

## Section 13-1: Solving Quadratic Equations

### Solving a Quadratic Equation by Factoring

1. 010215a, P.I. A.A.27  
What is the solution set of the equation  $3x^2 = 48$ ?  
[A] {2,8} [B] {-2,-8}  
[C] {4,4} [D] {4,-4}
2. 010808a, P.I. A.A.27  
A solution of the equation  $\frac{x^2}{4} = 9$  is  
[A] 3 [B] 12 [C] 6 [D]  $\frac{3}{2}$
3. 080733a, P.I. A.A.27  
What is the positive solution of the equation  $4x^2 - 36 = 0$ ?
4. 010727a, P.I. A.A.27  
What is the solution set of the equation  $x^2 - 5x = 0$ ?  
[A] {0,5} [B] {0} [C] {0,-5} [D] {5}
5. 080112b, P.I. A2.A.20  
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] 9.2 [B] 4.5 [C] 6 [D] 4
6. 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}
7. 060725a, P.I. A.A.27  
The solution set of the equation  $x^2 - 4x - 12 = 0$  is  
[A] {-4,3} [B] {-3,4}  
[C] {-6,2} [D] {-2,6}
8. 080118a, P.I. A.A.27  
What is the solution set of  $m^2 - 3m - 10 = 0$ ?  
[A] {2,-5} [B] {3,-10}  
[C] {3,10} [D] {5,-2}
9. 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}
10. 010520a, P.I. A.A.27  
What is the solution set for the equation  $x^2 - 5x + 6 = 0$ ?  
[A] {2,3} [B] {-2,-3}  
[C] {6,-1} [D] {-6,1}
11. 060514a, P.I. A.A.27  
What is the solution set of the equation  $x^2 + 11x + 28 = 0$ ?  
[A] {-7,4} [B] {3,4}  
[C] {-3,-4} [D] {-7,-4}
12. 089926a, P.I. A.A.27  
Solve for  $x$ :  $x^2 + 3x - 40 = 0$
13. 060229a, P.I. A.A.27  
Solve for  $x$ :  $x^2 + 3x - 28 = 0$
14. 010637a, P.I. A.A.27  
Solve for  $x$ :  $x^2 + 2x - 24 = 0$

15. 080525a, P.I. A.A.27  
The solution set for the equation  $x^2 - 5x = 6$  is  
[A]  $\{-1, 6\}$  [B]  $\{2, -3\}$   
[C]  $\{1, -6\}$  [D]  $\{-2, 3\}$
16. 060104a, P.I. A2.A.7  
One root of the equation  $2x^2 - x - 15 = 0$  is  
[A]  $\frac{3}{2}$  [B]  $-3$  [C]  $\frac{5}{2}$  [D]  $3$
17. 010419a, P.I. A2.A.7  
What is the solution set of the equation  $3x^2 - 34x - 24 = 0$ ?  
[A]  $\{-2, 6\}$  [B]  $\{-12, \frac{2}{3}\}$   
[C]  $\{-\frac{2}{3}, 12\}$  [D]  $\{-6, 2\}$
18. 069909a, P.I. A.A.28  
The larger root of the equation  $(x + 4)(x - 3) = 0$  is  
[A]  $-4$  [B]  $-3$  [C]  $3$  [D]  $4$
19. 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]  $6$  [B]  $-21$  [C]  $15$  [D]  $-6$
20. 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]  $3$
21. 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]  $9$  [D]  $3$
22. 080627a, P.I. A.A.5  
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]  $x + (x + 1) = 156$   
[B]  $(x + 1) + (x + 2) = 156$   
[C]  $(x + 1)(x + 3) = 156$   
[D]  $x(x + 1) = 156$
23. 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?
24. 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.
25. 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.
26. fall0726ia, P.I. A.A.5  
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]  $w^2 + 5w + 36 = 0$

27. 060425a, P.I. A.A.5

A farmer has a rectangular field that measures 100 feet by 150 feet. He plans to increase the area of the field by 20%. He will do this by increasing the length and width by the same amount,  $x$ . Which equation represents the area of the new field?

[A]  $2(100 + x) + 2(150 + x) = 15,000$

[B]  $(100 + x)(150 + x) = 15,000$

[C]  $(100 + x)(150 + x) = 18,000$

[D]  $(100 + 2x)(150 + x) = 18,000$

28. 080035a, P.I. A.A.8

Jack is building a rectangular dog pen that he wishes to enclose. The width of the pen is 2 yards less than the length. If the area of the dog pen is 15 square yards, how many yards of fencing would he need to completely enclose the pen?

