

6.2 Trigonometric Applications Day 2

Example 5 Height Above Sea Level

A straight road leads from an ocean beach at a constant upward angle of 3° . How high above sea level is the road at a point 1 mile from the beach?

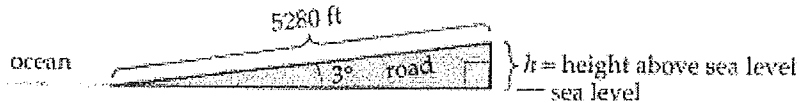


Figure 6.2-6

Example 6 Ladder Safety

According to the safety sticker on a 20-foot ladder, the distance from the bottom of the ladder to the base of the wall on which it leans should be one-fourth of the length of the ladder: 5 feet.

- How high up the wall will the ladder reach?
- If the ladder is in this position, what angle does it make with the ground?

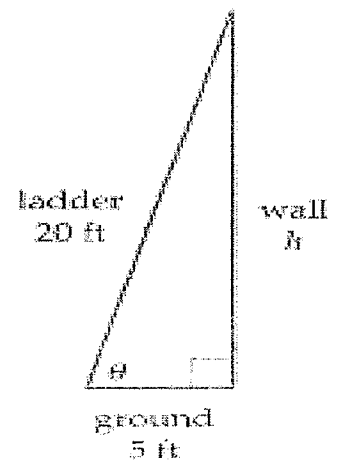


Figure 6.2-7

Angles of Elevation and Depression

In many applications the angle between a horizontal line and another line is used, such as the line of sight from an observer to a distant object. If the line is above the horizontal, the angle is called the **angle of elevation**.

If the line is below the horizontal, the angle is called the **angle of depression**.

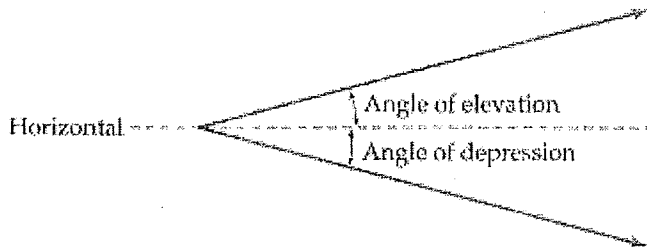


Figure 6.2-9

Example 7 Indirect Measurement

A flagpole casts a 60-foot shadow when the angle of elevation of the sun is 35° , as shown in Figure 6.2-10. Find the height of the flagpole.

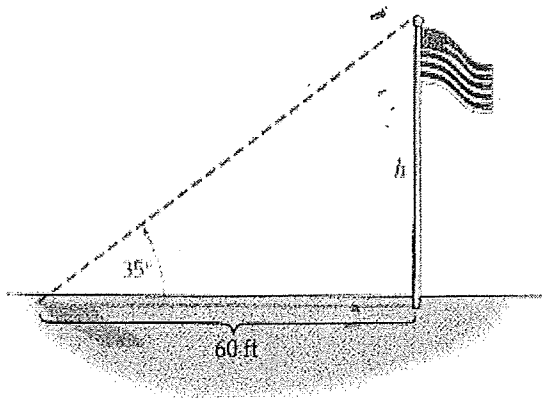
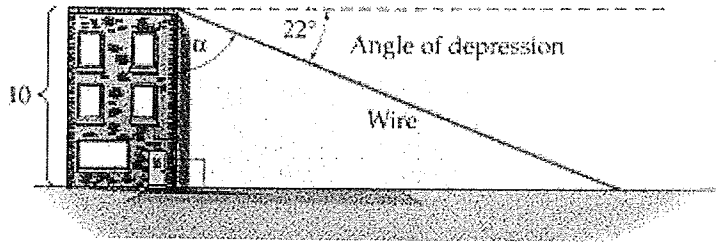


Figure 6.2-10

Example 8 Indirect Measurement

A wire needs to reach from the top of a building to a point on the ground. The building is 10 m tall, and the angle of depression from the top of the building to the point on the ground is 22° . How long should the wire be?



