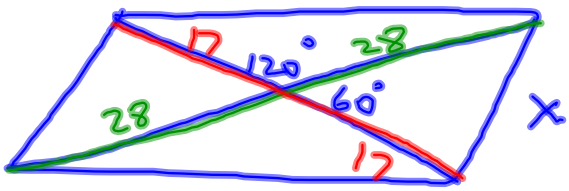
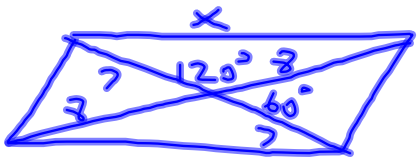
1. The diagonals of a parallelogram are 56 inches and 34 inches and intersect at an angle of 120°. Find the length of the shorter side.



$x = \sqrt{28^2 + 17^2 - 2(28)(17)\cos 60^\circ}$

$x = 24.4$ in.

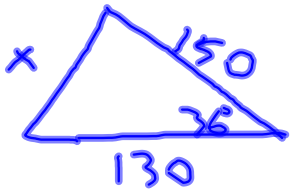
2. The diagonals of a parallelogram are 14 m and 16 m and intersect at an angle of 60°. Find the length of the longer side.



$x = \sqrt{7^2 + 8^2 - 2(7)(8)\cos 120^\circ}$

$x = 13$ m

3. Two planes leave an airport at the same time. Their speeds are 130 mph and 150 mph, and the angle between their courses is 36°. How far apart are they after 1.5 hours?



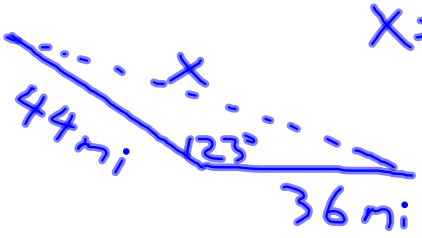
$x = \sqrt{130^2 + 150^2 - 2(130)(150)\cos 36^\circ}$

$x = 88.6 \times 1.5$

132.9 mi

4. Two ships leave a harbor entrance at the same time. The first ship is traveling at a constant 18 mph, while the second is traveling at a constant 22 mph. If the angle between their courses is 123°, how far apart are they after 2 hours?

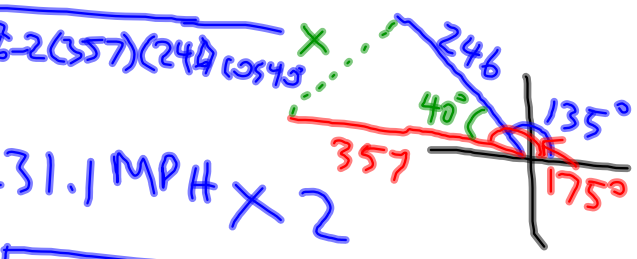
$X = \sqrt{36^2 + 44^2 - 2(36)(44)\cos 123^\circ}$



$X = 70.4 \text{ mi}$

5. Two planes take off at the same time from an airport. The first plane is flying at 246 mph on a course of *135.0°*. The second plane is flying in the direction 175.0° at 357 mph. Assuming there are no wind currents blowing, how far apart are they after 2 hours?

$X = \sqrt{357^2 + 246^2 - 2(357)(246)\cos 45}$



$X = 231.1 \text{ MPH} \times 2$

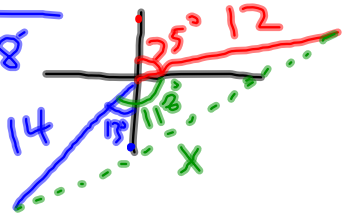
462.2 mi

6. Two ships leave the harbor at the same time. One ship is traveling at 14 mph on a course with a bearing of S 13° W, while the other is traveling at 12 mph on a course with a bearing of N 75° E. How far apart are they after 3 hours?

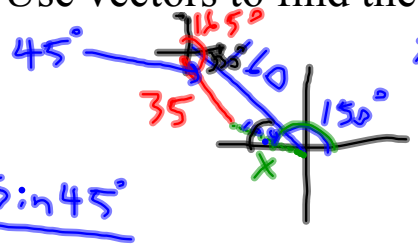
$X = \sqrt{14^2 + 12^2 - 2(14)(12)\cos 118°}$

$X = 22.3 \text{ MPH} \times 3$

66.9 mi.



7. A plane is flying with an airspeed of 160 mph and heading of 150°. The wind currents are running at 35 mph at 165° clockwise from due north. Use vectors to find the true course and ground speed of the plane.



