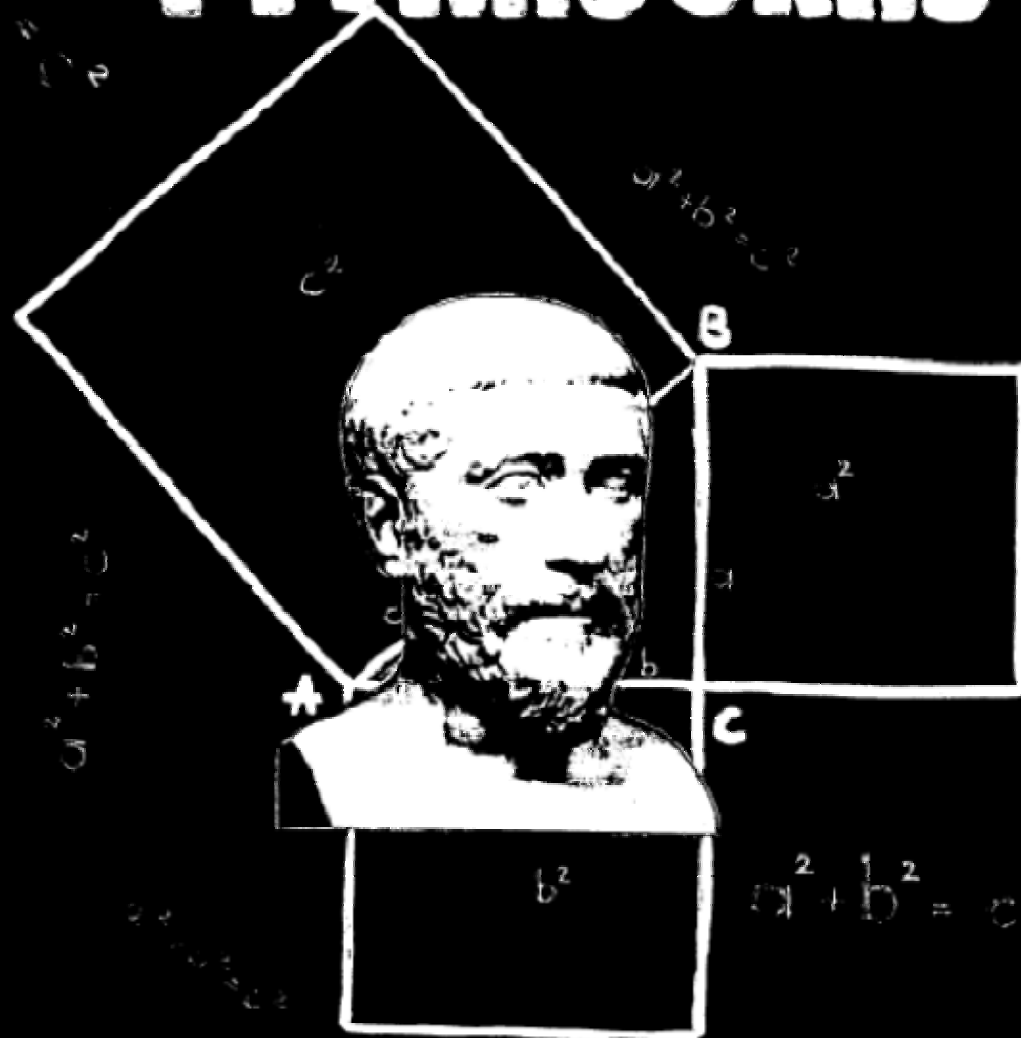


# PYTHAGORAS



Written by:

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# Pythagoras

*Pythagoras is one of the world's greatest man and an extremely important figure in the development of mathematics.*

*There is little we know about Pythagoras' doctrines. It is hard to say about how much of the doctrine we know as Pythagoras is due to the founder of the society and how much is later developed by his followers. It is also hard to say how much of what we know about his life is true and what parts about his life are legends.*

