

Theorem | Meaning, Types & Examples

Learn about and see examples of theorems and how they have played a role in the history of thought, especially in regard to the sciences in modern times. *Updated: 11/21/2023*

Frequently Asked Questions

What is a theorem in simple terms?

In simple terms, the theorem can be defined as a rule, principle, or statement that can be proved to be true. According to the Oxford dictionary, the definition of the theorem is a "rule or principle, especially in mathematics, that can be proved to be true. Example: Pythagorean theorem."

What is an example of a theorem?

The Pythagorean theorem is an example for theorem. It states that the square of the hypotenuse of a right-angled triangle is equal to the sum of the squares of the sides of the triangle.

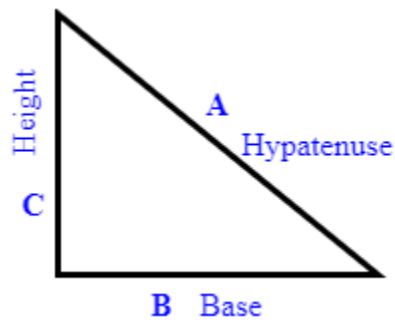
What's a theorem in math?

In mathematics, a theorem is defined as a statement that can be proved to be true based on known and proven facts and these known facts may be of mathematical expressions or operations. The pythagorean theorem is one of the best examples of the theorems.

Theorem Definition

In mathematics, a **theorem** can be defined as a statement that can be proved to be true based on known and proven facts. These known facts may be of mathematical expressions or operations. According to the Oxford dictionary, the definition of the theorem is "a rule or principle, especially in mathematics, that can be proved to be true". For example, in mathematics, the Pythagorean theorem is a well-known theorem and is most widely used in the domain of science. The **Pythagorean theorem** states that the square of the hypotenuse of a right-angled triangle is equal to the sum of the squares of the sides of the triangle. Mathematically,

$$A^2 = B^2 + C^2$$



Pythagorean theorem

The Pythagorean theorem is applied in various domains of study, like rigid body mechanics, solid mechanics, fluid mechanics, mechanics of materials, and so on.

For example, the Pythagorean theorem is most useful in the determination of forces acting on the structural members of a truss.

Types of Theorem:

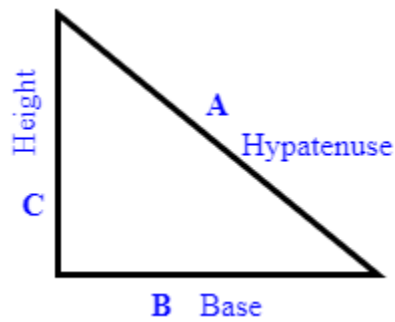
In mathematics, the following few are the important types of theorems widely used in various branches of study:

- Pythagorean theorem
- Sine rule
- Cosine rule
- Mean value theorem
- Mid-point theorem
- Triangle sum theorem
- Isosceles theorem
- Factor theorem
- Binomial theorem

Pythagorean Theorem

According to Pythagorean theorem, $A^2 = B^2 + C^2$

where, A is the hypotenuse, and B and C are the sides of a right-angled triangle.



Pythagorean theorem

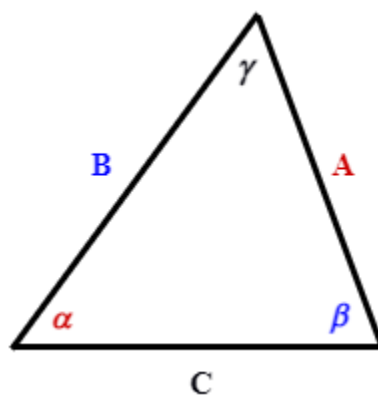
The Pythagorean theorem in mathematics and science can be proved in different ways and is widely used to determine the length of sides, the length of a hypotenuse, the angle made by the hypotenuse with respect to the sides, and trigonometric ratios. A few practical civil engineering applications of the Pythagorean theorem include the surveying of land and forest, building construction, and determination of slope and steepness of mountains and hills. When painting a building, the safe angle of inclination of the ladder with respect to the floor can be determined from the Pythagorean theorem. In the field of photo or video shooting, the setting up of the camera angle can be determined using the Pythagorean theorem. The Pythagorean theorem is used in two-dimensional navigation systems for the determination of the shortest distance.

