SOHCAHTOA: Right Triangle Word Problems

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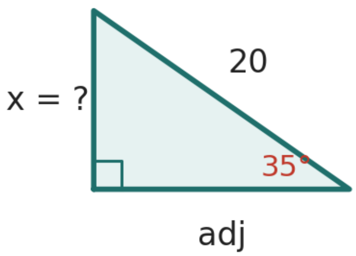
Name: ________________________________ Date: ________________ Score: / 9

Learning Objectives

- Apply sine, cosine, and tangent (SOH-CAH-TOA) to find missing sides of right triangles.
- Use inverse trig functions to find missing angles of right triangles.
- Correctly identify and set up angle-of-elevation word problems.
- Correctly identify and set up angle-of-depression word problems.

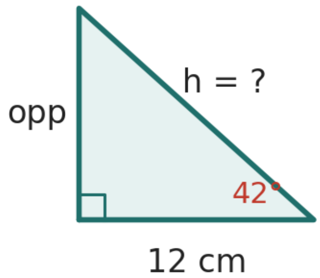
For each problem, draw and label a right triangle, identify which trig ratio applies (SOH, CAH, or TOA), write the equation, and solve for the unknown. Show all work and round as directed.

1. In the right triangle below, the angle at the bottom-right vertex measures 35°. Find the length of the missing side x.



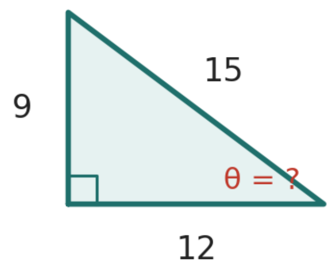
Answer: ___________________________________

2. In the right triangle below, the angle at the bottom-right vertex measures 42° and the adjacent (bottom) side is 12 cm. Find the hypotenuse h.



Answer: ___________________________________

3. In the right triangle below, all three sides are labeled. Find the missing angle θ at the bottom-right vertex. Round to the nearest hundredth of a degree.



Answer: ____________________________________

4. A 15-foot ladder leans against a building, making a 65° angle with the ground. How high up the wall does the ladder reach? Round to the nearest hundredth.

$$\sin(65^\circ) = \frac{h}{15}$$

Answer: ____________________________________

5. A person stands 40 m from the base of a tree. The angle of elevation to the top of the tree is 32°. Find the height of the tree. Round to the nearest tenth.

$$\tan(32^\circ) = \frac{h}{40}$$

Answer: ____________________________________

6. From the top of a 60-meter cliff, a boat is spotted at an angle of depression of 20°. Find the horizontal distance from the base of the cliff to the boat. Round to the nearest tenth.

$$\tan(20^\circ) = \frac{60}{d}$$

Answer: ____________________________________

7. A surveyor observes the top of a 45-meter radio tower at an angle of elevation of 55°. Find the horizontal distance from the surveyor to the base of the tower. Round to the nearest tenth.

$$\tan(55^\circ) = \frac{45}{d}$$

Answer: ____________________________________

8. A flagpole 13 m tall casts a shadow 18 m long on flat ground. Find the angle of elevation of the sun. Round to the nearest tenth of a degree.

$$\tan(\theta) = \frac{13}{18}$$

Answer: ____________________________________

9. An airplane flying at an altitude of 8,000 m spots an airport at an angle of depression of 12°. Find the horizontal distance from the airplane to the airport. Round to the nearest whole number.

$$\tan(12^\circ) = \frac{8000}{d}$$

Answer: ___________________________________

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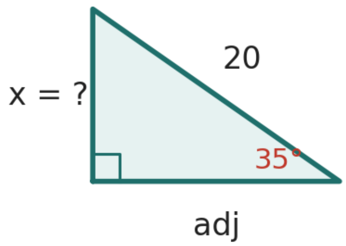
ANSWER KEY & SOLUTIONS

Ensure calculators are in DEGREE mode. For angle-of-depression problems, explicitly remind students that the depression angle equals the elevation angle via alternate interior angles — this is the most common error on these problems.

Solutions

1. In the right triangle below, the angle at the bottom-right vertex measures 35°. Find the length of the missing side x.



→ *The hypotenuse = 20 and the angle = 35°. Side x is opposite to the 35° angle.*
→ *Use SOH: sin(35°) = opposite / hypotenuse = x / 20.*
→ *Solve: x = 20 × sin(35°) ≈ 11.47.*

Answer: $x = 20\sin(35^\circ) \approx 11.47$

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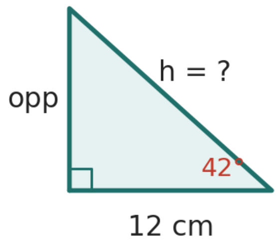
2. In the right triangle below, the angle at the bottom-right vertex measures 42° and the adjacent (bottom) side is 12 cm. Find the hypotenuse h.



