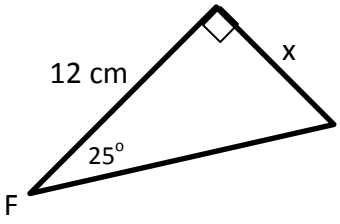
Math 10

Lesson 7–2 Using the trigonometry ratios

I. Determining lengths of sides

In Lesson 7-1 we learned how to find an angle if we were given any two sides of a right triangle. Now we will turn our attention to calculating a side of a triangle if we are given an angle and another side. For example, in the triangle to the right we are given an angle, a side and we are asked to find the length of the unknown side x. We note that the side 12 is adjacent to ∠F and that x is opposite ∠F. Opposite and adjacent are related in the tangent function. Therefore we write



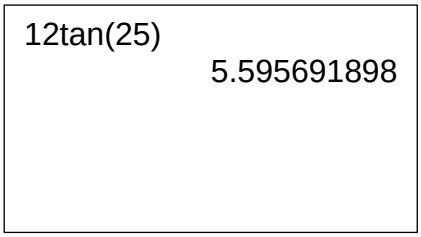
$$\tan K = \frac{\text{opp}}{\text{adj}}$$

$$\tan 25 = \frac{x}{12}$$

$$12\tan 25 = x$$

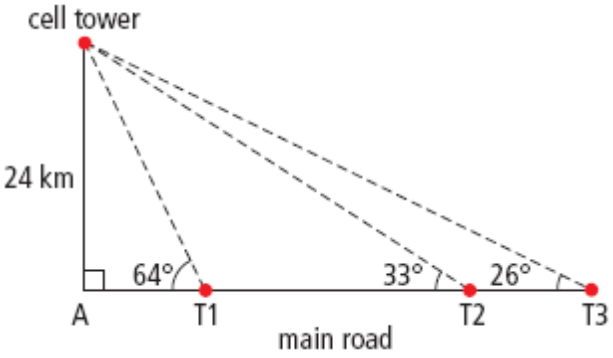
$$\mathbf{5.6\,cm} = x$$

Your calculation on your graphing calculator should look like this.



Example 1 Calculating the adjacent side

A satellite radio cell tower provides signals to three substations, T1, T2, and T3. The three substations are each located along a stretch of the main road. The cell tower is located 24 km down a road perpendicular to the main road. A surveyor measures the angle from T1 to the cell tower to be 64°, from T2 to the cell tower to be 33°, and from T3 to the cell tower to be 26°. Calculate the distance of substation T1 to the intersection of the two roads. Express your answers to the nearest tenth of a kilometre.



Solution

We note that the distance 24 km is opposite the 64° angle and the distance to T1 is the adjacent side. Therefore we write →

$$\tan = \frac{\text{opp}}{\text{adj}}$$

$$\tan 64 = \frac{24}{T1}$$

$$T1\tan 64 = 24$$

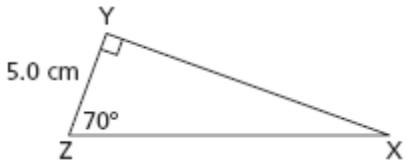
$$T1 = \frac{24}{\tan 64}$$

$$T1 = 11.7\text{km}$$

The distance from the intersection to T1 is 11.7 km.

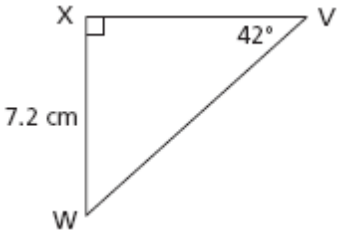
Question 1

Determine the length of XY to the nearest tenth of a centimetre.



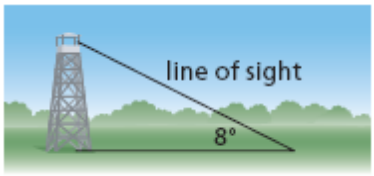
Question 2

Determine the length of VX to the nearest tenth of a centimetre.

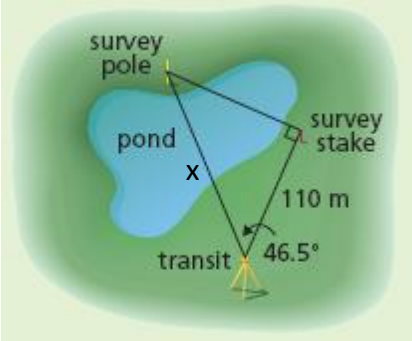


Question 3

At a horizontal distance of 200 m from the base of an observation tower, the angle between the ground and the line of sight to the top of the tower is 8°. How high is the tower to the nearest metre? The diagram is *not* drawn to scale.



