

Lesson 11-1: Simplifying Radicals

Part 1: Simplifying Radical Expressions Involving Products

1. 089902a, P.I. A.N.2

The expression $\sqrt{50}$ can be simplified to

- [A] $5\sqrt{10}$ [B] $2\sqrt{25}$
[C] $5\sqrt{2}$ [D] $25\sqrt{2}$

2. 010530a, P.I. A.N.2

When $\sqrt{72}$ is expressed in simplest $a\sqrt{b}$ form, what is the value of a ?

- [A] 3 [B] 6 [C] 2 [D] 8

3. fall0731ia, P.I. A.N.2

Express $5\sqrt{72}$ in simplest radical form.

4. 080125a, P.I. A2.A.13

Simplify: $\sqrt{50r^2s^4}$

5. 010422a, P.I. A2.A.13

If $a > 0$, then $\sqrt{9a^2 + 16a^2}$ equals

- [A] $5\sqrt{a}$ [B] $7a$ [C] $5a$ [D] $\sqrt{7a}$

6. 060627a, P.I. A.N.3

Expressed in simplest radical form, the product of $\sqrt{6} \cdot \sqrt{15}$ is

- [A] $3\sqrt{10}$ [B] $3\sqrt{15}$
[C] $\sqrt{90}$ [D] $9\sqrt{10}$

7. 010103a, P.I. A2.A.13

If $x > 0$, the expression $(\sqrt{x})(\sqrt{2x})$ is equivalent to

- [A] $x^2\sqrt{2}$ [B] $x\sqrt{2}$
[C] $\sqrt{2x}$ [D] $2x$

8. 080724b, P.I. A.N.3

Classical mathematics uses the term "Golden Ratio" for the ratio $(1 + \sqrt{5}):2$. The Golden Ratio was used by many famous artists to determine the dimensions of their paintings. If the ratio of the length to the width of a painting is $(1 + \sqrt{5}):2$, find the length, in feet, of a painting that has a width of 14 feet. Express your answer in simplest radical form.

Part 2: Simplifying Radical Expressions Involving Quotients

9. 010622a, P.I. A.N.3

The expression $\frac{6\sqrt{20}}{3\sqrt{5}}$ is equivalent to

- [A] $3\sqrt{15}$ [B] $2\sqrt{15}$ [C] 4 [D] 8

Lesson 11-2: Operations with Radical Expressions

Part 1: Simplifying Sums and Differences

10. 060316a, P.I. A.N.3

The sum of $\sqrt{18}$ and $\sqrt{72}$ is

- [A] $\sqrt{90}$ [B] $3\sqrt{10}$
[C] $6\sqrt{3}$ [D] $9\sqrt{2}$

11. 010311a, P.I. A.N.3

The sum of $\sqrt{75}$ and $\sqrt{3}$ is

- [A] $6\sqrt{3}$ [B] $\sqrt{78}$ [C] 15 [D] 18

12. 069920a, P.I. A.N.3

The expression $\sqrt{27} + \sqrt{12}$ is equivalent to

- [A] $5\sqrt{3}$ [B] $5\sqrt{6}$
[C] $\sqrt{39}$ [D] $13\sqrt{3}$

13. 060512a, P.I. A.N.3

The expression $\sqrt{50} + \sqrt{32}$ is equivalent to

- [A] 18 [B] $\sqrt{82}$ [C] $9\sqrt{2}$ [D] 6

14. 060724a, P.I. A.N.3

The expression $\sqrt{28} + \sqrt{63}$ is equivalent to

- [A] $5\sqrt{7}$ [B] $13\sqrt{7}$
[C] $\sqrt{91}$ [D] $6\sqrt{7}$

15. 080524a, P.I. A.N.3

What is the sum of $5\sqrt{7}$ and $3\sqrt{28}$?

- [A] $9\sqrt{7}$ [B] $8\sqrt{35}$
[C] $60\sqrt{7}$ [D] $11\sqrt{7}$

16. 080614a, P.I. A.N.3

What is the sum of $\sqrt{50}$ and $\sqrt{32}$?

- [A] $\sqrt{82}$ [B] $9\sqrt{2}$
[C] $20\sqrt{20}$ [D] $\sqrt{2}$

17. 080712a, P.I. A.N.3

What is the sum of $\sqrt{50}$ and $\sqrt{8}$?

- [A] $29\sqrt{2}$ [B] $9\sqrt{2}$
[C] $7\sqrt{2}$ [D] $\sqrt{58}$

18. 010826a, P.I. A.N.3

The expression $\sqrt{28} - \sqrt{7}$ is equivalent to

- [A] 4 [B] $\sqrt{7}$ [C] $3\sqrt{7}$ [D] 2

19. 080016a, P.I. A.N.3

The expression $2\sqrt{50} - \sqrt{2}$ is equivalent to

- [A] $9\sqrt{2}$ [B] $2\sqrt{48}$
[C] 10 [D] $49\sqrt{2}$

20. 060218a, P.I. A.N.3

The expression $\sqrt{90} \cdot \sqrt{40} - \sqrt{8} \cdot \sqrt{18}$ simplifies to

- [A] 22.9 [B] 3,456 [C] 864 [D] 48

Lesson 11-3: Solving Radical Equations

Part 1: Solving Radical Equations

21. 010802b, P.I. A2.A.22

What is the value of x in the equation

$$\sqrt{3+x} - 5 = -2?$$

- [A] 6 [B] 3 [C] 12 [D] 46

22. 010607b, P.I. A2.A.22

If $\sqrt{2x-1} + 2 = 5$, then x is equal to

- [A] 4 [B] 1 [C] 5 [D] 2

23. 080602b, P.I. A2.A.22

What is the solution of the equation

$$\sqrt{2x-3} - 3 = 6?$$

- [A] 39 [B] 42 [C] 6 [D] 3

24. 060214b, P.I. A2.A.22

What is the solution set of the equation

$$x = 2\sqrt{2x-3}?$$

- [A] {2} [B] { } [C] {2,6} [D] {6}

25. 060528b, P.I. A2.A.22

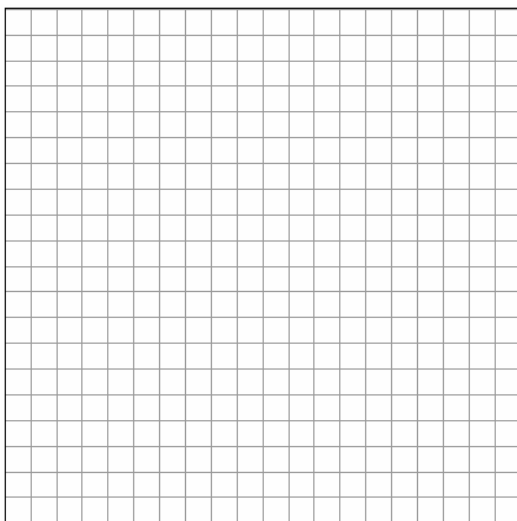
Solve for all values of q that satisfy the

$$\text{equation } \sqrt{3q+7} = q+3.$$

26. 010323b, P.I. A2.A.22
A wrecking ball suspended from a chain is a type of pendulum. The relationship between the rate of speed of the ball, R , the mass of the ball, m , the length of the chain, L , and the force, F , is $R = 2\pi\sqrt{\frac{mL}{F}}$. Determine the force, F , to the *nearest hundredth*, when $L = 12$, $m = 50$, and $R = 0.6$.

