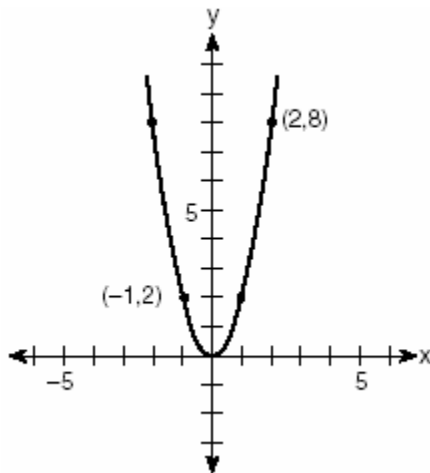


## Lesson 10-1: Exploring Quadratic Graphs

### Part 1: Graphing $y=ax^2$

1. 060404b, P.I. A.G.4

Which quadratic function is shown in the accompanying graph?



- [A]  $y = \frac{1}{2}x^2$       [B]  $y = -\frac{1}{2}x^2$   
[C]  $y = 2x^2$       [D]  $y = -2x^2$

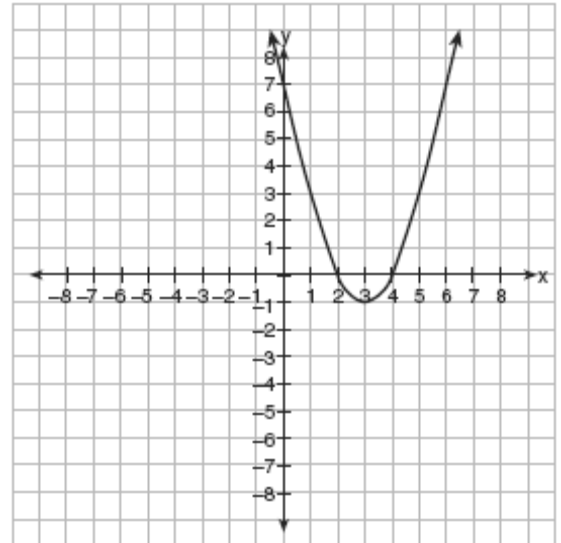
2. 080611b

What is the total number of points of intersection for the graphs of the equations  $y = x^2$  and  $y = -x^2$ ?

- [A] 3      [B] 0      [C] 1      [D] 2

3. 010606b, P.I. A.G.10

Which is an equation of the line of symmetry for the parabola in the accompanying diagram?



- [A]  $x = 4$       [B]  $y = 3$   
[C]  $x = 3$       [D]  $x = 2$

4. 060514b, P.I. A.A.41

For which quadratic equation is the axis of symmetry  $x = 3$ ?

- [A]  $y = -x^2 + 3x + 5$       [B]  $y = -x^2 + 6x + 2$   
[C]  $y = x^2 + x + 3$       [D]  $y = x^2 + 6x + 3$

### Part 2: Graphing $y=ax^2+c$

5. 060706b

What is one solution of the accompanying system of equations?  
 $y = -x^2 + 5$   
 $y = -0.5x^2 + 3$

- [A] (0,5)      [B] (0,3)  
[C] (-2,1)      [D] (3,5)

## Lesson 10-2: Quadratic Functions

### Part 1: Graphing $y=ax^2+bx+c$

6. 080508a, P.I. A.A.8

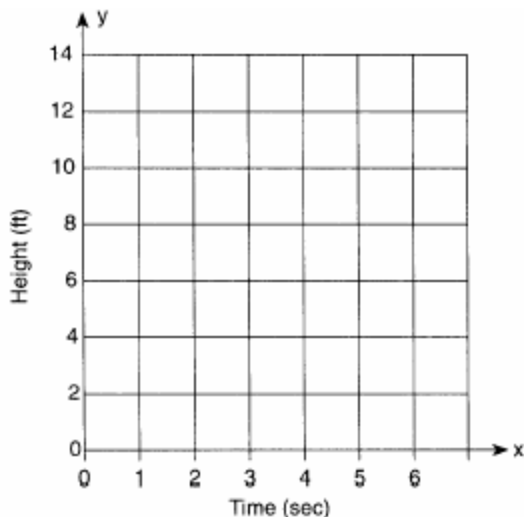
The height of a golf ball hit into the air is modeled by the equation  $h = -16t^2 + 48t$ , where  $h$  represents the height, in feet, and  $t$  represents the number of seconds that have passed since the ball was hit. What is the height of the ball after 2 seconds?

[A] 80 ft [B] 16 ft [C] 32 ft [D] 64 ft

7. 010031a, P.I. A.G.4

Amy tossed a ball in the air in such a way that the path of the ball was modeled by the equation  $y = -x^2 + 6x$ . In the equation,  $y$  represents the height of the ball in feet and  $x$  is the time in seconds.

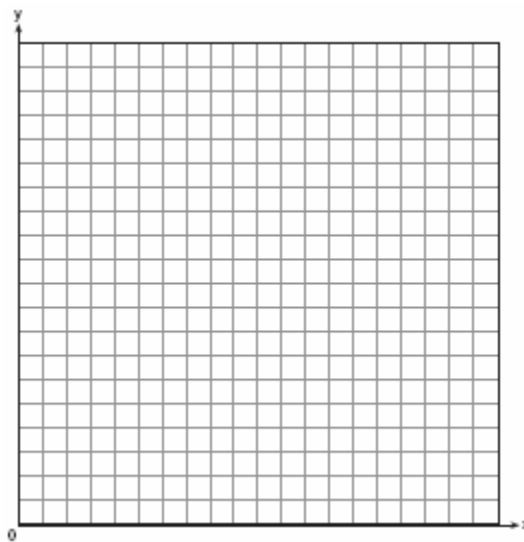
a Graph  $y = -x^2 + 6x$  for  $0 \leq x \leq 6$  on the grid provided below.



b At what time,  $x$ , is the ball at its highest point?

8. 060333a, P.I. A.G.4

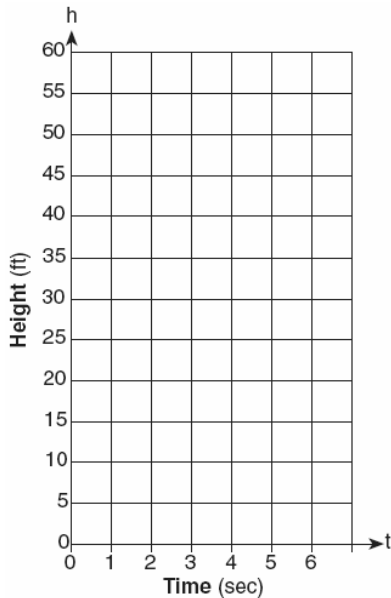
An architect is designing a museum entranceway in the shape of a parabolic arch represented by the equation  $y = -x^2 + 20x$ , where  $0 \leq x \leq 20$  and all dimensions are expressed in feet. On the accompanying set of axes, sketch a graph of the arch and determine its maximum height, in feet.



