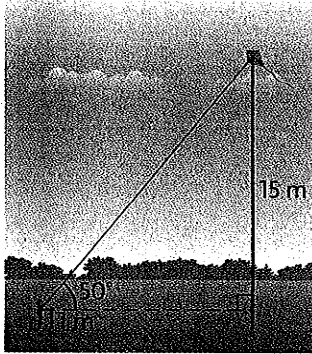
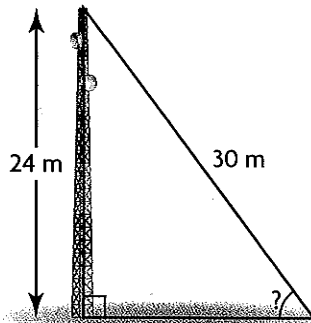
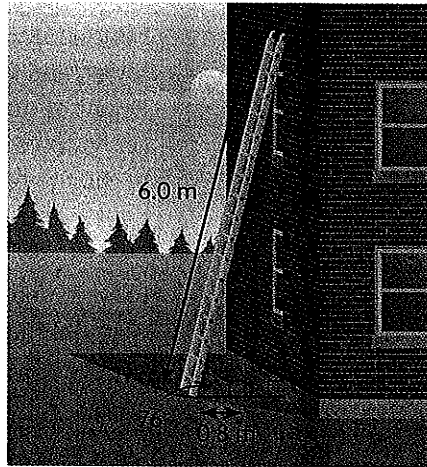


CHECK Your Understanding



1. Isabelle is flying a kite on a windy day. When the kite is 15 m above ground, it makes an angle of 50° with the horizontal. If Isabelle is holding the string 1 m above the ground, how much string has she released? Round your answer to the nearest metre.
2. Bill was climbing a 6.0 m ladder, which was placed against a wall at a 76° angle. He dropped one of his tools directly below the ladder. The tool landed 0.8 m from the base of the ladder. How far from the top of the ladder was Bill?



3. A guy wire is attached to a cellphone tower as shown at the left. The guy wire is 30 m long, and the cellphone tower is 24 m high. Determine the angle that is formed by the guy wire and the ground.

PRACTISING

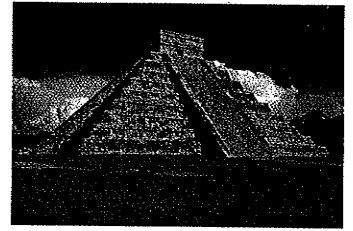
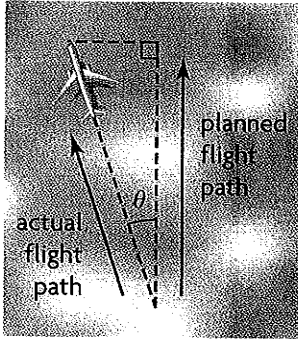
4. A tree that is 9.5 m tall casts a shadow that is 3.8 m long.
K What is the angle of elevation of the Sun?
5. The rise of a rafter drops by 3 units for every 5 units of run. Determine the angle of depression of the rafter.
6. A building code states that a set of stairs cannot rise more than 72 cm for each 100 cm of run. What is the maximum angle at which the stairs can rise?
7. A contractor is laying a drainage pipe. For every 3.0 m of horizontal pipe, there must be a 2.5 cm drop in height. At what angle should the contractor lay the pipe? Round your answer to the nearest tenth of a degree.



Career Connection

Jobs in construction include designer, engineer, architect, project manager, carpenter, mason, electrician, plumber, and welder.

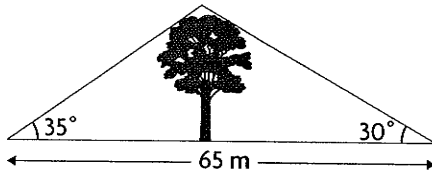
8. Firefighters dig a triangular trench around a forest fire to prevent the fire from spreading. Two of the trenches are 800 m long and 650 m long. The angle between them is 30° . Determine the area that is enclosed by these trenches.
9. A Mayan pyramid at Chichén-Itzá has stairs that rise about 64 cm for every 71 cm of run. At what angle do these stairs rise?
10. After 1 h, an airplane has travelled 350 km. Strong winds, however, have caused the plane to be 48 km west of its planned flight path. By how many degrees is the airplane off its planned flight path?



