

The Triangle Below Has A Total Perimeter Of 450 Cm: Picture Of A Triangle With Sides 128 And 150. Third

The Triangle Below Has A Total Perimeter Of 450 Cm: Picture Of A Triangle With Sides 128 And 150. Third

Understanding the properties of triangles is fundamental in geometry, whether you're a student, educator, or someone interested in practical applications like construction, design, or engineering. This article delves into a specific problem involving a triangle with a known perimeter and two given side lengths, aiming to determine the unknown side and explore related concepts thoroughly. By analyzing this scenario, you'll gain insights into perimeter calculations, triangle inequalities, and the importance of accurate measurements in real-world contexts.

Introduction to Triangle Properties and Perimeter Calculations

Triangles are among the simplest yet most essential shapes in geometry. A triangle consists of three sides and three angles, and understanding their relationships is crucial for solving various mathematical problems.

Perimeter of a Triangle: The perimeter is the total length of all three sides. It is calculated by summing the lengths of sides a , b , and c :

$$P = a + b + c$$

In the problem at hand, the perimeter is given as 450 cm, and two sides are known: 128 cm and 150 cm. The goal is to find the length of the third side.

Problem Breakdown: Given Data and Objective

The given data points are:

- Total perimeter $(P = 450\text{ cm})$
- Side $(a = 128\text{ cm})$
- Side $(b = 150\text{ cm})$
- Side $(c = ?)$ (unknown)

Our primary objective is to determine the length of the third side, (c) , and verify whether the given measurements satisfy the triangle inequality theorem.

Calculating the Unknown Side Length

Using the perimeter formula:

$$c = P - a - b$$

Substituting the known values:

$$c = 450\text{ cm} - 128\text{ cm} - 150\text{ cm}$$

Calculating step-by-step:

$$c = 450\text{ cm} - 278\text{ cm}$$

$$c = 172\text{ cm}$$

Result: The third side measures 172 cm.

Verifying Triangle Inequality Theorem

Before confirming that these measurements form a valid triangle, it's essential to check the triangle inequality theorem, which states:

- The sum of any two sides must be greater than the third side.

For sides 128 cm, 150 cm, and 172 cm:

1. $(128 + 150 = 278, \text{cm} > 172, \text{cm}) \checkmark$
2. $(128 + 172 = 300, \text{cm} > 150, \text{cm}) \checkmark$
3. $(150 + 172 = 322, \text{cm} > 128, \text{cm}) \checkmark$

Since all three conditions are satisfied, the sides indeed form a valid triangle.

Understanding the Significance of Side Lengths and Perimeter

Knowing the sides of a triangle and its perimeter has numerous practical applications. For example:

- Construction: Accurate side measurements ensure structures are built correctly.
- Navigation: Triangles are fundamental in triangulation methods used in surveying and GPS technology.
- Design and Art: Precise dimensions are essential for creating balanced and proportionate designs.

In this specific problem, the side lengths are within reasonable proportions, making the triangle feasible for various real-world applications.

Analyzing the Triangle's Properties

Having determined the side lengths, we can further analyze properties such as:

- Type of Triangle:
- If $(c^2 = a^2 + b^2)$, the triangle is right-angled.
- If $(c^2 > a^2 + b^2)$, it is obtuse.
- If $(c^2 < a^2 + b^2)$, it is acute.

Let's evaluate:

```
\[
a = 128\,cm, \quad b = 150\,cm, \quad c = 172\,cm
\]
```

Calculate squares:

```
\[
```

$$128^2 = 16,384$$

\]

\[

$$150^2 = 22,500$$

\]

\[

$$172^2 = 29,584$$

\]

Sum of squares of legs:

\[

$$16,384 + 22,500 = 38,884$$

\]

Compare with c^2 :

\[

$$29,584 < 38,884$$

\]

Since $c^2 < a^2 + b^2$, the triangle is acute.

