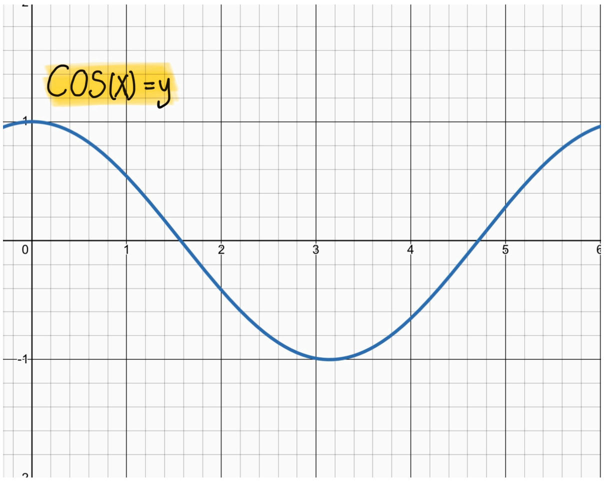
The above equations give **sin(θ)=y** and **cos(θ)=x**, which when substituting back into the Pythagorean theorem yields:

$\sin^2(\theta) + \cos^2(\theta)=1$

(We just proved the famous trigonometric identity as well!)

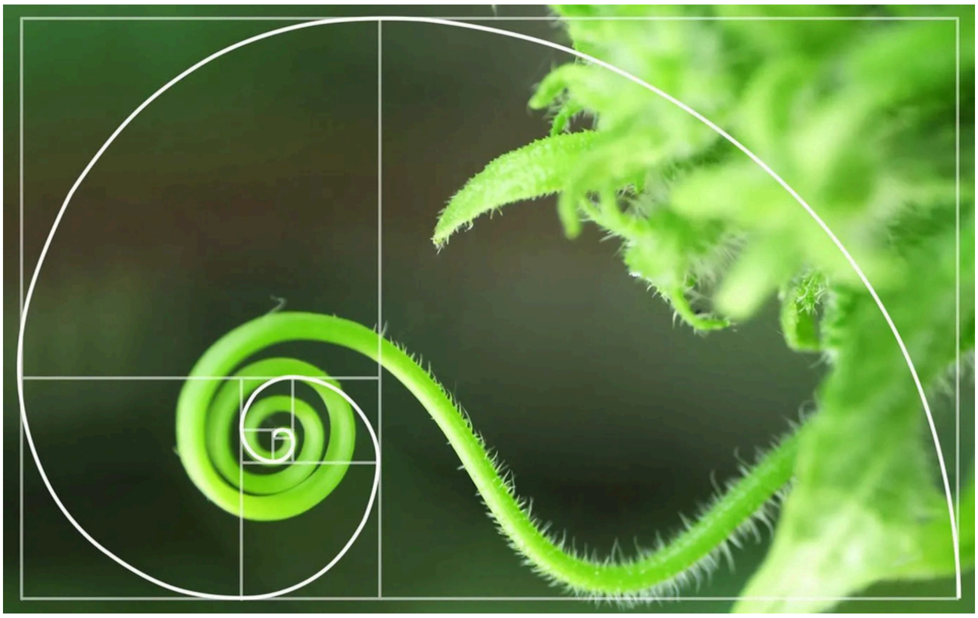
For varying values of ***x*** and ***y***, the hypotenuse remains unchanged. As such, we can graph separately the fluctuation of each with respect to the radius.





An interesting fact about trigonometric functions is that when applying derivatives and integrals, it *must* be in radians, as doing so in degrees would complicate calculations with the need for a conversion factor–this just goes to show that angles in radians are the natural method!

While Pi may seem fascinating in design, it is not the only way nature tries to communicate to us how it really works. The Golden Ratio, Phi, appears in many natural phenomena such as plant growth; the spiral shape prevents overlapping, maximizing sunlight exposure.



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Additionally, Euler's number, for which exponential functions display continuous growth as the limit of x approaches infinity, shows up in cell multiplying or growth of bacteria.

It is worth noting how extraordinary the universe that we occupy is, as it codes these distinctive numbers in the design of everything around us. Even if you still do not completely understand, keep in mind what Neil deGrasse Tyson once said: “The universe is under no obligation to make sense to you.” Considering how Pi is all around us, one can only really come to a simple conclusion: All roads lead to Pi...zza ;).

Reference:-

The Real Reason Pi Appears Everywhere