Example 2 Surveyor measurement



The diagram shows the measurements taken by surveyors. What is the distance between the transit and the survey pole to the nearest tenth of a metre?

Solution

We note that the 110 m distance is adjacent to the 46.5^{o} angle and the distance x is the hypotenuse of the right triangle. Therefore we write

$$\cos = \frac{\text{adj}}{\text{hyp}}$$

$$\cos 46.5 = \frac{110}{x}$$

$$x \cos 46.5 = 110$$

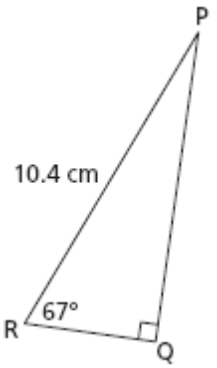
$$x = \frac{110}{\cos 46.5}$$

$$x = 159.8\text{m}$$

The distance from the transit to the surveying pole is 159.8 m.

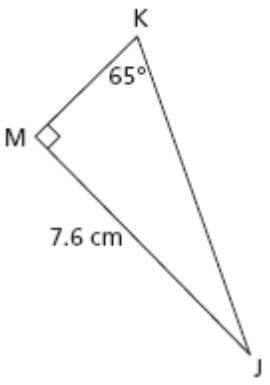
Question 4

Determine the length of PQ to the nearest tenth of a centimetre.



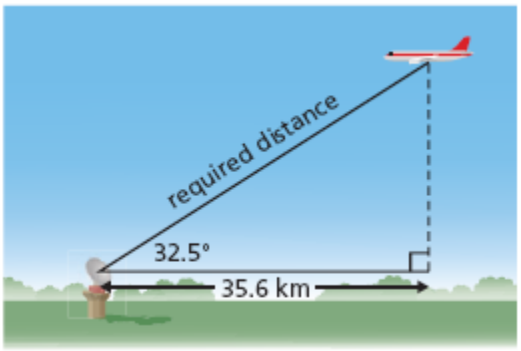
Question 5

Determine the length of JK to the nearest tenth of a centimetre.



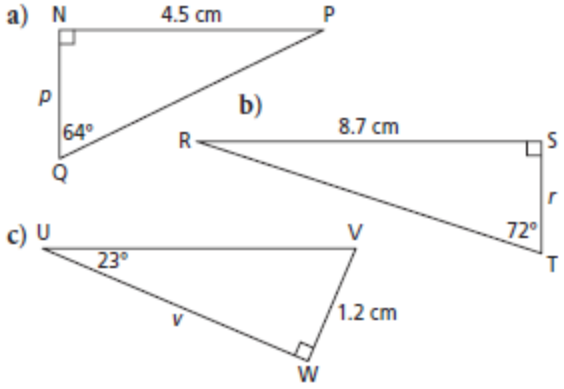
Question 6

From a radar station, the angle of elevation of an approaching airplane is 32.5°. The horizontal distance between the plane and the radar station is 35.6 km. How far is the plane from the radar station to the nearest tenth of a kilometre?

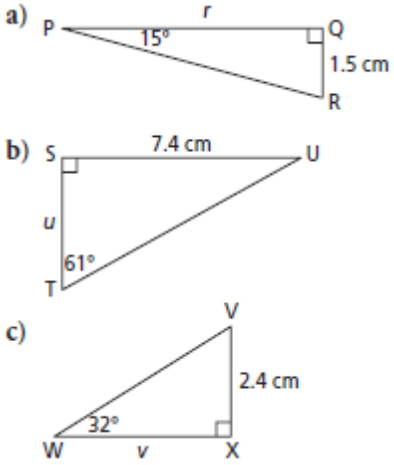


II. Assignment

1. Determine the length of each indicated side to the nearest tenth of a centimetre.



2. Determine the length of each indicated side to the nearest tenth of a centimetre.

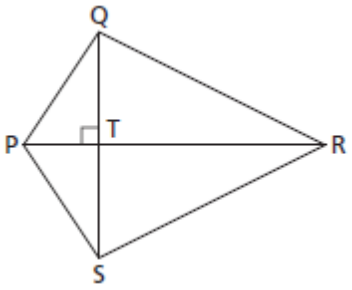


3. The base of a ladder is on level ground 1.3 m from a wall. The ladder leans against the wall. The angle between the ladder and the ground is 71°. How far up the wall does the ladder reach to the nearest tenth of a metre?

4. The angle between one longer side of a rectangle and a diagonal is 34°. One shorter side of the rectangle is 2.3 cm.
   a) Sketch and label the rectangle.
   b) What is the length of the rectangle to the nearest tenth of a centimetre?

