

Calculate The Length Of The Side Marked X In Each Triangle. Give Answer To 3 Significant Figures.

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Introduction to Triangle Side Calculations

Understanding how to calculate the length of a missing side in a triangle is a fundamental skill in geometry. It involves applying various mathematical principles and formulas depending on the type of triangle and the known information provided. In many problems, you are given some sides and angles, and your task is to find the length of the side marked as X, ensuring your answer is accurate to three significant figures. This article will explore different methods, such as the Pythagorean theorem, trigonometry, and the Law of Cosines, to effectively determine the length of side X in various triangle configurations.

Types of Triangles and Relevant Methods

Right-Angled Triangles

In right-angled triangles, the calculation of an unknown side often involves the Pythagorean theorem or basic trigonometric ratios.

Oblique Triangles (Non-Right Angled)

For triangles without a right angle, the Law of Cosines and Law of Sines are essential. These formulas help relate sides and angles, allowing you to solve for the unknown side marked as X.

Calculating Side X in Right-Angled Triangles

Using the Pythagorean Theorem

The Pythagorean theorem states:

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

where c is the hypotenuse, and a and b are the legs.

Example Problem

Suppose you have a right-angled triangle where the legs are 3.0 m and 4.0 m, and you are asked to find the hypotenuse (X).

Solution:

- Applying the Pythagorean theorem:

$$c^2 = 3.0^2 + 4.0^2 = 9 + 16 = 25$$

- Taking the square root:

$$c = \sqrt{25} = 5.00 \text{ m}$$

Result: The length of side X (hypotenuse) is 5.00 meters.

Calculating Side X in Non-Right Triangles

When the triangle does not contain a right angle, trigonometric ratios and the Law of Cosines become necessary.

Using the Law of Cosines

The Law of Cosines relates the lengths of sides of a triangle to the cosine of one of its angles:

- $c^2 = a^2 + b^2 - 2ab \cos C$

where c is the side opposite angle C , and a and b are the other two sides.

To find side X :

- Identify the known sides and the included angle.
- Rearrange the Law of Cosines formula to solve for X .

Example Problem:

Given a triangle with sides $a = 7.5$ m, $b = 10.0$ m, and included angle $C = 60^\circ$, find side X (which is side c).

Solution:

1. Convert the angle to radians if necessary (for calculator mode).
2. Apply the Law of Cosines:

$$X^2 = 7.5^2 + 10.0^2 - 2 \cdot 7.5 \cdot 10.0 \cos(60^\circ)$$

3. Calculate:

$$X^2 = 56.25 + 100 - (2 \cdot 7.5 \cdot 10 \cdot 0.5) = 156.25 - (150) = 6.25$$

4. Take the square root:

$$X = \sqrt{6.25} = 2.50 \text{ m}$$

Result: The length of side X is 2.50 meters.

Applying the Law of Sines for Side X

When you are given two angles and one side (AAS or ASA), the Law of Sines can be used:

- $(a / \sin A) = (b / \sin B) = (c / \sin C)$

Example:

Suppose in a triangle, side $a = 8.0$ m opposite angle $A = 40^\circ$, and side $b =$

10.0 m opposite angle B = 70°. Find side c (marked as X) opposite angle C.

Solution:

1. Find angle C:

$$C = 180^\circ - A - B = 180^\circ - 40^\circ - 70^\circ = 70^\circ$$

2. Use Law of Sines to find side c:

$$c / \sin 70^\circ = a / \sin 40^\circ$$

$$c = (a \sin 70^\circ) / \sin 40^\circ$$

3. Calculate:

$$c = (8.0 \sin 70^\circ) / \sin 40^\circ$$

Using sine values:

$$\sin 70^\circ \approx 0.9397$$

$$\sin 40^\circ \approx 0.6428$$

$$c \approx (8.0 \cdot 0.9397) / 0.6428 \approx (7.5176) / 0.6428 \approx 11.71 \text{ m}$$

Result: Side X (c) is approximately 11.7 meters.

Special Cases and Tips for Accurate Calculations

Handling Ambiguous Cases

- In cases where the Law of Sines yields two possible solutions (the ambiguous case), carefully analyze the triangle's context to select the correct one.

Ensuring Correct Units and Angles

- Always confirm whether your calculator is set to degrees or radians.
- Convert angles to degrees if necessary.

Rounding to Three Significant Figures

- After computing the side length, round your answer to three significant figures.
- Be aware of the precision of your calculations, including intermediate steps.

Using Scientific Calculators or Software

- For complex calculations, utilize scientific calculators or software like GeoGebra, WolframAlpha, or calculator apps to improve accuracy.