$x = \sqrt{160^2 + 35^2 - 2(160)(35)\cos 45^\circ}$

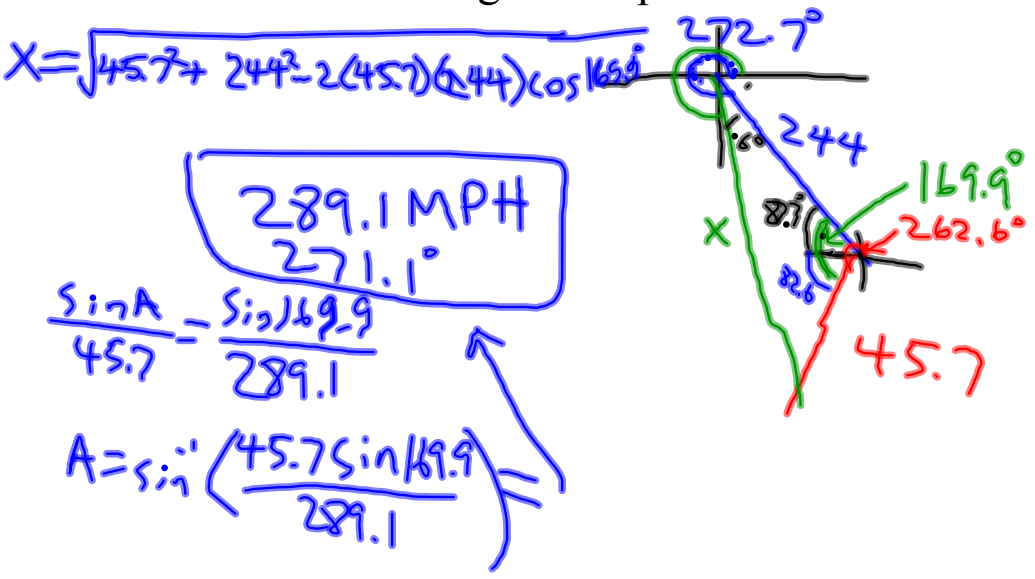
$x =$ 137.5 MPH

160.4°

$\frac{\sin A}{35} = \frac{\sin 45^\circ}{137.5}$

$A = \sin^{-1}\left(\frac{35 \sin 45^\circ}{137.5}\right)$

8. A plane is flying with an airspeed of 244 mph with heading 272.7°. The wind currents are running at a constant 45.7 mph in the direction 262.6°. Find the ground speed and true course of the plane.

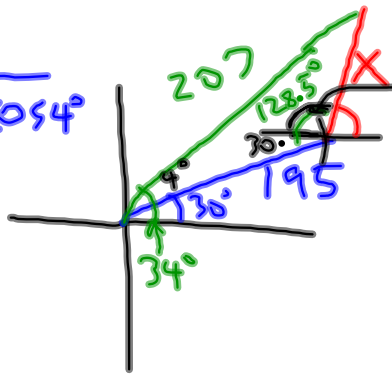


9. A plane has an airspeed of 195 mph and a heading of 30.0°. The ground speed of the plane is 207 mph, and its true course is in the direction 34.0°. Find the speed and direction of the air currents, assuming they are constants.

$X = \sqrt{195^2 + 207^2 - 2(195)(207)\cos 4^\circ}$

$\frac{\sin A}{207} = \frac{\sin 4^\circ}{18.5}$

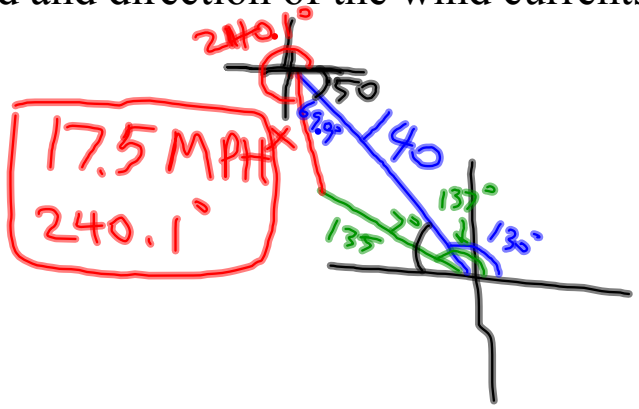
$A = \sin^{-1}\left(\frac{207 \sin 4^\circ}{18.5}\right)$



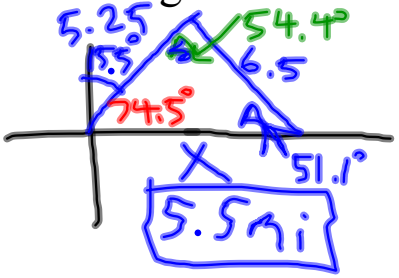
18.5 MPH

81.5°

10. The airspeed and heading of a plane are 140 mph and 130°, respectively. If the ground speed of the plane is 135 mph and its true course is 137°, find the speed and direction of the wind currents, assuming they are constants.