*The written historical background of Pythagoras is hard to find. Xenophanes was the earliest reference that wrote about Pythagoras. He wrote about Pythagoras' doctrine of transmigration. Also another Greek philosopher, Plato, mentioned Pythagoras by name in all his writings. He wrote about the "way of life", which was called Pythagorean. Plato told us a great deal about men whom we knew from other sources to have been Pythagoreans, but he avoided Pythagoras' name. Today Pythagoras is a mysterious figure. The society which he led was*

*half scientific and half religious which followed a code of secrecy. There is very little information recorded about the life and personality of Pythagoras. The main events of Pythagoras' life may be differing mostly be twenty years.*

*Pythagoras was born about 569 BC in Samos, Ionia. He was a Greek philosopher, mathematician, and the founder of the Pythagorean school. Mnesarchus was Pythagoras' father and Pythais was his mother. His father was a merchant that came from Tyre. Pythagoras as a child spent his early years in Samos, yet mostly he traveled with his father. He and his father also visited Italy together. There is very little information known of Pythagoras' childhood. The accounts of Pythagoras' physical appearance is most likely fictitious except for the birthmark which Pythagoras had on his thigh. It is probable that Pythagoras had two brothers, even though some sources say that he had three. Pythagoras was well educated. He learned how to play the lyre, learned poetry, and recited Homer. His teachers were philosophers who influenced Pythagoras as a young man. Pherekydes was one of the most important teachers of Pythagoras.*

*Thales and his pupil Anaximander, were the other philosophers who influenced Pythagoras, and introduced him to mathematical ideas. In about 535 BC, Pythagoras escaped the tyranny of Polycrates and went to Egypt. There he visited many temples and took part in many discussions with the priests. He learned geometry from the Egyptian priests. While in Egypt he also learned to refuse to eat beans, to refuse to wear clothes that were made of animal skins, and he learned to strive for purity. In about 525 BC Cambyses II, the king of Persia, invaded Egypt. At that time Pythagoras was taken prisoner and taken to Babylon. While being held hostage in Babylon, he learned about a very mystical worship of the gods, reached a perfection in arithmetic, music and other mathematical sciences taught by the Babylonians. In about 520 BC, Pythagoras returned to Samos from Babylon (after Polycrates was dead). After returning to Samos he founded a school which he called the "Semicircle". In the Semicircle the Samians held political meetings. Pythagoras made a cave outside the city as his own private site of his own philosophical teachings. In about 518 BC (some say much earlier- 530 BC), Pythagoras left Samos and went*

to Croton in southern Italy. There his teachings attracted a large number of followers. He tried to use his symbolic method of teaching (which was similar to the lessons he learned in Egypt). In Croton he founded a philosophical and religious school. There he drew up a rule of life. His followers of the society were known as Mathematikoi's. Mathematikoi's lived permanently with the society, they had no personal possessions and were vegetarians. There they had to obey strict rules. Some of these rules were to protract a period of silence, celibacy, and various kinds of abstinence. There Pythagoras also forbade them to eat beans. Both men and women were aloud to become members of his society. Several women later even became famous philosophers. Another society that was known was the Akousmatics. This society lived in their own homes, only coming to the society during the day. Akousmatics were allowed their own possessions and were not required to be vegetarians. Pythagoras' school made outstanding contributions to mathematics of today. His followers were not interested in trying to formulate or solve mathematical problems. Pythagoras and his followers were interested in the principles of