27. 080528b, P.I. A2.A.22
The lateral surface area of a right circular cone, s , is represented by the equation $s = \pi r\sqrt{r^2 + h^2}$, where r is the radius of the circular base and h is the height of the cone. If the lateral surface area of a large funnel is 236.64 square centimeters and its radius is 4.75 centimeters, find its height, to the *nearest hundredth of a centimeter*.

28. 010532b, P.I. A2.A.22
The equation $V = 20\sqrt{C + 273}$ relates speed of sound, V , in meters per second, to air temperature, C , in degrees Celsius. What is the temperature, in degrees Celsius, when the speed of sound is 320 meters per second? [The use of the accompanying grid is optional.]



29. 060205b, P.I. A2.A.22
The path of a rocket is represented by the equation $y = \sqrt{25 - x^2}$. The path of a missile designed to intersect the path of the rocket is represented by the equation $x = \frac{3}{2}\sqrt{y}$. The value of x at the point of intersection is 3. What is the corresponding value of y ?
[A] 2 [B] -4 [C] -2 [D] 4

Part 2: Solving Equations with Extraneous Solutions

30. 080104b, P.I. A2.A.22
The solution set of the equation $\sqrt{x+6} = x$ is
[A] {-2} [B] {3} [C] { } [D] {-2,3}
31. 010305b, P.I. A2.A.22
What is the solution set of the equation $\sqrt{9x+10} = x$
[A] {9} [B] {10}
[C] {10, -1} [D] {-1}
32. 010427b, P.I. A2.A.22
Solve algebraically: $\sqrt{x+5} + 1 = x$
33. 060629b, P.I. A2.A.22
Solve algebraically for x : $\sqrt{3x+1} + 1 = x$

Extension P. 636: Standard Deviation

34. 010406b, P.I. A2.S.4

Jean's scores on five mathematics tests were 98, 97, 99, 98, and 96. Her scores on five English tests were 78, 84, 95, 72, and 79. Which statement is true about the standard deviations for the scores?

- [A] The standard deviation for the English scores is greater than the standard deviation for the math scores.
- [B] More information is needed to determine the relationship between the standard deviations.
- [C] The standard deviations for both sets of scores are equal.
- [D] The standard deviation for the math scores is greater than the standard deviation for the English scores.

35. 060221b

On a nationwide examination, the Adams School had a mean score of 875 and a standard deviation of 12. The Boswell School had a mean score of 855 and a standard deviation of 20. In which school was there greater consistency in the scores? Explain how you arrived at your answer.

36. 010707b, P.I. A2.S.4

The term “snowstorms of note” applies to all snowfalls over 6 inches. The snowfall amounts for snowstorms of note in Utica, New York, over a four-year period are as follows: 7.1, 9.2, 8.0, 6.1, 14.4, 8.5, 6.1, 6.8, 7.7, 21.5, 6.7, 9.0, 8.4, 7.0, 11.5, 14.1, 9.5, 8.6. What are the mean and population standard deviation for these data, to the *nearest hundredth*?

- [A] mean = 9.46; standard deviation = 3.74
- [B] mean = 9.45; standard deviation = 3.85
- [C] mean = 9.45; standard deviation = 3.74
- [D] mean = 9.46; standard deviation = 3.85

37. 060630b, P.I. A2.S.4

The number of children of each of the first 41 United States presidents is given in the accompanying table. For this population, determine the mean and the standard deviation to the *nearest tenth*. How many of these presidents fall within one standard deviation of the mean?

Number of Children (x_i)	Number of Presidents (f_i)
0	6
1	2
2	8
3	6
4	7
5	3
6	5
7	1
8	1
10	1
15	1

38. 060729b, P.I. A2.S.4

Conant High School has 17 students on its championship bowling team. Each student bowled one game. The scores are listed in the accompanying table.

Score (x_i)	Frequency (f_i)
140	4
145	3
150	2
160	3
170	2
180	2
194	1

Find, to the *nearest tenth*, the population standard deviation of these scores. How many of the scores fall within one standard deviation of the mean?

39. 080730b, P.I. A2.S.4

Mr. Koziol has 17 students in his high school golf club. Each student played one round of golf. The summarized scores of the students are listed in the accompanying table.

Score	Frequency
70	4
73	3
75	2
80	3
85	1
86	1
90	2
92	1

Find the population standard deviation of this set of students' scores, to the *nearest tenth*. How many of the individual students' golf scores fall within one population standard deviation of the mean?

40. 080625b, P.I. A2.S.4

Beth's scores on the six Earth science tests she took this semester are 100, 95, 55, 85, 75, and 100. For this population, how many scores are within one standard deviation of the mean?

41. 010529b, P.I. A2.S.4

From 1984 to 1995, the winning scores for a golf tournament were 276, 279, 279, 277, 278, 278, 280, 282, 285, 272, 279, and 278. Using the standard deviation for the sample, S_x , find the percent of these winning scores that fall within one standard deviation of the mean.

42. 060227b, P.I. A2.S.4

An electronics company produces a headphone set that can be adjusted to accommodate different-sized heads. Research into the distance between the top of people's heads and the top of their ears produced the following data, in inches: 4.5, 4.8, 6.2, 5.5, 5.6, 5.4, 5.8, 6.0, 5.8, 6.2, 4.6, 5.0, 5.4, 5.8. The company decides to design their headphones to accommodate three standard deviations from the mean. Find, to the *nearest tenth*, the mean, the standard deviation, and the range of distances that must be accommodated.

43. 010604b

On a standardized test, a score of 86 falls exactly 1.5 standard deviations below the mean. If the standard deviation for the test is 2, what is the mean score for this test?