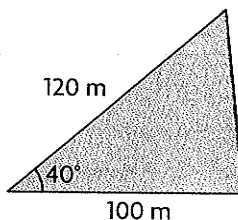
History Connection

Chichén-Itzá, in the Yucatan peninsula of Mexico, was part of the Mayan civilization. The pyramid called El Castillo, or the castle, is a square-based structure with four staircases and nine terraces.

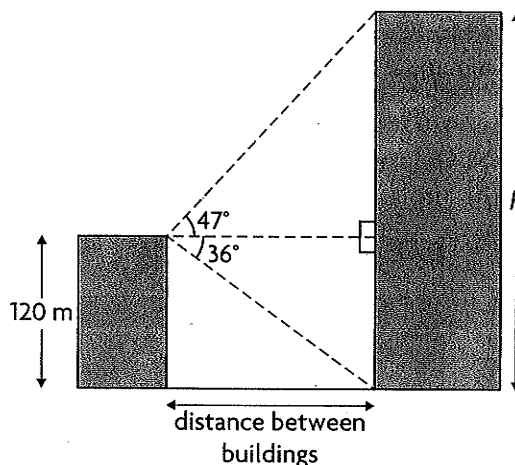
11. Angles were measured from two points on opposite sides of a tree, **A** as shown. How tall is the tree?



12. Determine the angle between the line $y = \frac{3}{2}x + 4$ and the x -axis.
13. A bridge is going to be built across a river. To determine the width of **T** the river, a surveyor on one bank sights the top of a pole, which is 3 m high, on the opposite bank. His optical device is mounted 1.2 m above the ground. The angle of elevation to the top of the pole is 8.5° . How wide is the river?
14. Élise drew a diagram of her triangular yard. She wants to cover her **C** yard with sod. Explain how you could calculate the cost, if sod costs $\$1.50/\text{m}^2$.

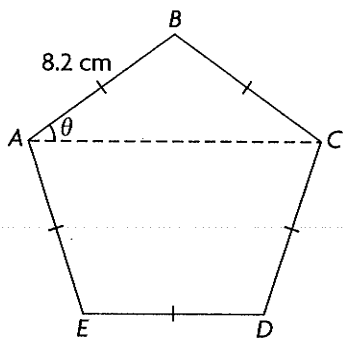


15. A video camera is mounted on top of a building that is 120 m tall. The angle of depression from the camera to the base of another building is 36° . The angle of elevation from the camera to the top of the same building is 47° .



- How far apart are the two buildings? Round your answer to the nearest metre.
 - How tall is the building viewed by the camera? Round your answer to the nearest metre.
16. An isosceles triangle has a height of 12.5 m (measured from the unequal side) and two equal angles that measure 55° . Determine the area of the triangle.
17. To photograph a rocket stage separating, Lucien mounts his camera on a tripod. The tripod can be set to the angle at which the stage will separate. This is where Lucien needs to aim his lens. He begins by aiming his camera at the launch pad, which is 1500 m away. The stage will separate at 20 000 m. At what angle should Lucien set the tripod?
18. Explain the steps you would use to solve a problem that involves a right triangle model and the use of trigonometry.

Extending



- Each side length of regular pentagon $ABCDE$ is 8.2 cm.
 - Calculate the measure of θ to the nearest degree.
 - Calculate the length of diagonal AC to the nearest tenth of a centimetre.
- Determine the acute angle at which $y = 2x - 1$ and $y = 0.5x + 2$ intersect.

FREQUENTLY ASKED Questions

Q: What are the primary trigonometric ratios, and how do you use them?

