SOHCAHTOA: Word Problems on Right Triangles

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Name: ______________________________ Date: _______________ Score: / 9

Learning Objectives

- Apply the SOHCAHTOA ratios (sine, cosine, tangent) to find missing sides of a right triangle in real-world contexts
- Distinguish between angle of elevation and angle of depression, and correctly set up the corresponding trigonometric equation
- Use inverse trigonometric functions to determine unknown angles in a right triangle given two known side lengths

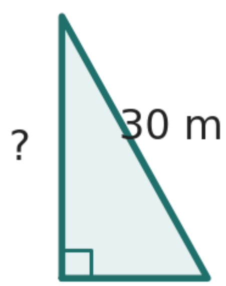
For each problem, sketch a right triangle (or use the diagram provided), label the known and unknown sides, select the correct trigonometric ratio using SOHCAHTOA, and solve; round all answers to two decimal places unless stated otherwise.

1. From a point 80 meters from the base of a building, the angle of elevation to the top of the building is 42°. Find the height of the building to the nearest meter.

$$\tan(42^\circ) = \frac{h}{80}$$

Answer: ________________________________

2. A 30-meter ladder leans against a vertical wall, making a 65° angle with the ground. Find the height h at which the ladder touches the wall.



Answer: ________________________________

3. From the top of a cliff 96 meters high, a ship is spotted at an angle of depression of 24°. Find the horizontal distance d from the base of the cliff to the ship.

$$\tan(24^\circ) = \frac{96}{d}$$

Answer: ________________________________

4. A kite is attached to a taut 120-meter string that makes a 38° angle with the horizontal ground. Find the height h of the kite above the ground.

$$\sin(38^\circ) = \frac{h}{120}$$

Answer: ______________________________________

5. A tree casts a shadow 45 feet long on level ground. If the angle of elevation of the sun is 53°, find the height of the tree.

$$\tan(53^\circ) = \frac{h}{45}$$

Answer: ______________________________________

6. An airplane flying at an altitude of 2,500 meters spots an airport runway at an angle of depression of 32°. Find the horizontal distance d between the airplane and the runway.

$$\tan(32^\circ) = \frac{2500}{d}$$

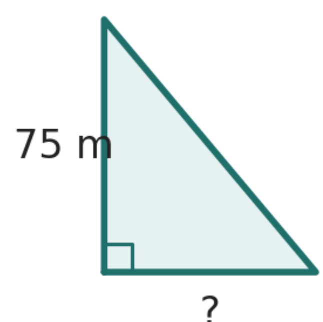
Answer: ______________________________________

7. A right triangle has legs measuring 9 cm and 40 cm. Find the measure of the acute angle θ that is opposite the 9-cm leg. Round to the nearest hundredth of a degree.

$$\tan(\theta) = \frac{9}{40}$$

Answer: ______________________________________

8. A person standing at a horizontal distance d from a 75-meter-tall lighthouse observes the top at an angle of elevation of 50°. The diagram shows the right triangle formed. Find the distance d.



Answer: ______________________________________

9. From a window 20 meters above the ground, a person observes a car parked on the street at an angle of depression of 35°. Find the horizontal distance d from the base of the building to the car.

$$\tan(35^\circ) = \frac{20}{d}$$

Answer: ______________________________________

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ANSWER KEY & SOLUTIONS

Remind students that the angle of depression from an elevated observer always equals the angle of elevation from the object below, because they are alternate interior angles formed by a transversal cutting two parallel horizontal lines — drawing both angles on the same diagram reinforces this relationship.

Solutions

1. From a point 80 meters from the base of a building, the angle of elevation to the top of the building is 42°. Find the height of the building to the nearest meter.

$$\tan(42^\circ) = \frac{h}{80}$$

→ *Draw a right triangle: the 80-m horizontal distance is the adjacent side and h is the opposite side, with the 42° angle at the observer's feet*

→ *Use tangent: tan(42°) = opposite / adjacent = h / 80*

→ *Solve: h = 80 × tan(42°) ≈ 80 × 0.9004 ≈ 72 m*

Answer: $h = 80 \cdot \tan(42^\circ) \approx 72$ m

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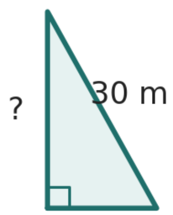
2. A 30-meter ladder leans against a vertical wall, making a 65° angle with the ground. Find the height h at which the ladder touches the wall.