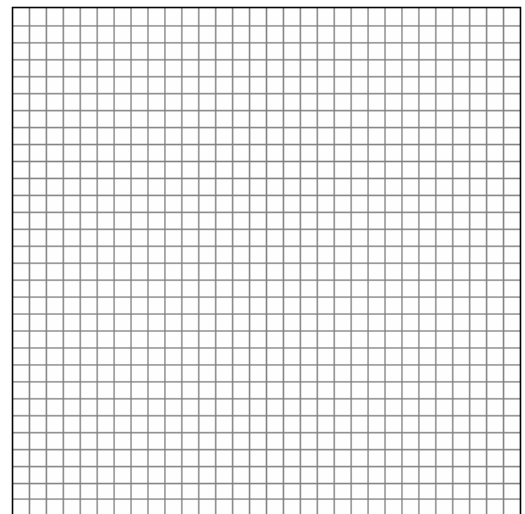
[A] 84 [B] 87.5 [C] 89 [D] 84.5

Lesson 11-4: Graphing Square Root Functions

Part 2: Translating Graphs of Square Root Functions

44. 010532b, P.I. A2.A.22

The number of people, y , involved in recycling in a community is modeled by the function $y = 90\sqrt{3x} + 400$, where x is the number of months the recycling plant has been open. Construct a table of values, sketch the function on the grid, and find the number of people involved in recycling exactly 3 months after the plant opened. After how many months will 940 people be involved in recycling?

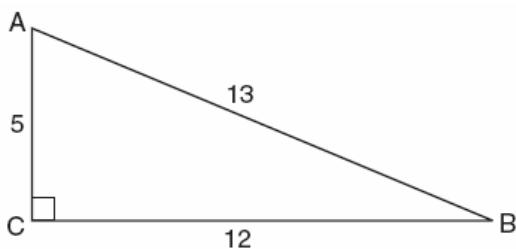


Lesson 11-5: Trigonometric Ratios

Part 1: Finding Trigonometric Ratios

45. 080414a, P.I. A.A.42

Which ratio represents $\cos A$ in the accompanying diagram of $\triangle ABC$?



- [A] $\frac{13}{5}$ [B] $\frac{12}{5}$ [C] $\frac{12}{13}$ [D] $\frac{5}{13}$

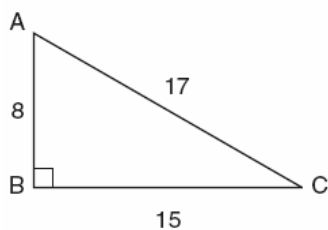
46. fall0721ia, P.I. A.A.42

In triangle MCT , the measure of $\angle T = 90^\circ$, $MC = 85$ cm, $CT = 84$ cm, and $TM = 13$ cm. Which ratio represents the sine of $\angle C$?

- [A] $\frac{13}{84}$ [B] $\frac{84}{85}$ [C] $\frac{84}{13}$ [D] $\frac{13}{85}$

47. 010316a, P.I. A.A.42

In the accompanying diagram of right triangle ABC , $AB = 8$, $BC = 15$, $AC = 17$, and $m\angle ABC = 90$.

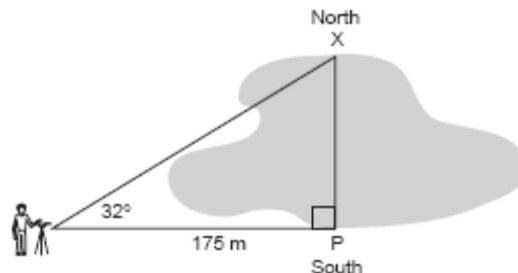


What is $\tan \angle C$?

- [A] $\frac{8}{15}$ [B] $\frac{15}{17}$ [C] $\frac{17}{15}$ [D] $\frac{8}{17}$

48. 060030a, P.I. A.A.44

A surveyor needs to determine the distance across the pond shown in the accompanying diagram. She determines that the distance from her position to point P on the south shore of the pond is 175 meters and the angle from her position to point X on the north shore is 32° . Determine the distance, PX , across the pond, rounded to the nearest meter.

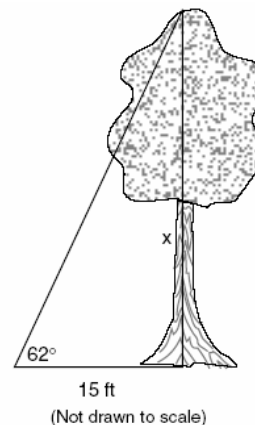


49. 080033a, P.I. A.A.44

A 10-foot ladder is to be placed against the side of a building. The base of the ladder must be placed at an angle of 72° with the level ground for a secure footing. Find, to the nearest inch, how far the base of the ladder should be from the side of the building and how far up the side of the building the ladder will reach.

50. 010135a, P.I. A.A.44

Find, to the nearest tenth of a foot, the height of the tree represented in the accompanying diagram.



51. 010531a, P.I. A.A.44

In the accompanying diagram, a ladder leaning against a building makes an angle of 58° with level ground. If the distance from the foot of the ladder to the building is 6 feet, find, to the *nearest foot*, how far up the building the ladder will reach.

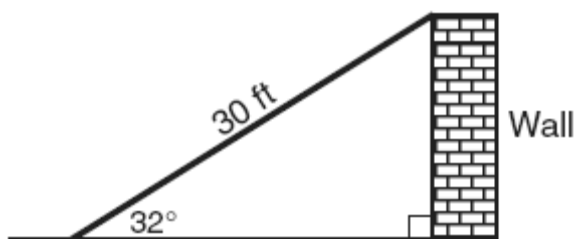


52. 010235a, P.I. A.A.44

Draw and label a diagram of the path of an airplane climbing at an angle of 11° with the ground. Find, to the *nearest foot*, the ground distance the airplane has traveled when it has attained an altitude of 400 feet.

53. 080724a, P.I. A.A.44

The accompanying diagram shows a ramp 30 feet long leaning against a wall at a construction site.

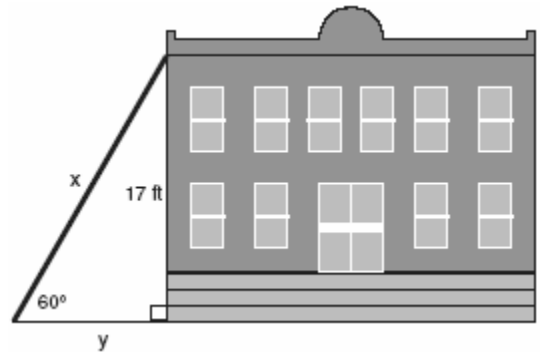


If the ramp forms an angle of 32° with the ground, how high above the ground, to the *nearest tenth*, is the top of the ramp?

