

Given The Following Information, Find The Length Of The Missing Side. Leave Your Answer As A Simplified

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When working with triangles and geometric figures, one of the most common challenges students and learners face is determining the length of a missing side. This problem requires understanding the principles behind various geometric theorems and formulas, such as the Pythagorean theorem, the Law of Sines, and the Law of Cosines. Whether you're dealing with right triangles, oblique triangles, or other polygons, knowing how to approach the problem systematically is key to arriving at an accurate and simplified answer.

In this comprehensive guide, we will explore different methods to find the length of a missing side in various contexts, providing step-by-step instructions, tips, and real-world examples. Our goal is to ensure you gain a deep understanding of the concepts involved and can confidently apply these methods to your own problems.

Understanding the Basics of Triangle Types and Their Properties

Before diving into the formulas and methods, it's essential to understand the types of triangles you might encounter and their unique properties.

1. Right Triangles

- Have one 90-degree angle.
- The side opposite the right angle is called the hypotenuse.
- The Pythagorean theorem applies: $a^2 + b^2 = c^2$.

2. Oblique Triangles

- Do not contain a right angle.
- Can be either acute (all angles less than 90°) or obtuse (one angle greater than 90°).
- Require different formulas for side length calculations, such as the Law of Sines or Law of Cosines.

3. Equilateral and Isosceles Triangles

- Equilateral: all sides and angles are equal.

- Isosceles: two sides and two angles are equal.
- These properties can simplify calculations when dealing with missing sides.

Methods to Find the Missing Side Length

Depending on the information given in your problem, different methods are applicable. The most common approaches include:

1. Pythagorean Theorem

- Used exclusively for right triangles.
- Formula: $a^2 + b^2 = c^2$, where c is the hypotenuse.
- To find a missing side:
- If hypotenuse c and one side are known, find the other: $a = \sqrt{c^2 - b^2}$.
- If both legs are known, find the hypotenuse: $c = \sqrt{a^2 + b^2}$.

2. Law of Sines

- Useful when:
- Two angles and one side are known (AAS or ASA).
- Two sides and an angle opposite one of them are known (SSA, with caution).
- Formula: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$.
- To find a missing side:
- Rearrange the formula: $a = \frac{\sin A \times \text{side length}}{\sin \text{angle}}$.

3. Law of Cosines

- Used when:
- Two sides and the included angle are known (SAS).
- All three sides are known (SSS).
- Formula: $c^2 = a^2 + b^2 - 2ab \cos C$.
- To find the missing side:
- Rearrange as necessary:
- $c = \sqrt{a^2 + b^2 - 2ab \cos C}$.

Step-by-Step Approach to Find the Missing Side

When approaching a problem, follow these steps:

Step 1: Identify Given Information

- List all known sides and angles.
- Determine the type of triangle you are working with.

Step 2: Determine the Appropriate Method

- Right triangle with known hypotenuse and one side: Pythagoras.
- Two angles and one side: Law of Sines.
- Two sides and the included angle: Law of Cosines.
- All three sides known: Law of Cosines (to find angles), or straightforward calculations if applicable.

Step 3: Apply the Formula

- Plug in known values.
- Carefully perform calculations, ensuring the correct order and units.

Step 4: Simplify the Result

- Simplify radicals.
- Reduce fractions.
- Express your answer as a simplified radical or decimal, depending on instructions.

Step 5: Verify Your Answer

- Check if the answer makes sense in the context.
- Confirm that side lengths satisfy triangle inequalities (sum of two sides > third side).

Real-World Example Problems

To solidify your understanding, here are example problems illustrating the process:

Example 1: Find the Missing Side in a Right Triangle

- Given: one leg ($a = 3$) units, hypotenuse ($c = 5$) units.
- Find: the other leg (b).

Solution:

Using Pythagorean theorem:

$$b = \sqrt{c^2 - a^2} = \sqrt{5^2 - 3^2} = \sqrt{25 - 9} = \sqrt{16} = 4$$

Answer: The missing side is 4 units.

Example 2: Find a Side Using Law of Sines

- Given: $\angle A = 30^\circ$, $\angle B = 45^\circ$, side $a = 10$ units.
- Find: side b .

Solution:

First, find $\angle C$:

$$\angle C = 180^\circ - 30^\circ - 45^\circ = 105^\circ$$

Apply Law of Sines:

$$\frac{a}{\sin A} = \frac{b}{\sin B}$$
$$b = \frac{\sin B \times a}{\sin A} = \frac{\sin 45^\circ \times 10}{\sin 30^\circ}$$

Calculate:

$$\sin 45^\circ \approx 0.7071, \quad \sin 30^\circ = 0.5$$
$$b = \frac{0.7071 \times 10}{0.5} = \frac{7.071}{0.5} \approx 14.14$$

Answer: The length of side b is approximately 14.14 units.

