MATHEMATICS · GRADES 10-12

Sine, cosine, and tangent

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you work out a height or a distance you cannot measure directly, like how tall a tree is from its shadow or how high a ramp climbs, using one angle and one side you do know. You cannot climb every tree or stretch a tape across every gap, but you can stand back, measure an angle, and measure the ground you can reach. The three ratios turn that angle and that one known side into the side you need. Surveyors, builders, and navigators use this whenever the direct measurement is out of reach.



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Rule

Sine, cosine, and tangent: in a right triangle,

$$\sin = \frac{\text{opposite}}{\text{hypotenuse}},$$

$$\cos = \frac{\text{adjacent}}{\text{hypotenuse}},$$

$$\text{and } \tan = \frac{\text{opposite}}{\text{adjacent}}.$$

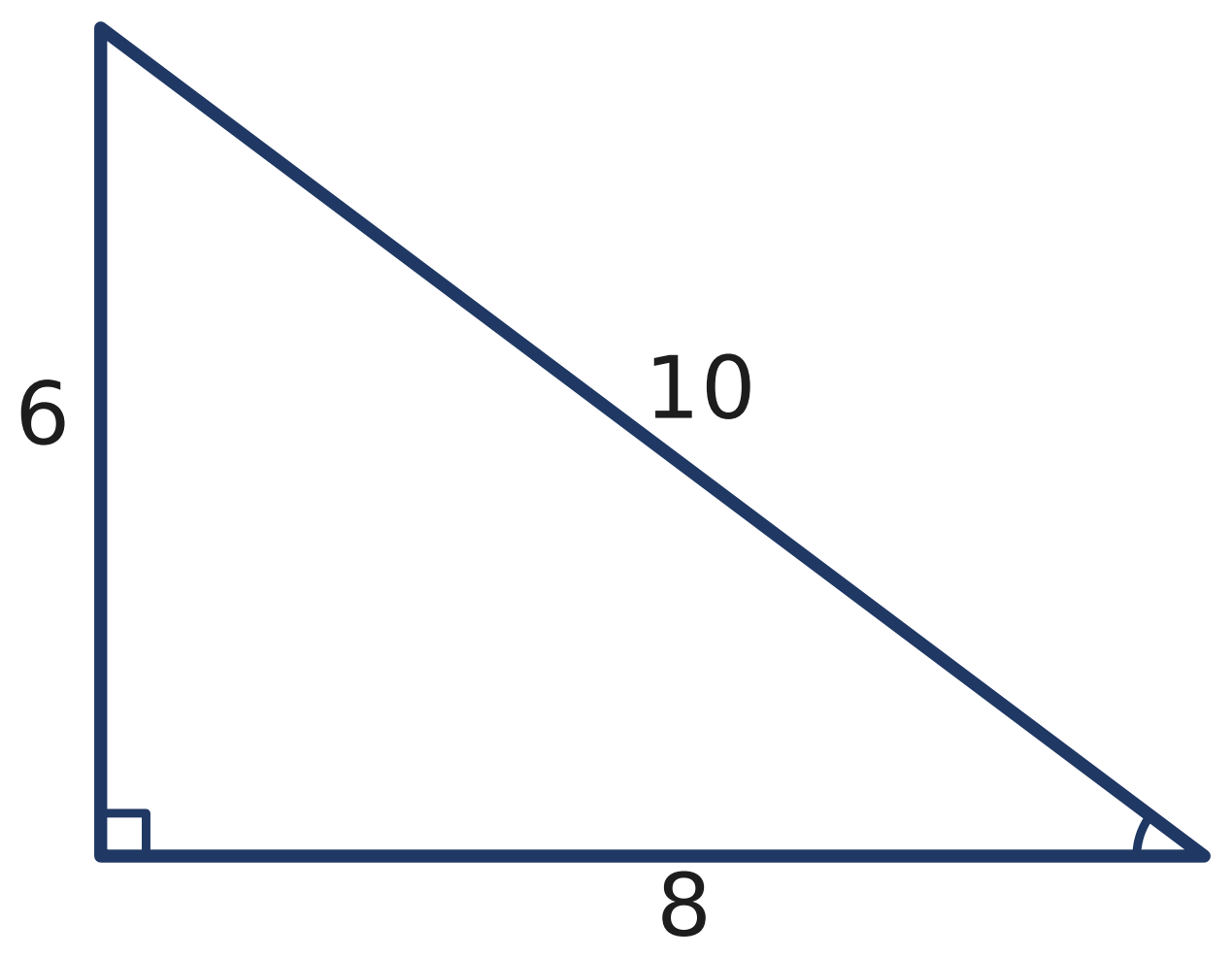
The three ratios always use the sides named by the angle you are working with.

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Worked examples

EXAMPLE 1

Q A right triangle has opposite 6, adjacent 8, hypotenuse 10. Find sin, cos, and tan of the angle.



SOLUTION

Sine is opposite over hypotenuse, so $\sin = \frac{6}{10} = \frac{3}{5}$.