9. 010439a, P.I. A.G.4

Tom throws a ball into the air. The ball travels on a parabolic path represented by the equation  $h = -8t^2 + 40t$ , where  $h$  is the height, in feet, and  $t$  is the time, in seconds.

*a* On the accompanying set of axes, graph the equation from  $t = 0$  to  $t = 5$  seconds, including all integral values of  $t$  from 0 to 5.

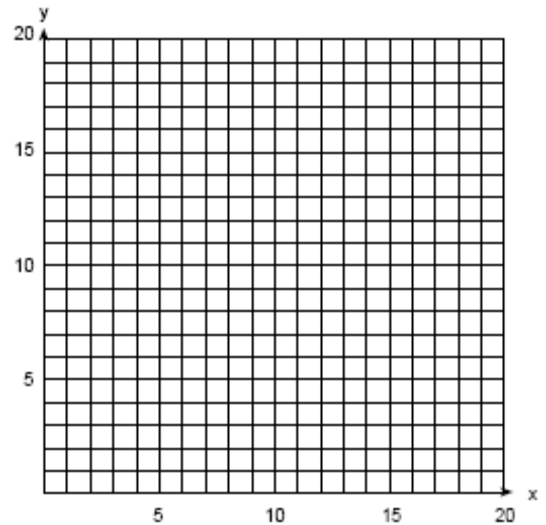


*b* What is the value of  $t$  at which  $h$  has its greatest value?

10. 089933a, P.I. A.G.4

An arch is built so that it is 6 feet wide at the base. Its shape can be represented by a parabola with the equation  $y = -2x^2 + 12x$ , where  $y$  is the height of the arch.

*a* Graph the parabola from  $x = 0$  to  $x = 6$  on the grid below.

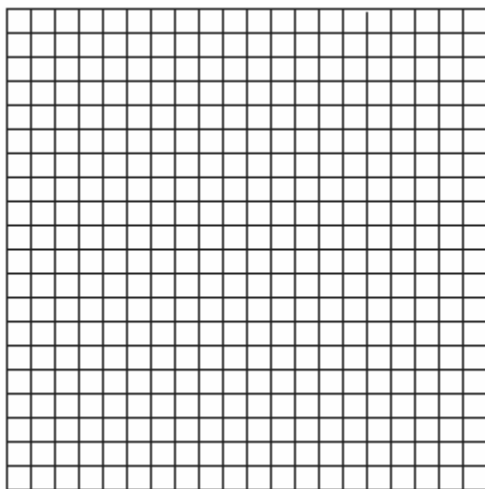


*b* Determine the maximum height,  $y$ , of the arch.

11. 060632b, P.I. A.G.4

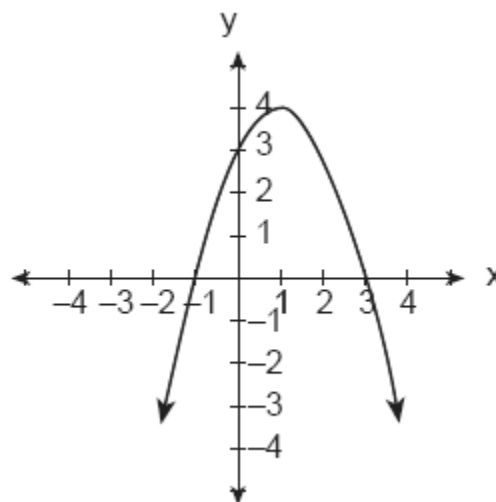
A small rocket is launched from a height of 72 feet. The height of the rocket in feet,  $h$ , is represented by the equation

$h(t) = -16t^2 + 64t + 72$ , where  $t$  = time, in seconds. Graph this equation on the accompanying grid. Use your graph to determine the number of seconds that the rocket will remain at or above 100 feet from the ground. [Only a graphic solution can receive full credit.]



12. 080017a, P.I. A.G.4

Which is an equation of the parabola shown in the accompanying diagram?

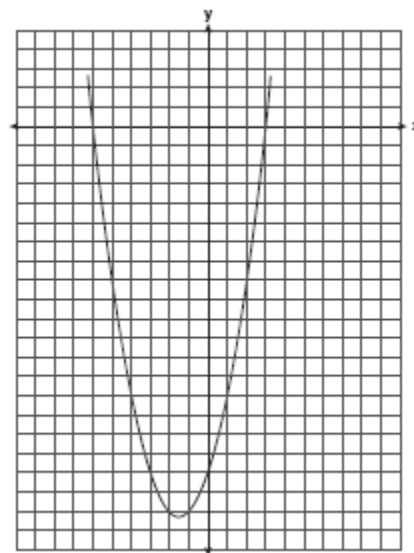


[A]  $y = -x^2 + 2x + 3$       [B]  $y = -x^2 - 2x + 3$

[C]  $y = x^2 - 2x + 3$       [D]  $y = x^2 + 2x + 3$

13. 010328a, P.I. A.G.4

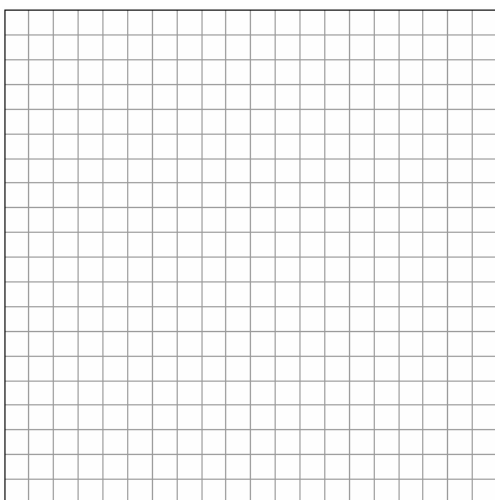
The graph of a quadratic equation is shown in the accompanying diagram. The scale on the axes is a unit scale. Write an equation of this graph in standard form.