A: The primary trigonometric ratios for $\angle A$ in $\triangle ABC$ are

$$\sin A = \frac{\text{opposite}}{\text{hypotenuse}} \quad \cos A = \frac{\text{adjacent}}{\text{hypotenuse}} \quad \tan A = \frac{\text{opposite}}{\text{adjacent}}$$

To calculate an angle or a side using a trigonometric ratio, follow these steps:

- Label the sides of the triangle relative to either an acute angle you know or the angle you want to calculate.
- Use the appropriate trigonometric ratio to write an equation that involves the angle or side you want to calculate.
- Solve your equation.

Q: How do you know when to use the inverse trigonometric ratios?

A: Use \sin^{-1} , \cos^{-1} , or \tan^{-1} when you need to determine the measure of an angle and you know the value of a ratio of two sides in a right triangle.

Q: What strategies can you use to solve a problem that involves a right triangle model?

A1: Draw a diagram to model the problem. If you know the measure of one acute angle and the length of one side, follow these steps:

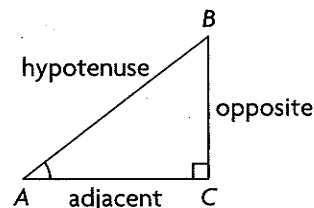
- Determine the third angle by subtracting the right angle and the other known angle from 180° .
- Calculate the two unknown side lengths using trigonometric ratios. Alternatively, calculate one unknown side length using a trigonometric ratio and solve for the last side length using the Pythagorean theorem.

A2: Draw a diagram to model the problem. If you know two side lengths but neither acute angle, follow these steps:

- Use inverse trigonometric ratios to calculate one of the missing angles.
- Calculate the third angle by subtracting the angle you found and the right angle from 180° .
- Calculate the third side using a trigonometric ratio or the Pythagorean theorem.

Study Aid

- See Lesson 7.4, Examples 1 to 3.
- Try Chapter Review Questions 5 to 10.

**Study Aid**

- See Lesson 7.4, Example 3, and Lesson 7.5, Example 3.
- Try Chapter Review Questions 5 b), 7, and 8 b).

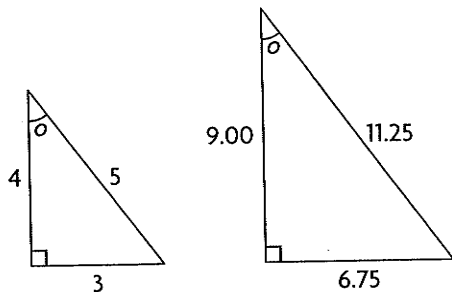
Study Aid

- See Lesson 7.5, Examples 1 to 4, and Lesson 7.6, Examples 1 to 4.
- Try Chapter Review Questions 11 to 17.

PRACTICE Questions

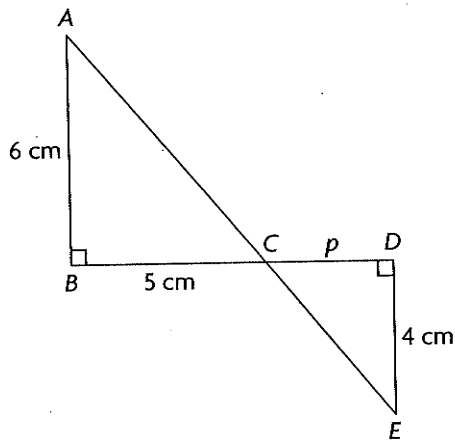
Lesson 7.1

1. Determine whether these triangles are similar. If they are similar, write a proportion statement and determine the scale factor.