Example 9 Indirect Measurement

A person on the edge of a canal observes a lamp post on the other side with an angle of elevation of 12° to the top of the lamp post and an angle of depression of 7° to the bottom of the lamp post from eye level. The person's eye level is 152 cm (about 5 ft).

- a. Find the width of the canal.
- b. Find the height of the lamp post.

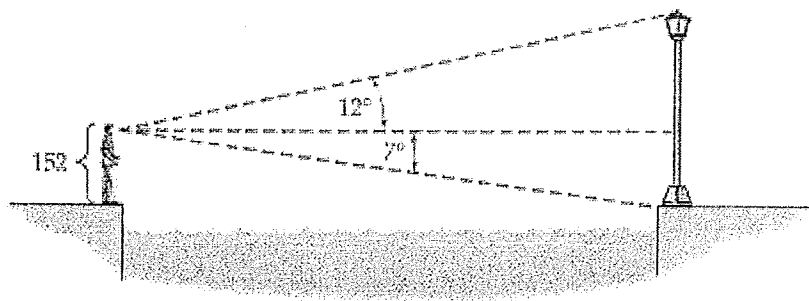
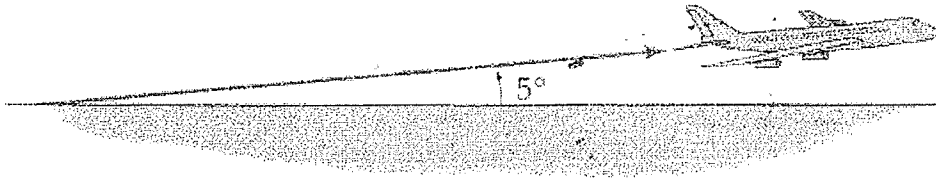


Figure 6.2-12

1.2 HOMEWORK!!!

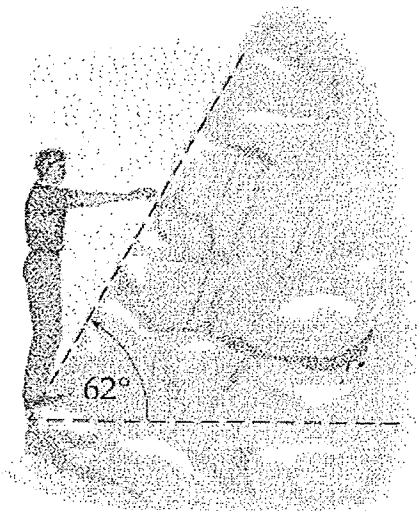
37. A 24-ft ladder positioned against a wall forms an angle of 75° with the ground.
- How high up the wall does the ladder reach?
 - How far is the base of the ladder from the wall?

39. A plane takes off at an angle of 5° . After traveling 1 mile along this flight path, how high (in feet) is the plane above the ground? (1 mi = 5280 ft)



41. The Ohio Turnpike has a maximum uphill slope of 3° . How long must a straight uphill segment of the road be in order to allow a vertical rise of 450 feet?

43. Suppose that a person with a reach of 27 inches and a shoulder height of 5 feet is standing upright on a mountainside that makes a 62° angle with the horizontal, as shown in the figure below. Can the person touch the mountain?



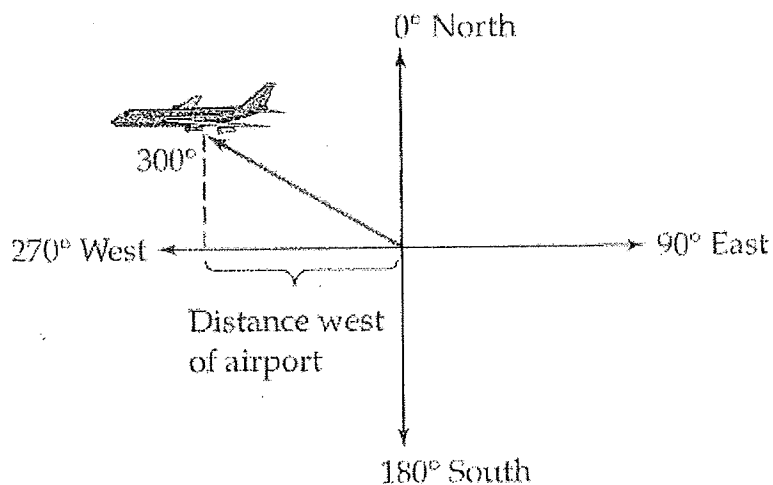
45. A wire from the top of a TV tower makes an angle of 49.5° with the ground and touches the ground 225 feet from the base of the tower. How high is the tower?

