

In ABC, AD Is The Altitude From A To BC .Angle B Is 48,angle C Is 52 And BC Is 12,8 Cm.

Determine The

Understanding the Geometry of Triangle ABC and Its Altitude

In ABC, AD is the altitude from A to BC. Angle B is 48° , angle C is 52° , and BC measures 12.8 cm. Determine the specific property or measurement related to this triangle, such as the length of side AB, AC, or the area of triangle ABC. This problem involves fundamental concepts of triangle geometry, including the use of angles, side lengths, and altitude, to find unknown measurements. In this article, we will explore the steps to analyze such a triangle, understand the relevant theorems, and calculate the required values systematically.

Fundamental Concepts in Triangle Geometry

Properties of Triangle ABC

Given the angles and side of triangle ABC, we can utilize various geometric principles to find unknown measurements:

- The sum of interior angles in a triangle is 180° .
- The Law of Sines relates the sides and angles of the triangle.

- The altitude from a vertex divides the triangle into two right triangles, enabling use of right triangle trigonometry.

Understanding the Altitude AD

The altitude AD from vertex A to side BC creates two right triangles, ABD and ACD. This division allows us to apply trigonometric ratios to find side lengths or other measurements.

Step-by-Step Approach to Solve the Problem

1. Summarize Known Data

- Angles: Angle B = 48° , Angle C = 52°
- Side BC: 12.8 cm
- Altitude: AD from A to BC (unknown length)

2. Find Angle A

Since the sum of angles in a triangle is 180° , we calculate:

$$\text{Angle A} = 180^\circ - (\text{Angle B} + \text{Angle C}) = 180^\circ - (48^\circ + 52^\circ) = 80^\circ$$

3. Apply Law of Sines to Find Sides AB and AC

The Law of Sines states:

$$\frac{AB}{\sin C} = \frac{AC}{\sin B} = \frac{BC}{\sin A}$$

Given $BC = 12.8$ cm, and angles A, B, C , we can find AB and AC .

Calculate:

$$\frac{BC}{\sin A} = \frac{12.8}{\sin 80^\circ}$$

Using $(\sin 80^\circ \approx 0.9848)$:

$$\frac{12.8}{0.9848} \approx 13.0$$

Now, find AB and AC :

$$AB = 13.0 \sin C = 13.0 \sin 52^\circ$$

$$(\sin 52^\circ \approx 0.7880)$$

$$AB \approx 13.0 \times 0.7880 \approx 10.25 \text{ cm}$$

Similarly,

$$AC = 13.0 \sin B = 13.0 \sin 30^\circ$$

$$AC = 13.0 \times \sin B = 13.0 \times \sin 48^\circ$$

]

$$(\sin 48^\circ \approx 0.7431)$$

[

$$AC \approx 13.0 \times 0.7431 \approx 9.66 \text{ cm}$$

]

4. Calculate the Altitude AD

The altitude AD drops from A to BC, dividing BC into two segments: BD and DC.

Using the right triangles ABD and ACD, we can find AD via trigonometry.

Alternatively, since we now know AB, AC, and BC, we can find the area of triangle ABC using the formula:

[

$$\text{Area} = \frac{1}{2} \times BC \times AD$$

]

But first, we need to find AD.

Method 1: Using the Law of Sines

In triangle ABC:

[

$$\text{Area} = \frac{1}{2} \times BC \times AD$$

]

To find AD, we can use the formula:

$$\begin{aligned} & \backslash[\\ AD &= AB \times \sin C = AC \times \sin B \\ & \backslash] \end{aligned}$$

Let's verify:

$$\begin{aligned} & \backslash[\\ AD &= AB \times \sin C = 10.25 \times \sin 52^\circ \approx 10.25 \times 0.7880 \approx 8.09, \text{cm} \\ & \backslash] \end{aligned}$$

or,

$$\begin{aligned} & \backslash[\\ AD &= AC \times \sin B = 9.66 \times 0.7431 \approx 7.18, \text{cm} \\ & \backslash] \end{aligned}$$

Since these are different, it's more accurate to use the formula involving the sides and angles directly.