Applications and Practical Considerations

Understanding how to determine missing side lengths from perimeter data is crucial in various fields:

- Architecture: Designing triangular components with specific perimeter constraints.
- Surveying: Calculating unknown distances based on known measurements and total perimeter.
- Engineering: Ensuring structural stability by verifying side lengths satisfy geometric constraints.

In real-world scenarios, measurements often have tolerances, so understanding the relationships between sides and perimeter helps in quality control and adjustments.

Advanced Concepts: Heron's Formula and Area

Calculation

Once the side lengths are known, it's possible to compute the area of the triangle using Heron's formula:

$$A = \sqrt{s(s - a)(s - b)(s - c)}$$

where s is the semi-perimeter:

$$s = \frac{a + b + c}{2} = \frac{450\text{ cm}}{2} = 225\text{ cm}$$

Calculate:

$$s - a = 225 - 128 = 97\text{ cm}$$

$$s - b = 225 - 150 = 75\text{ cm}$$

$$s - c = 225 - 172 = 53\text{ cm}$$

Now, compute the area:

$$A = \sqrt{225 \times 97 \times 75 \times 53}$$

Multiplying step-by-step:

- $225 \times 97 = 21,825$
- $21,825 \times 75 = 1,636,875$
- $1,636,875 \times 53 = 86,720,625$

Finally:

$$A = \sqrt{86,720,625} \approx 9,310.57\text{ cm}^2$$

Thus, the area of the triangle is approximately 9,310.57 square centimeters.

Summary and Key Takeaways

- The third side of the triangle can be accurately calculated using the perimeter formula.
- Given sides of 128 cm and 150 cm with a total perimeter of 450 cm, the missing side is 172 cm.
- Verification through the triangle inequality confirms the validity of the triangle.
- The triangle is acute, based on side length calculations.
- Practical applications include construction, surveying, and design, where precise measurements are essential.
- Heron's formula allows calculation of the triangle's area once the side lengths are known.

Final Thoughts

Mastering the relationships between triangle sides, perimeter, and area enhances problem-solving skills in geometry and related fields. Whether designing physical structures or analyzing spatial data, understanding these principles ensures accuracy and efficiency. The problem discussed illustrates a fundamental approach to solving for unknown measurements in geometric figures, highlighting the importance of systematic calculations and geometric theorems in achieving reliable results.

Remember: Always verify that your measurements satisfy the fundamental properties of triangles, such as the triangle inequality theorem, to ensure your solutions are geometrically valid and applicable in real-world scenarios.

Frequently Asked Questions

What is the length of the third side of the triangle if the other two sides are 128 cm and 150 cm and the total perimeter is 450 cm?

The third side length is 172 cm, calculated by subtracting the sum of the two given sides from the total perimeter: $450 - (128 + 150) = 172$ cm.

Is the triangle with sides 128 cm, 150 cm, and 172 cm valid?

Yes, the triangle is valid because the sum of any two sides exceeds the third: $128 + 150 = 278 > 172$, $128 + 172 = 300 > 150$, and $150 + 172 = 322 > 128$.

What type of triangle is formed with sides 128 cm, 150 cm, and 172 cm?

Since all sides are of different lengths, the triangle is scalene.

How do you verify if a triangle with given side lengths is valid?

By checking that the sum of any two sides is greater than the third side. In this case, all three conditions are satisfied, confirming a valid triangle.

What is the significance of knowing the perimeter when analyzing a triangle?

Knowing the perimeter helps determine missing side lengths, assess the triangle's shape, and is essential for calculations involving area, similarity, or other geometric properties.

Can the third side of the triangle be any length between 122 cm and 278 cm?

Yes, for the triangle to exist with sides 128 cm and 150 cm, the third side must be greater than the difference (22 cm) and less than the sum (278 cm), so it must be between 22 cm and 278 cm. Since the total perimeter is 450 cm, the third side is specifically 172 cm.