- [A] 15.9 ft [B] 56.6 ft
[C] 18.7 ft [D] 25.4 ft

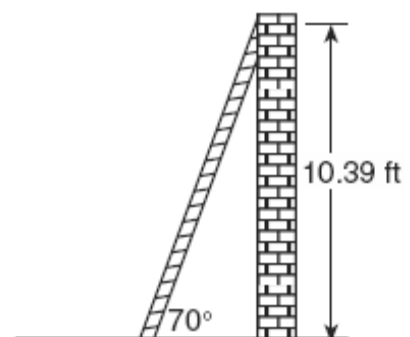
54. 080231a, P.I. A.A.44

In the accompanying diagram, x represents the length of a ladder that is leaning against a wall of a building, and y represents the distance from the foot of the ladder to the base of the wall. The ladder makes a 60° angle with the ground and reaches a point on the wall 17 feet above the ground. Find the number of feet in x and y .



55. 010638a, P.I. A.A.44

As shown in the accompanying diagram, a ladder is leaning against a vertical wall, making an angle of 70° with the ground and reaching a height of 10.39 feet on the wall. Find, to the *nearest foot*, the length of the ladder. Find, to the *nearest foot*, the distance from the base of the ladder to the wall.



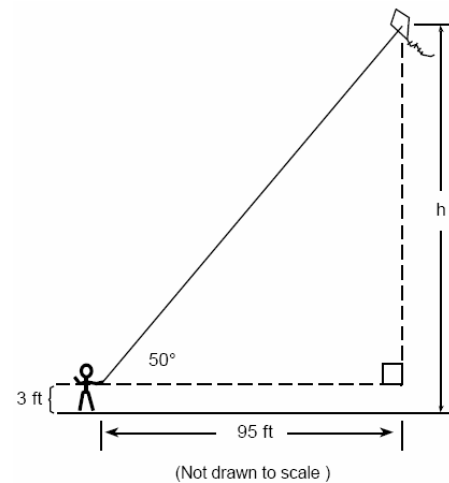
56. 080108b, P.I. A.A.44

At Mogul's Ski Resort, the beginner's slope is inclined at an angle of 12.3° , while the advanced slope is inclined at an angle of 26.4° . If Rudy skis 1,000 meters down the advanced slope while Valerie skis the same distance on the beginner's slope, how much longer was the horizontal distance that Valerie covered?

- [A] 231.6 m [B] 895.7 m
[C] 977.0 m [D] 81.3 m

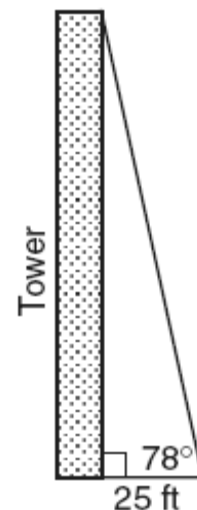
58. 069934a, P.I. A.A.44

Joe is holding his kite string 3 feet above the ground, as shown in the accompanying diagram. The distance between his hand and a point directly under the kite is 95 feet. If the angle of elevation to the kite is 50° , find the height, h , of his kite, to the nearest foot.



59. 010735a, P.I. A.A.44

From a point on level ground 25 feet from the base of a tower, the angle of elevation to the top of the tower is 78° , as shown in the accompanying diagram. Find the height of the tower, to the nearest tenth of a foot.



Lesson 11-6: Angles of Elevation and Depression

Part 1: Solving Problems Using Trigonometric Ratios

57. 060419a, P.I. A.A.44

The angle of elevation from a point 25 feet from the base of a tree on level ground to the top of the tree is 30° . Which equation can be used to find the height of the tree?

- [A] $\cos 30^\circ = \frac{x}{25}$ [B] $\sin 30^\circ = \frac{x}{25}$
[C] $30^2 + 25^2 = x^2$ [D] $\tan 30^\circ = \frac{x}{25}$

60. 080536a, P.I. A.A.44

A tree casts a shadow that is 20 feet long. The angle of elevation from the end of the shadow to the top of the tree is 66° . Determine the height of the tree, to the *nearest foot*.

61. 080133a, P.I. A.A.44

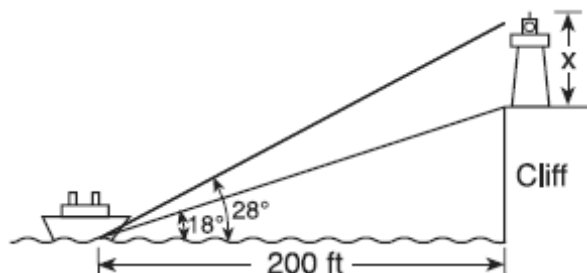
A ship on the ocean surface detects a sunken ship on the ocean floor at an angle of depression of 50° . The distance between the ship on the surface and the sunken ship on the ocean floor is 200 meters. If the ocean floor is level in this area, how far above the ocean floor, to the *nearest meter*, is the ship on the surface?

62. 060639a, P.I. A.A.44

A person measures the angle of depression from the top of a wall to a point on the ground. The point is located on level ground 62 feet from the base of the wall and the angle of depression is 52° . How high is the wall, to the *nearest tenth of a foot*?

63. 010838a, P.I. A.A.44

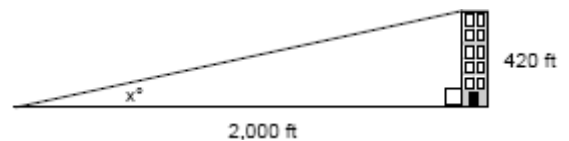
A lighthouse is built on the edge of a cliff near the ocean, as shown in the accompanying diagram. From a boat located 200 feet from the base of the cliff, the angle of elevation to the top of the cliff is 18° and the angle of elevation to the top of the lighthouse is 28° . What is the height of the lighthouse, x , to the *nearest tenth of a foot*?



Extension P. 654: Finding Angles in Right Triangles

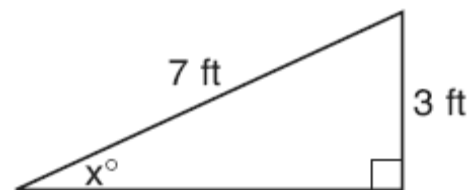
64. 089927a, P.I. A.A.43

A person standing on level ground is 2,000 feet away from the foot of a 420-foot-tall building, as shown in the accompanying diagram. To the *nearest degree*, what is the value of x ?