Example 3: Find a Side in an Oblique Triangle Using Law of Cosines

- Given: $a = 7$, $b = 9$, included angle $C = 60^\circ$.
- Find: side c .

Solution:

Apply Law of Cosines:

$$c^2 = a^2 + b^2 - 2ab \cos C$$
$$c^2 = 7^2 + 9^2 - 2 \times 7 \times 9 \times \cos 60^\circ$$
$$c^2 = 49 + 81 - 2 \times 7 \times 9 \times 0.5$$
$$c^2 = 130 - (2 \times 7 \times 9 \times 0.5) = 130 - (2 \times 7 \times 9 \times 0.5)$$

Calculate:

$$2 \times 7 \times 9 = 126$$

Then:

$$126 \times 0.5 = 63$$

So:

$$c^2 = 130 - 63 = 67$$

$$c = \sqrt{67} \approx 8.19$$

Answer: The missing side (c) is approximately 8.19 units.

Tips for Simplifying Your Final Answer

Achieving a simplified answer is crucial for clarity and correctness. Here are some tips:

- Express radicals in simplest form: For example, $\sqrt{18} = 3\sqrt{2}$.
- Reduce fractions to lowest terms.
- Round decimals to an appropriate number of decimal places, as specified.
- Double-check calculations to avoid errors in radical simplification or arithmetic.

Common Mistakes to Avoid

While solving for missing sides, be mindful of these common pitfalls:

- Confusing the hypotenuse with legs in right triangles.
- Forgetting to convert angles to radians if working with calculators set to radian mode.
- Using the wrong formula for the given data (e.g., Law of Sines vs. Law of Cosines).
- Failing to verify if the triangle inequality holds after calculating the side length.
- Not simplifying radicals or fractions properly.

Conclusion: Mastering the Art of Finding Missing Side

Lengths

Finding the length of a missing side in a triangle or geometric figure hinges on understanding the properties of different

Frequently Asked Questions

Given a right triangle with legs of 6 units and 8 units, find the length of the hypotenuse. Leave your answer as a simplified square root or decimal.

The hypotenuse is $\sqrt{6^2 + 8^2} = \sqrt{36 + 64} = \sqrt{100} = 10$ units.

In a triangle, two sides measure 9 units and 12 units, and the included angle is 90° . Find the length of the third side.

Using the Law of Cosines: $c^2 = 9^2 + 12^2 - 2 \cdot 9 \cdot 12 \cos(90^\circ) = 81 + 144 - 0 = 225$. So, the missing side is $\sqrt{225} = 15$ units.

A triangle has sides of 7 units and 24 units, and the third side is unknown. If the triangle is right-angled with the 24-unit side as the hypotenuse, what is the length of the missing side?

Using Pythagoras: $\text{missing side}^2 = 24^2 - 7^2 = 576 - 49 = 527$. So, the side is $\sqrt{527}$, which simplifies to approximately 22.9 units.

Given two sides of a triangle are 5 units and 13 units, and the angle between them is 60° , find the length of the third side.

Using the Law of Cosines: $c^2 = 5^2 + 13^2 - 2 \cdot 5 \cdot 13 \cos(60^\circ) = 25 + 169 - 130 \cdot 0.5 = 194 - 65 = 129$. The third side is $\sqrt{129}$, approximately 11.36 units.

A right triangle has one leg of 15 units and a hypotenuse of 17 units. Find the length of the other leg.

Using Pythagoras: $\text{other leg} = \sqrt{17^2 - 15^2} = \sqrt{289 - 225} = \sqrt{64} = 8$ units.

In a triangle, sides measure 10 units and 14 units, and the third side measures 16 units. Is this a valid triangle? If yes,

find the length of the missing side if it was unknown.

Since all sides are given, the triangle is valid as all triangle inequalities hold. If the third side was unknown, it must satisfy $14 + x > 10$, $10 + x > 14$, and $14 + 10 > x$, which is true for x between 4 and 24.

Two sides of a triangle measure 9 and 12 units, and the angle between them is 45° . Find the length of the third side.

Using Law of Cosines: $c^2 = 9^2 + 12^2 - 2 \cdot 9 \cdot 12 \cos(45^\circ) = 81 + 144 - 216 (\sqrt{2}/2) \approx 225 - 216 \cdot 0.7071 \approx 225 - 152.91 \approx 72.09$. The side length is $\sqrt{72.09} \approx 8.49$ units.

A triangle has sides of 8 units and 15 units, and the third side is unknown. If the triangle is a right triangle with the side 15 units as the hypotenuse, what is the length of the missing side?

Using Pythagoras: missing side $= \sqrt{(15^2 - 8^2)} = \sqrt{(225 - 64)} = \sqrt{161} \approx 12.69$ units.

Additional Resources

Given The Following Information, Find The Length Of The Missing Side. Leave Your Answer As A Simplified — this type of problem is a fundamental aspect of geometry that often appears in homework, standardized tests, and real-world applications. Understanding how to approach such problems is crucial because they reinforce your grasp of the basic principles of triangles, Pythagoras' theorem, and other geometric concepts. Whether you're dealing with right triangles, scalene, or isosceles triangles, knowing how to find the missing side length and present your answer in its simplest form is an essential skill for students and professionals alike.