11. A boy is riding his motorcycle on a road that runs east and west. He leaves the road at a service station and rides 5.25 mi in the direction N *15.5°* E. Then he turns to his right and rides 6.50 mi back to the road, where his motorcycle breaks down. How far will he have to walk to get back to the service station?



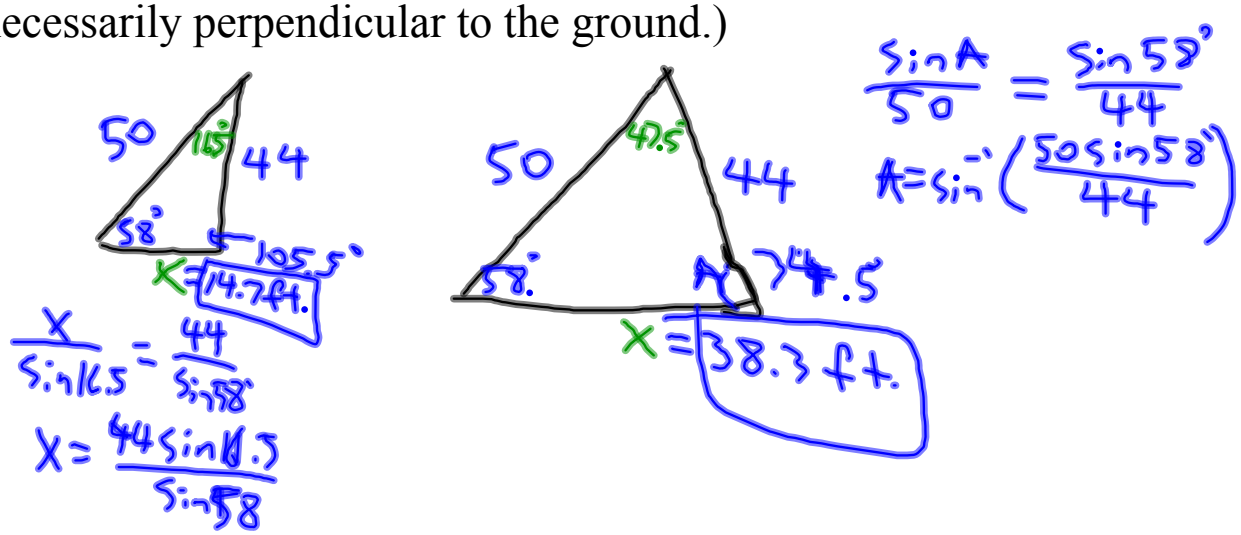
$$\frac{\sin A}{5.25} = \frac{\sin 74.5^\circ}{6.5}$$

$$A = \sin^{-1}\left(\frac{5.25 \sin 74.5^\circ}{6.5}\right)$$

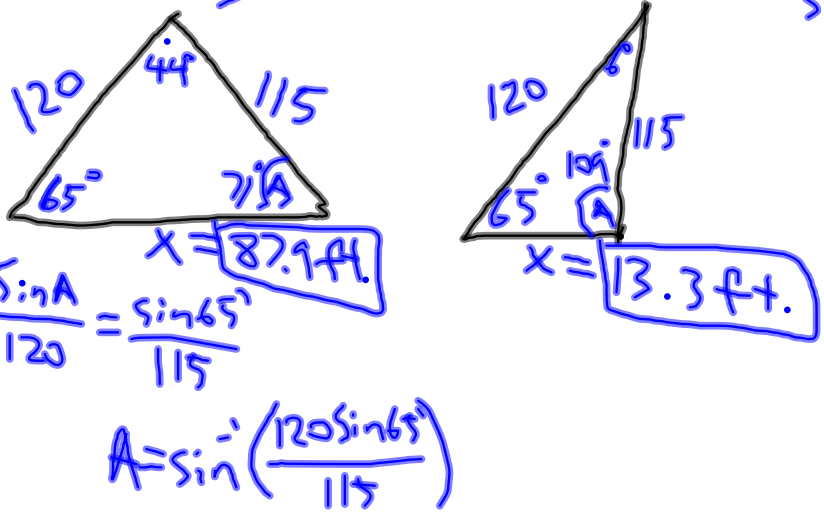
$$\frac{x}{\sin 54.4} = \frac{6.5}{\sin 74.5}$$