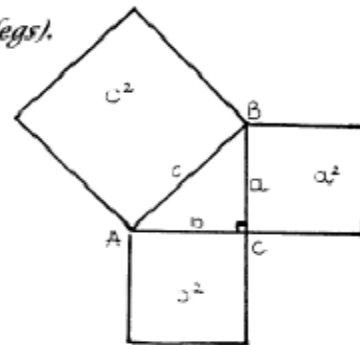
*mathematics (concepts of numbers, of triangles or other mathematical figures). Probably Pythagoras had a wife, yet that is not certain. Theano was called Pythagoras' wife, but sometimes called his daughter and sometimes called his pupil. Telauges was often called Pythagoras' son, but he also had other sons, daughters, and successors. There is really not much information about his personal life. In 510 BC, Croton had attacked and defeated Sybaris. Some say that Pythagoras became involved in the dispute. Later in 508 BC, Pythagoras' society at Croton was attacked by a noble from there, Cylon. At that time Pythagoras escaped to Metapontium, Lucania and in about 475 BC he died there. There is such evidence known and strong belief that Pythagoras may have lived till he was around one hundred years old. How Pythagoras died is not certain, but some say he might have committed suicide due to Cylon's attack. (Some evidence is unclear as where, when and how Pythagoras died). Pythagoras' society (the Pythagoreans) thrived for many years later after his death and even spread from Croton to many other Italian cities. The Pythagorean Society did expand rapidly after 500 BC, and*

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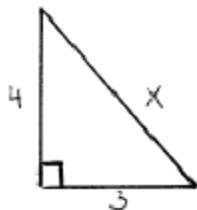
became political in nature.

Pythagoras is known mostly by his famous mathematical discovery. The Pythagorean Theorem states that the square of the hypotenuse of a right triangle equals the sum of the squares of the right triangle. If the sum of the squares of two sides of a triangle equal the square of the third side, then the triangle is a right triangle. The Pythagorean Theorem is also called the Hypotenuse Rule. The formula is  $a^2 + b^2 = c^2$ . The legs are  $a^2$  and  $b^2$ , and the hypotenuse is  $c^2$  (which equals the two legs).

$$a^2 + b^2 = c^2$$



Example of the Pythagorean Theorem:



$$\begin{aligned} a^2 + b^2 &= c^2 \\ (4)^2 + (3)^2 &= (x)^2 \\ 16 + 9 &= x^2 \\ 25 &= x^2 \\ \sqrt{25} &= \sqrt{x^2} \\ 5 &= x \end{aligned}$$

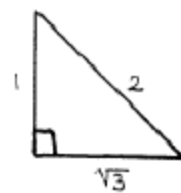
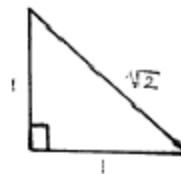
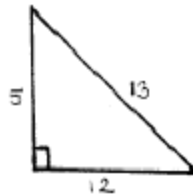
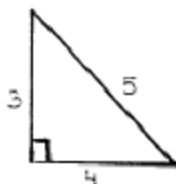
The theorem was known to the Babylonians 1000 years earlier, but he may have been the first to prove it. Early Egyptians

knew that when the sides of a triangle fit the ratio 3,4,5 the triangle is a right triangle. The early Egyptians used "rope stretches" to know how to construct right angles by applying the Hypotenuse Rule. They used this method for building. The right triangle geometry is important in our world today in mathematics, and in measurement, construction, and also in architecture.



The Pythagorean Triple is any three numbers (like 3, 4, 5) that will make the Pythagorean Theorem work to prove that it is a right triangle.

Some Examples of the Pythagorean Triple:





Another problem that Pythagoras and his followers were working on was the theory of numbers. They studied odd and even numbers, and of prime and square numbers. From this standpoint they cultivated the concept of number, which became for them the ultimate principle of all proportion, order, and harmony in the universe. Through such studies he and his followers had established a scientific foundation for mathematics. The Pythagoreans were carried by the enthusiasm of their discoveries that the numbers not only were symbols of reality, but also substances of real things (magic codes). Pythagoreans held, for example that one is the point, two is the line, three is the surface, and four is the solid. They considered the number seven a fate that dominates human life, since infancy ceases at seven. They said that maturity begins at fourteen, marriage at twenty-one, and life span usually allotted to man is seventy. Pythagoreans said that the number ten is the perfect number, since it is the sum of one, two, three, and four. They observed that all numbers may be ranged in parallel columns under "odd" and "even".