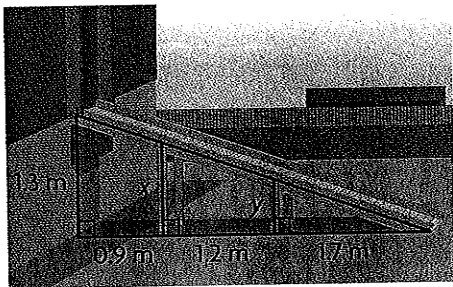


Lesson 7.2

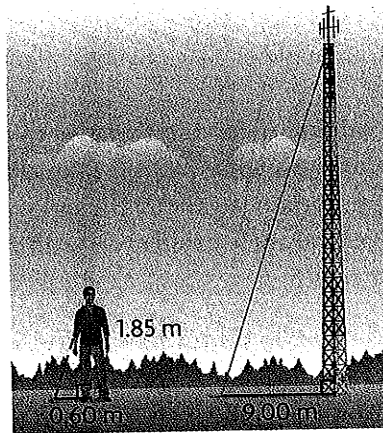
2. State whether the triangles in the diagram are similar. Then determine p .



3. Calculate the heights of the two ramp supports, x and y . Round your answers to the nearest tenth of a metre.

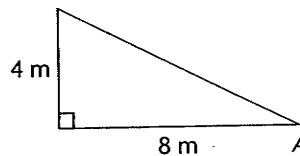


4. Brett needs to support a radio tower with guy wires. Each guy wire must run from the top of the tower to its own anchor 9.00 m from the base of the tower. When the tower casts a shadow that is 9.00 m long, Brett's shadow is 0.60 m long. Brett is 1.85 m tall. What is the length of each guy wire that Brett needs?



Lesson 7.4

5. a) Determine the three primary trigonometric ratios for $\angle A$.



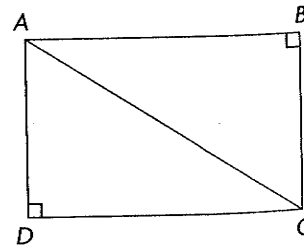
- b) Calculate the measure of $\angle A$ to the nearest degree.

6. Determine x to one decimal place.

a) $\tan 46^\circ = \frac{x}{14.2}$ b) $\cos 29^\circ = \frac{17.3}{x}$

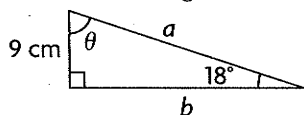
Lesson 7.5

7. $ABCD$ is a rectangle with $AB = 15$ cm and $BC = 10$ cm. What is the measure of $\angle BAC$ to the nearest degree?



8. In $\triangle PQR$, $\angle R = 90^\circ$ and $p = 12.0$ cm.
 a) Determine r , when $\angle Q = 53^\circ$.
 b) Determine $\angle P$, when $q = 16.5$ cm.

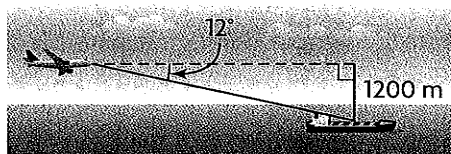
9. Solve this triangle.



10. Maria needs to load cars onto a transport truck. She is planning to drive up a ramp, onto the truck bed. The truck bed is 1.5 m high, and the maximum angle of the slope of the ramp is 35° .
 a) How far is the rear of the truck from the point where the ramp touches the ground?
 b) How long should the ramp be? Round your answer to one decimal place.

Lesson 7.6

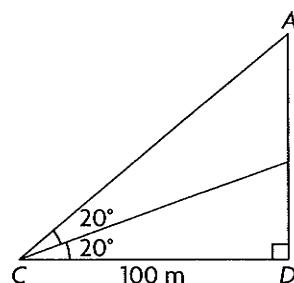
11. A search-and-rescue airplane is flying at an altitude of 1200 m toward a disabled ship. The pilot notes that the angle of depression to the ship is 12° . How much farther does the airplane have to fly to end up directly above the ship?



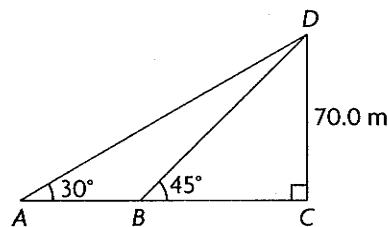
12. The angle of elevation from the top of a 16 m building to the top of a second building is 48° . The buildings are 30 m apart. What is the height of the taller building?
 13. A cyclist pedals his bike 6.5 km up a mountain road, which has a steady incline. By the time he has reached the top of the mountain, he has climbed 1.1 km vertically. Calculate the angle of elevation of the road.