$$x = \frac{6.5 \sin 54.4}{\sin 74.5}$$

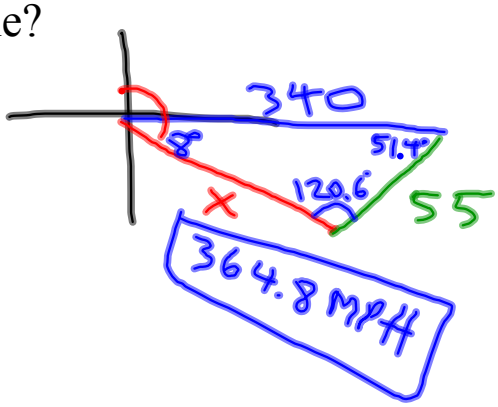
12. A 50-ft wire running from the top of a tent pole to the ground makes an angle of 58° with the ground. If the length of the tent pole is 44 ft, how far is it from the bottom of the tent pole to the point where the wire is fastened to the ground? (The tent pole is not necessarily perpendicular to the ground.)

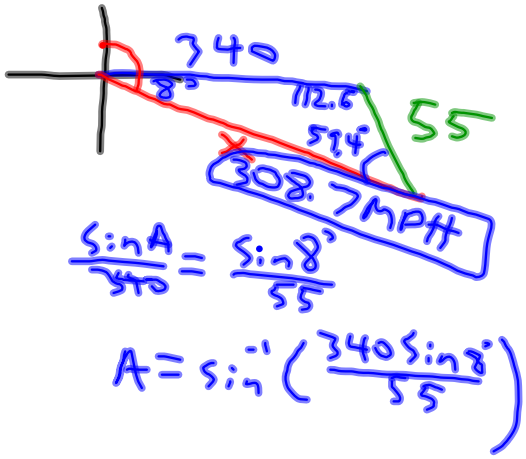


13. A hot-air balloon is held at a constant altitude by two ropes that are anchored to the ground. One rope is 120 ft long and makes an angle of 65° with the ground. The other rope is 115 ft long. What is the distance between the points on the ground at which the two ropes are anchored?

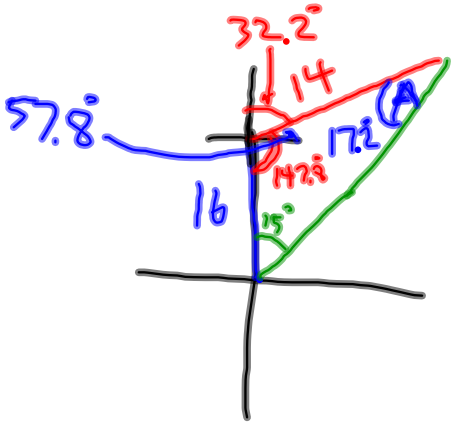


14. A plane is headed due east with an airspeed of 340 mph. Its true course, however, is at 98° from due north. If the wind currents are a constant 55 mph, what are the possibilities for the ground speed of the plane?





15. A ship is headed due north at a constant 16 mph. Because of the ocean current, the true course of the ship is N 15° E. If the currents are a constant 14 mph, in what direction are the currents running?

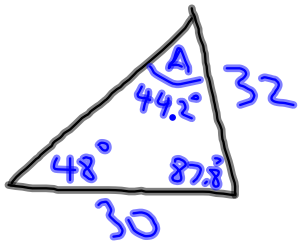


$$\frac{\sin A}{16} = \frac{\sin 15^\circ}{14}$$

$$A = \sin^{-1}\left(\frac{16 \sin 15^\circ}{14}\right)$$

N 32.2° E

16. After a wind storm, a farmer notices that his 32-ft windmill may be leaning, but he is not sure. From a point on the ground 30 ft from the base of the windmill, he finds that the angle of elevation to the top of the windmill is 48°. Is the windmill leaning? If so, what is the acute angle the windmill makes with the ground?

