MATHEMATICS · GRADES 10-12

Sine law

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how surveyors and builders work out a missing side or angle in a triangle that has no right angle, like measuring across a river or a field you cannot walk straight through. When there is no right angle, the ordinary right triangle tools do not apply, but the sides and their opposite angles still keep a fixed relationship. That relationship lets you work out the distance across the river from measurements taken safely on your own bank. It is the same tool used to map land, lay out a building site, or plot a course that crosses open ground.



Rule

Sine law: in any triangle, each side divided by the sine of its opposite angle gives the same number, so $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$.

A side always pairs with the sine of the angle opposite it.

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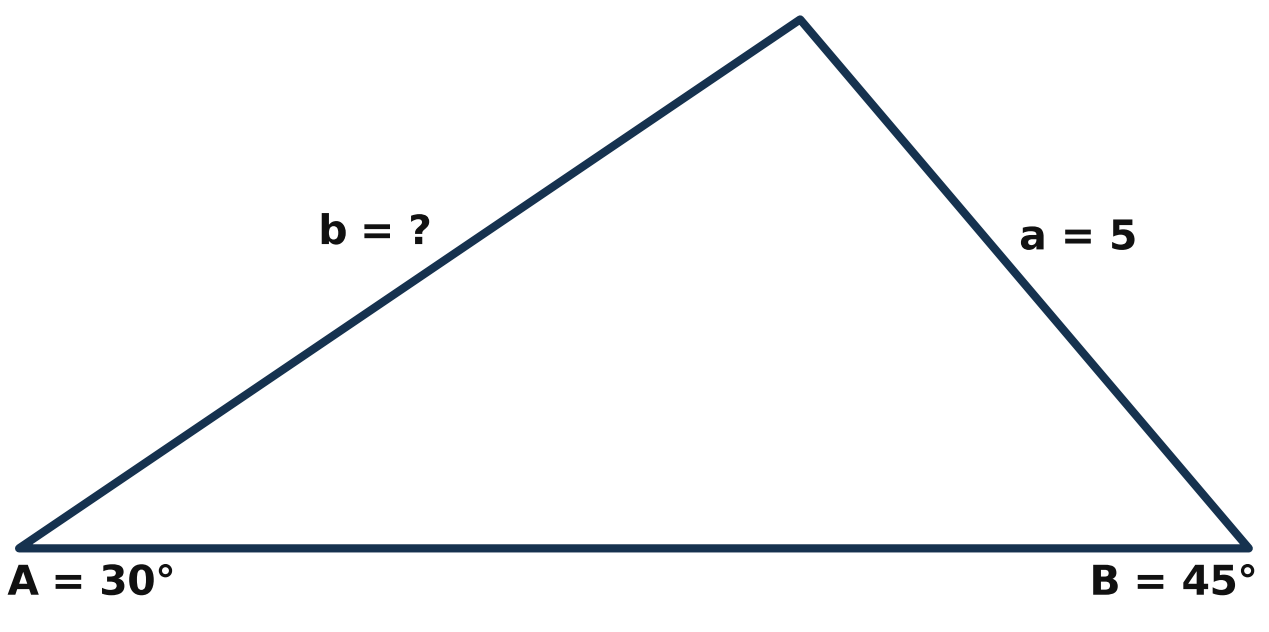
Worked examples

EXAMPLE 1

Q Triangle with A = 30 degrees, a = 5, B = 45 degrees. Find b.



SOLUTION

Sine law: $\frac{a}{\sin A} = \frac{b}{\sin B}$

So $\frac{5}{\sin 30}$ degrees = $\frac{b}{\sin 45}$ degrees. Sin 30 degrees is 0.5 and sin 45 degrees is about 0.707, so this is $\frac{5}{0.5} = \frac{b}{0.707}$.

5 ÷ 0.5 = 10, so b ÷ 0.707 = 10 as well.

That means b = 10 × 0.707 = 7.07.