47. A buoy in the ocean is observed from the top of a 40-meter-high radar tower on shore. The angle of depression from the top of the tower to the base of the buoy is 6.5° . How far is the buoy from the base of the radar tower?

49. A man stands 12 feet from a statue. The angle of elevation from eye level to the top of the statue is 30° , and the angle of depression to the base of the statue is 15° . How tall is the statue?

51. A rocket shoots straight up from the launch pad. Five seconds after lift-off, an observer 2 miles away notes that the rocket's angle of elevation is 3.5° . Four seconds after that, the angle of elevation is 41° . How far did the rocket rise during those 4 seconds?

55. In aerial navigation, directions are given in degrees clockwise from north, called *headings*. Thus east is 90° , south is 180° , and so on, as shown below. A plane travels from an airport for 200 miles at a heading of 300° . How far west of the airport is the plane?



6.2 Trigonometric Applications Day 2

Example 5 Height Above Sea Level

A straight road leads from an ocean beach at a constant upward angle of 3° . How high above sea level is the road at a point 1 mile from the beach?

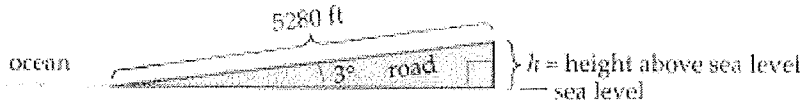


Figure 6.2-6

$$\begin{aligned}\sin 3 &= \frac{h}{5280} \\ h &= 5280 \sin 3 \\ &\approx 276.33 \text{ ft}\end{aligned}$$

Example 6 Ladder Safety

According to the safety sticker on a 20-foot ladder, the distance from the bottom of the ladder to the base of the wall on which it leans should be one-fourth of the length of the ladder: 5 feet.

- How high up the wall will the ladder reach?
- If the ladder is in this position, what angle does it make with the ground?

$$\begin{aligned}\text{a) } h^2 + 5^2 &= 20^2 \\ h^2 + 25 &= 400 \\ h^2 &= 375 \\ h &\approx 19.36\end{aligned}$$

$$\begin{aligned}\text{b) } \cos \theta &= \frac{5}{20} = \frac{1}{4} \\ \theta &\approx 75.5^\circ\end{aligned}$$

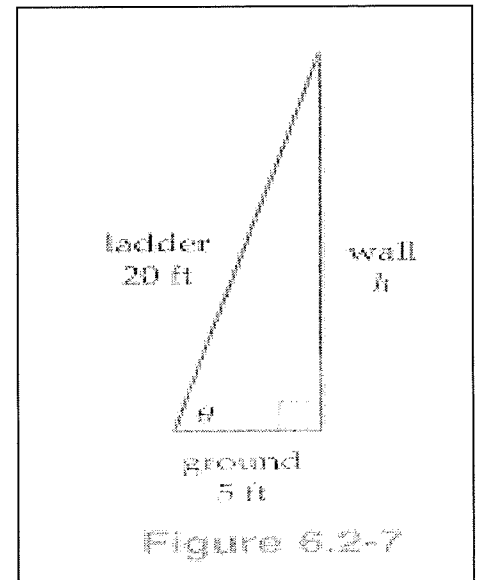


Figure 6.2-7

Angles of Elevation and Depression

In many applications the angle between a horizontal line and another line is used, such as the line of sight from an observer to a distant object. If the line is above the horizontal, the angle is called the **angle of elevation**.