29. 060035a, P.I. A.A.8

The area of the rectangular playground enclosure at South School is 500 square meters. The length of the playground is 5 meters longer than the width. Find the dimensions of the playground, in meters.  
[Only an algebraic solution will be accepted.]

30. 010233a, P.I. A.A.8

Javon's homework is to determine the dimensions of his rectangular backyard. He knows that the length is 10 feet more than the width, and the total area is 144 square feet. Write an equation that Javon could use to solve this problem. Then find the dimensions, in feet, of his backyard.

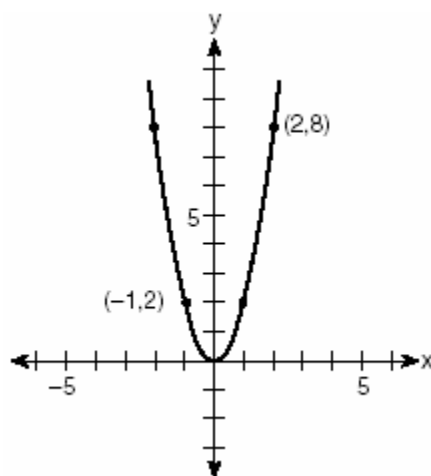
31. 080232a, P.I. A.A.8

A rectangular park is three blocks longer than it is wide. The area of the park is 40 square blocks. If  $w$  represents the width, write an equation in terms of  $w$  for the area of the park. Find the length and the width of the park.

## Section 13-2: The Graph of a Quadratic Function

32. 060404b, P.I. A.G.4

Which quadratic function is shown in the accompanying graph?



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

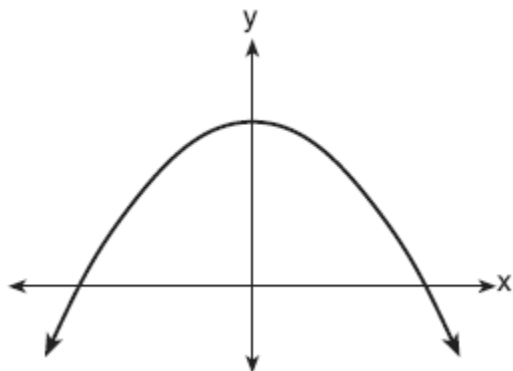
[B]  $y = -2x^2$

[C]  $y = 2x^2$

[D]  $y = \frac{1}{2}x^2$

33. 060703b, P.I. A.G.4

Which equation is best represented by the accompanying graph?



[A]  $y = -x^2 + 1$

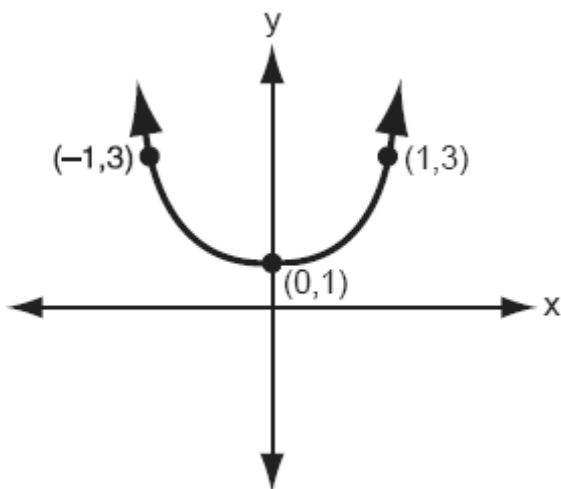
[B]  $y = 6x + 1$

[C]  $y = 6x^2$

[D]  $y = 6^x$

34. 010801b, P.I. A.G.4

Which equation is represented by the accompanying graph?