Summary of Steps to Calculate Side X

1. Identify the triangle type (right-angled or oblique).
2. Determine known values: sides, angles, or a combination.
3. Choose the appropriate formula:
 - Pythagorean theorem for right-angled triangles.
 - Law of Cosines for SAS (Side-Angle-Side) or SSS (Side-Side-Side) cases.
 - Law of Sines for ASA or AAS cases.
4. Substitute known values into the formula.
5. Solve for X.
6. Round the answer to three significant figures.

Conclusion

Calculating the length of the side marked as X in a triangle requires understanding the relationship between sides and angles. Whether using the Pythagorean theorem in right-angled triangles or the Law of Cosines and Law of Sines for oblique triangles, the key is to correctly identify the known quantities and apply the appropriate formula. Precision is critical; hence, answers should be rounded to three significant figures for consistency and clarity. With practice, applying these methods becomes intuitive, enabling accurate and efficient solutions to various geometric problems involving triangles.

Remember: Always double-check your calculations, ensure your units are consistent, and verify your answer makes sense within the context of the

problem.

Frequently Asked Questions

In a right triangle with legs of 6.0 cm and 8.0 cm, what is the length of the hypotenuse (side marked X)?

X = 10.0 cm

A triangle has sides of 5.0 cm and 12.0 cm, with the included angle of 90° . What is the length of side X (the third side)?

X = 13.0 cm

In an isosceles triangle where the two equal sides are each 7.5 cm and the base is 10.0 cm, what is the length of the leg marked X?

X = 6.47 cm

A triangle has sides 9.0 cm and 15.0 cm, with the included angle of 60° . What is the length of side X opposite this angle?

X = 16.4 cm

Using the Law of Cosines, find side X in a triangle with sides 7.0 cm and 10.0 cm and included angle 45° . Round to 3 significant figures.

X = 12.0 cm

In a triangle, two sides are 4.5 cm and 9.0 cm with an included angle of 30° , what is the length of side X opposite the 30° angle?

X = 8.96 cm

If two sides of a triangle are 13.0 cm and 14.0 cm with an included angle of 110° , what is the length of side X opposite this angle?

X = 26.4 cm

In a triangle, sides are 3.0 cm and 4.0 cm with an included angle of 70° , find the length of side X across from this angle.

X = 4.89 cm

A triangle has sides 8.0 cm and 15.0 cm with an included angle of 120° . Calculate the length of side X opposite this angle, rounded to 3 significant figures.

X = 17.3 cm

Additional Resources

Calculate The Length Of The Side Marked X In Each Triangle. Give Answer To 3 Significant Figures.

Understanding how to determine the length of an unknown side in a triangle is a fundamental skill in geometry, with applications spanning from basic classroom exercises to complex engineering and architectural design. When faced with a triangle featuring an unknown side labeled as 'X,' the task involves applying various geometric principles, including the Pythagorean theorem, trigonometry, and properties of special triangles. This article aims to provide a comprehensive, detailed guide on calculating the length of side X across different types of triangles, emphasizing clarity, analytical rigor, and practical insights.

Introduction to Triangle Measurement and the Importance of Calculating Unknown Sides

Triangles are among the simplest yet most versatile geometrical shapes. Their properties underpin numerous fields such as construction, navigation, physics, and computer graphics. The challenge of determining an unknown side—here marked as X—is central to many geometric problems. Accurate

calculations enable precise modeling, structural analysis, and problem-solving.

The process often involves the use of:

- Basic geometric rules
- Trigonometric ratios
- The Pythagorean theorem
- The Law of Sines and Law of Cosines

The choice of method depends on the specific information available about the triangle, such as side lengths, angles, or a combination thereof.

Types of Triangles and Corresponding Strategies for Calculating Side X

The approach to calculating side X varies significantly based on the type of triangle and the information provided. The primary categories include:

- Right-angled triangles
- Oblique triangles (acute or obtuse)

Within these, specific methods are applicable:

2.1 Right-Angled Triangles

In right-angled triangles, calculating an unknown side is often straightforward using the Pythagorean theorem or basic trigonometric ratios.

2.2 Oblique Triangles (Acute or Obtuse)

Calculations for non-right triangles employ the Law of Sines and Law of Cosines, which generalize the Pythagorean theorem for triangles lacking a 90° angle.

Calculating Side X in Right-Angled Triangles

The Pythagorean theorem is the cornerstone for right-angled triangles. It states:

$$\sqrt{a^2 + b^2} = c$$

where:

- a and b are the legs (the sides adjacent to the right angle),
- c is the hypotenuse (the side opposite the right angle).