14. 060101b, P.I. A.A.8  
An archer shoots an arrow into the air such that its height at any time,  $t$ , is given by the function  $h(t) = -16t^2 + kt + 3$ . If the maximum height of the arrow occurs at time  $t = 4$ , what is the value of  $k$ ?  
[A] 64      [B] 4      [C] 128      [D] 8
15. 080501b, P.I. A.A.41  
What is the turning point, or vertex, of the parabola whose equation is  $y = 3x^2 + 6x - 1$ ?  
[A] (1,8)      [B] (3,44)  
[C] (-1,-4)      [D] (-3,8)
16. 080603b, P.I. A.A.41  
What is the minimum point of the graph of the equation  $y = 2x^2 + 8x + 9$ ?  
[A] (2,33)      [B] (-2,-15)  
[C] (2,17)      [D] (-2,1)
17. 010322b, P.I. A.A.8  
The height of an object,  $h(t)$ , is determined by the formula  $h(t) = -16t^2 + 256t$ , where  $t$  is time, in seconds. Will the object reach a maximum or a minimum? Explain or show your reasoning.
18. 060321b, P.I. A.A.41  
Vanessa throws a tennis ball in the air. The function  $h(t) = -16t^2 + 45t + 7$  represents the distance, in feet, that the ball is from the ground at any time  $t$ . At what time, to the nearest tenth of a second, is the ball at its maximum height?
19. 080321b, P.I. A.A.41  
The height,  $h$ , in feet, a ball will reach when thrown in the air is a function of time,  $t$ , in seconds, given by the equation  $h(t) = -16t^2 + 30t + 6$ . Find, to the nearest tenth, the maximum height, in feet, the ball will reach.
20. 010424b, P.I. A.A.41  
When a current,  $I$ , flows through a given electrical circuit, the power,  $W$ , of the circuit can be determined by the formula  $W = 120I - 12I^2$ . What amount of current,  $I$ , supplies the maximum power,  $W$ ?
21. 060225b, P.I. A.A.41  
The equation  $W = 120I - 12I^2$  represents the power ( $W$ ), in watts, of a 120-volt circuit having a resistance of 12 ohms when a current ( $I$ ) is flowing through the circuit. What is the maximum power, in watts, that can be delivered in this circuit?

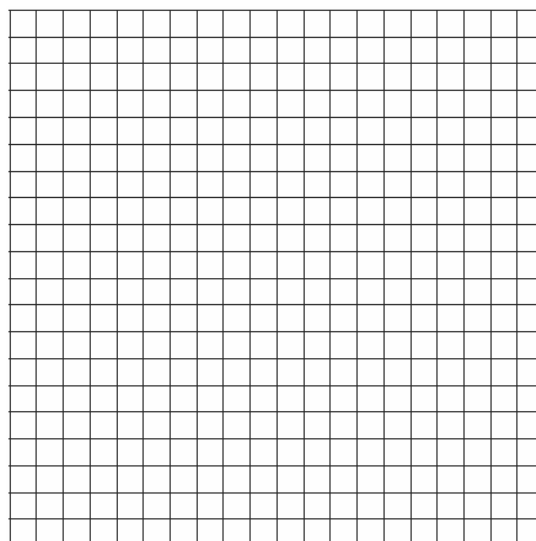
22. 060430b, P.I. A.A.41

A baseball player throws a ball from the outfield toward home plate. The ball's height above the ground is modeled by the equation  $y = -16x^2 + 48x + 6$  where  $y$  represents height, in feet, and  $x$  represents time, in seconds. The ball is initially thrown from a height of 6 feet. How many seconds after the ball is thrown will it again be 6 feet above the ground? What is the maximum height, in feet, that the ball reaches? [The use of the accompanying grid is optional.]



23. 080229b, P.I. A.A.41

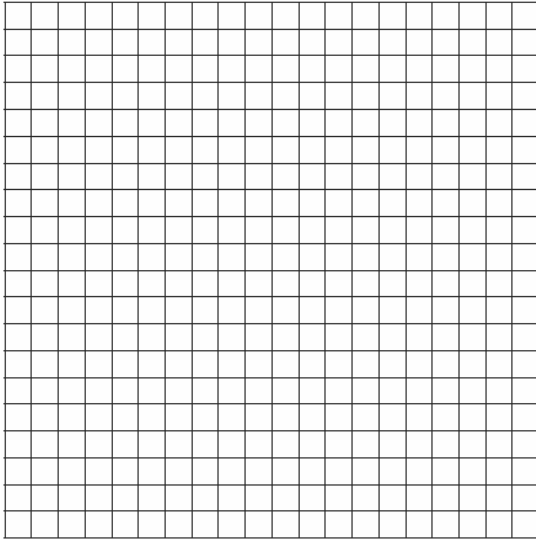
A rock is thrown vertically from the ground with a velocity of 24 meters per second, and it reaches a height of  $2 + 24t - 4.9t^2$  after  $t$  seconds. How many seconds after the rock is thrown will it reach maximum height, and what is the maximum height the rock will reach, in meters? How many seconds after the rock is thrown will it hit the ground? Round your answers to the *nearest hundredth*. [Only an algebraic or graphic solution will be accepted.]



24. 060732b, P.I. A.A.41

The path of a rocket fired during a fireworks display is given by the equation

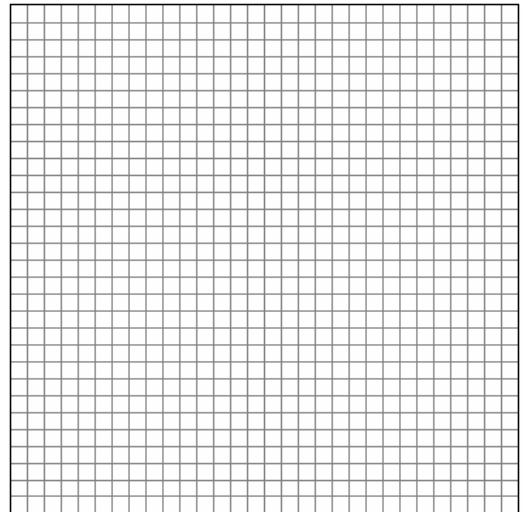
$s(t) = 64t - 16t^2$ , where  $t$  is the time, in seconds, and  $s$  is the height, in feet. What is the maximum height, in feet, the rocket will reach? In how many seconds will the rocket hit the ground? [The grid is optional.]



25. 010834b, P.I. A.A.41

The members of the Lincoln High School Prom Committee are trying to raise money for their senior prom. They plan to sell teddy bears. The senior advisor told them that the profit equation for their project is

$y = -0.1x^2 + 9x - 50$ , where  $x$  is the price at which the teddy bears will be sold and  $y$  is the profit, in dollars. On the grid below, graph this relationship so that  $0 \leq x \leq 90$  and  $-50 \leq y \leq 160$ . How much profit can the committee expect to make if they sell the teddy bears for \$20 each? What price should they charge for the teddy bears to make the maximum profit possible?