Sine Rule

According to the sine rule, $\frac{A}{\sin \alpha} = \frac{B}{\sin \beta} = \frac{C}{\sin \gamma}$

where, A, B, and C are the sides of a triangle and α , β , and γ are the angles.

The sine rule can be used for triangles to determine the two unknown sides if the other side and the angles are known.



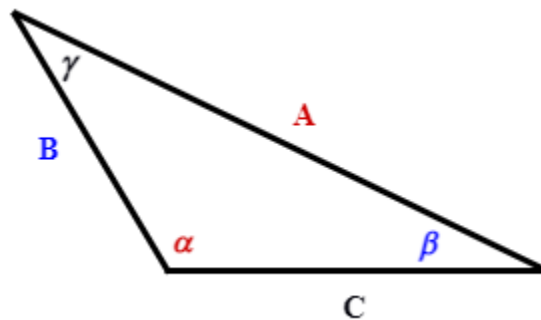
Sine Rule

Cosine Rule

According to the [cosine rule](#), $A = \sqrt{B^2 + C^2 - 2BC \cos \gamma}$

where A, B, and C are the sides of a triangle and α , β , and γ are the angles.

The cosine rule can be used for triangles to determine the two unknown sides if the other side and the angles are known.

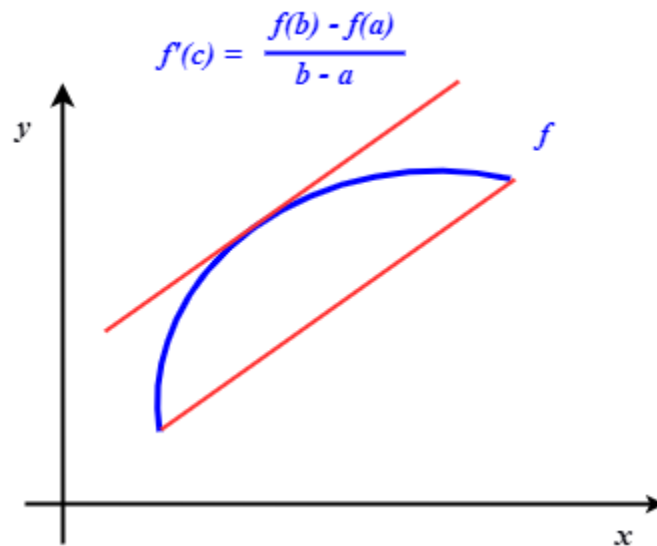


Cosine Rule

Mean Value Theorem

The mean value theorem used in calculus states that for a curve passing through any two given points, there will be at least one point on the curve where the tangent will be parallel to the secant passing through the two given points. Mathematically, this can be written as,

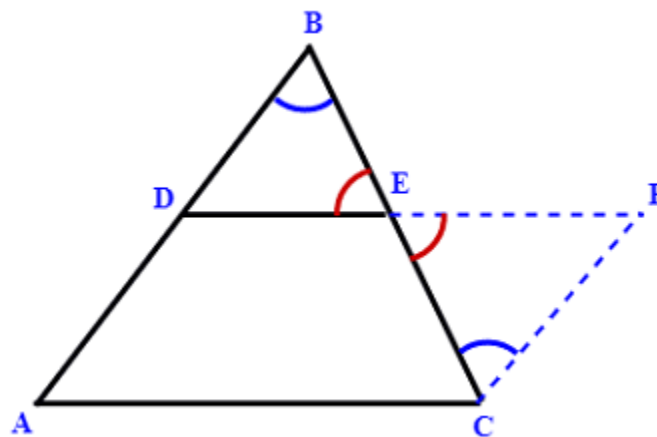
$$F'(c) = \frac{f(b) - f(a)}{b - a}$$



Mean Value Theorem

Mid-Point Theorem

The mid-point theorem states that a line joining the mid-points of the two sides of a triangle is parallel to the third side of the triangle and that its length is equal to half of the length of the third side.