If the line is below the horizontal, the angle is called the **angle of depression**.

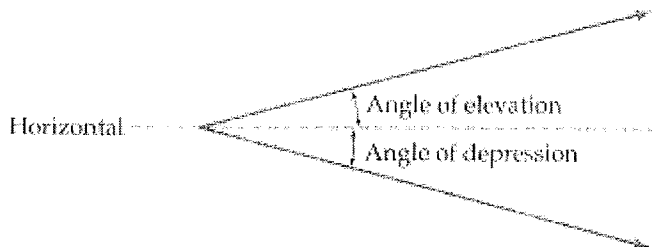


Figure 6.2-9

Example 7 Indirect Measurement

A flagpole casts a 60-foot shadow when the angle of elevation of the sun is 35° , as shown in Figure 6.2-10. Find the height of the flagpole.

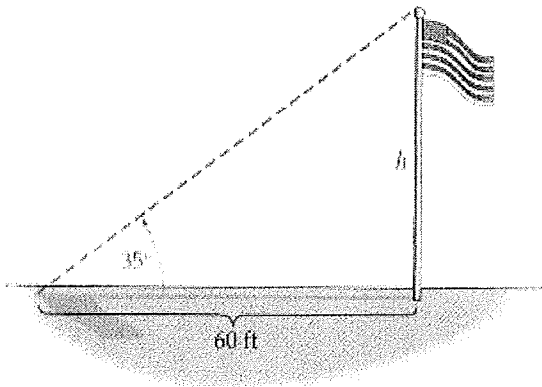
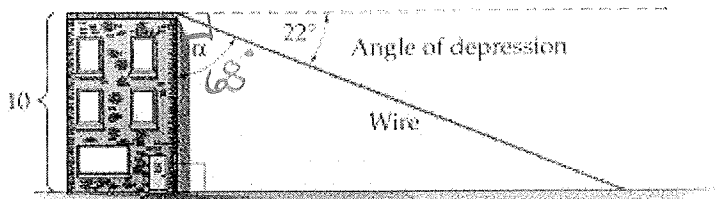


Figure 6.2-10

$$\begin{aligned}\tan 35 &= \frac{h}{60} \\ h &= 60 \tan 35 \\ &\approx 42.01\end{aligned}$$

Example 8 Indirect Measurement

A wire needs to reach from the top of a building to a point on the ground. The building is 10 m tall, and the angle of depression from the top of the building to the point on the ground is 22° . How long should the wire be?



$$\alpha = 90 - 22 = 68^\circ$$

$$\cos 68^\circ = \frac{10}{w}$$

$$w = \frac{10}{\cos 68} \approx 26.7 \text{ m}$$

Example 9 Indirect Measurement

A person on the edge of a canal observes a lamp post on the other side with an angle of elevation of 12° to the top of the lamp post and an angle of depression of 7° to the bottom of the lamp post from eye level. The person's eye level is 152 cm (about 5 ft).

- Find the width of the canal.
- Find the height of the lamp post.

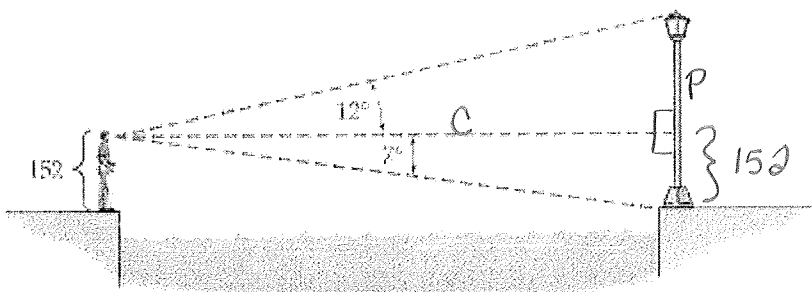


Figure 6.2-12

$$a) \tan 7 = \frac{152}{C}$$

$$C = \frac{152}{\tan 7} \approx 1237.94 \text{ cm}$$

$$b) \tan 12 = \frac{P}{1237.94}$$

$$P = 1237.94 \tan 12$$

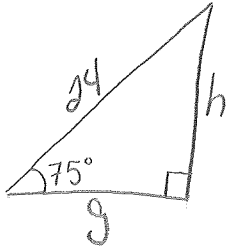
$$\approx 263.13$$

$$\text{post} \approx 263.13 + 152 \approx 415.13 \text{ cm}$$

1.2 HOMEWORK!!!

37. A 24-ft ladder positioned against a wall forms an angle of 75° with the ground.

- How high up the wall does the ladder reach?
- How far is the base of the ladder from the wall?