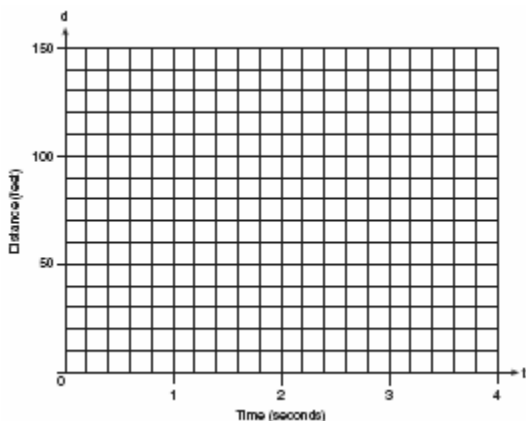


## Lesson 10-3: Solving Quadratic Equations

### Part 1: Solving Quadratic Equations by Graphing

26. 080234a, P.I. A.A.27

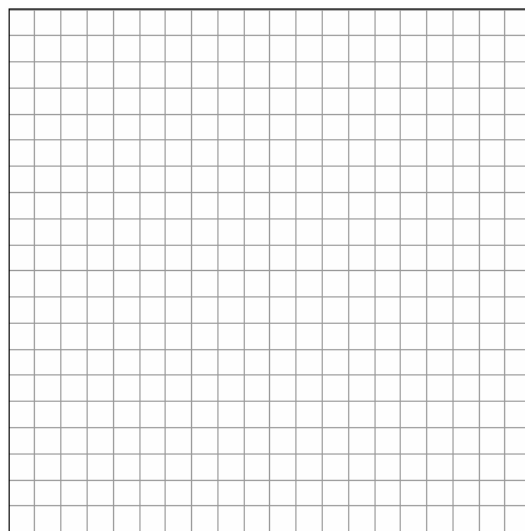
Greg is in a car at the top of a roller-coaster ride. The distance,  $d$ , of the car from the ground as the car descends is determined by the equation  $d = 144 - 16t^2$ , where  $t$  is the number of seconds it takes the car to travel down to each point on the ride. How many seconds will it take Greg to reach the ground?



27. 010431b, P.I. A2.A.7

An acorn falls from the branch of a tree to the ground 25 feet below. The distance,  $S$ , the acorn is from the ground as it falls is represented by the equation

$S(t) = -16t^2 + 25$ , where  $t$  represents time, in seconds. Sketch a graph of this situation on the accompanying grid. Calculate, to the nearest hundredth of a second, the time the acorn will take to reach the ground.



### Part 2: Solving Quadratic Equations Using Square Roots

28. 010215a, P.I. A.A.27

What is the solution set of the equation  $3x^2 = 48$ ?

- [A]  $\{4,4\}$  [B]  $\{4,-4\}$   
[C]  $\{2,8\}$  [D]  $\{-2,-8\}$

29. 010808a, P.I. A.A.27

A solution of the equation  $\frac{x^2}{4} = 9$  is

- [A] 3 [B] 6 [C]  $\frac{3}{2}$  [D] 12



30. 080733a, P.I. A.A.27  
What is the positive solution of the equation  
 $4x^2 - 36 = 0$ ?

## Lesson 10-4: Factoring to Solve Quadratic Equations

### Part 1: Solving Quadratic Equations

31. 069909a, P.I. A.A.28  
The larger root of the equation  
 $(x + 4)(x - 3) = 0$  is  
[A] 4 [B] -4 [C] -3 [D] 3
32. 080622a, P.I. A.A.27  
One of the roots of the equation  
 $x^2 + 3x - 18 = 0$  is 3. What is the other root?  
[A] 15 [B] -21 [C] -6 [D] 6
33. 010727a, P.I. A.A.27  
What is the solution set of the equation  
 $x^2 - 5x = 0$ ?  
[A] {0,-5} [B] {5} [C] {0} [D] {0,5}
34. 080012a, P.I. A.A.27  
The solution set for the equation  
 $x^2 - 2x - 15 = 0$  is  
[A] {-5,-3} [B] {-5,3}  
[C] {5,-3} [D] {5,3}
35. 060725a, P.I. A.A.27  
The solution set of the equation  
 $x^2 - 4x - 12 = 0$  is  
[A] {-6,2} [B] {-3,4}  
[C] {-2,6} [D] {-4,3}
36. 080118a, P.I. A.A.27  
What is the solution set of  $m^2 - 3m - 10 = 0$ ?  
[A] {3,-10} [B] {3,10}  
[C] {5,-2} [D] {2,-5}

37. 060313a, P.I. A.A.27  
What is the solution set of the equation  
 $x^2 - 5x - 24 = 0$ ?  
[A] {3,8} [B] {3,-8}  
[C] {-3,8} [D] {-3,-8}
38. 010520a, P.I. A.A.27  
What is the solution set for the equation  
 $x^2 - 5x + 6 = 0$ ?  
[A] {-6,1} [B] {2,3}  
[C] {-2,-3} [D] {6,-1}
39. 060514a, P.I. A.A.27  
What is the solution set of the equation  
 $x^2 + 11x + 28 = 0$ ?  
[A] {3,4} [B] {-7,4}  
[C] {-7,-4} [D] {-3,-4}
40. 089926a, P.I. A.A.27  
Solve for  $x$ :  $x^2 + 3x - 40 = 0$
41. 060229a, P.I. A.A.27  
Solve for  $x$ :  $x^2 + 3x - 28 = 0$
42. 010637a, P.I. A.A.27  
Solve for  $x$ :  $x^2 + 2x - 24 = 0$
43. 080525a, P.I. A.A.27  
The solution set for the equation  $x^2 - 5x = 6$  is  
[A] {1,-6} [B] {-1,6}  
[C] {-2,3} [D] {2,-3}
44. 060430a, P.I. A.A.28  
If  $(x - 4)$  is a factor of  $x^2 - x - w = 0$ , then the value of  $w$  is  
[A] 12 [B] -3 [C] -12 [D] 3