Method 2: Using the formula involving side BC and angles

The altitude AD from A to BC can be found using:

$$\begin{aligned} & \backslash[\\ AD &= BC \times \sin A \\ & \backslash] \end{aligned}$$

But this is incorrect because the altitude is perpendicular from A; the correct approach is:

$\backslash[$

$$AD = AB \sin C$$

]

or

[

$$AD = AC \sin B$$

]

From earlier calculations, the inconsistent results suggest averaging or re-evaluating.

Alternatively, we can find the area directly:

[

$$\text{Area} = \frac{1}{2} AB \sin C \sin B / \sin A$$

]

But perhaps the simplest is to use the formula:

[

$$\text{Area} = \frac{1}{2} BC \sin A$$

]

and solve for AD:

[

$$AD = \frac{2 \text{Area}}{BC \sin A}$$

]

To find the area, use the formula:

[

$$\text{Area} = \frac{1}{2} AB \sin C \sin B$$

\]

or

\[

$$\text{Area} = \frac{1}{2} \times BC \times \text{height}$$

\]

Given that, we can calculate the area using sides AB and AC and the included angle at A.

Using the formula:

\[

$$\text{Area} = \frac{1}{2} \times AB \times AC \times \sin A$$

\]

Plug in values:

\[

$$\text{Area} = \frac{1}{2} \times 10.25 \times 9.66 \times \sin 80^\circ$$

\]

$$(\sin 80^\circ \approx 0.9848)$$

Calculate:

\[

$$\text{Area} \approx 0.5 \times 10.25 \times 9.66 \times 0.9848$$

\]

\[

$$\approx 0.5 \times 99.315 \times 0.9848 \approx 49.66 \times 0.9848 \approx 48.91, \text{ cm}^2$$

Now, find AD:

$$AD = \frac{2 \times \text{Area}}{BC} = \frac{2 \times 48.91}{12.8} \approx \frac{97.82}{12.8} \approx 7.64, \text{ cm}$$

So, the altitude AD is approximately 7.64 cm.

Summary of Calculated Measurements

- Angle A = 80°
- Side AB ≈ 10.25 cm
- Side AC ≈ 9.66 cm
- Altitude AD ≈ 7.64 cm
- Side BC = 12.8 cm
- Area of triangle ABC ≈ 48.91 cm²

Additional Insights and Applications

Using the Results in Real-World Contexts

Understanding how to find unknown measurements in a triangle like ABC has practical applications in fields such as architecture, engineering, and navigation. For instance:

- Designing structures where precise angles and lengths are critical.
- Calculating distances or heights indirectly through triangulation.
- Analyzing the stability or strength of triangular components.

Applying the Knowledge to Similar Problems

The methodology used here can be adapted to solve a variety of triangle-related problems:

1. Identify known angles and sides.
2. Calculate missing angles if necessary.
3. Apply the Law of Sines or Law of Cosines to find unknown side lengths.
4. Use right triangle trigonometry to find altitudes or other segments.
5. Compute areas using appropriate formulas.

Conclusion: Mastering Triangle Geometry for Precise Calculations

Through systematic application of

Frequently Asked Questions

What is the length of the altitude AD in triangle ABC?

Given angles $B = 48^\circ$ and $C = 52^\circ$, and side $BC = 12.8$ cm, first find side AB or AC using the Law of Sines, then use the area formula to find the altitude AD. Calculations show that $AD \approx 6.4$ cm.

How do you find the length of side AB in triangle ABC?

Using the Law of Sines: $AB / \sin C = BC / \sin A$. Since angles B and C are known, find angle $A = 180^\circ - 48^\circ - 52^\circ = 80^\circ$. Then, $AB = (BC \sin C) / \sin A = (12.8 \sin 52^\circ) / \sin 80^\circ$, which calculates to approximately 10.3 cm.

What is the measure of angle A in triangle ABC?

Angle $A = 180^\circ - 48^\circ - 52^\circ = 80^\circ$.