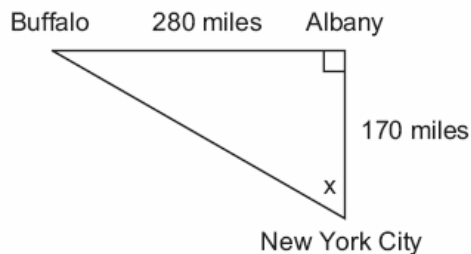
65. 060735a, P.I. A.A.43

Ron and Francine are building a ramp for performing skateboard stunts, as shown in the accompanying diagram. The ramp is 7 feet long and 3 feet high. What is the measure of the angle, x , that the ramp makes with the ground, to the *nearest tenth of a degree*?



66. 060231a, P.I. A.A.43, G.G.48

As seen in the accompanying diagram, a person can travel from New York City to Buffalo by going north 170 miles to Albany and then west 280 miles to Buffalo.

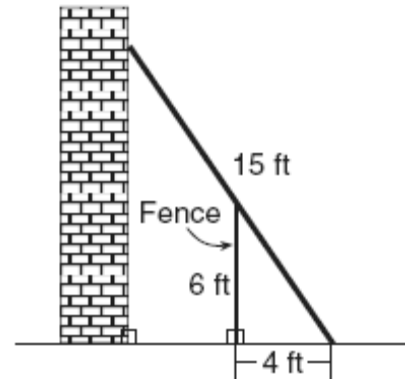


a If an engineer wants to design a highway to connect New York City directly to Buffalo, at what angle, x , would she need to build the highway? Find the angle to the *nearest degree*.

b To the *nearest mile*, how many miles would be saved by traveling directly from New York City to Buffalo rather than by traveling first to Albany and then to Buffalo?

67. 010438a, P.I. A.A.43

In the accompanying diagram, the base of a 15-foot ladder rests on the ground 4 feet from a 6-foot fence.

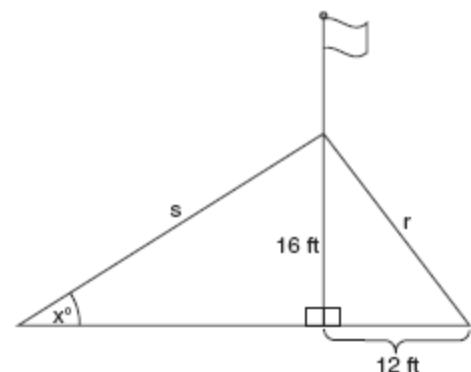


a If the ladder touches the top of the fence and the side of a building, what angle, to the *nearest degree*, does the ladder make with the ground?

b Using the angle found in part *a*, determine how far the top of the ladder reaches up the side of the building, to the *nearest foot*.

68. 060539a, P.I. A.A.43

The accompanying diagram shows a flagpole that stands on level ground. Two cables, r and s , are attached to the pole at a point 16 feet above the ground. The combined length of the two cables is 50 feet. If cable r is attached to the ground 12 feet from the base of the pole, what is the measure of the angle, x , to the *nearest degree*, that cable s makes with the ground?



[1] C

[2] B

[2] $30\sqrt{2}$, and appropriate work is shown.

[1] Appropriate work is shown, but one computational error is made.

or [1] Appropriate work is shown, but one conceptual error is made.

or [1] Appropriate work is shown, but the answer is not in simplest radical form.

or [1] $30\sqrt{2}$, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[3] incorrect procedure.

[2] $5rs^2\sqrt{2}$, and appropriate work is shown.

[1] A partially correct answer is found, such as $5r\sqrt{2s^4}$ or $5s^2\sqrt{2r^2}$, and appropriate work is shown.

or [1] $7.07rs^2$, but appropriate work is shown.

or [1] $5rs^2\sqrt{2}$, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[4] incorrect procedure.

[5] C

[6] A

[7] B

[2] $7 + 7\sqrt{5}$ and $7(1 + \sqrt{5})$, appropriate work is shown.

[1] Appropriate work is shown, but one computational error is made, or the answer is not expressed in simplest radical form.

or [1] Appropriate work is shown, but one conceptual error is made.

or [1] $7 + 7\sqrt{5}$ or $7(1 + \sqrt{5})$, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[8] incorrect procedure.

[9] C

[10] D

[11] A

[12] A

[13] C

[14] A

[15] D

[16] B

[17] C

[18] B

[19] A

[20] D

[21] A

[22] C

[23] B

[24] C

[4] -2 and -1 , and appropriate work is shown.

[3] Appropriate work is shown, but one computational error is made.

or [3] Appropriate work is shown, but only one value of q is found.

[2] Appropriate work is shown, but two or more computational errors are made.

or [2] Appropriate work is shown, but one conceptual error is made, such as squaring only the left side of the equation.

[1] Appropriate work is shown, but one conceptual error and one computational error are made.

or [1] -2 and -1 , but no work is shown.

[0] -2 or -1 , but no work is shown.

or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an

[25] obviously incorrect procedure.

- [2] 65,797.36, and appropriate work is shown.
 [1] Appropriate work is shown, but one computational or rounding error is made.
 or [1] An incorrect derivation of the equation is solved appropriately.
 or [1] 65,797.36, but no work is shown.
 [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
-

- [4] 15.13, and appropriate work is shown, such as solving the equation

$$236.64 = \pi(4.75)\sqrt{(4.75)^2 + h^2}.$$

 [3] Appropriate work is shown, but one computational or rounding error is made.
 [2] Appropriate work is shown, but two or more computational or rounding errors are made.
 or [2] Appropriate work is shown, but one conceptual error is made.
 [1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.
 or [1] Correct substitution of values is made into the equation, but no further correct work is shown.
 or [1] 15.13, but no work is shown.
 [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
-

- [2] -17, and appropriate work is shown.
 [1] Appropriate work is shown, but one conceptual error or one computational or graphing error is made.
 or [1] -17, but no work is shown.
 [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
-

[29] D

[30] B

[31] B

- [4] 4, and appropriate work is shown.
 [3] Appropriate work is shown, but one computational error is made.
 or [3] Appropriate work is shown, but $x = -1$ is not rejected.
 [2] Appropriate work is shown, but two or more computational errors are made.
 or [2] Appropriate work is shown, but one conceptual error is made.
 or [2] The correct quadratic equation is written in standard form, but no further correct work is shown.
 or [2] A quadratic equation of equal difficulty is solved appropriately.
 [1] Both sides of the equation are squared correctly, but no further correct work is shown.
 or [1] 4, but no work is shown.
 [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
-

[4] 5, and appropriate algebraic work is shown.

[3] Appropriate work is shown, but one computational error is made.

or [3] 5 and 0, and appropriate work is shown, but the zero is not rejected.