45. 080627a, P.I. A.A.8  
When Albert flips open his mathematics textbook, he notices that the product of the page numbers of the two facing pages that he sees is 156. Which equation could be used to find the page numbers that Albert is looking at?
- [A]  $(x+1) + (x+2) = 156$   
[B]  $(x+1)(x+3) = 156$   
[C]  $x + (x+1) = 156$  [D]  $x(x+1) = 156$
46. fall0726ia, P.I. A.A.8  
The length of a rectangular window is 5 feet more than its width,  $w$ . The area of the window is 36 square feet. Which equation could be used to find the dimensions of the window?
- [A]  $w^2 - 5w + 36 = 0$  [B]  $w^2 - 5w - 36 = 0$   
[C]  $w^2 + 5w + 36 = 0$  [D]  $w^2 + 5w - 36 = 0$
47. 010326a, P.I. A.A.8  
Three brothers have ages that are consecutive even integers. The product of the first and third boys' ages is 20 more than twice the second boy's age. Find the age of *each* of the three boys.
48. 060636a, P.I. A.A.8  
Tamara has two sisters. One of the sisters is 7 years older than Tamara. The other sister is 3 years younger than Tamara. The product of Tamara's sisters' ages is 24. How old is Tamara?
49. 060131a, P.I. A.A.8  
Find three consecutive odd integers such that the product of the first and the second exceeds the third by 8.
50. 060606b, P.I. A.A.8  
If the equation  $x^2 - kx - 36 = 0$  has  $x = 12$  as one root, what is the value of  $k$ ?
- [A] -9 [B] 3 [C] -3 [D] 9
51. 060104a, P.I. A2.A.7  
One root of the equation  $2x^2 - x - 15 = 0$  is
- [A] -3 [B] 3 [C]  $\frac{3}{2}$  [D]  $\frac{5}{2}$
52. 010419a, P.I. A2.A.7  
What is the solution set of the equation  $3x^2 - 34x - 24 = 0$ ?
- [A]  $\{-\frac{2}{3}, 12\}$  [B]  $\{-12, \frac{2}{3}\}$   
[C]  $\{-2, 6\}$  [D]  $\{-6, 2\}$
53. 080112b, P.I. A.A.8  
A ball is thrown straight up at an initial velocity of 54 feet per second. The height of the ball  $t$  seconds after it is thrown is given by the formula  $h(t) = 54t - 12t^2$ . How many seconds after the ball is thrown will it return to the ground?
- [A] 6 [B] 4.5 [C] 9.2 [D] 4
54. 080612b, P.I. A.A.8  
For which equation is the sum of the roots equal to the product of the roots?
- [A]  $x^2 - 4x + 4 = 0$  [B]  $x^2 - 8x - 4 = 0$   
[C]  $x^2 + x + 1 = 0$  [D]  $x^2 + 3x - 6 = 0$
55. 010830b, P.I. A2.A.21  
Write a quadratic equation such that the sum of its roots is -5 and the product of its roots is 6. What are the roots of this equation?

## Extension P. 577: Rational Exponents

56. 010217b, P.I. A2.N.1

The value of  $\left(\frac{3^0}{27^{\frac{2}{3}}}\right)^{-1}$  is

- [A]  $\frac{1}{9}$  [B]  $-9$  [C]  $9$  [D]  $-\frac{1}{9}$

57. 080601b, P.I. A2.N.1

The expression  $4^{\frac{1}{2}} \cdot 2^3$  is equal to

- [A]  $8^{\frac{3}{2}}$  [B]  $4^{\frac{3}{2}}$  [C]  $16$  [D]  $4$

58. 080218b, P.I. A2.N.1

The expression  $\frac{3^{\frac{1}{3}}}{3^{-\frac{2}{3}}}$  is equivalent to

- [A]  $\frac{1}{\sqrt[3]{3}}$  [B]  $\sqrt{3}$  [C]  $3$  [D]  $1$

59. 060208b, P.I. A2.A.10

If  $x$  is a positive integer,  $4x^{\frac{1}{2}}$  is equivalent to

- [A]  $4\sqrt{x}$  [B]  $2x$  [C]  $\frac{2}{x}$  [D]  $4\frac{1}{x}$

60. 010413b, P.I. A2.A.10

The expression  $b^{-\frac{3}{2}}$ ,  $b > 0$ , is equivalent to

- [A]  $(\sqrt[3]{b})^2$  [B]  $\frac{1}{(\sqrt[3]{b})^2}$   
[C]  $\frac{1}{(\sqrt{b})^3}$  [D]  $-(\sqrt{b})^3$

61. 060708b, P.I. A2.A.11

The volume of a soap bubble is represented by the equation  $V = 0.094\sqrt{A^3}$ , where  $A$  represents the surface area of the bubble. Which expression is also equivalent to  $V$ ?

- [A]  $0.094A^6$  [B]  $0.094A^{\frac{2}{3}}$   
[C]  $(0.094A^3)^{\frac{1}{2}}$  [D]  $0.094A^{\frac{3}{2}}$

62. 060419b, P.I. A2.A.11

The expression  $\sqrt[4]{16a^6b^4}$  is equivalent to

- [A]  $4a^2b$  [B]  $2a^{\frac{3}{2}}b$   
[C]  $2a^2b$  [D]  $4a^{\frac{3}{2}}b$

63. 010617b, P.I. A2.A.8

When simplified, the expression  $(\sqrt[3]{m^4})(m^{-\frac{1}{2}})$  is equivalent to

- [A]  $\sqrt[3]{m^{-2}}$  [B]  $\sqrt[4]{m^3}$   
[C]  $\sqrt[6]{m^5}$  [D]  $\sqrt[5]{m^{-4}}$

64. 080322b, P.I. A2.N.1

Find the value of  $(x+2)^0 + (x+1)^{-\frac{2}{3}}$  when  $x = 7$ .

65. 060602b, P.I. A2.A.8

If  $f(x) = x^{-\frac{3}{2}}$ , then  $f(\frac{1}{4})$  is equal to

- [A]  $-\frac{1}{8}$  [B]  $8$  [C]  $-2$  [D]  $-4$

66. 060516b

If  $(a^x)^{\frac{2}{3}} = \frac{1}{a^2}$ , what is the value of  $x$ ?

- [A]  $-1$  [B]  $-3$  [C]  $2$  [D]  $1$

67. 080325b

Meteorologists can determine how long a storm lasts by using the function

$t(d) = 0.07d^{\frac{3}{2}}$ , where  $d$  is the diameter of the storm, in miles, and  $t$  is the time, in hours. If the storm lasts 4.75 hours, find its diameter, to the *nearest tenth of a mile*.

71. 060128b, P.I. A2.A.25

A homeowner wants to increase the size of a rectangular deck that now measures 15 feet by 20 feet, but building code laws state that a homeowner cannot have a deck larger than 900 square feet. If the length and the width are to be increased by the same amount, find, to the *nearest tenth*, the maximum number of feet that the length of the deck may be increased in size legally.

72. 080727b, P.I. A2.A.25

A rectangular patio measuring 6 meters by 8 meters is to be increased in size to an area measuring 150 square meters. If both the width and the length are to be increased by the same amount, what is the number of meters, to the *nearest tenth*, that the dimensions will be increased?

## Lesson 10-6: Using the Quadratic Formula

### Part 1: Using the Quadratic Formula

68. 080217b

If the sum of the roots of  $x^2 + 3x - 5$  is added to the product of its roots, the result is

[A] 15      [B] -15      [C] -2      [D] -8

69. 080634b, P.I. A2.A.25

Barb pulled the plug in her bathtub and it started to drain. The amount of water in the bathtub as it drains is represented by the equation  $L = -5t^2 - 8t + 120$ , where  $L$  represents the number of liters of water in the bathtub and  $t$  represents the amount of time, in minutes, since the plug was pulled. How many liters of water were in the bathtub when Barb pulled the plug? Show your reasoning. Determine, to the *nearest tenth of a minute*, the amount of time it takes for all the water in the bathtub to drain.

70. 010729b, P.I. A2.A.25

Matt's rectangular patio measures 9 feet by 12 feet. He wants to increase the patio's dimensions so its area will be twice the area it is now. He plans to increase both the length and the width by the same amount,  $x$ . Find  $x$ , to the *nearest hundredth of a foot*.