→ *Known: adjacent = 12 cm, angle = 42°. Unknown: hypotenuse h.*
→ *Use CAH: cos(42°) = adjacent / hypotenuse = 12 / h.*
→ *Rearrange: h = 12 / cos(42°) ≈ 16.15 cm.*

Answer: $h = \dfrac{12}{\cos(42^\circ)} \approx 16.15\text{ cm}$

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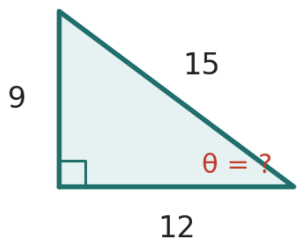
3. In the right triangle below, all three sides are labeled. Find the missing angle θ at the bottom-right vertex. Round to the nearest hundredth of a degree.



→ *Relative to angle θ: opposite = 9, adjacent = 12.*
→ *Use TOA: tan(θ) = opposite / adjacent = 9 / 12 = 0.75.*
→ *Apply inverse tangent: θ = $\tan^{-1}(0.75) \approx 36.87°$.*

Answer: $\theta = \tan^{-1}(0.75) \approx 36.87^\circ$

4. A 15-foot ladder leans against a building, making a 65° angle with the ground. How high up the wall does the ladder reach? Round to the nearest hundredth.

$\sin(65^\circ) = \frac{h}{15}$

→ *Draw a right triangle: ladder (15 ft) = hypotenuse, height h on wall = opposite, ground = adjacent.*
→ *Angle between ladder and ground is 65°. Use SOH: sin(65°) = h / 15.*
→ *Solve: h = 15 × sin(65°) ≈ 13.59 ft.*

Answer: $h = 15\sin(65^\circ) \approx 13.59 \text{ ft}$

5. A person stands 40 m from the base of a tree. The angle of elevation to the top of the tree is 32°. Find the height of the tree. Round to the nearest tenth.

$\tan(32^\circ) = \frac{h}{40}$

→ *Horizontal distance (40 m) = adjacent, tree height h = opposite.*
→ *Use TOA: tan(32°) = h / 40.*
→ *Solve: h = 40 × tan(32°) ≈ 25.0 m.*

Answer: $h = 40\tan(32^\circ) \approx 25.0 \text{ m}$

6. From the top of a 60-meter cliff, a boat is spotted at an angle of depression of 20°. Find the horizontal distance from the base of the cliff to the boat. Round to the nearest tenth.

$\tan(20^\circ) = \frac{60}{d}$

→ *Angle of depression from cliff top = angle of elevation from boat (alternate interior angles) = 20°.*
→ *In the right triangle: cliff height 60 m = opposite, horizontal distance d = adjacent.*
→ *Use TOA: tan(20°) = 60 / d → d = 60 / tan(20°) ≈ 164.8 m.*

Answer: $d = \frac{60}{\tan(20^\circ)} \approx 164.8 \text{ m}$

7. A surveyor observes the top of a 45-meter radio tower at an angle of elevation of 55°. Find the horizontal distance from the surveyor to the base of the tower. Round to the nearest tenth.

$\tan(55^\circ) = \frac{45}{d}$

→ *Tower height (45 m) = opposite, horizontal distance d = adjacent.*
→ *Use TOA: tan(55°) = 45 / d.*
→ *Rearrange: d = 45 / tan(55°) ≈ 31.5 m.*

Answer: $d = \frac{45}{\tan(55^\circ)} \approx 31.5 \text{ m}$

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8. A flagpole 13 m tall casts a shadow 18 m long on flat ground. Find the angle of elevation of the sun. Round to the nearest tenth of a degree.

$\tan(\theta) = \frac{13}{18}$

→ *Flagpole height (13 m) = opposite, shadow length (18 m) = adjacent.*
→ *Use TOA: tan(θ) = 13 / 18 ≈ 0.722.*
→ *Apply inverse tangent: θ = $\tan^{-1}$(0.722) ≈ 35.8°.*

Answer: $\theta = \tan^{-1}(0.722) \approx 35.8^\circ$

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9. An airplane flying at an altitude of 8,000 m spots an airport at an angle of depression of 12°. Find the horizontal distance from the airplane to the airport. Round to the nearest whole number.

$\tan(12^\circ) = \frac{8000}{d}$

→ *Angle of depression from airplane (12°) = angle of elevation from airport (alternate interior angles).*
→ *Set up TOA: tan(12°) = altitude / horizontal distance = 8000 / d.*
→ *Solve: d = 8000 / tan(12°) ≈ 37,635 m.*

Answer: $d = \frac{8000}{\tan(12^\circ)} \approx 37635 \text{ m}$