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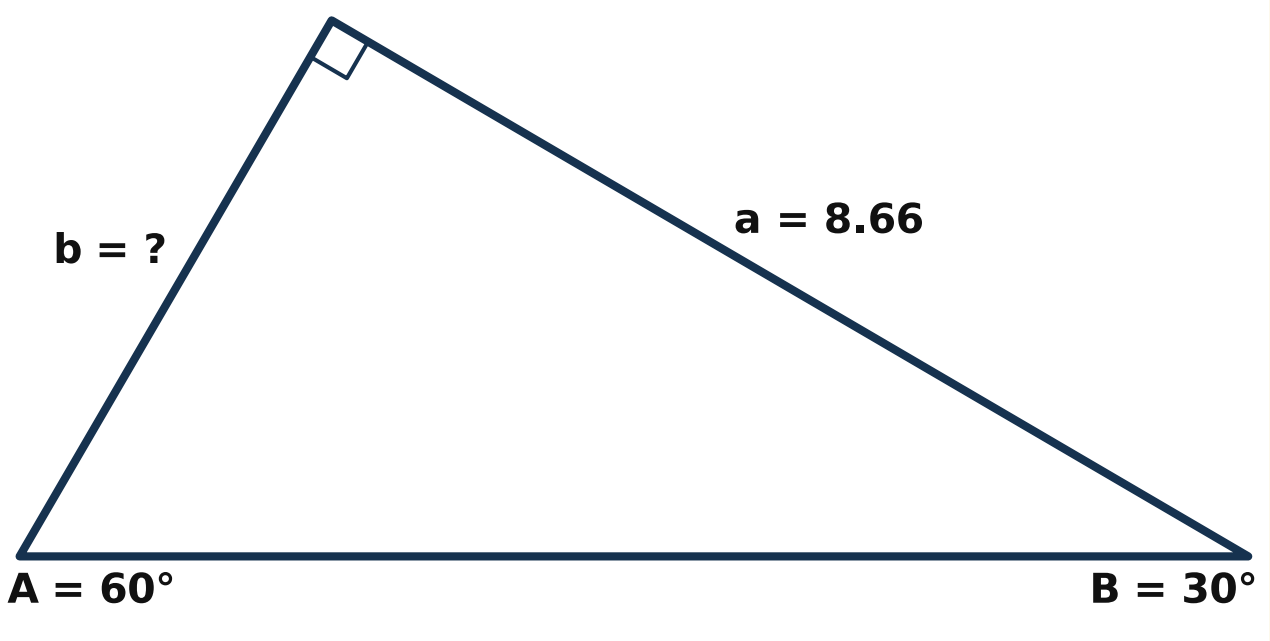
EXAMPLE 2

Q A = 60 degrees, a = 8.66, B = 30 degrees. Find b.



SOLUTION

Set up $\frac{8.66}{\sin 60}$ degrees = $\frac{b}{\sin 30}$ degrees.

sin 60 degrees is about 0.866

8.66 ÷ 0.866 = 10

The left side equals 10, so b ÷ 0.5 = 10 as well.

That means b = 10 × 0.5 = 5.

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Practice questions

1 A triangle has sides a, b, c and opposite angles A, B, C. Write the sine law.

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

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

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

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

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2 A = 30 degrees, a = 6, B = 90 degrees. Find b.

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3 A = 50 degrees, a = 10, b = 8. Find B.

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4 Two triangles share the same $\frac{a}{\sin A}$ value of 10. In one triangle, B = 30 degrees. What is b?

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5 **Why do you use the sine law instead of SOH CAH TOA?**

- **A** When the triangle is right-angled
- **B** When the triangle is not right-angled
- **C** When all three sides are known
- **D** When only one side is known

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6 **A student writes $b = a \times \frac{\sin B}{\sin A}$. Is this the right rearrangement of the sine law?**

- **A** Yes
- **B** No, it should be $a \times \frac{\sin A}{\sin B}$
- **C** No, the sine law uses cos
- **D** No, b = a + sin B

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7 A surveyor measures across a river: A = 30 degrees, a = 50 m, B = 60 degrees. How wide is the river (side b), to the nearest metre?

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8 In the sine law, each side is divided by the sine of what?

- A Its opposite side
- B Its longest side
- C Its opposite angle
- D Its smallest angle

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9 A = 45 degrees, B = 60 degrees, a = 10. Find c.

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10 A = 35 degrees, B = 55 degrees, a = 7. Find b, c, and C.

A. C = 90 degrees, b = 12.20, c = 10.00

B. C = 90 degrees, b = 10.00, c = 12.20

C. C = 55 degrees, b = 10.00, c = 12.20

D. C = 90 degrees, b = 7.00, c = 12.20

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ANSWER KEY

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

2. 12

3. 37.8

4. 5

5. When the triangle is not right-angled

6. Yes

7. 87

8. Its opposite angle

9. 13.66

10. C = 90 degrees, b = 10.00, c = 12.20

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