How do you calculate the area of triangle ABC using the given data?

Using the formula: $\text{Area} = 0.5 BC AD$. First, find AD using the relation between side and altitude: $AD = AB \sin C$. Alternatively, use Heron's formula after calculating all sides, or directly compute the area using the formula: $\text{Area} = 0.5 BC \text{ altitude from A}$.

What is the length of the altitude AD from A to BC in triangle ABC?

After calculating the sides, the altitude AD from A to BC is approximately 6.4 cm.

Can you determine side AC in triangle ABC?

Yes. Using Law of Sines: $AC / \sin B = BC / \sin A$. Plugging in the known values: $AC = (12.8 \sin 48^\circ) / \sin 80^\circ$, which is approximately 9.9 cm.

What is the overall process to find the altitude AD in triangle ABC?

First, determine all sides using Law of Sines, then find the area of the triangle, and finally use the area formula ($\text{Area} = 0.5 \text{ base height}$) to solve for AD. The calculations show AD $\approx$ 6.4 cm.

Additional Resources

Understanding the Geometry of Triangle ABC: Analyzing the Altitude from A to BC

In the realm of geometry, triangles serve as fundamental structures that embody a multitude of properties and relationships. Among these, the study of altitudes—the perpendicular segments from a vertex to the opposite side—reveals critical insights into the triangle's internal angles, side lengths, and area. The problem at hand involves triangle ABC with an altitude AD drawn from vertex A to side BC, where the given data includes angles at vertices B and C, as well as the length of side BC. This analysis aims to dissect the problem comprehensively, employing geometric principles and analytical methods to determine the unknowns in the figure.

Understanding the Given Data and Its Significance

Details of the Triangle

The problem provides the following key data points:

- Angles at B and C:
- Angle B = 48°
- Angle C = 52°
- Side BC: 12.8 cm
- Altitude AD: Drawn from vertex A perpendicular to side BC, with D being the foot of the altitude.

This information forms the foundation for calculating various properties of the triangle, such as the remaining angles, sides, area, and the length of the altitude itself.

Significance of the Data

The angles at B and C are close in measure, suggesting the triangle is nearly isosceles but not quite, given the slight difference. The side BC, as the base, is crucial for establishing scale and serves as a reference for deriving other side lengths and heights.

Fundamental Geometric Principles Involved

Sum of Angles in a Triangle

In any triangle, the sum of interior angles is always 180° . Given angles B and C:

- Angle A = $180^\circ - (\text{Angle B} + \text{Angle C})$
- Calculated as: $180^\circ - (48^\circ + 52^\circ) = 180^\circ - 100^\circ = 80^\circ$

This is a straightforward but essential calculation, as knowing all three angles allows for the application of various trigonometric laws.

Law of Sines

The Law of Sines relates the sides of a triangle to the sines of their opposite angles:

$$\frac{AB}{\sin C} = \frac{AC}{\sin B} = \frac{BC}{\sin A}$$

Using this law, we can determine the lengths of sides AB and AC, given BC and all angles.

Altitude in a Triangle

The altitude from A to BC divides the triangle into two right-angled triangles, which can be analyzed using basic trigonometry to find the height (AD) and other side lengths.

Calculating Unknown Side Lengths Using the Law of Sines

Applying the Law of Sines

Given:

- BC = 12.8 cm
- Angle A = 80°
- Angle B = 48°
- Angle C = 52°

The Law of Sines states:

$$\frac{AB}{\sin C} = \frac{BC}{\sin A} = \frac{AC}{\sin B}$$

From this, side AB (opposite angle B) can be found as:

$$AB = \frac{\sin C}{\sin A} \times BC$$

Similarly, side AC (opposite angle C) is:

$$AC = \frac{\sin B}{\sin A} \times BC$$

Calculations

Using known sine values:

- $\sin 80^\circ \approx 0.9848$
- $\sin 52^\circ \approx 0.7880$
- $\sin 48^\circ \approx 0.7431$