## Activity Lab P. 612: Surface Area and Volumes

73. 010802a, P.I. A.G.2

A block of wood is 5 inches long, 2 inches wide, and 3 inches high. What is the volume of this block of wood?

[A]  $30 \text{ in}^3$       [B]  $38 \text{ in}^3$   
[C]  $25 \text{ in}^3$       [D]  $10 \text{ in}^3$

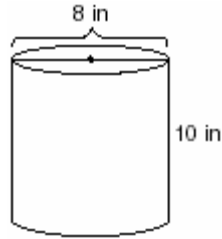
74. 010123a, P.I. A.G.2

A cardboard box has length  $x - 2$ , width  $x + 1$ , and height  $2x$ .

*a* Write an expression, in terms of  $x$ , to represent the volume of the box.  
*b* If  $x = 8$  centimeters, what is the number of cubic centimeters in the volume of the box?

75. 060530a, P.I. A.G.2

A storage container in the shape of a right circular cylinder is shown in the accompanying diagram.

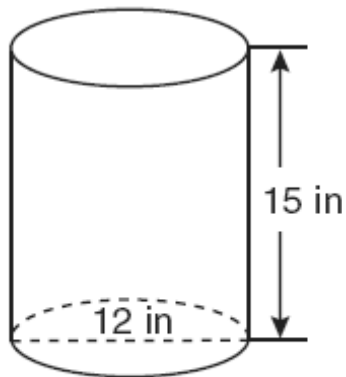


What is the volume of this container, to the nearest hundredth?

- [A]  $251.33 \text{ in}^3$       [B]  $502.65 \text{ in}^3$   
[C]  $125.66 \text{ in}^3$       [D]  $56.55 \text{ in}^3$

76. fall0712ia, P.I. A.G.2

A cylindrical container has a diameter of 12 inches and a height of 15 inches, as illustrated in the diagram below.



(Not drawn to scale)

What is the volume of this container to the nearest tenth of a cubic inch?

- [A] 4,241.2      [B] 2,160.0  
[C] 1,696.5      [D] 6,785.8

[1] C

[2] C

[3] C

[4] B

[5] C

[6] C

a [3] A parabola is correctly graphed through (0,0), (1,5), (2,8), (3,9), (4,8), (5,5), and (6,0).

[2] The correct table of values is shown but is not graphed through the entire domain.

or [2] The correct points are graphed but as a broken line graph not a curve.

or [2] At least three values are correctly calculated and graphed.

[1] At least two of the values are correctly calculated, and the student tried to graph all points.

b [1] 3

or [1] The correct time,  $x$ , for an incorrect graph in part a is found.

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

[7] obviously incorrect procedure.

[4] 100 and a correct parabolic arch is drawn, and appropriate work is shown, such as a table of values for the parabola or correctly labeled points.

[3] 100 and a correct parabolic arch is drawn, but no table of values or labeled points are shown.

or [3] 100 and a correct parabolic arch is drawn, and appropriate work is shown, but no scale or an incorrect scale is shown.

or [3] A correct parabolic arch is drawn, but the maximum height is missing or is incorrect.

[2] An incorrect parabolic arch is drawn, but an appropriate maximum height is found.

or [2] A correct height is determined algebraically, but a parabolic arch is not drawn.

or [2] 100 and an appropriate parabolic arch is drawn, but it is not drawn between  $0 \leq x \leq 20$ .

[1] A correct parabolic arch is drawn, but no work is shown, such as a table of values or correctly labeled points, and the maximum height is missing or is incorrect.

or [1] 100, but no work is shown and no parabolic arch is drawn.

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

[8] incorrect procedure.

- a [3] A parabola with points graphed at (0,0), (1,32), (2,48), (3,48), (4,32), and (5,0) is shown. [Points do not have to be labeled on the graph for full credit.]  
[2] Appropriate work is shown, such as a table of values, but one graphing error is made.  
or [2] The correct points are graphed, but the parabola is drawn incorrectly, such as connecting (2,48) and (3,48) as a line segment or not connecting the points at all.  
or [2] At least four correct values are found, and the parabola is graphed appropriately.  
or [2] A correct table of values is shown for all values from 0 to 5, but no graph is drawn.  
[1] Two or three correct values are found, and the parabola is graphed appropriately.  
or [1] A correct table of values is shown for an incorrectly transcribed equation, such as  $h = 8t^2 + 40t$ , but no graph is drawn.  
b [1] 2.5 is found algebraically or identified from a table or from the graph of the parabola.  
or [1] An appropriate value of  $t$  is found, based on an incorrect graph.  
or [1]  $2 < t < 3$  is given as the range of values based on the line segment drawn in part a.  
a and b [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
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- [9] \_\_\_\_\_
- a [3] A parabola is correctly graphed through (0,0), (1,10), (2,16), (3,18), (4,16), (5,10), and (6,0).  
[2] A correct table of values is shown, but not all the points are graphed correctly.  
or [2] The correct points are graphed but as a broken-line graph, not a curve.  
or [2] At least four values are calculated correctly and graphed.  
[1] The student has at least two of the values calculated correctly and has tried to graph all the points.  
[0] Fewer than two values are calculated correctly.  
b [1] A maximum height of 18 is found.  
or [1] Correct  $y$  is found for an incorrect graph in part a.  
a and b [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
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- [10] \_\_\_\_\_
- [4] A correct graph is drawn, and 3.  
[3] 3, and appropriate work is shown, but one graphing error is made.  
or [3] A correct graph is drawn and the points 0.5 and 3.5 are identified, but the difference is not calculated.  
[2] Appropriate work is shown, but two or more graphing errors are made.  
or [2] Appropriate work is shown, but one conceptual error is made.  
or [2] 3, but a method other than a graphic solution is used.  
[1] Appropriate work is shown, but one conceptual error and one graphing error are made.  
or [1] A correct graph is sketched with  $t = 0$  to  $t = 4$ , but no further correct work is shown.  
or [1] 3, but no work is shown and no graph is drawn.  
[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
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- [11] \_\_\_\_\_
- [12] A \_\_\_\_\_

[3]  $y = x^2 + 3x - 18$ , and appropriate work leading from the roots to the equation is shown.

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

or [2]  $x^2 + 3x - 18 = 0$ , but appropriate work is shown.

or [2] Only the correct factors  $(x + 6)$  and  $(x - 3)$  are shown.

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

or [1] Only the roots  $-6$  and  $3$  are shown, such as  $x = -6$ ,  $x = 3$ .

or [1]  $y = x^2 + 3x - 18$ , 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

[13] incorrect procedure.

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[14] C

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[15] C

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[16] D

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[2] Maximum, and an appropriate reason is given, such as the value of  $a$  is negative (less than 0) or the graph opens downward.