[2] Appropriate work is shown, but two or more computational errors are made.

or [2] Appropriate work is shown, but one conceptual error is made, such as squaring $x - 1$ incorrectly.

or [2] 5, but a method other than an algebraic solution is used, such as graphing or trial and error with at least three trials and appropriate checks.

or [2] A correct quadratic equation is written in standard form, such as $0 = x^2 - 5x$, but no further correct work is shown.

or [2] An incorrect quadratic equation of equal difficulty is solved appropriately.

[1] Appropriate work is shown, but one conceptual error and one computational error are made.

or [1] An incorrect equation of a lesser degree of difficulty is solved appropriately.

or [1] 5, but no work is shown.

[0] 5 and 0, and no work is shown.

or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an

[33] obviously incorrect procedure.

[34] A _____

[2] The Adams School, and an appropriate explanation is given, such as the standard deviation is a measure of dispersion, which is how much the scores, on the average, differ from the mean. Therefore, the school with the smaller standard deviation would have the more consistent scores.

[1] The Adams School, but an incomplete explanation is given, or the school is not stated, but an appropriate explanation is given.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[35] incorrect procedure.

[36] A _____

- [4] Mean = 3.6, standard deviation = 2.9, and 31, and appropriate work is shown, such as an explanation of how the solutions were found.
- [3] Appropriate work is shown, but one computational or rounding error is made.
- or [3] The mean and standard deviation are calculated correctly and appropriate work is shown, but the number of presidents in the specified interval is found incorrectly.
- [2] Appropriate work is shown, but two or more computational or rounding errors are made.
- or [2] Appropriate work is shown, but one conceptual error is made, such as using the sample standard deviation.
- or [2] The mean and standard deviation are calculated correctly, but the number of presidents is not found.
- or [2] The mean and standard deviation are calculated incorrectly, but an appropriate number of presidents is found.
- [1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.
- or [1] Mean = 3.6, standard deviation = 2.9, and 31, but no work is shown.
- [0] Mean = 3.6 or standard deviation = 2.9 or 31, but no work is shown.
- or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
- [37] obviously incorrect procedure.
- [4] 16.2 and 10, and appropriate work is shown.
- [3] Appropriate work is shown, but one computational or rounding error is made.
- or [3] Appropriate work is shown, but the sample standard deviation(s) is used, resulting in answers of 16.7 and 10.
- [2] Appropriate work is shown, but two or more computational or rounding errors are made.
- or [2] Appropriate work is shown, but one conceptual error is made.
- [1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.
- or [1] 16.2 and 10, but no work is shown.
- [0] 16.2 or 10, but no work is shown.
- or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
- [38] obviously incorrect procedure.
- [4] 7.5 and 9, and appropriate work is shown.
- [3] Appropriate work is shown, but one computational or rounding error is made.
- [2] Appropriate work is shown, but two or more computational or rounding errors are made.
- or [2] Appropriate work is shown, but one conceptual error is made, such as using 7.7, the sample standard deviation.
- or [2] The population standard deviation and mean are found correctly, but no further correct work is shown.
- [1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.
- or [1] 7.5 and 9, but no work is shown.
- [0] 7.5 or 9, but no work is shown.
- or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
- [39] obviously incorrect procedure.

- [2] 5, and appropriate work is shown, such as stating the mean and the standard deviation.
[1] Appropriate work is shown, but one computational error is made, but an appropriate number of scores is found.
or [1] Appropriate work is shown, but one conceptual error is made, such as using the sample standard deviation.
or [1] The mean and standard deviation are found correctly, but the number of scores is missing or is incorrect.
or [1] 5, but no work is shown.
[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
-

- [4] 75, and appropriate work is shown, such as determining the mean (278.5833333) and the standard deviation for the sample (3.146667309).
[3] Appropriate work is shown, but one computational or rounding error is made.
or [3] Appropriate work is shown, but the standard deviation for the population (σ) is used.
or [3] The mean, standard deviation for the sample, and interval are determined correctly, but an error is made in determining the percentage.
or [3] The mean and standard deviation for the sample are determined correctly, but an appropriate percentage is determined for an incorrect interval.
[2] Appropriate work is shown, but two or more computational or rounding errors are made.
or [2] Appropriate work is shown, but one conceptual error is made.
or [2] The mean and standard deviation for the sample are determined correctly, but no further correct work is shown.
or [2] Either the mean or the standard deviation for the sample is determined incorrectly, but an appropriate percentage is found.
[1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.
or [1] The standard deviation for the sample is determined correctly, but no further correct work is shown.
or [1] 75, but no work is shown.
[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
-

[4] $\bar{x} = 5.5$, $\sigma = 0.5$, and the range is 4-7, and appropriate work is shown.

[3] $\bar{x} = 5.5$, $\sigma = 0.5$, but one computational error is made when finding the range, but appropriate work is shown.

or [3] \bar{x} is correct, but σ is incorrect, but the range is appropriate, based on the incorrect σ .

or [3] \bar{x} is incorrect, but σ and the range are appropriate, based on the incorrect \bar{x} .

[2] \bar{x} is incorrect and σ is incorrect, but the range is appropriate, based on the incorrect \bar{x} and σ .

or [2] \bar{x} is correct and σ is correct, but the range is not determined.

[1] $\bar{x} = 5.5$, $\sigma = 0.5$, and the range is 4-7, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[42] incorrect procedure.

[43] C

[4] A correct table of values is provided, a correct graph is drawn, and 670; 12, and appropriate work is shown, such as extending the graph or solving algebraically.

[3] Appropriate work is shown, but one computational or graphing error is made.

or [3] A correct table of values is provided, a correct graph is drawn, and 670, but no further correct work is shown.

[2] Appropriate work is shown, but two or more computational or graphing errors are made.

or [2] Appropriate work is shown, but one conceptual error is made.

or [2] 670 and 12, but an algebraic solution is provided.

or [2] 670 and 12, but either the graph is not drawn or the table of values is not provided.

[1] Appropriate work is shown, but one conceptual error and one computational or graphing error are made.

or [1] A correct graph is drawn, but no further correct work is shown.

or [1] A correct table of values is provided, but no further correct work is shown.

or [1] 670 and 12, but no work is shown and no graph is drawn.

[0] 670 or 12, but no work is shown and no graph is drawn.

or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an

[44] obviously incorrect procedure.

[45] D

[46] D

[47] A

[3] 109 meters and appropriate work is shown by using an appropriate trigonometric ratio,

such as $\tan 32^\circ = \frac{y}{175}$.

