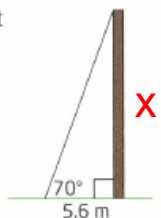# Solutions

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1. A telephone pole is secured at its top with a guy wire, as shown. The guy wire makes an angle of 70° with the ground and is secured 5.6 m from the bottom of the pole. Find the height of the telephone pole.
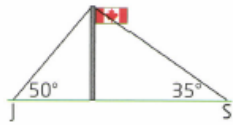
x

70°
5.6 m

tan(θ) = opp/adj

tan(70) = x/5.6
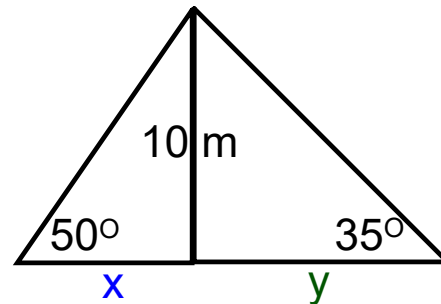
5.6tan(70) = x

15.4 = x

The height of the telephone pole is 15.4 metres.

5. Jack and Sangita are facing each other on opposite sides of a 10-m flagpole. From Jack's point of view, the top of the flagpole is at an angle of elevation of 50°. From Sangita's it is 35°.

How far apart are Jack and Sangita?

$\tan(\theta) = \text{opp/adj}$

10 m

50°   35°

x   y

$\tan(50) = 10/x$

$x\tan(50) = 10$
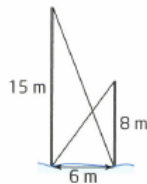
$x = 10/\tan(50)$

$x = 8.4$

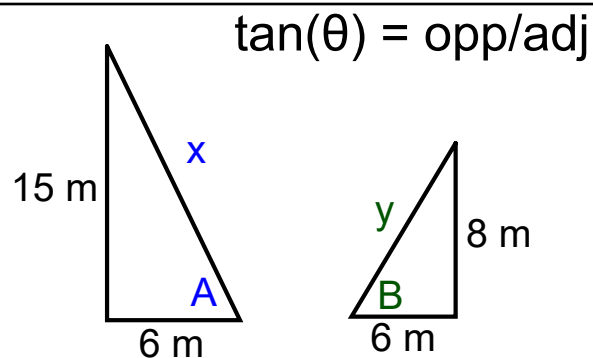$\tan(35) = 10/y$

$y\tan(35) = 10$

$y = 10/\tan(35)$

$y = 14.3$

The distance between Jack and Sangita is 8.4 + 14.3 = 22.7 metres

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7. At the bottom of a ski lift, there are two vertical poles: one 15 m tall and the other 8 m tall. The ground between the poles is level, and the bases of the poles are 6 m apart. The poles are connected by two straight wires.

15 m

8 m

6 m

a) What angle does each wire make with the ground?

b) What is the length of each wire?

$\tan(\theta) = \text{opp/adj}$

15 m   x

A

6 m

y   8 m

B

6 m

a) $\tan(A) = 15/6$
   $A = \tan^{-1}(15/6)$
   $A = 68°$

$\tan(B) = 8/6$
$B = \tan^{-1}(8/6)$
$B = 53°$
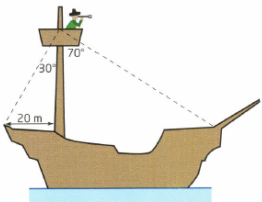
b) As the angles from part a) are rounded you should use the Pythagorean theorem to solve for each hypotenuse.

$x^2 = 15^2 + 6^2$
$x^2 = 225 + 36$
$x^2 = 261$
$x = \sqrt{261}$
$x = 16.2$ m

$y^2 = 8^2 + 6^2$
$y^2 = 64 + 36$
$y^2 = 100$
$y = \sqrt{100}$
$y = 10.0$ m

2

11. Captain Jack is sitting in the crow's-nest of his ship, as shown.
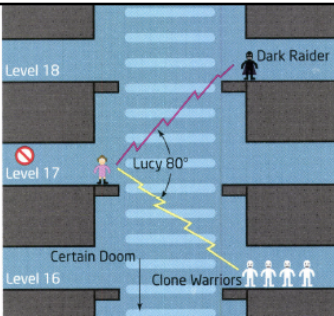
a) How high above the deck is Captain Jack?
b) What is the length of Captain Jack's ship?
c) How long is each wire holding up the crow's-nest?