How does the perimeter relate to the side lengths in a triangle?

The perimeter is the total length of all sides, so it is the sum of the three side lengths. Knowing two sides and the perimeter allows you to find the third side.

What real-world applications involve calculating the third side of a triangle with given perimeters?

Applications include construction, navigation, design, and engineering, where precise measurements of triangular components are essential for stability and accuracy.

If the perimeter of the triangle was different, say 500 cm, what would be the length of the third side?

With a perimeter of 500 cm, the third side would be $500 - (128 + 150) = 222$ cm.

Why is understanding the relationship between sides and perimeter important in geometry?

It helps in solving problems related to shape dimensions, ensuring the feasibility of designs, and applying geometric principles in various practical scenarios.

Additional Resources

Triangle Perimeter Analysis

When examining geometric figures, especially triangles, understanding their dimensions and properties provides crucial insights into their structure and potential applications. The particular problem at hand involves a triangle with a total perimeter of 450 cm, with two known sides measuring 128 cm and 150 cm, respectively. The third side, which we will refer to as the unknown side, completes the triangle's dimensions. This scenario is not just an exercise in simple arithmetic; it offers a comprehensive opportunity to explore triangle properties, perimeter calculations, and their implications in real-world contexts such as construction, design, and engineering.

In this article, we'll delve deeply into the specifics of this triangle, analyzing how the given data informs us about its possible configurations, constraints, and characteristics. We will also discuss relevant mathematical principles, including triangle inequalities, perimeter calculations, and how to determine the unknown side. Our goal is to provide a detailed, expert-level understanding that can be applied practically or serve as a foundational concept for further study.

Understanding the Basics: Triangle Perimeters and Side Lengths

What Is a Triangle's Perimeter?

The perimeter of a triangle is the total length of its three sides. It's calculated by simply adding the lengths of all three sides:

$$[P = a + b + c]$$

where a , b , and c are the lengths of the sides.

In our case, the total perimeter is given as 450 cm, and two sides are known:

```
\[ a = 128\, \text{cm} \]
\[ b = 150\, \text{cm} \]
\[ c = ? \]
```

The objective is to determine the length of the third side, c , based on the perimeter constraint.

Constraints on the Side Lengths

The triangle inequality theorem states that for any triangle, the sum of the lengths of any two sides must be greater than the length of the remaining side. Specifically:

```
\[
\begin{cases}
a + b > c \\
a + c > b \\
b + c > a
\end{cases}
\]
```

Applying these to our known sides helps us understand the feasible range for the unknown side:

- $128 + 150 = 278$ cm, which means:

```
\[ c < 278\, \text{cm} \]
```

- For the other inequalities:

```
\[ 128 + c > 150 \Rightarrow c > 22\, \text{cm} \]
\[ 150 + c > 128 \Rightarrow c > -22\, \text{cm} \] (which is always true
since side lengths are positive)
```

Thus, the third side, c , must satisfy:

```
\[ 22\, \text{cm} < c < 278\, \text{cm} \]
```

Calculating the Unknown Side: The Core Equation

Step 1: Use the Perimeter Constraint

The total perimeter is 450 cm, so:

$$\begin{aligned} & \backslash[\\ & a + b + c = 450 \\ & \backslash] \end{aligned}$$

Plugging in the known sides:

$$\begin{aligned} & \backslash[\\ & 128 + 150 + c = 450 \\ & \backslash] \end{aligned}$$

Simplifying:

$$\begin{aligned} & \backslash[\\ & 278 + c = 450 \\ & \backslash] \end{aligned}$$

$$\begin{aligned} & \backslash[\\ & c = 450 - 278 = 172 \backslash, \text{cm} \\ & \backslash] \end{aligned}$$

Step 2: Verify Feasibility

Check whether this value complies with the triangle inequality:

- $(128 + 150 = 278)$ cm, and since $(c = 172)$ cm:

$$\begin{aligned} & \backslash[\\ & 128 + 150 = 278 > 172 \\ & \backslash] \end{aligned}$$

- Other inequalities:

$$\begin{aligned} & \backslash[\\ & 128 + 172 = 300 > 150 \\ & \backslash[\\ & 150 + 172 = 322 > 128 \\ & \backslash] \end{aligned}$$

All conditions are satisfied, confirming that the triangle with sides 128 cm, 150 cm, and 172 cm is valid, and the perimeter sums to 450 cm.