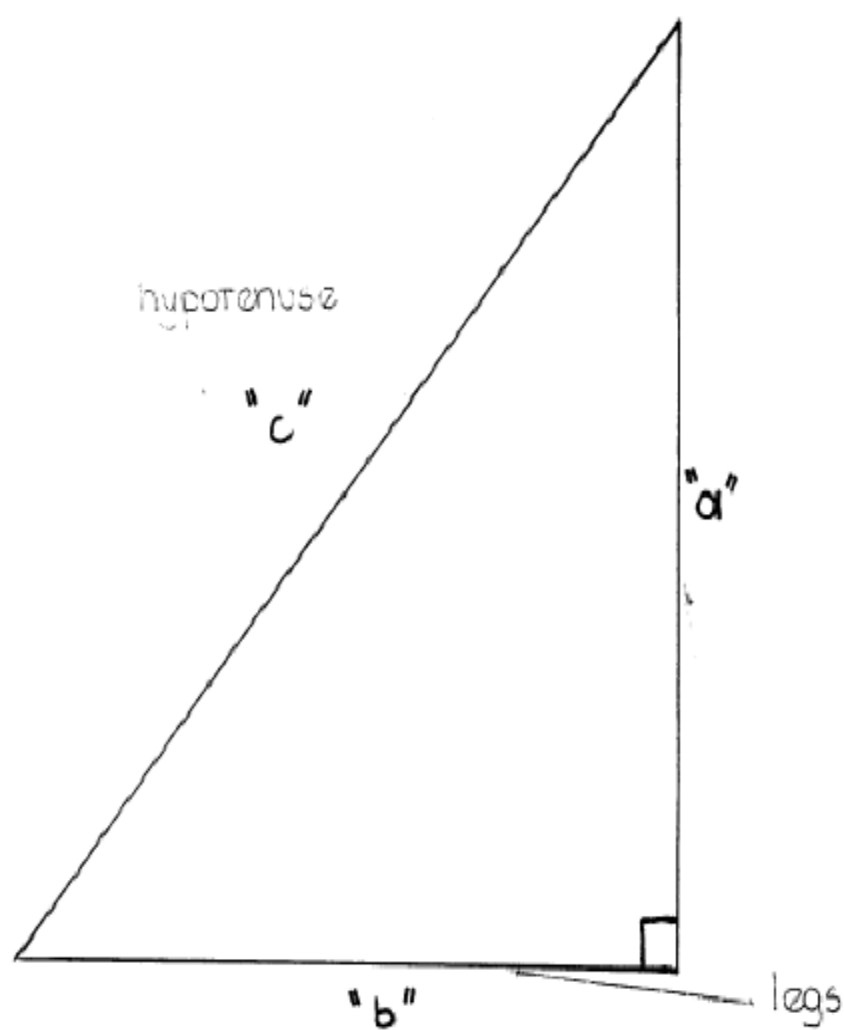
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*Pythagoras believed in harmony of the spheres. He regarded the sphere as the most beautiful of solid objects, and he thought that the universe itself has a perfect form. The celestial spheres of the planets produce a harmony called the music of the spheres. Pythagoreans believed that the earth itself was also in motion, and was the center of the universe. They marked an important advance in ancient scientific thought, for they were the first to consider the earth as a globe revolving with the other planets around a central fire. Pythagoreans explained the harmonious arrangement of things as that of bodies moving according to a numerical scheme. They thought that the heavenly bodies are separated from one another by intervals corresponding to the harmonic lengths of strings, they held that the movement of the spheres gives rise to a musical sound- "the harmony of the spheres". He thought that the cosmos is a mathematically ordered whole.*