$$\begin{aligned} \text{a) } \sin 75 &= \frac{h}{24} \\ h &= 24 \sin 75 \\ &\approx 23.18 \text{ ft.} \end{aligned}$$

$$\begin{aligned} \text{b) } \cos 75 &= \frac{g}{24} \\ g &= 24 \cos 75 \\ &\approx 6.21 \text{ ft.} \end{aligned}$$

39. A plane takes off at an angle of 5° . After traveling 1 mile along this flight path, how high (in feet) is the plane above the ground? (1 mi = 5280 ft)



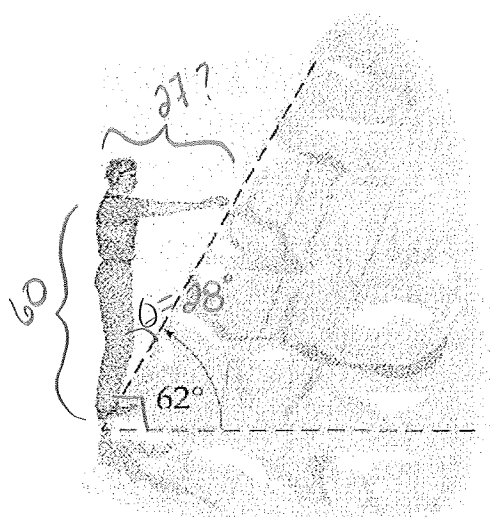
$$\begin{aligned} \sin 5 &= \frac{h}{5280} \\ h &= 5280 \sin 5 \\ &\approx 460.2 \text{ ft.} \end{aligned}$$

41. The Ohio Turnpike has a maximum uphill slope of 3° . How long must a straight uphill segment of the road be in order to allow a vertical rise of 450 feet?



$$\begin{aligned} \sin 3 &= \frac{450}{h} \\ h &= \frac{450}{\sin 3} \\ &\approx 8598.3 \text{ ft.} \end{aligned}$$

43. Suppose that a person with a reach of 27 inches and a shoulder height of 5 feet is standing upright on a mountainside that makes a 62° angle with the horizontal, as shown in the figure below. Can the person touch the mountain?



$$\theta = 90 - 62 = 28^\circ$$

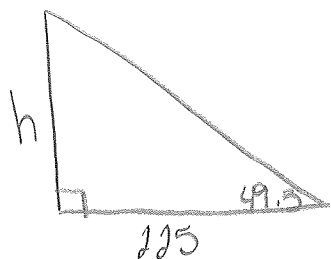
$$\tan 28 = \frac{h}{60}$$

$$h = 60 \tan 28$$

$$\approx 31.9 \text{ in}$$

No, will not be able to reach mountain.

45. A wire from the top of a TV tower makes an angle of 49.5° with the ground and touches the ground 225 feet from the base of the tower. How high is the tower?

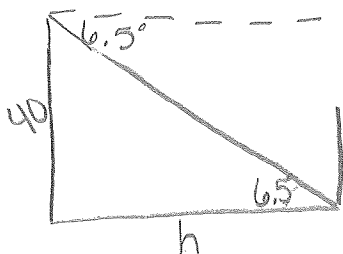


$$\tan 49.5 = \frac{h}{225}$$

$$h = 225 \tan 49.5$$

$$\approx 263.4 \text{ ft.}$$

47. A buoy in the ocean is observed from the top of a 40-meter-high radar tower on shore. The angle of depression from the top of the tower to the base of the buoy is 6.5° . How far is the buoy from the base of the radar tower?