→ *The ladder is the hypotenuse (30 m) and h is the side opposite the 65° angle at the ground*

→ *Use sine: sin(65°) = opposite / hypotenuse = h / 30*

→ *Solve: h = 30 × sin(65°) ≈ 30 × 0.9063 ≈ 27.19 m*

Answer: $h = 30 \cdot \sin(65^\circ) \approx 27.19$ m

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3. From the top of a cliff 96 meters high, a ship is spotted at an angle of depression of 24°. Find the horizontal distance d from the base of the cliff to the ship.

$$\tan(24^\circ) = \frac{96}{d}$$

→ *The angle of depression (24°) from the cliff top equals the angle of elevation from the ship — alternate interior angles with the horizontal line*

→ *The cliff height (96 m) is the opposite side and d is the adjacent side*

→ *Set up: tan(24°) = 96 / d → d = 96 / tan(24°) ≈ 96 / 0.4452 ≈ 215.60 m*

Answer: $d = \frac{96}{\tan(24^\circ)} \approx 215.60$ m

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4. A kite is attached to a taut 120-meter string that makes a 38° angle with the horizontal ground. Find the height h of the kite above the ground.

$$\sin(38^\circ) = \frac{h}{120}$$

→ *The string is the hypotenuse (120 m) and h is the vertical height opposite the 38° angle*
→ *Use sine: sin(38°) = opposite / hypotenuse = h / 120*
→ *Solve: h = 120 × sin(38°) ≈ 120 × 0.6157 ≈ 73.88 m*

Answer: $h = 120 \cdot \sin(38^\circ) \approx 73.88\ \text{m}$

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5. A tree casts a shadow 45 feet long on level ground. If the angle of elevation of the sun is 53°, find the height of the tree.

$$\tan(53^\circ) = \frac{h}{45}$$

→ *The shadow (45 ft) is the adjacent side and the tree height h is the opposite side relative to the 53° sun angle*
→ *Use tangent: tan(53°) = h / 45*
→ *Solve: h = 45 × tan(53°) ≈ 45 × 1.3270 ≈ 59.72 ft*

Answer: $h = 45 \cdot \tan(53^\circ) \approx 59.72\ \text{ft}$

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6. An airplane flying at an altitude of 2,500 meters spots an airport runway at an angle of depression of 32°. Find the horizontal distance d between the airplane and the runway.

$$\tan(32^\circ) = \frac{2500}{d}$$

→ *The angle of depression (32°) from the plane equals the angle of elevation from the runway — alternate interior angles*
→ *Set up: tan(32°) = altitude / horizontal distance = 2500 / d*
→ *Solve: d = 2500 / tan(32°) ≈ 2500 / 0.6249 ≈ 4000.54 m*

Answer: $d = \dfrac{2500}{\tan(32^\circ)} \approx 4000.54\ \text{m}$

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7. A right triangle has legs measuring 9 cm and 40 cm. Find the measure of the acute angle θ that is opposite the 9-cm leg. Round to the nearest hundredth of a degree.

$$\tan(\theta) = \frac{9}{40}$$

→ *The angle θ is opposite the 9-cm leg and adjacent to the 40-cm leg*
→ *Use tangent: tan(θ) = opposite / adjacent = 9/40 = 0.225*
→ *Apply the inverse tangent: θ = tan■^{1}(0.225) ≈ 12.68°*

Answer: $\theta = \tan^{-1}\left(\frac{9}{40}\right) \approx 12.68^\circ$

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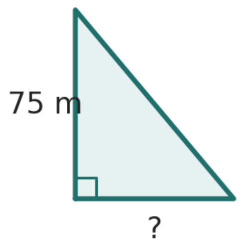
8. A person standing at a horizontal distance d from a 75-meter-tall lighthouse observes the top at an angle of elevation of 50°. The diagram shows the right triangle formed. Find the distance d.



→ *The lighthouse height (75 m) is the opposite side and d is the adjacent side, with the 50° angle at the observer*
→ *Use tangent: tan(50°) = opposite / adjacent = 75 / d*
→ *Solve: d = 75 / tan(50°) ≈ 75 / 1.1918 ≈ 62.97 m*

Answer: $d = \frac{75}{\tan(50^\circ)} \approx 62.97\text{ m}$

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9. From a window 20 meters above the ground, a person observes a car parked on the street at an angle of depression of 35°. Find the horizontal distance d from the base of the building to the car.

$\tan(35^\circ) = \frac{20}{d}$

→ *The angle of depression (35°) from the window equals the angle of elevation from the car*
→ *The window height (20 m) is the opposite side and d is the adjacent side*
→ *Set up: tan(35°) = 20 / d → d = 20 / tan(35°) ≈ 20 / 0.7002 ≈ 28.56 m*

Answer: $d = \frac{20}{\tan(35^\circ)} \approx 28.56\text{ m}$