*Pythagoras taught a certain way of life. He created moral and religious teachings. He believed in obedience and silence, abstinence from food, simplicity in dress and possessions. The Pythagoreans believed in immortality and in the transmigration*

*of souls (reincarnation). Pythagoras discovered the numerical ratios which determine the concordant intervals of the musical scale. He noticed that the vibrating strings produce harmonious tones when the ratios of the lengths of the strings are whole numbers, and that these ratios could be extended to other instruments. The doctrine of Pythagoras was that all things are numbers.*

*In the history of the world Pythagoras made a great contribution to mathematics. In our everyday lives we will use the Pythagorean Theorem the most. For example we would use it if we needed to figure out how tall a ladder must be for getting onto a building, we would use the  $a^2 + b^2 = c^2$  method. As much of the Pythagorean doctrine that has survived consists of numerology and number mysticism. The influence of the idea that the world can be understood through mathematics was extremely important to the development of sciences and mathematics.*

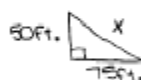


## Applications of the Pythagorean Theorem:

(SHOW ALL WORK AND CIRCLE ALL YOUR FINAL ANSWERS)

1. Draw a diagram and solve the following problem. Approximate your answer to the nearest tenths place:

Two telephone poles are 75 feet apart and the poles are each 50 feet tall. What is the distance from the base of one pole to the top of the other pole (in feet)?



$$\begin{aligned}
 a^2 + b^2 &= c^2 \\
 (50)^2 + (75)^2 &= (x)^2 \\
 2500 + 5625 &= x^2 \\
 8125 &= x^2 \\
 \sqrt{8125} &= \sqrt{x^2} \\
 \sqrt{8125} &= \sqrt{x^2} \\
 5\sqrt{325} &= x \\
 5\sqrt{25 \cdot 13} &= x \\
 25\sqrt{13} &= x \\
 90.1 \text{ ft.} &\approx x
 \end{aligned}$$

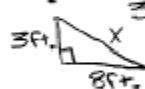
check:  $a^2 + b^2 = c^2$

$$\begin{aligned}
 (50)^2 + (75)^2 &= (90.1)^2 \\
 2500 + 5625 &= 8118.01 \\
 8125 &\approx 8118.01 \checkmark
 \end{aligned}$$

$\therefore$  The distance from the base of one pole to the top of the other pole is approx. 90.1 feet.

2. Draw a diagram and solve the following problem. Approximate to the nearest tenths place.

You need to construct a ramp to roll a cart from your garage into the back of your truck. The truck is 8 feet from the garage. The back of the truck is 36 inches above the ground. How long does the ramp have to be (in feet)?



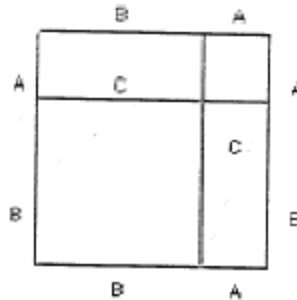
$$\begin{aligned}
 36 \text{ inches} &= 3 \text{ ft.} \\
 a^2 + b^2 &= c^2 \\
 (3)^2 + (8)^2 &= (x)^2 \\
 9 + 64 &= x^2 \\
 73 &= x^2 \\
 \sqrt{73} &= \sqrt{x^2} \\
 8.5 \text{ ft.} &\approx x
 \end{aligned}$$

check:  $a^2 + b^2 = c^2$

$$\begin{aligned}
 (3)^2 + (8)^2 &= (8.5)^2 \\
 9 + 64 &= 72.25 \\
 73 &\approx 72.25 \checkmark
 \end{aligned}$$

$\therefore$  The ramp has to be approx. 8.5 feet. (over)

Mathematical Proof: Figures 1 and 2



*The figure demonstrates the relationship  $a^2 + b^2 = c^2$  holds in a right-angled triangle with sides  $a$  and  $b$  and hypotenuse  $c$ .*

*Figure 1 shows that the square of side  $a + b$  can be divided into four of the right-angled triangles.*

*Figure 2 shows that the square of side  $a + b$  can also be dissected into four of the right-angled triangles and a square of side  $c$ . Since the two squares of side  $a + b$  have the same area, they must still have the same area once the four triangles are removed from each of them. The total area of the squares that remain on the left side is*

$$a^2 + b^2 = c^2$$



This is a detail from the fresco *The School of Athens* by Raphael



Greek coin



14.