[1] Minimum, but an appropriate reason is given, based on an incorrect equation, such as an error in finding the axis of symmetry.

[0] Maximum or minimum, but no reason or an inappropriate reason is given.

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

[17] obviously incorrect procedure.

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[2] 1.4, and appropriate work is shown, such as finding the axis of symmetry.

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

or [1] 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

[18] incorrect procedure.

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[2] 20.1, 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.

or [1] The time when the ball reaches its maximum height is found correctly, but no further correct work is shown.

or [1] 20.1, 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.

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[19]

[2] 5, 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] 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

[20] incorrect procedure.

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[2] 300, and appropriate work is shown.

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

or [1] 300, 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

[21] incorrect procedure.

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- [4] 3 and 42, and appropriate work is shown, such as a graph, substitution, or a table of values.
- [3] Appropriate work is shown, but one computational or graphing error is made.
- [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] The number of seconds is found correctly, and appropriate work is shown, but the height is not found or is found incorrectly.
- or [2] The height is found correctly, and appropriate work is shown, but the number of seconds is not found or is found incorrectly.
- [1] 3 and 42, but no work is shown.
- [0] 3 or 42, 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.
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- [22]
- [4] Time of maximum height = 2.45, maximum height = 31.39, time when it hit the ground = 4.98, and appropriate algebraic or graphic work is shown. [Answers for time, in seconds, may vary based on method of solution.]
- [3] Appropriate algebraic or graphic work is shown, but one computational or graphing error is made.
- or [3] The times are found correctly, but the maximum height is incorrect.
- [2] The rock's maximum height and the time it takes to reach that height are found correctly, but the time it takes to hit the ground is incorrect.
- or [2] The time it takes the rock to hit the ground is found correctly, but the maximum height and the time it takes to reach that height are incorrect.
- [1] Time of maximum height = 2.45, maximum height = 31.39, time when it hit the ground = 4.98, 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.
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- [23]

- [4] Maximum height = 64 and time = 4, and appropriate work is shown.
- [3] Appropriate work is shown, but one computational or graphing error is made.
- or [3] The correct time is found, and appropriate work is shown, but the maximum height is not found.
- [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] The maximum height is found correctly, and appropriate work is shown, but an incorrect value is found for  $t$ .
- or [2] Appropriate work is shown, but only the time that the maximum height occurs is found, and the quadratic equation  $64t - 16t^2 = 0$  is factored, but no further correct work is shown.
- [1] Appropriate work is shown, but one conceptual error and one computational or graphing error are made.
- or [1] Appropriate work is shown, but only the time that the maximum height occurs is found, or the quadratic equation  $64t - 16t^2 = 0$  is factored.
- or [1] Maximum height = 64 and time = 4, but no work is shown.
- [0] Maximum height = 64 or time = 4, 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.
- [24] \_\_\_\_\_
- [6] A correct graph is drawn, 90 and 45, and appropriate work is shown.
- [5] Appropriate work is shown to answer all three parts of the question, but one computational or graphing error is made.
- [4] Appropriate work is shown, but two or more computational or graphing errors are made.
- or [4] A correct graph is drawn, and 90 or 45, and appropriate work is shown.
- [3] Appropriate work is shown, but one conceptual error is made.
- or [3] 90 and 45, and appropriate work is shown, but no graph is drawn.
- or [3] A correct graph is drawn, but no further correct work is shown.
- [2] Appropriate work is shown, but one conceptual error and one computational or graphing error are made.
- [1] 90 or 45, and appropriate work is shown.
- or [1] 90 and 45, but no work is shown and no graph is drawn.
- [0] 90 or 45, 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.
- [25] \_\_\_\_\_
- [4] 3, and an appropriate algebraic or graphic solution is shown.
- [3] The equation is graphed correctly, but the time to reach the ground is not identified.
- or [3] Appropriate work is shown for an algebraic solution, but either no solution is found or the negative root is not rejected.
- or [3] An appropriate algebraic solution is shown, but one computational error is made.
- [2] The equation is graphed incorrectly, but an appropriate time to reach the ground is identified.
- or [2] The equation is factored incorrectly, but an appropriate solution is found.
- [1] 3, 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.
- [26] \_\_\_\_\_

[4] A correct graph is sketched and 1.25, and appropriate work is shown.

[3] A correct graph is sketched, but one computational or rounding error is made in determining the time.

or [3] Appropriate work is shown, but one error is made in sketching the graph, such as the axes are not labeled or are labeled incorrectly, but the time is determined correctly.

or [3] A correct graph is sketched and appropriate work is shown to calculate the time, but the negative root is not rejected.

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

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

or [2] A correct graph is sketched, but no further correct work is shown.

or [2] Appropriate work is shown to calculate the time, but no graph or an incorrect graph is sketched.

[1] Appropriate work is shown to calculate the time, but one computational or rounding error is made, and no graph or an incorrect graph is sketched.

or [1] Appropriate work is shown to calculate the time, but the negative root is not rejected, and no graph or an incorrect graph is sketched.

or [1] 1.25, but no graph or an incorrect graph is sketched, and 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

[27] incorrect procedure.

[28] B

[29] B

[2] 3, and appropriate work is shown, such as factoring or trial and error with at least three trials and appropriate checks.

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

or [1] Appropriate work is shown, but one conceptual error is made, such as not rejecting the negative root.

or [1] The trial-and-error method is attempted and at least six systematic trials and appropriate checks are shown, but no solution is found.

or [1] 3, but no work or fewer than three trials and appropriate checks are shown.

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

[30] incorrect procedure.

[31] D

[32] C

[33] D

[34] C

[35] C

[36] C

[37] C

[38] B

[39] C

[3] -8 and 5 and appropriate work is shown, such as factoring or trial and error.

[2] The student shows correct factoring into  $(x + 8)(x - 5)$  or correct use of the quadratic formula but finds only one correct value for  $x$ .

[1] Correct factoring is shown, but no values are found.

or

[1] Incorrect factoring is shown, but two appropriate values are found.

or

[1] Either -8 or 5 is arrived at by trial and error.

or

[1] -8 and 5 and 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

[40] incorrect procedure.

[3] -7 and 4, and appropriate work is shown, such as factoring.

[2] Correct factoring  $(x + 7)(x - 4)$  is shown, but only one correct value of  $x$  is found.

or [2] Correct factoring is shown, but the negative value of  $x$  is rejected.

[1] Correct factoring is shown, but the values of  $x$  are not found.

or [1] Incorrect factoring is shown, but appropriate values are found.

or [1] Only one value is found by trial and error.

or [1] -7 and 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

[41] incorrect procedure.

[3] -6 and 4, and appropriate work is shown, such as factoring or trial and error with at least three trials and appropriate checks.

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

or [2] Appropriate work is shown, but only one correct value for  $x$  is found.

or [2] The trial-and-error method is used to find the correct solutions, but only two trials and appropriate checks are shown.