14. Two watch towers at an historic fort are located 375 m apart. The first tower is 14 m tall, and the second tower is 30 m tall.
 a) What is the angle of depression from the top of the second tower to the top of the first tower?
 b) The guards in the towers simultaneously spot a suspicious car parked between the towers. The angle of depression from the lower tower to the car is 7.7° . The angle of depression from the higher tower is 6.3° . Which guard is closer to the car? Explain how you know.
 15. Calculate the length of AB using the information provided. Show all your steps.



16. A swimmer observes that from point A , the angle of elevation to the top of a cliff at point D is 30° . When the swimmer swims toward the cliff for 1.5 min to point B , he estimates that the angle of elevation to the top of the cliff is about 45° . If the height of the cliff is 70.0 m, calculate the distance the swimmer swam.

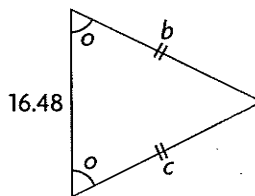
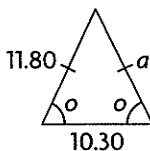


17. A plane takes off in a straight line and travels along this line for 10 s, when it reaches a height of 300 m. If the plane is travelling at 60 m/s, at what angle is the plane ascending?

Process Checklist

- ✓ Questions 2 and 5: Did you visualize or sketch a diagram that represents the information accurately?
- ✓ Question 7: Did you communicate your thinking with words and a diagram that connect the situation with trigonometry?
- ✓ Questions 8 and 9: Did you reflect on the relationship between the given information and the questions asked as you solved the problems?

1. Determine the indicated side lengths in the triangles.



2. Two trees cast a shadow when the Sun is up. The shadow of one tree is 12.1 m long. The shadow of the other tree is 7.6 m long. If the shorter tree is 5.8 m tall, determine the height of the taller tree. Round your answer to the nearest tenth of a metre.

3. Determine each unknown value. Round your answer to one decimal place.

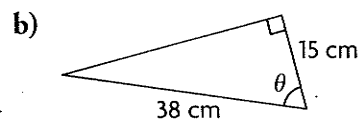
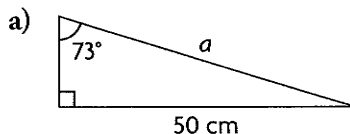
a) $\sin 28^\circ = \frac{x}{5}$

c) $\tan A = 7.1154$

b) $\cos 43^\circ = \frac{13}{y}$

d) $\cos B = \frac{7}{9}$

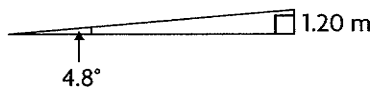
4. Determine the length of the indicated side or the measure of the indicated angle.



5. Solve each triangle.

a) In $\triangle ABC$, $\angle A = 90^\circ$, $\angle B = 14^\circ$, and $b = 5.3$ cm.

b) In $\triangle DEF$, $\angle F = 90^\circ$, $d = 7.8$ mm, and $e = 6.9$ mm.



6. A ramp has an angle of elevation of 4.8° and a rise of 1.20 m, as shown at the left. How long is the ramp and what is its run? Round your answers to the nearest hundredth of a metre.



7. Surveyors need to determine the width of a river. Explain how they can do this without crossing the river. Use a diagram to illustrate your answer.
8. Jane is on the fifth floor of an office building 16 m above the ground. She spots her car and estimates that it is parked 20 m from the base of the building. Determine the angle of depression to the nearest degree.
9. A pilot who is heading due north spots two forest fires. The fire that is due east is at an angle of depression of 47° . The fire that is due west is at an angle of depression of 38° . What is the distance between the two fires, to the nearest metre, if the altitude of the airplane is 2400 m?