a)

$\tan(\theta) = \text{opp/adj}$

$\tan(30) = 20/x$

$30°$ x $x\tan(30) = 20$

$x = 20/\tan(30)$

20 m $x = 34.6$ m

b)

$70°$

34.6 m

y

$\tan(70) = y/34.6$

$34.6\tan(70) = y$

$95.1 = y$

The length of the ship is
20 + 95.1 = 115.1 metres

c)

$70°$ b

a $30°$ 34.6 m

20 m   95.1 m
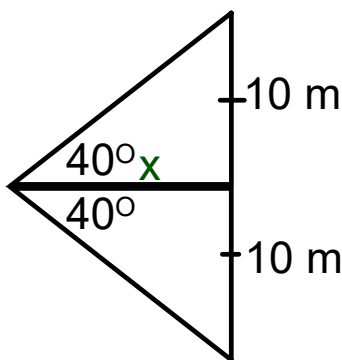
$\sin(\theta) = \text{opp/hyp}$

$\sin(30) = 20/a$ $\sin(70) = 95.1/b$

$a\sin(30) = 20$ $b\sin(70) = 95.1$

$a = 20/\sin(30)$ $b = 95.1/\sin(70)$

$a = 40.0$ m $b = 101.2$ m

12. Lucy Starstrider is trapped on Level 17 of a space station. The evil Dark Raider and his Clone Warriors, who are on Levels 18 and 16 across a deep trench, face her. Lucy's retreat path behind her has been blocked. Her only chance for escape is to try to jump directly across the trench. If she does not make it, she will fall to certain doom.

Lucy estimates that the lines of sight to her enemies are 80° apart, as shown. She also recalls, from the technical plans of the space station, that consecutive levels are 10 m apart, vertically. Using the Source of Power, Lucy can leap a horizontal distance of 12 m. Time is quickly running out! Will Lucy Starstrider escape the clutches of the evil ones, or will she perish? Justify your answer.
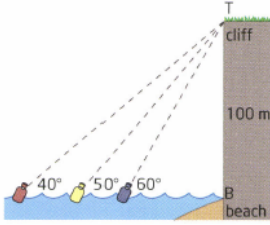
$\tan(\theta) = \text{opp/adj}$

10 m

$40°$ x
$40°$

10 m

$\tan(40) = 10/x$

$x\tan(40) = 10$

$x = 10/\tan(40)$

$x = 11.9$ m

Lucy can jump a total of 12 metres, so she will be able to make the jump of 11.9 metres (just).

15. Theresa and Branko are competing in a series of outdoor challenges that will eventually lead them to a hidden treasure. Each clue they find helps them find a new clue. Theresa is at the top of a cliff that she knows to be 100 m high, looking down at three anchored floating bottles, as shown.
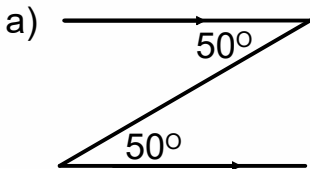
T
cliff
100 m
40° 50° 60°
B
beach

She reads the clue that she and Branko just found:

From the top of the cliff, find the bottle whose angle of depression is 50°.

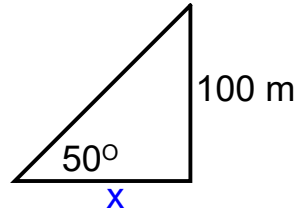Branko is waiting on the beach below for instructions from Theresa.

a) What colour bottle should Theresa tell Branko to look for?

b) How far out should she tell him to swim?

a)

50°

50°

Angle of Depression is the angle between the horizontal and the object you are looking at.

Angle of depression = angle between line of sight and the water.

Therefore, Branko should look for the yellow bottle.

b)

100 m

50°

x

tan(θ) = opp/adj

tan(50) = 100/x

xtan(50) = 100

x = 100/tan(50)

x = 83.9 m

Branko should swim out 84 metres.