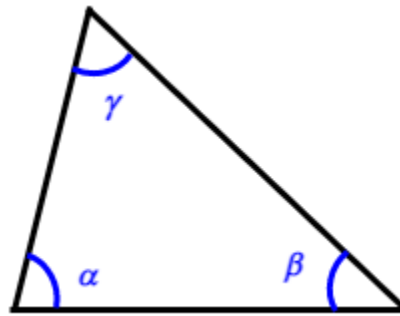
Mid-Point Theorem

Triangle Sum Theorem

The [triangle sum theorem](#) states that the sum of interior angles of any triangle is equal to 180° . Mathematically,

$$\angle\alpha + \angle\beta + \angle\gamma = 180^\circ$$

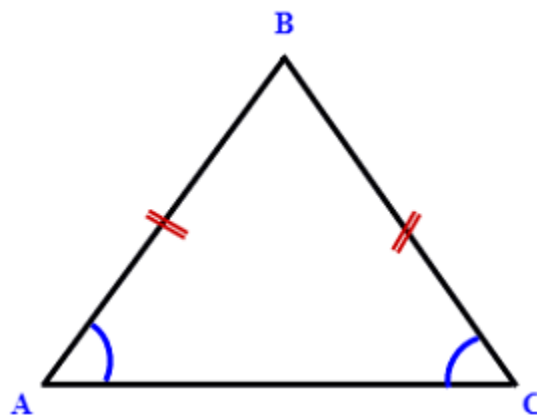
Like the Pythagorean theorem, the triangle sum theorem can also be proved in many different methods and is widely used in applications of science and engineering.



Triangle Sum Theorem

Isosceles Triangle Theorem

The [isosceles triangle theorem](#) states that if two sides of a triangle are congruent, then the angles opposite to the sides are congruent. The application of the isosceles triangle theorem can be found on a slice of cake or pizza.



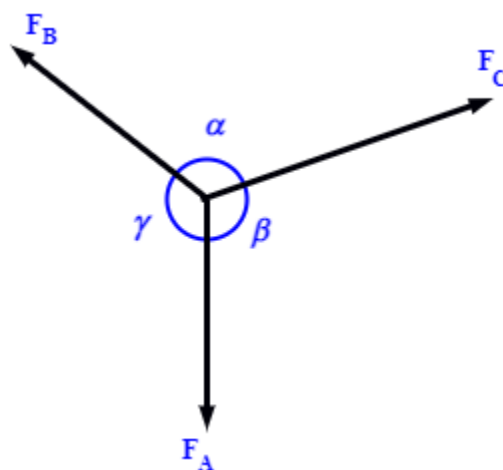
Isosceles Triangle Theorem

Lami's theorem

Lami's theorem is similar to the sine law and is used in mechanics to determine the magnitude and direction of the three forces acting at a single point. According to Lami's theorem, if three forces acting at a point are in equilibrium, then each force is directly proportional to the sine angle of the other two forces. This can mathematically be written as,

$$\frac{F_A}{\sin \alpha} = \frac{F_B}{\sin \beta} = \frac{F_C}{\sin \gamma}$$

where A, B, and C are the sides of a triangle and α , β , and γ are the angles.



Lami



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Theorem Examples:

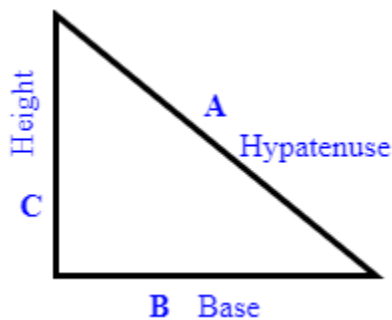
Example 1:

Find the hypotenuse of a right-angled triangle with a of height 3 cm and base 4 cm using the Pythagorean theorem.

Let A be the hypotenuse, B be the base, and C be the height of the triangle.