[2] 109 meters but one rounding error is made.

or [2] The student uses an appropriate trigonometric function with an inverted ratio,

such as $\tan 32^\circ = \frac{175}{y}$, but completes the

calculation appropriately, such as showing 280 meters.

[1] The student uses an incorrect trigonometric ratio but completes the calculation appropriately.

or [1] The student uses an inverted tangent ratio and makes one computational or rounding error.

or [1] The student uses the correct trigonometric ratio but solves it incorrectly or does not solve it at all.

or [1] 109 meters but no work or explanation is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[48] incorrect procedure.

[4] 114" (9 feet 6 inches) and 37" (3 feet 1 inch) and appropriate work is shown, such as

$\sin 72^\circ = \frac{x}{10}$ and $\cos 72^\circ = \frac{y}{10}$ or use of the

Pythagorean theorem.

[3] An incorrect diagram is drawn, but appropriate work and an appropriate solution for that diagram are shown.

or [3] Appropriate work is shown, but the answers are rounded to the nearest foot and then converted to inches, arriving at 120" and 36".

or [3] The setup is correct, but the answers are not converted to the nearest inch.

[2] One correct dimension is shown, such as 114" (9 feet 6 inches) or 37" (3 feet 1 inch).

or [2] Only one error involving interchanging sine and cosine is made.

or [2] An incorrect diagram is drawn, and the solution is appropriate for the diagram but is not rounded to the nearest inch.

[1] The student switches sine and cosine and does not round to the nearest inch.

or [1] The student uses the correct trigonometric function to compute one side correctly but does not convert it to the nearest inch.

or [1] 114" (9 feet 6 inches) and 37" (3 feet 1 inch) but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[49] incorrect procedure.

[4] 28.2, and an appropriate equation is shown, such as $\tan 62 = \frac{x}{15}$.

[3] Appropriate work is shown, but the answer is rounded incorrectly.

or [3] The student uses the correct tangent function and rounds the answer, but makes one computational error.

[2] The student uses the correct tangent function, but makes several errors.

or [2] An incorrect trigonometric function is used, but appropriate work is shown.

[1] The tangent function is indicated, but the ratio is set up incorrectly.

or [1] 28.2, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[50] incorrect procedure.

[2] 10, and appropriate work is shown.

[1] Appropriate work is shown, but one computational or rounding error is made.

or [1] Appropriate work is shown, but one conceptual error is made, such as using an incorrect trigonometric function.

or [1] Appropriate work is shown, but the length of the ladder is found.

or [1] 10, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[51] incorrect procedure.

[4] 2,058, and appropriate work is shown, such as the accompanying diagram and equation.



[3] Appropriate work is shown, including a correct diagram and the use of the tangent function, but one computational error is made.

or [3] Appropriate work is shown, including a correct diagram and the use of the tangent function, but the answer is not rounded or is rounded incorrectly.

[2] A correct diagram is drawn, but an incorrect trigonometric function is selected, but it is solved and rounded appropriately.

or [2] A correct diagram is drawn and the tangent function is selected, but no further work is shown.

or [2] An incorrect diagram is drawn, but the appropriate trigonometric function, based on the drawing, is selected, solved, and rounded appropriately.

[1] An incorrect diagram is drawn and an incorrect trigonometric function is selected, but it is solved and rounded appropriately.

or [1] Only a correct diagram is drawn.

or [1] 2,058, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[52] incorrect procedure.

[53] A

[4] $x = 19.62990915$ and $y = 9.814954576$ or equivalent answers, and appropriate work is shown, such as $\sin 60^\circ = \frac{17}{x}$ and

$\tan 60^\circ = \frac{17}{y}$ or the Pythagorean theorem.

[3] Appropriate work is shown, but one computational or rounding error is made.
or [3] Appropriate work is shown, and the correct answers are found, but not identified.

[2] Appropriate work is shown, but one conceptual error is made, such as

$$\sin 60^\circ = \frac{x}{17}.$$

or [2] Appropriate work is shown, but more than one computational or rounding error is made.

[1] Appropriate work is shown, but two conceptual errors are made, such as

$$\sin 60^\circ = \frac{x}{17} \text{ and } \tan 60^\circ = \frac{y}{17}.$$

or [1] $x = 19.62990915$ and $y = 9.814954576$ or equivalent answers, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[54] incorrect procedure.

[4] Length of ladder = 11 and distance from the base of the ladder to the wall = 4, and appropriate work is shown, such as using sine and then tangent or the Pythagorean theorem.

[3] Appropriate work is shown, but one computational or rounding error is made.
or [3] Appropriate work is shown, but the correct answers are not labeled or are labeled incorrectly.

[2] Appropriate work is shown, but two or more computational or rounding errors are made.

or [2] Appropriate work is shown, but one conceptual error is made, such as using one incorrect trigonometric ratio.

or [2] Appropriate work is shown, but only the length of the ladder or the distance from the base of the ladder to the wall is found.

or [2] Two correct trigonometric equations are written, but no further correct work is shown.

[1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.

or [1] Only one correct trigonometric equation is written, and no further correct work is shown.

or [1] Length of ladder = 11 and distance from the base of the ladder to the wall = 4, but no work is shown.

[0] Length of ladder = 11 or distance from the base of the ladder to the wall = 4, but no work is shown.

or [0] 11 and 4, but no work is shown, and the solutions are not labeled.

or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an

[55] obviously incorrect procedure.

[56] D

[57] D

[4] 116 and an appropriate method is shown.

[3] An appropriate method is shown, but the answer is left in an inappropriate form, such as 116.2.

or [3] An appropriate method is shown, but 3 feet is not added, and the answer is left 113.

or [3] Tangent function is used, but computational mistakes are made, but 3 feet is added to the incorrect value and the answer is found correctly.

[2] An incorrect trigonometric function is used, 3 feet is added, and the answer is rounded correctly.

or [2] Tangent function is used, but computational mistakes are made, and 3 feet is not added to an incorrect answer.

[1] 116 and no work is shown.

or [1] An incorrect trigonometric function is used, and 3 feet is added to the incorrect answer, but the answer is rounded incorrectly.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[58] incorrect procedure.

[2] 117.6, and appropriate work is shown,

such as $\tan 78^\circ = \frac{x}{25}$.

[1] Appropriate work is shown, but one computational or rounding error is made.

or [1] Appropriate work is shown, but one conceptual error is made, such as using an incorrect trigonometric function, but an appropriate solution is found.

or [1] A correct trigonometric equation is written, but no further correct work is shown.

or [1] 117.6, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[59] incorrect procedure.