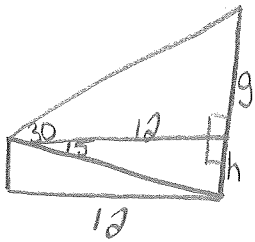


$$\tan 6.5 = \frac{40}{h}$$

$$h = \frac{40}{\tan 6.5}$$

$$\approx 351.1 \text{ m}$$

49. A man stands 12 feet from a statue. The angle of elevation from eye level to the top of the statue is 30° , and the angle of depression to the base of the statue is 15° . How tall is the statue?



$$\tan 15 = \frac{h}{12} \quad 3.21 + 6.93$$

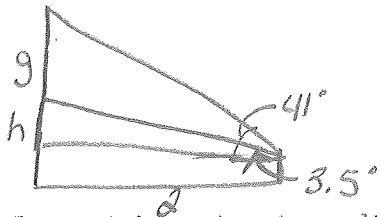
$$h = 12 \tan 15 \quad \approx 10.1 \text{ ft.}$$

$$\approx 3.21$$

$$\tan 30 = \frac{g}{12} \quad g = 12 \tan 30$$

$$\approx 6.93$$

51. A rocket shoots straight up from the launch pad. Five seconds after lift-off, an observer 2 miles away notes that the rocket's angle of elevation is 3.5° . Four seconds after that, the angle of elevation is 41° . How far did the rocket rise during those 4 seconds?



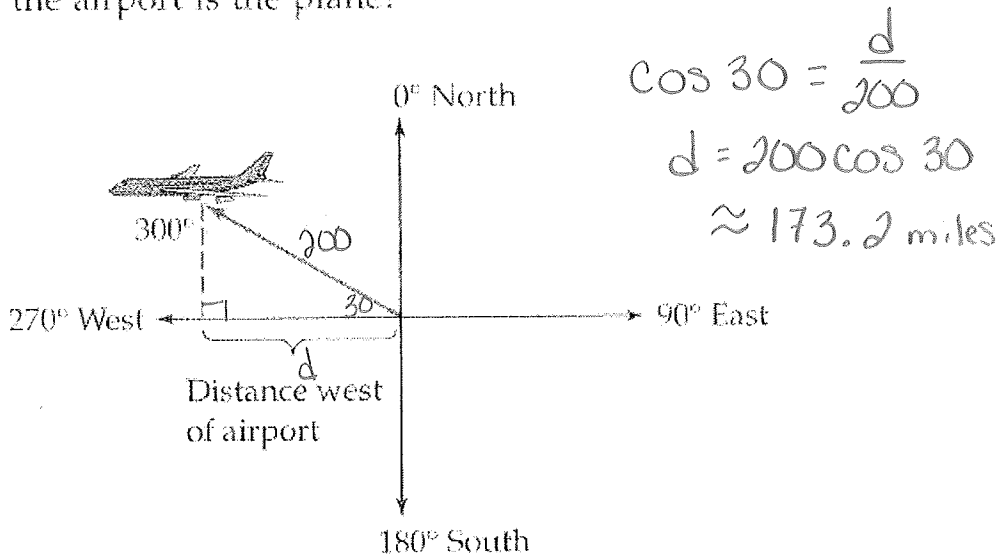
$$\tan 3.5 = \frac{h}{2} \quad \tan 41 = \frac{g}{2}$$

$$h = 2 \tan 3.5 \quad h = 2 \tan 41$$

$$\approx 0.1223 \quad \approx 1.7386$$

$$1.7386 - 0.1223 \approx 1.6 \text{ miles}$$

55. In aerial navigation, directions are given in degrees clockwise from north, called *headings*. Thus east is 90° , south is 180° , and so on, as shown below. A plane travels from an airport for 200 miles at a heading of 300° . How far west of the airport is the plane?



$$\cos 30 = \frac{d}{200}$$

$$d = 200 \cos 30$$

$$\approx 173.2 \text{ miles}$$