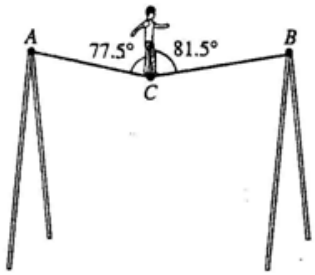


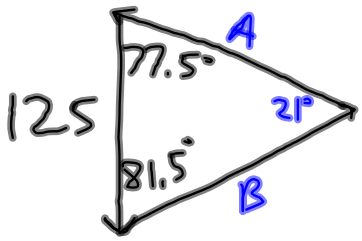
$$\frac{\sin A}{30} = \frac{\sin 48^\circ}{32}$$

$$A = \sin^{-1}\left(\frac{30 \sin 48^\circ}{32}\right)$$

Yes, 87.8°

17. A tightrope walker is standing still with one foot on the tightrope as shown in Figure 17. If the tightrope walker weighs 125 pounds, find the magnitudes of the tension in the rope toward each of the ends of the rope.





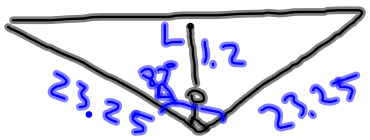
$$\frac{A}{\sin 81.5} = \frac{125}{\sin 21}$$

$$A = \frac{125 \sin 81.5}{\sin 21}$$

$A = 345$ lbs

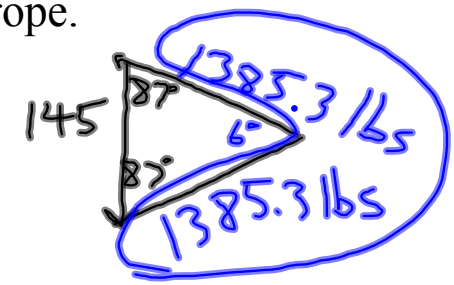
$B = 340.5$ lbs

18. A tightrope walker weighing 145 pounds is standing still at the center of a tightrope that is 46.5 feet long. The weight of the walker causes the center of the tightrope to move down 14.5 inches. Find the magnitude of the tension in the tightrope.

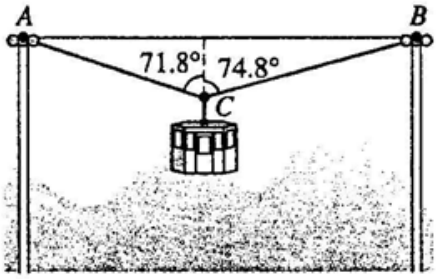


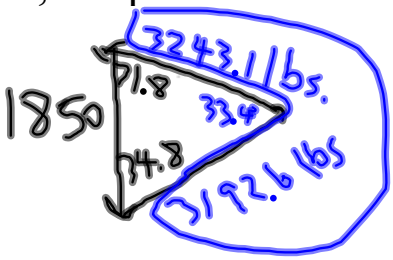
$$\cos A = \frac{1.2}{23.25}$$

$$A = \cos^{-1}\left(\frac{1.2}{23.25}\right)$$



19. If you have ever ridden on a chair lift at a ski area and had it stop, you know that the chair will pull down on the cable, dropping you down to a lower height than when the chair is in motion. Figure 18 shows a gondola that is stopped. Find the magnitudes of the tension in the cable toward each end of the cable if the total weight of the gondola and its occupants is 1,850 pounds.