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

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

or [1] The equation is factored correctly, but no values are found.

or [1] The equation is factored incorrectly, but two appropriate values are found.

or [1] -6 and 4, but no work or only one trial with an appropriate check is shown.

[0] -6 or 4, but no work or only one trial with an appropriate check is shown.

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

[42] obviously incorrect procedure.

[43] B

[44] A

[45] D

[46] D

[3] 4, 6, and 8, and appropriate work is shown, such as the correct quadratic equation or trial and error with at least three trials and appropriate checks.

[2] The correct quadratic equation is solved, but one computational error is made, but three appropriate ages are listed.

or [2] The correct quadratic equation is solved, but the negative root is not rejected, but three appropriate ages are listed.

or [2] The correct quadratic equation is solved, but only one age is found.

or [2] The trial-and-error method is used to find a correct solution, but only two trials and appropriate checks are shown.

[1] An incorrect equation of lesser difficulty is solved appropriately, and the three ages are listed.

or [1] An incorrect quadratic equation of equal difficulty is solved appropriately, and the three ages are listed.

or [1] The correct quadratic equation is shown, but more than one computational error is made.

or [1] The correct quadratic equation is shown, but no further correct work is shown.

or [1] 4, 6, and 8, but no work or only one trial with an appropriate check is shown.

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

[47] incorrect procedure.

[3] 5, and appropriate work is shown, such as the quadratic equation  $(x + 7)(x - 3) = 24$  or trial and error with at least three trials and appropriate checks.

[2] A correct quadratic equation is written, but one computational error is made in finding Tamara's age.

or [2] 12 and 2 are found as the sisters' ages, but Tamara's age is not found.

or [2] The trial-and-error method is used to find the correct solution, but only two trials and appropriate checks are shown.

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

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

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

or [1] An incorrect equation of equal difficulty is solved appropriately for Tamara's age.

or [1] The trial-and-error method is attempted and at least six systematic trials and appropriate checks are shown, but no solution is found.

or [1] 5, but no work or only one trial with an appropriate check 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] 3, 5, and 7, and appropriate work is shown, such as an appropriate quadratic equation or trial-and-error method.

[3] An appropriate equation is written and solved, but one computational error is made.

or [3] An appropriate equation is written and solved, but the even solutions are also listed.

[2] An incorrect quadratic equation is shown, but it is solved appropriately.

or [2] Integers are misrepresented, but the subsequent quadratic equation is solved appropriately.

or [2] An appropriate equation is written and solved, but more than one computational error is made.

or [2] The correct solution is given, but only one trial is shown with appropriate checks when a trial-and-error method is used.

[1] A linear equation is solved appropriately.

or [1] 3, 5, and 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

[49] incorrect procedure.

[50] D

[51] B

[52] A

[53] B

[54] A

[4]  $x^2 + 5x + 6 = 0$  or an equivalent equation and -3 and -2, and appropriate work is shown, such as using the sum and product formulas or factoring the equation.

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

or [3] The expression  $x^2 + 5x + 6 = 0$  is written and -3 and -2, and appropriate work is shown.

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

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

or [2] A correct quadratic equation is written, and appropriate work is shown, but the roots are not found.

or [2] Appropriate work is shown to find -3 and -2, but no quadratic equation is written.

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

or [1]  $x^2 + 5x + 6 = 0$  or an equivalent equation and -3 and -2, but no work is shown.

[0] A correct quadratic equation or -3 and -2, 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

[55] obviously incorrect procedure.

[56] C

[57] C

[58] C

[59] A

[60] C

[61] D

[62] B

[63] C

[2]  $1\frac{1}{4}$  or an equivalent answer, 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]  $1\frac{1}{4}$  or an equivalent answer, 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

[64] incorrect procedure.

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[65] B

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[66] B

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[2] 16.6, 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.

or [1] A correct substitution of 4.75 for  $t$  is made, but no further correct work is shown.

or [1] 16.6, 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

[67] incorrect procedure.

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[68] D

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[6] 120 and 4.2, and appropriate work is shown, such as substituting  $t = 0$  into the equation and solving the equation

$$-5t^2 - 8t + 120 = 0.$$

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

or [5] 120 and 4.2, but no work is shown to find the amount of water, but appropriate work is shown to find the amount of time.

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

or [4] Appropriate work is shown, and the amount of water is found correctly, but one conceptual error is made in finding the amount of time.

or [4] The amount of time is found correctly, and appropriate work is shown, but the amount of water is not found.

or [4] The amount of water is found correctly, and appropriate work is shown, and a correct substitution into the quadratic formula is made, but the amount of time is not found.

[3] Appropriate work is shown, but one conceptual error is made in finding the amount of time, and one computational error is made in finding the amount of water.

[2] The amount of water is found correctly, and appropriate work is shown, but no further correct work is shown.

or [2] 120 and 4.2, but no work is shown.

[1] 120 or 4.2, 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

[69] incorrect procedure.

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- [4] 4.27, and appropriate work is shown, such as solving the equation  $(9 + x)(12 + x) = 216$ .  
 [3] Appropriate work is shown, but one computational or rounding error is made.  
 or [3] Appropriate work is shown, but the negative root is not rejected.  
 [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] A correct equation is written in standard form, 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 or rounding error are made.  
 or [1] An incorrect quadratic equation of a lesser degree of difficulty is solved appropriately.  
 or [1] 4.27, 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.
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- [70]

- [4] 12.6, 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 quadratic formula is incorrect.  
 [2] An appropriate equation is shown and put in standard form, but the quadratic formula is not used correctly.  
 or [2] An appropriate equation is shown and put in standard form, but no further work is shown.  
 or [2] Appropriate work is shown, but more than one computational error or one computational and one rounding error are made.  
 [1] An appropriate equation is shown, but all other work is missing or is incorrect.  
 or [1] 12.6, 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 incorrect procedure.
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- [71]
- [4] 5.3, and appropriate work is shown, such as solving the equation  $(x + 6)(x + 8) = 150$  by using a table or the quadratic formula.  
 [3] Appropriate work is shown, but one computational or rounding error is made.  
 or [3] Appropriate solutions are found, but the negative root is not rejected.  
 [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] The correct quadratic equation in standard form,  $x^2 + 14x - 102 = 0$ , is written, but no further correct work is shown.  
 or [1] An incorrect quadratic equation is solved appropriately.  
 or [1] 5.3, 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.
- 
- [72]
- [73] A
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a [1] Either  $(x - 2)(x + 1)(2x) = V$  or the same expression without “=  $V$ ” is shown.

or [1]  $2x^3 - 2x^2 - 4x$  or an equivalent expression is shown.

b [1] 864

or [1] The student substitutes appropriately into an incorrect part a equation.

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

[74] incorrect procedure.

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[75] B

[76] C