Scenario 1: Known legs, find hypotenuse (X)

Suppose in a right-angled triangle, the legs are known, and side X is the hypotenuse:

$$X = c = \sqrt{a^2 + b^2}$$

Scenario 2: Known hypotenuse and one leg, find the other leg

If the hypotenuse and one leg are known:

$$\text{Unknown leg} = \sqrt{c^2 - a^2}$$

Example:

Given legs of 3.00 units and 4.00 units, find X as the hypotenuse.

$$X = \sqrt{3.00^2 + 4.00^2} = \sqrt{9 + 16} = \sqrt{25} = 5.00 \text{ units}$$

Calculating Side X in Oblique Triangles

When the triangle lacks a right angle, the Pythagorean theorem no longer applies directly. Instead, the Law of Sines and Law of Cosines are essential.

Law of Sines

The Law of Sines relates the ratios of sides to their opposite angles:

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

If two angles and one side are known, the unknown side can be found by:

$$X = \frac{\sin(\text{opposite angle})}{\sin(\text{known angle})} \times \text{known side}$$

\]

Application Example:

Suppose in a triangle, angles $(A = 30^\circ)$, $(B = 45^\circ)$, side $(b = 10.0)$ units (opposite (B)), and side (X) is opposite (A) .

Calculate side (X) :

$$\begin{aligned} X &= \frac{\sin 30^\circ \times 10.0}{\sin 45^\circ} = \frac{0.5 \times 10.0}{0.707} \approx \frac{5.0}{0.707} \approx 7.07 \text{ units} \end{aligned}$$

Law of Cosines

The Law of Cosines is used when two sides and the included angle are known, or when all three sides are known:

$$c^2 = a^2 + b^2 - 2ab \cos C$$

Rearranged to find an unknown side (X) :

$$X = \sqrt{a^2 + b^2 - 2ab \cos C}$$

Application Example:

Given sides $(a=8.00)$ units, $(b=6.00)$ units, and included angle $(C=60^\circ)$, find side (X) :

$$X = \sqrt{8.00^2 + 6.00^2 - 2 \times 8.00 \times 6.00 \times \cos 60^\circ}$$

Calculate:

$$\begin{aligned} X &= \sqrt{64 + 36 - 2 \times 8 \times 6 \times 0.5} = \sqrt{100 - 48} = \\ &= \sqrt{52} \approx 7.21 \text{ units} \end{aligned}$$

Step-by-Step Approach to Calculating Side X

To systematically determine the length of side X, follow these steps:

1. Identify the known quantities: sides, angles, or both.
2. Determine the triangle type: right-angled or oblique.
3. Select the appropriate method:
 - Pythagorean theorem for right-angled triangles.
 - Law of Sines or Law of Cosines for oblique triangles.
4. Perform calculations:
 - Use calculator functions for sine, cosine, and square roots.
 - Keep track of units and decimal places.
5. Round the result to 3 significant figures: adhere to proper rounding conventions.

Practical Examples and Applications

4.1 Structural Engineering

In designing bridges or towers, engineers often need to determine unknown member lengths based on angles and existing measurements. For instance, calculating the length of a support beam (X) when the angles and other side lengths are known ensures structural integrity and safety.

4.2 Navigation and Surveying

Surveyors frequently use triangulation to determine distances. If they know two angles and a baseline, they can calculate unknown distances (such as side X) with high precision, critical for mapping and land division.

4.3 Computer Graphics

Rendering 3D models involves calculating distances between points. Understanding how to compute side lengths from angles and known distances allows for accurate modeling of objects and environments.

Common Pitfalls and Tips for Accurate Calculation

- Incorrect Angle Units: Always verify whether angles are in degrees or radians; mismatched units can lead to erroneous results.

- Rounding Errors: Carry extra decimal places during intermediate steps and round only at the end.
- Using the Correct Formula: Ensure the formula matches the problem context; mixing methods can lead to inconsistent results.
- Double-Check Known Data: Confirm that the given sides and angles are correctly identified and labeled.

Summary and Final Remarks

Calculating the length of side X in any triangle hinges on understanding the specific geometry of the problem and selecting the appropriate mathematical tools. Right-angled triangles simplify calculations via the Pythagorean theorem, whereas oblique triangles require the Law of Sines or Law of Cosines. Mastery of these methods facilitates precise measurements critical across scientific, engineering, and everyday contexts.

In practice, systematic problem-solving—identifying what is known, choosing the suitable formula, performing careful calculations, and rounding accurately—ensures reliable results. Whether in academic exercises or real-world applications, the ability to calculate unknown side lengths enhances spatial understanding and problem-solving prowess.

By adhering to these principles and methods, one can confidently determine side X with a high degree of accuracy, providing a solid foundation for advanced geometric analysis and practical implementation.

Note: The actual calculation of specific triangles' side X depends on the provided measurements. The examples above illustrate the methodology applicable across various scenarios, emphasizing clarity, precision, and analytical rigor necessary for achieving three significant figures in the final answer.

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