Introduction to Finding the Missing Side

When given specific information about a triangle, such as side lengths or angles, the goal is often to find an unknown side. This task involves applying various geometric principles. The most common scenario involves right triangles, where the Pythagorean theorem is used, but other cases may require the Law of Sines or Law of Cosines.

Key points to remember:

- Always identify the type of triangle.
- Determine what information is given.
- Choose the appropriate formula or theorem.
- Simplify your answer to its lowest terms.

This guide will walk you through these steps, providing a thorough understanding and strategy for solving such problems efficiently.

Understanding Types of Triangles and Relevant Theorems

Right Triangles

In right triangles, the Pythagorean theorem is the primary tool:

Pythagorean Theorem:

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

where:

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

Non-Right Triangles

When the triangle is not a right triangle, other formulas come into play:

- Law of Sines:

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

Useful when you know angles and sides opposite those angles.

- Law of Cosines:

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

Useful when you know two sides and the included angle or all three sides.

Step-by-Step Approach to Finding the Missing Side

Step 1: Analyze the Given Data

Carefully note what is provided:

- Lengths of sides
- Measures of angles
- Which side is missing

Tip: Draw a clear diagram if one isn't provided. Label all known quantities.

Step 2: Identify the Type of Triangle

Determine whether the triangle is:

- Right-angled
- Acute or obtuse (non-right triangle)

This decision influences the selection of the appropriate theorem.

Step 3: Select the Appropriate Formula or Theorem

Based on the triangle type:

- Use Pythagoras' theorem for right triangles.
- Use Law of Sines or Cosines for non-right triangles.

Step 4: Set Up the Equation

Insert known values into the formula, paying attention to units and ensuring consistency.

Step 5: Solve for the Missing Side

Perform algebraic manipulations carefully:

- Square roots, if necessary.
- Simplify algebraic expressions.

Step 6: Simplify Your Final Answer

Express your answer in simplest radical form or lowest fractional terms:

- Reduce fractions.
- Simplify radicals (e.g., express $\sqrt{8}$ as $2\sqrt{2}$).

Practical Examples

Example 1: Right Triangle with Known Legs

Problem:

Given a right triangle with legs of lengths 6 and 8, find the hypotenuse.

Solution:

Using Pythagoras' theorem:

$$c^2 = 6^2 + 8^2 = 36 + 64 = 100$$

$$c = \sqrt{100} = 10$$

Final Answer:

The hypotenuse is 10.

Example 2: Non-Right Triangle with Two Sides and Included Angle

Problem:

A triangle has sides of lengths 7 and 10, with the included angle of 60° . Find the length of the third side.

Solution:

Use Law of Cosines:

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

$$c^2 = 7^2 + 10^2 - 2 \times 7 \times 10 \times \cos 60^\circ$$

$$c^2 = 49 + 100 - 140 \times 0.5$$

$$c^2 = 149 - 70 = 79$$

$$c = \sqrt{79}$$

Simplify radical:

Since 79 is prime, radical form is simplest.

Final Answer:

The missing side length is $\sqrt{79}$.

Tips for Simplifying Your Final Answer

- Radical simplification:

Factor out perfect squares from under radicals.

Example: $\sqrt{50} = \sqrt{25 \times 2} = 5\sqrt{2}$.

- Fraction reduction:

Reduce fractions to lowest terms by dividing numerator and denominator by their greatest common divisor.

- Expressing radical form:

When radicals cannot be simplified further, leave the answer in radical form.

Common Mistakes to Avoid

- Misidentifying the triangle type:

Using the wrong theorem can lead to incorrect answers.

- Forgetting to simplify radicals or fractions.

Always reduce to lowest terms to present a clean, professional answer.

- Mixing units:

Ensure all measurements are in the same units before calculations.

- Incorrectly assigning known values:

Label sides and angles accurately based on the given data.

Summary

Given The Following Information, Find The Length Of The Missing Side. Leave Your Answer As A Simplified — problems of this nature require a systematic approach:

- Understand the triangle and what information is provided.
- Identify the appropriate formula (Pythagoras, Law of Sines, Law of Cosines).
- Set up and solve the equation carefully.
- Simplify your answer to its lowest terms.

Mastering these steps enhances your problem-solving skills and confidence in geometry. Remember, practice makes perfect—work through various problems to become proficient at finding missing sides and presenting your answers clearly and accurately.

Final Thoughts

Whether you're tackling a classroom assignment or applying geometry principles in real-world contexts, understanding how to find the length of a missing side and expressing your answer in its simplest form is invaluable. Keep practicing with different types of triangles and given data, and you'll develop a strong intuition for selecting the right method and simplifying your results efficiently.

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