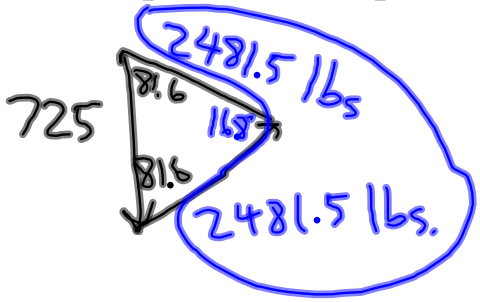




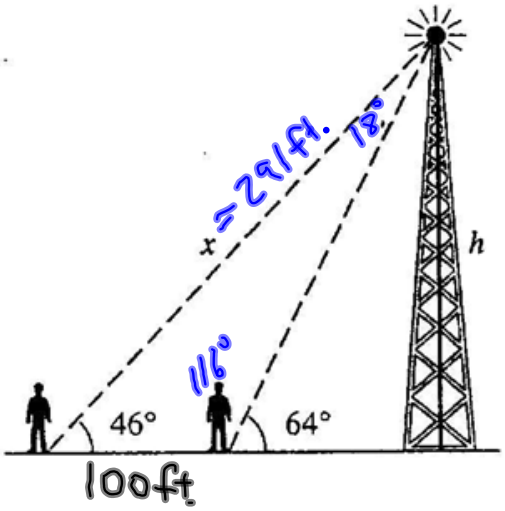
20. A chair lift at a ski resort is stopped halfway between two poles that support the cable to which the chair is attached. The poles are 215 feet apart and the combined weight of the chair and the three people on the chair is 725 pounds. If the weight of the chair and the people riding it causes the chair to move to a position 15.8 feet below the horizontal line that connects the top of the two poles, find the tension in the cable.

$\cos A = \frac{15.8}{107.5}$

$A = \cos^{-1}\left(\frac{15.8}{107.5}\right)$



21. A man standing near a radio station antenna observes that the angle of elevation to the top of the antenna is 64°. He then walks 100 ft further away and observes that the angle of elevation to the top of the antenna is 46°. Find the height of the antenna to the nearest foot. (*Hint:* Find x first.)



$\frac{x}{\sin 116} = \frac{100}{\sin 18}$

$x = \frac{100 \sin 116}{\sin 18}$

$x = 291 \text{ ft.}$

$\sin 46° = \frac{h}{291}$

$h = 291 \sin 46°$

$h = 209 \text{ ft.}$

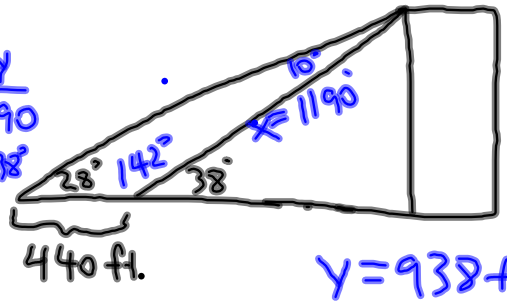
22. A person standing on the street looks up to the top of a building and finds that the angle of elevation is 38°. She then walks one block further away (440 ft) and finds that the angle of elevation to the top of the building is now 28°. How far away from the building is she when she makes her second observation?

$\frac{x}{\sin 28^\circ} = \frac{440}{\sin 10}$

$x = \frac{440 \sin 28^\circ}{\sin 10^\circ}$

$\cos 38^\circ = \frac{y}{1190}$

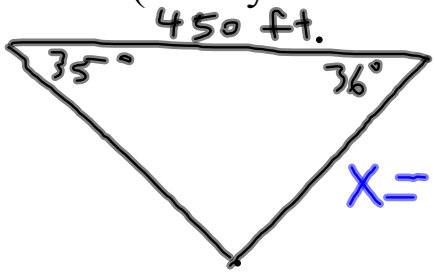
$y = 1190 \cos 38^\circ$



$y = 938$ ft.

1378 ft.

23. A man is flying in a hot-air balloon in a straight line at a constant rate of 5 ft/sec, while keeping it at a constant altitude. As he approaches the parking lot of a market, he notices that the angle of depression from his balloon to a friend's car in the parking lot is *35°*. A minute and a half later, after flying directly over his friend's car, he looks back to see his friend getting into the car and observes the angle of depression to be 36°. At that time, what is the distance between him and his friend? (Give your answer to the nearest foot.)



X=273 ft.

24. A woman entering an outside glass elevator on the ground floor of a hotel glances up to the top of the building across the street and notices that the angle of elevation is 48°. She rides the elevator up three floors (60 *ft)* and finds that the angle of elevation to the top of the building across the street is 32°. How tall is the building across the street? (Give your answer to the nearest foot.)

$\frac{x}{\sin 122^\circ} = \frac{60}{\sin 16}$

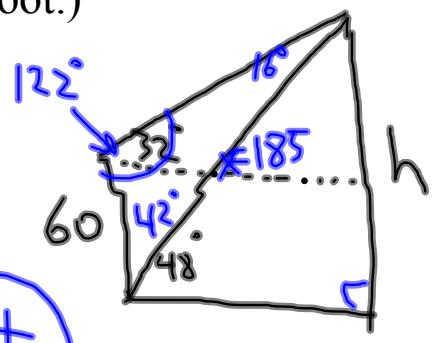
$x = \frac{60 \sin 122}{\sin 16}$

$x =$

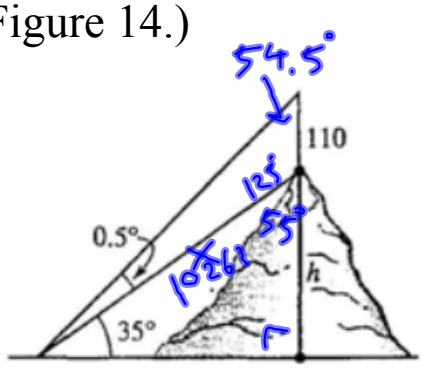
$\sin 48^\circ = \frac{h}{185}$

$h = 185 \sin 48$

$h = 138$ ft.