20. Edmonton's CN Tower is a highrise office building. From a point 35 m from the base of the building and level with the base, the angle of elevation of the top is 72.5°. Find the height of Edmonton's CN Tower, to the nearest metre.
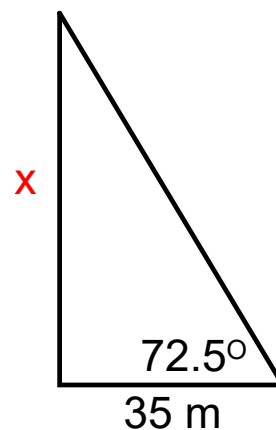
x

72.5°

35 m

tan(θ) = opp/adj
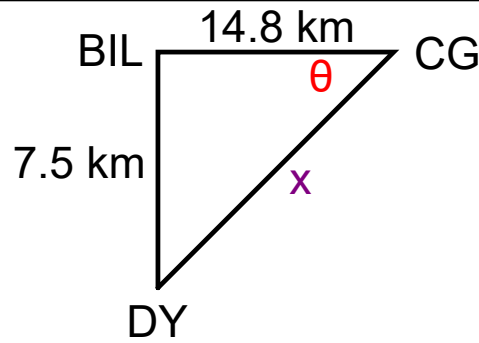
tan(72.5) = x/35

35tan(72.5) = x

111.0 = x
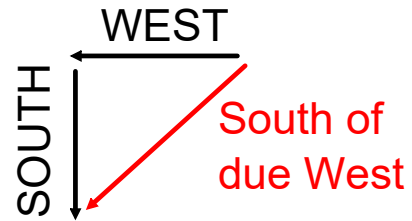
The height of Edmonton's CN Tower is 111 metres.

21. A coast guard patrol boat is 14.8 km east of the Brier Island lighthouse. A disabled yacht is 7.5 km south of the lighthouse.

a) How far is the patrol boat from the yacht, to the nearest tenth of a kilometre?

b) At what angle south of due west, to the nearest degree, should the patrol boat travel to reach the yacht?
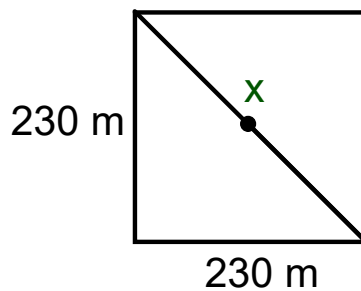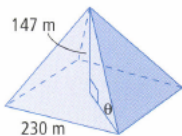
BIL — 14.8 km — CG

θ

7.5 km

x

DY

a) $x^2 = 14.8^2 + 7.5^2$
    $x^2 = 219.04 + 56.25$
    $x^2 = 275.29$
    $x = \sqrt{275.29}$
    $x = 16.6$ km

b) $\tan(\theta) = opp/adj$

WEST

SOUTH

South of due West

$\tan(\theta) = 7.5/14.8$
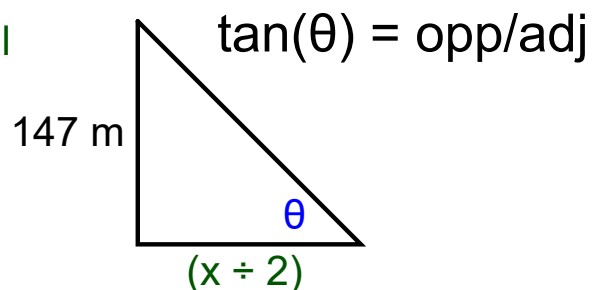
$\theta = \tan^{-1}(7.5/14.8)$

$\theta = 27°$

23. The Great Pyramid of Cheops is a square-based pyramid with a height of 147 m and a base length of 230 m. Find the angle, to the nearest degree, that one of the edges of the pyramid makes with the base.

147 m

230 m

Plan view (from above) of the pyramid. Dot represents the tip of the pyramid.

230 m

x

230 m

Use Pythagorean theorem to find the length of the diagonal of the square

$x^2 = 230^2 + 230^2$
$x^2 = 52900 + 52900$
$x^2 = 105800$
$x = \sqrt{105800}$
$x = 325.3$ m

$\tan(\theta) = opp/adj$

147 m

θ

$(x \div 2)$

$\tan(\theta) = 147/(325.3 \div 2)$

$\theta = \tan^{-1}(147/162.65)$

$\theta = 42°$