Properties and Implications of the Triangle

Side Lengths and Shape Characteristics

With side lengths:

- $a = 128$, cm
- $b = 150$, cm
- $c = 172$, cm

we can analyze the shape and classification of this triangle:

- Scalene Triangle: Since all sides are different, this is a scalene triangle.
- Range of angles: The longest side, $c = 172$, cm , suggests that the triangle is obtuse if the angle opposite c exceeds 90° . To verify, use the Law of Cosines.

Law of Cosines: Determining the Largest Angle

The Law of Cosines states:

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

where C is the angle opposite side c . Solving for $\cos C$:

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

Plugging in the values:

$$\cos C = \frac{(128)^2 + (150)^2 - (172)^2}{2 \times 128 \times 150}$$

Calculations:

$$128^2 = 16,384$$

$$150^2 = 22,500$$

$$172^2 = 29,584$$

Thus:

$$\cos C = \frac{16,384 + 22,500 - 29,584}{2 \times 128 \times 150}$$

$$[$$

$$\cos C = \frac{38,884 - 29,584}{38,400}$$

$$\cos C = \frac{9,300}{38,400} \approx 0.2422$$

Since $\cos C \approx 0.2422 > 0$, the angle C is acute (less than 90°). To find C :

$$C = \arccos(0.2422) \approx 76.0^\circ$$

Similarly, we can determine the other angles, but the key takeaway is that the triangle is acute-angled.

Practical Applications and Contextual Significance

How Such a Triangle Could Be Used in Real Life

Understanding the precise dimensions of a triangle with these side lengths and perimeter is essential in several practical contexts:

- **Construction and Engineering:** Accurate measurements of triangular components are vital in structural design, bridges, and frameworks where load distribution and stability depend on exact angles and lengths.
- **Design and Aesthetics:** Architects and designers might use such triangles in creating patterns, tiling, or decorative elements that require precise geometric shapes.
- **Educational Tools:** This triangle exemplifies fundamental geometric principles and can serve as a teaching model for perimeter calculations, triangle inequalities, and the Law of Cosines.

Customization and Variations

Depending on the specific application, one might explore:

- **Changing the known sides:** How does the triangle's shape change if, say, the side of 150 cm is increased or decreased?
- **Perimeter adjustments:** What if the total perimeter is altered? How does that affect the third side?
- **Angles and height:** Computing the height from the base or analyzing the angles' measures for detailed design work.

Summary and Key Takeaways

- Given the total perimeter of 450 cm and two sides measuring 128 cm and 150 cm, the third side of the triangle is 172 cm.
- The triangle satisfies the triangle inequality theorem, confirming its validity.
- Its classification as a scalene, acute-angled triangle provides insights into its geometric properties and potential use cases.
- The mathematical process involved straightforward algebraic calculations, verification via inequalities, and application of the Law of Cosines to analyze angles.

In conclusion, this triangle exemplifies how basic geometric principles intertwine with practical problem-solving. Whether in academic settings or real-world applications, understanding the relationships between sides, angles, and perimeters empowers designers, engineers, and students alike to craft precise, functional, and aesthetically pleasing structures and objects.

Note: If you envision this triangle visually, imagine a sleek, well-proportioned shape with sides that extend to accommodate various design constraints. Its dimensions make it versatile for multiple uses, from supporting frameworks to artistic geometric patterns, showcasing the importance of precise measurements in both theoretical and applied contexts.

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