### Works Cited

<http://138.25.60.81/numericon/triples.html>

<http://scidiv.bcc.ctc.edu/math/Pythagoras.html>

<http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Pythagoras.html>

<http://history.hanover.edu/texts/presoc/pythagor.htm>

<http://www.utm.edu/research/iep/p/pythagor.htm>

<http://www.cohums.ohio-state.edu/philo/pythagoras.html>

<http://www.geom.umn.edu/~demo5337/Group3/hist.html>

Grolier Incorporated. "Pythagoras, theorem of" and "Pythagoreans." Academic American Encyclopedia. 1990.

F. E. Compton Company. "Pythagoras," Compton's Encyclopedia. 1984.

The Macmillian Company and The Free Press, NY. "Pythagoras." The Encyclopedia of Philosophy. 1967.

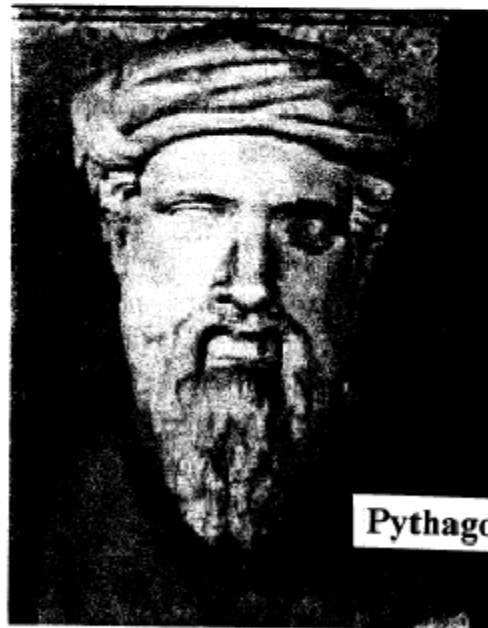
Facts on File, 460 Park Ave. South, New York, NY 10016. "Pythagoras." A Biographical Encyclopedia of Science. 1981.



- ♦ *Pythagoreans believed that all relations could be reduced to number relations. This generalization stemmed from observations in music, mathematics, and astronomy.*
- ♦ *Pythagoras studied properties of numbers which would be familiar to mathematicians today; even and odd numbers, triangular numbers, perfect numbers, etc.*

$$[1 + 2 + 3 + 4 = 10]$$

*"formed a perfect triangle"*



**Pythagoras of Samos**

## Work Cited:

- ♦ *Theoni Pappas. The Joy of Mathematics. Wide World Publishing. San Carlos, California. 1989 pg.4-5*
- ♦ *Walter Burkert. Lore and Science in Ancient Pythagoreanism. Harvard University Press. Cambridge, Massachusetts. 1972 pg.109-120*
- ♦ *"Pythagoras of Samos". January 1999. <<http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Pythagoras.html>> (March 13, 1999)*
- ♦ *"Pythagoras (fl. 530 BCE.)". 1996. <<http://www.utm.edu/research/lep/p/pythagor.htm>> (March 13, 1999)*
- ♦ *William Turner. "Pythagoras and Pythagoreanism". 1997. <<http://www.knight.org/advent/cathen/12587b.htm>> (March 19, 1999)*

# Work Cited:

## For Pictures

- ♦ "Pythagoras". January 1999. <<http://www-groups.dcs.st-and.ac.uk/~history/PictDisplay/Pythagoras.html>> (March 13, 1999)