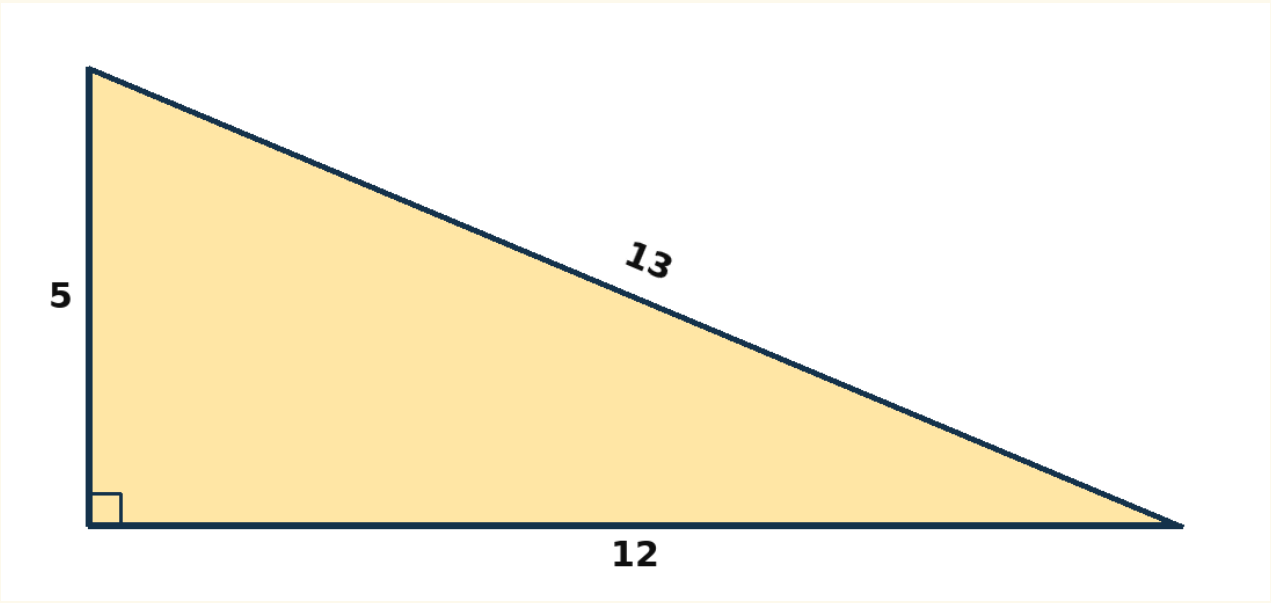
Cosine is adjacent over hypotenuse, so $\cos = \frac{8}{10} = \frac{4}{5}$.

Tangent is opposite over adjacent, so $\tan = \frac{6}{8} = \frac{3}{4}$.

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EXAMPLE 2

Q Opposite 5, adjacent 12, hypotenuse 13. Find the three ratios.



SOLUTION

Sin = opposite over hypotenuse = $\frac{5}{13}$

Cos = adjacent over hypotenuse = $\frac{12}{13}$

Tan = opposite over adjacent = $\frac{5}{12}$

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Practice questions

1 **Opposite 9, adjacent 40, hypotenuse 41. Find sin, cos, and tan of the angle.**

A $\sin \frac{9}{41}, \cos \frac{40}{41}, \tan \frac{9}{40}$

B $\sin \frac{40}{41}, \cos \frac{9}{41}, \tan \frac{40}{9}$

C $\sin \frac{9}{40}, \cos \frac{40}{41}, \tan \frac{9}{41}$

D $\sin \frac{9}{41}, \cos \frac{40}{41}, \tan \frac{40}{9}$

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2 You know the hypotenuse and the angle, and you need the opposite side. Which ratio do you use?

- **A** sin
- **B** cos
- **C** tan
- **D** None of them

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3 A ladder leans so that sin of the angle is $\frac{3}{5}$ and the hypotenuse is 10 m. How long is the opposite side?

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4 Cos of an angle is $\frac{4}{5}$ and the adjacent side is 8 cm. What is the hypotenuse?

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5 Opposite 3, adjacent 4, hypotenuse 5. Find just the tangent of the angle.

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6 A slide drops 12 m over a run of 5 m, with length 13 m. Find just the sine of the angle.

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7 A right triangle has opposite 6 and hypotenuse 10. What is cos of the angle?

- **A** $\frac{4}{5}$
- **B** $\frac{3}{5}$
- **C** $\frac{3}{4}$
- **D** $\frac{5}{4}$

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8 A right triangle has opposite 6 and hypotenuse 10. Write sin of the angle in lowest terms.

- **A** $\frac{3}{5}$
- **B** $\frac{6}{10}$
- **C** $\frac{4}{5}$
- **D** $\frac{5}{3}$

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9 A poster defines sine as adjacent over hypotenuse. What is the correct definition?

- **A** Opposite over hypotenuse
- **B** Adjacent over hypotenuse
- **C** Opposite over adjacent
- **D** Adjacent over opposite

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A poster defines cosine as opposite over hypotenuse. What is the correct definition?

A Opposite over hypotenuse

B Adjacent over hypotenuse

C Opposite over adjacent

D Hypotenuse over adjacent

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ANSWER KEY

1. $\sin \frac{9}{41}, \cos \frac{40}{41}, \tan \frac{9}{40}$

2. sin

3. 6

4. 10

5. $\frac{3}{4}$

6. $\frac{12}{13}$

7. $\frac{4}{5}$

8. $\frac{3}{5}$

9. Opposite over hypotenuse

10. Adjacent over hypotenuse

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