[3] 45, and appropriate work is shown, such

as $\tan 66^\circ = \frac{x}{20}$.

[2] A correct trigonometric ratio is used, and values are substituted correctly, but one computational or rounding error is made, or the calculator is left in radian mode.

[1] Appropriate work is shown, but two or more computational or rounding errors are made.

or [1] Appropriate work is shown, but one conceptual error is made, such as using an incorrect trigonometric ratio.

or [1] An incorrect diagram is drawn, but an appropriate solution is found.

or [1] A correctly labeled diagram is drawn, but no further correct work is shown.

or [1] A correct trigonometric ratio is written, but no further correct work is shown.

or [1] 45, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[60] incorrect procedure.

[4] 153, and appropriate work is shown, such

as $\sin 50^\circ = \frac{x}{200}$.

[3] An appropriate analysis is shown, but one computational or rounding error is made.

[2] An incorrect trigonometric function is

used, such as $\cos 50^\circ = \frac{x}{200}$, but it is carried

to an appropriate final answer and is rounded correctly.

[1] An incorrect trigonometric function is used and solved appropriately, but it is rounded incorrectly.

or [1] Only an appropriate diagram is shown.

or [1] 153, but no work is shown.

[0] Use of the Pythagorean theorem, such as $200^2 = 50^2 + x^2$, is shown.

or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an

[61] obviously incorrect procedure.

[4] 79.4, and appropriate work is shown, such as $\tan 52 = \frac{x}{62}$.

[3] Appropriate work is shown, but one computational or rounding error is made.
or [3] An incorrectly labeled diagram is drawn, but the appropriate trigonometric function is used, and an appropriate answer is found.

[2] Appropriate work is shown, but two or more computational or rounding errors are made.

or [2] Appropriate work is shown, but one conceptual error is made, such as using an incorrect trigonometric function or ratio.

[1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.

or [1] A correctly labeled diagram is drawn, but no further correct work is shown.

or [1] A correct equation is written, but no further correct work is shown.

or [1] An incorrectly labeled diagram is drawn, but an appropriate equation is written, but no further correct work is shown.

or [1] 79.4, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[62] incorrect procedure.

[4] 41.4, and appropriate work is shown, such as $200 \tan 28^\circ - 200 \tan 18^\circ$.

[3] Appropriate work is shown, but one computational or rounding error is made.
or [3] Appropriate work is shown to find the correct height of the cliff and the correct combined height of the lighthouse and the cliff, but they are not subtracted.

[2] Appropriate work is shown, but two or more computational or rounding errors are made.

[2] Appropriate work is shown, but one conceptual error is made, such as using an incorrect trigonometric function.

or [2] Appropriate work is shown to find the correct height of the cliff or the correct combined height of the lighthouse and the cliff, but no further correct work is shown.

[1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.

or [1] A correct equation is written to find the height of the lighthouse, but no further correct work is shown.

or [1] 41.4, but no work is shown.

[0] The correct height of the cliff or the correct combined height of the lighthouse and cliff is found, but no work is shown.

or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an

[63] obviously incorrect procedure.

[3] 12 and the equation $\tan x = \frac{420}{2000} = .21$ is

shown.

or [3] 12 and the Pythagorean theorem and an appropriate trigonometric function are correctly used.

[2] Tan function is correctly used, but the answer is not rounded, such as 11.859.

or [2] The setup is correct, but one computational mistake is made, and an appropriate angle is found.

or [2] The answer is incorrectly expressed, such as $\tan x = 12$.

[1] The tan function is set up correctly, but the angle is not computed.

or [1] 12 and no work is shown.

or [1] 12 and $\sin x = \frac{420}{2000}$ is used.

or [1] 78 and $\cos x = \frac{420}{2000}$ is used.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[64] incorrect procedure.

[2] 25.4, and appropriate work is shown, such as solving the equation $\sin x = \frac{3}{7}$.

[1] Appropriate work is shown, but one computational or rounding error is made.

or [1] Appropriate work is shown, but one conceptual error is made, such as using an incorrect trigonometric function.

or [1] A correct trigonometric equation is written, but no further correct work is shown.

or [1] 25.4, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[65] incorrect procedure.

a [2] 59, and the equation $\tan x = \frac{280}{170}$ is

shown, or the Pythagorean theorem is used first to find the hypotenuse, and either sine or cosine is used correctly to find x.

[1] Appropriate work is shown, but one computational or rounding error is made.

or [1] 59, but no work is shown.

b [2] 122, if the Pythagorean theorem is used or if a trigonometric function of the angle is used before it was rounded to 59° .

or [2] 120, if $\cos 59 = \frac{170}{hyp}$ is used.

or [2] 123, if $\sin 59 = \frac{170}{hyp}$ is used.

[1] Appropriate work is shown, but one computational or rounding error is made.

or [1] 122 or 120 or 123, but no work is shown.

a and b [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an

[66] obviously incorrect procedure.

a [2] 56, and appropriate work is shown, such as $\tan A = \frac{6}{4}$ or finding the hypotenuse and

then using sine or cosine or using proportional sides of similar triangles.

[1] Appropriate work is shown, but one computational or rounding error is made.

or [1] Appropriate work is shown, but one conceptual error is made.

or [1] The length of the hypotenuse is found correctly, but no further correct work is shown.

or [1] 56, but no work is shown.

b [2] 12, and appropriate work is shown, such as $\sin 56 = \frac{h}{15}$.

or [2] An appropriate answer is found based on an incorrect angle found in part a.

[1] Appropriate work is shown, but one computational or rounding error is made.

or [1] Appropriate work is shown, but one conceptual error is made.

or [1] 12, but no work is shown.

a and b [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an

[67] obviously incorrect procedure.

[4] 32, and appropriate work is shown, such as $12^2 + 16^2 = r^2$, $50 - r = s$, and $\sin x = \frac{16}{30}$.

[3] Appropriate work is shown, but one computational error is made.

or [3] Appropriate work is shown to find $r = 20$ and $s = 30$ and the trigonometric equation

$\sin x = \frac{16}{30}$ is written, but it is not solved or is

solved incorrectly.

[2] Appropriate work is shown, but two or more computational errors are made.

or [2] Appropriate work is shown, but one conceptual error is made, such as using an incorrect trigonometric function to find the angle.

or [2] The lengths of r and s are found correctly, but no further correct work is shown.

or [2] Incorrect lengths are found for r and s , but the sine function is used correctly to find an appropriate angle.

[1] Appropriate work is shown, but one conceptual error and one computational error are made.

or [1] The length of r is found correctly, but no further correct work is shown.

or [1] 32, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[68] incorrect procedure.