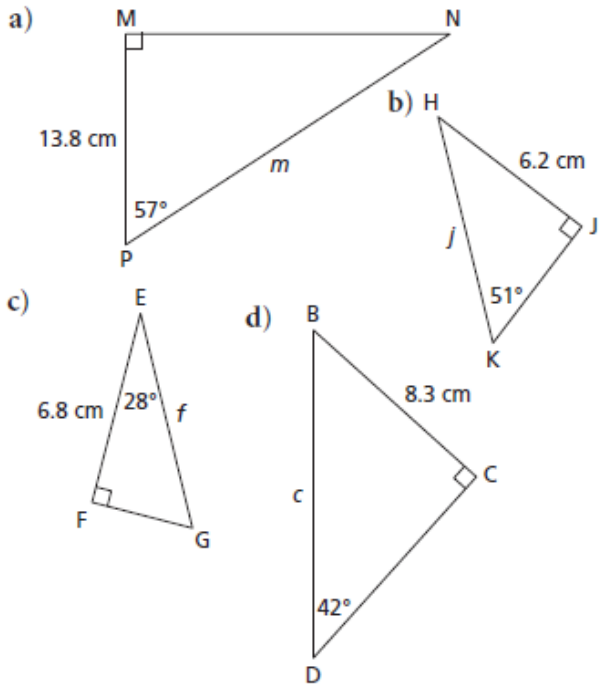
5. In ΔPQR,∠R _90°,∠P _58°, and PR _7.1 cm. Determine the area of ΔPQR to the nearest tenth of a square centimetre.

6. In kite PQRS, the shorter diagonal, QS, is 6.0 cm long, ∠QRT is 26.5°, and ∠QPT is 56.3°. Determine the measures of all the angles and the lengths of the sides of the kite to the nearest tenth.

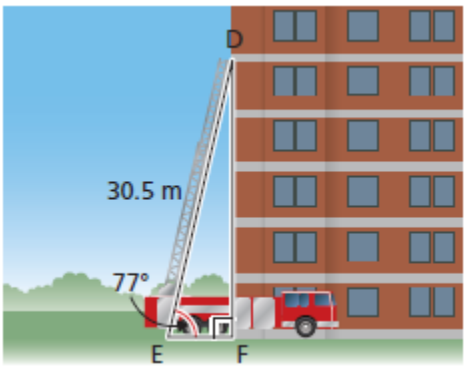


7. On a coordinate grid:
   a) Draw a line through the points A(4, 5) and B(–4,–5). Determine the measure of the acute angle between AB and the *y*-axis.
   b) Draw a line through the points C(1, 4) and D(4,–2). Determine the measure of the acute angle between CD and the *x*-axis.

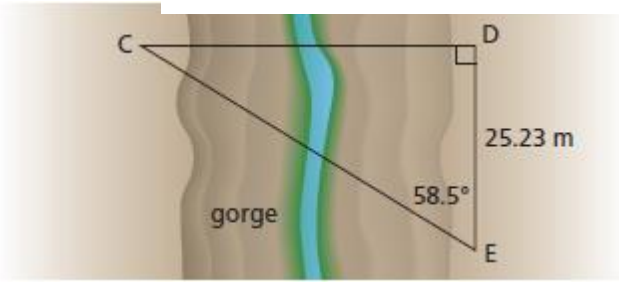
8. Determine the length of each indicated side to the nearest tenth of a centimetre.



9. A fire truck has an aerial ladder that extends 30.5 m measured from the ground. The angle of inclination of the ladder is 77°. To the nearest tenth of a metre, how far up the wall of an apartment building can the ladder reach?



10. A surveyor makes the measurements shown in the diagram to determine the distance from C to E across a gorge.
    a) To the nearest tenth of a metre, what is the distance from C to E?
    b) How could the surveyor calculate the distance from C to D?

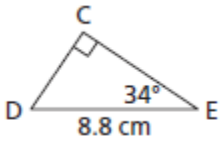


11. A ship is sailing off the north coast of the Queen Charlotte Islands. At a certain point, the navigator sees the lighthouse at Langara Point, due south of the ship. The ship then sails 3.5 km due east. The angle between the ship's path and the line of sight to the lighthouse is then 28.5°. To the nearest tenth of a kilometre, how far is the ship from the lighthouse?

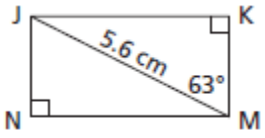
12. An airplane approaches an airport. At a certain time, it is 939 m high. Its angle of elevation measured from the airport is 19.5°. To the nearest metre, how far is the plane from the airport?

13. Determine the perimeter of each shape to the nearest tenth of a centimetre.

i)



ii)



14. In trapezoid CDEF, $\angle D = \angle E = 90°$, $\angle C = 60°$, EF = 4.5 cm, and DE = 3.5 cm. What is the perimeter of the trapezoid to the nearest millimetre?