MATHEMATICS · GRADES 10-12

Ambiguous case of the sine law

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how surveyors and navigators avoid being fooled when a triangle measurement could describe two different triangles. The same set of measurements can sometimes fit a boat in two different positions seen from shore, and both look right on paper. Knowing the ambiguous case exists stops you from picking one answer when there are actually two.



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Rule

Ambiguous case of the sine law: sin x = sin (180 - x).

When you solve for an angle with the sine law, there are two possible angles, the acute angle and its supplement (180 degrees minus the acute angle), and you must check both against the triangle to see which ones fit.

Two triangles are possible only when the side opposite the known angle is shorter than the other known side and longer than the altitude from the known angle (the straight height from the known angle's corner down to the side opposite it).

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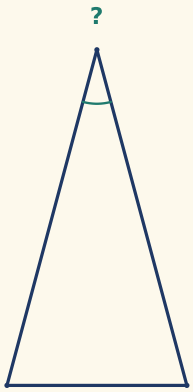
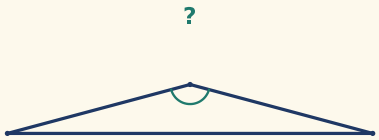
Worked examples

EXAMPLE 1

Q Sin of the unknown angle is 0.5, and the angle is in a triangle. List the possible angles.



Acute angle



Obtuse angle

SOLUTION

$\sin^{-1}(0.5) = 30$ degrees

sin 150 degrees = sin 30 degrees = 0.5

$150 = 180 - 30$

Result: 30 degrees or 150 degrees, before checking the triangle.

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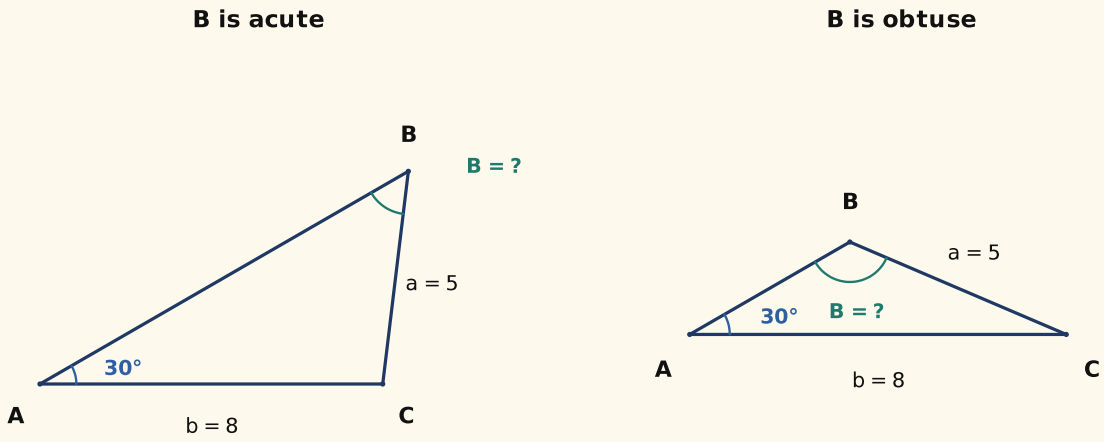
EXAMPLE 2

Q A triangle has A = 30 degrees, a = 5, b = 8. Why might there be two triangles?



SOLUTION

Use the sine law: $\sin B = b \times \frac{\sin A}{a} = 8 \times \frac{0.5}{5} = 0.8$

sin B = 0.8 gives B about 53.13 degrees or about 126.87 degrees.

30 + 53.13 = 83.13 < 180

30 + 126.87 = 156.87 < 180

Result: Both fit, so there are two triangles, one with B acute and one with B obtuse.

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Practice questions

1 If sin x = 0.707, what are the two angles between 0 and 180 degrees?

- A 30 degrees and 150 degrees
- B 45 degrees and 135 degrees
- C 60 degrees and 120 degrees
- D 45 degrees and 90 degrees

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2 If sin x = 0.5 and x is obtuse, what is x?

- A 30 degrees
- B 60 degrees
- C 120 degrees
- D 150 degrees

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3 Why is the sine law case called ambiguous?

- A One sine value gives two possible angles
- B The sine law only works for right triangles
- C Every triangle has two possible solutions
- D The sine law always gives one angle

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4 A triangle has A = 30 degrees, a = 7, and b = 16. How many triangles are possible?

- A One triangle
- B Two triangles
- C Three triangles
- D No triangle

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5 A triangle has A = 40 degrees and a possible B of 60 or 120 degrees. Which sums are valid?

- **A** Only 100 degrees
- **B** Both: 100 degrees and 160 degrees
- **C** Only 160 degrees
- **D** Neither: both sums are over 180 degrees

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6 A triangle has A = 30 degrees, and B could be 53 degrees or 127 degrees. What are the two possible values of the third angle?

- **A** 97 degrees or 23 degrees
- **B** 53 degrees or 127 degrees
- **C** 97 degrees or 127 degrees
- **D** 83 degrees or 157 degrees

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7 What is the supplement of 70 degrees?

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8 A triangle has A = 58 degrees, a = 20, and b = 10. How many triangles are possible?

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9 In the ambiguous case, which side is opposite the known angle: the shorter or the longer of the two known sides?

A The shorter side

B The longer side

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10

If the known angle is obtuse, can there still be two triangles?

A Yes

B No

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ANSWER KEY

1. 45 degrees and 135 degrees

2. 150 degrees

3. One sine value gives two possible angles

4. No triangle

5. Both: 100 degrees and 160 degrees

6. 97 degrees or 23 degrees

7. 110 degrees

8. 1

9. The shorter side

10. No

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