25. From a point on the ground, a person notices that a 110-ft antenna on the top of a hill subtends an angle of 0.5°. If the angle of elevation to the bottom of the antenna is 35°, find the height of the hill. (See Figure 14.)



$\frac{x}{\sin 54.5^\circ} = \frac{110}{\sin .5^\circ}$

$x = \frac{110 \sin 54.5^\circ}{\sin .5^\circ}$

$x = 10262$

$\sin 35^\circ = \frac{h}{10262}$

$h = 10262 \sin 35^\circ$

$h = 5886 \text{ ft.}$

26. A 150-ft antenna is on top of a tall building. From a point on the ground, the angle of elevation to the top of the antenna is 28.5°, while the angle of elevation to the bottom of the antenna from the same point is 23.5°. How tall is the building?

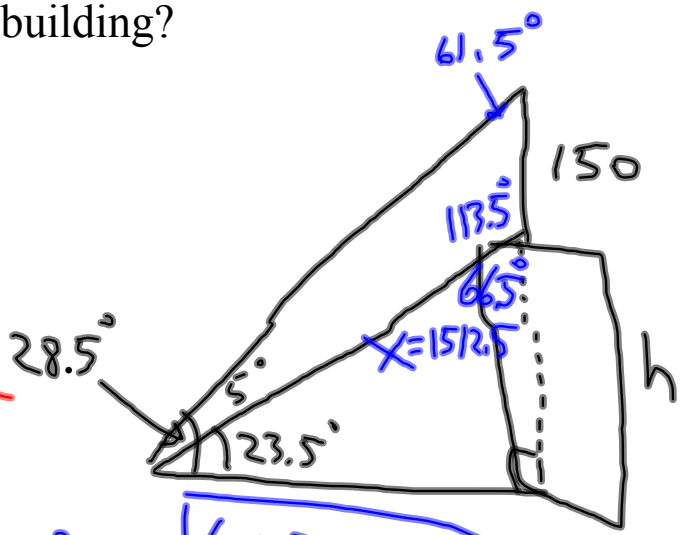
$$\frac{X}{\sin 61.5^\circ} = \frac{150}{\sin 5^\circ}$$

$$X = \frac{150 \sin 61.5^\circ}{\sin 5^\circ}$$

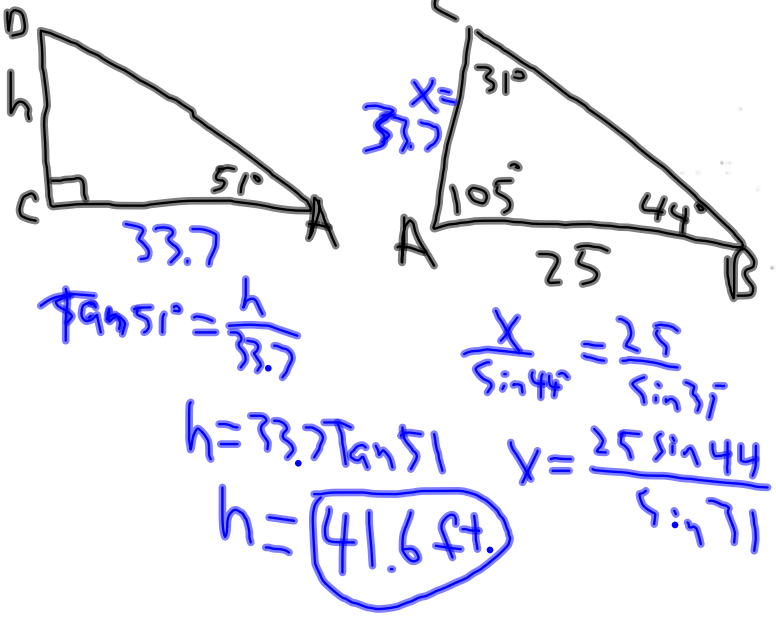
$$X = 1512.5$$

$$\sin 23.5^\circ = \frac{h}{1512.5}$$

$$h = 1512.5 \sin 23.5^\circ = \boxed{603.1 \text{ ft.}}$$



27. Figure 15 is a diagram that shows how Colleen estimates the height of a tree that is on the other side of a stream. She stands at point *A* facing the tree and finds the angle of elevation from *A* to the top of the tree to be 51°. Then she turns 105° walks 25 ft to point *B*, where she measures the angle between her path and the base of the tree. She finds that angle to be 44°. Use this information to find the height of the tree.