According to the Pythagorean theorem, the square of the hypotenuse of a right-angled triangle is equal to the sum of the squares of the sides of the triangle. Mathematically,

$$A^2 = B^2 + C^2$$



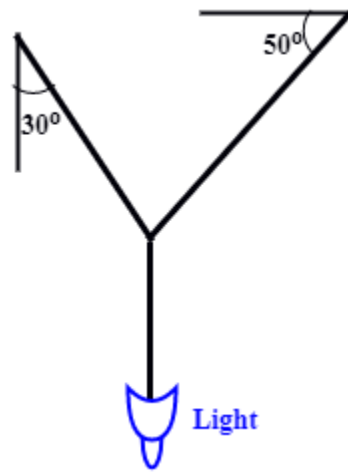
Pythagorean theorem

Plug in the given values of the base and the height of the triangle and find the length of the hypotenuse.

$$A^2 = 4^2 + 3^2 \quad A = 5\text{cm}$$

Example 2:

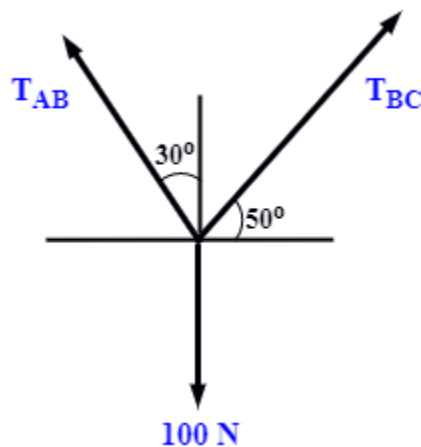
A light fixture of weight 100 N is supported by two cables. The cable AB makes an inclination of 30° to the vertical, and the cable BC makes an inclination of 50° to the horizontal. Find the tension in the cables.



Light fixture

Let T_{AB} and T_{BC} be the tension in the cables AB and BC.

The weight of the light fixture and the tension acting on the cables are shown in the free body diagram.



Free body diagram

According to Lami's theorem,

$$\frac{W}{\sin \alpha} = \frac{T_{AB}}{\sin \beta} = \frac{T_{BC}}{\sin \gamma}.$$

Plug in the given values and find the tension in the cables AB and BC.

$$\frac{100}{\sin 70^\circ} = \frac{T_{AB}}{\sin 140^\circ} = \frac{T_{BC}}{\sin 120^\circ} \quad T_{AB} = 68.4 \text{ N} \quad T_{BC} = 53.2 \text{ N}$$



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History of Theorems

The concept of theorems began beyond 600 BC, and history says that Greek mathematicians used logical thinking and reasoning for the development of various theorems. The collection of mathematical theorems was first developed by the Greek mathematician Euclid around 300 BC. According to the philosopher Thales, the early theorems were subjected to rigorous validation for proof before acceptance. The word theorem has been derived from the Ancient Greek word *theorema*, meaning to 'look at,' of unknown origin. The theorem was originally a sight or the act of seeing.

More than 1000 years before Pythagoras, a Greek mathematician developed the Pythagorean theorem. It was first used by the Babylonians in 1900 BC for construction activities.

The sine rule was discovered in the tenth century, and the name for the sine rule was derived from the Latin word *sinus*, which means "bosom" or "bay" or "folds".



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Lesson Summary:

A **theorem** can be defined as a statement that can be proved to be true based on known and proved facts; all theorems contain a math rule and at least one proof. The **Pythagorean theorem** states that the square of the hypotenuse of a right-angled triangle is equal to the sum of the squares of the sides of the triangle. The Pythagorean theorem has many proofs in addition to its math rule and formula, and it is applied in various domains of study, like rigid body mechanics, solid mechanics, fluid mechanics, and mechanics of materials. Some of the other important theorems widely used in various branches of study are Sine rule, Cosine rule, Mean value theorem, Mid-point theorem, Triangle sum theorem, Isosceles theorem, Factor theorem, and Binomial theorem. As an example of one of these theorems, the triangle sum theorem states that if the three interior angles of a triangle are added together, they equal 180 degrees.

In daily life, the Pythagorean theorem is applied in various fields like video shooting, civil engineering, and two-dimensional navigation systems. The word theorem has been derived

from the Ancient Greek word *theorema*, meaning to 'look at,' of unknown origin. The theorem was originally a sight or the act of seeing. **Lami's theorem** states that if three forces acting at a point are in equilibrium, then each force is directly proportional to the sine angle of the other two forces.



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