Calculate AB:

$$AB = \frac{\sin 52^\circ}{\sin 80^\circ} \times 12.8 \approx \frac{0.7880}{0.9848} \times 12.8 \approx 0.8009 \times 12.8 \approx 10.25, \text{ cm}$$

Calculate AC:

$$AC = \frac{\sin 48^\circ}{\sin 80^\circ} \times 12.8 \approx \frac{0.7431}{0.9848} \times 12.8 \approx 0.755 \times 12.8 \approx 9.66, \text{ cm}$$

Summary of side lengths:

- AB $\approx$ 10.25 cm

- AC = 9.66 cm
- BC = 12.8 cm

These lengths provide a complete picture of the triangle's dimensions.

Determining the Length of the Altitude AD

Approach Overview

The altitude AD from A divides BC into two segments: BD and DC. Since D is the foot of the perpendicular from A, D lies on BC, enabling us to use right triangle trigonometry to find AD.

The process involves:

- Finding the position of D along BC
- Using the known angles and side lengths to compute the height AD

Calculating the Area of Triangle ABC

The area is a key component because the altitude relates directly to the area:

$$\text{Area} = \frac{1}{2} \times BC \times AD$$

Alternatively, the area can be calculated using two sides and the included angle:

$$\text{Area} = \frac{1}{2} \times AB \times AC \times \sin B$$

or

$$\text{Area} = \frac{1}{2} \times BC \times AD$$

Using the formula with sides AB and AC:

$$\text{Area} = \frac{1}{2} \times AB \times AC \times \sin B$$

$$= \frac{1}{2} \times 10.25 \times 9.66 \times \sin 48^\circ$$

$$\approx 0.5 \times 10.25 \times 9.66 \times 0.7431 \approx 0.5 \times 99.2 \times 0.7431 \approx 49.6 \times 0.7431 \approx 36.9, \text{ cm}^2$$

Now, using the area to find AD:

$$AD = \frac{2 \times \text{Area}}{BC} = \frac{2 \times 36.9}{12.8} \approx \frac{73.8}{12.8} \approx 5.77, \text{ cm}$$

Conclusion:

The length of the altitude AD is approximately 5.77 centimeters.

Analyzing the Geometric Properties and Implications

Significance of the Altitude Length

The altitude's length (≈ 5.77 cm) reveals the height of the triangle from vertex A to side BC. This measurement is critical for various applications, including calculating the area, understanding the triangle's shape, and solving related geometric problems.

Area and Its Relevance

The calculated area (~ 36.9 cm²) indicates the size of the triangle. A larger altitude would mean a larger area, assuming the base remains constant. Conversely, a smaller altitude indicates a more elongated or narrow triangle.

Triangle Classification Based on the Calculations

Given the side lengths:

- AB ≈ 10.25 cm
- AC ≈ 9.66 cm
- BC = 12.8 cm

and the angles:

- A = 80°
- B = 48°
- C = 52°

The triangle is scalene (all sides different) and acute-angled (all angles less than 90°). The nearly balanced side lengths and angles suggest a well-proportioned triangle, not leaning towards being obtuse or right-angled.

Applications and Broader Implications

Practical Applications

Understanding such geometric properties has real-world applications, including:

- Architectural Design: Ensuring structural stability and aesthetic proportions.
- Engineering: Calculating forces and stresses in triangular components.
- Navigation and Surveying: Determining distances and angles for mapping.

Educational Significance

The problem exemplifies the integration of multiple geometric principles:

- Use of the Law of Sines and Cosines
- Properties of triangles
- Trigonometric calculations
- Relationship between angles, sides, and heights

It serves as an excellent pedagogical example for students learning advanced geometry and trigonometry.

Summary of Findings and Conclusions

- The angles at vertices B and C are 48° and 52° , respectively, leading to an angle of 80° at vertex A.
- Using the Law of Sines, side lengths AB and AC are approximately 10.25 cm and 9.66 cm, respectively.
- The base BC measures 12.8 cm.

- The altitude AD from A to BC is approximately 5.77 cm, calculated through the area of the triangle

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