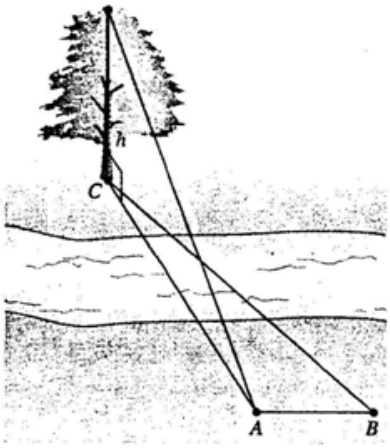
$\tan 51° = \frac{h}{33.7}$

$h = 33.7 \tan 51$

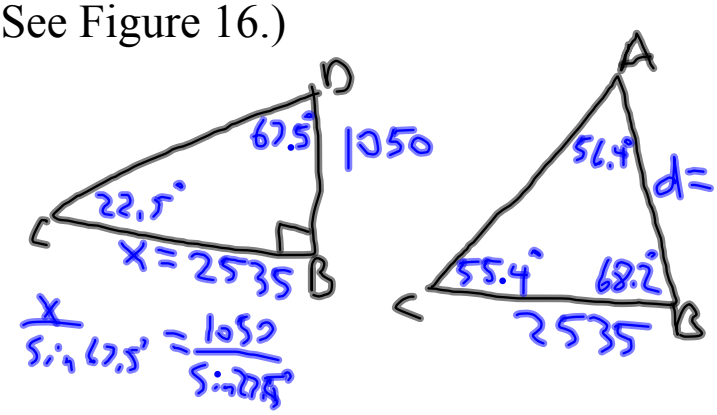
$h = 41.6 \text{ ft.}$

$\frac{X}{\sin 44°} = \frac{25}{\sin 31°}$

$X = \frac{25 \sin 44}{\sin 31}$



28. A plane makes a forced landing at sea. The last radio signal received at station C gives the bearing of the plane from C as N 55.4° E at an altitude of 1,050 ft. An observer at C sights the plane and gives $\angle DCB$ as 22.5°. How far will a rescue boat at A have to travel to reach any survivors at B, if the bearing of B from A is S 56.4° E? (See Figure 16.)



$$\frac{X}{\sin 67.5^\circ} = \frac{1052}{\sin 22.5^\circ}$$

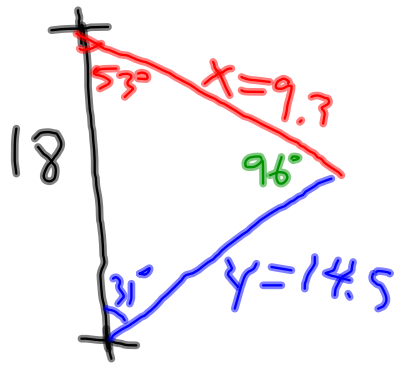
$$X = \frac{1050 \sin 67.5^\circ}{\sin 22.5^\circ}$$

$$\frac{d}{\sin 55.4^\circ} = \frac{2535}{\sin 56.4^\circ}$$

$$d = \frac{2535 \sin 55.4^\circ}{\sin 56.4^\circ}$$

$d = 2505$ ft.

29. A ship is anchored off a long straight shoreline that runs north and south. From two observation points 18 mi apart on shore, the bearings of the ship are N 31° E and S 53° E. What is the distance from the ship to each of the observation points?



$x =$ 9.3 mi

$y =$ 14.5 mi

30. Tom and Fred are 3.5 mi apart watching a rocket being launched from Vandenberg Air Force Base. Tom estimates the bearing of the rocket from his position to be S 75° W, while Fred estimates that the bearing of the rocket from his position is N 65° W. If Fred is due south of Tom, how far is each of them from the rocket?

$x =$ 4.9 mi

$y =$ 5.3 mi