[A]  $y = x^2$

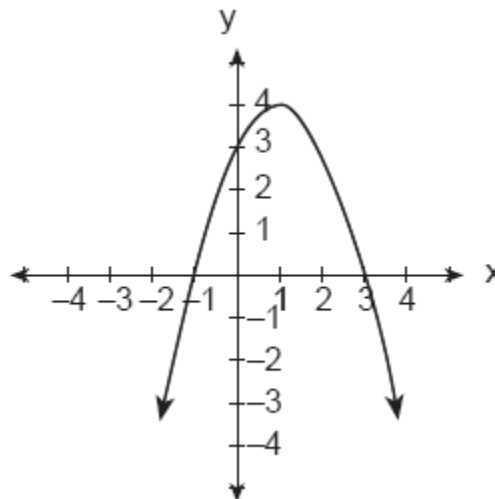
[B]  $y = 2(x^2 + 1)$

[C]  $y = 2x^2 + 1$

[D]  $y = 2x^2$

35. 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]  $y = x^2 + 2x + 3$

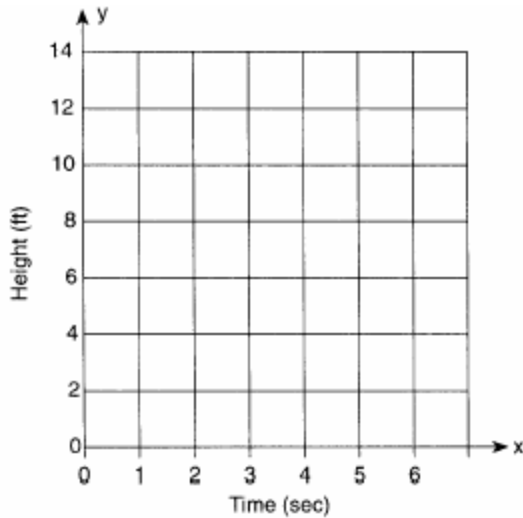
[C]  $y = -x^2 + 2x + 3$

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

36. 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.

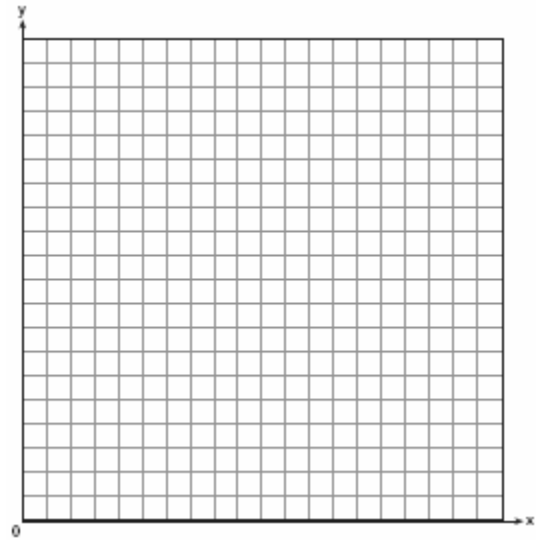
a Graph  $y = -x^2 + 6x$  for  $0 \leq x \leq 6$  on the grid provided below.



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

37. 060333a, P.I. A.G.4

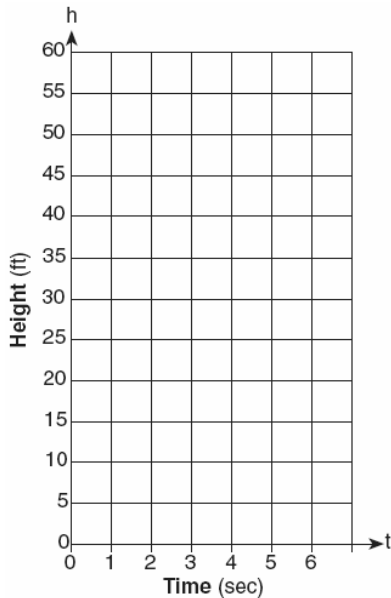
An architect is designing a museum entranceway in the shape of a parabolic arch represented by the equation  $y = -x^2 + 20x$ , where  $0 \leq x \leq 20$  and all dimensions are expressed in feet. On the accompanying set of axes, sketch a graph of the arch and determine its maximum height, in feet.



38. 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.

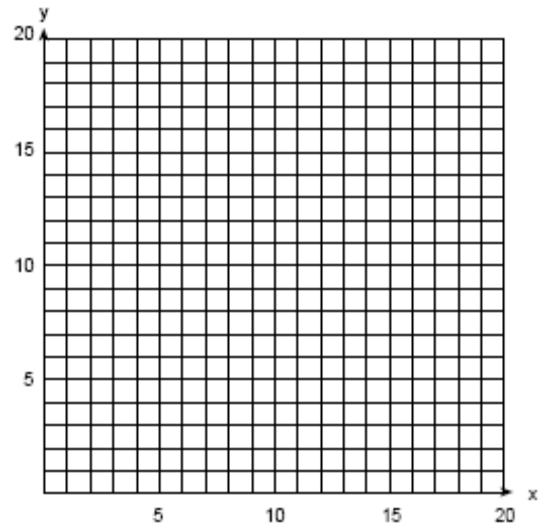


*b* What is the value of  $t$  at which  $h$  has its greatest value?

39. 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.

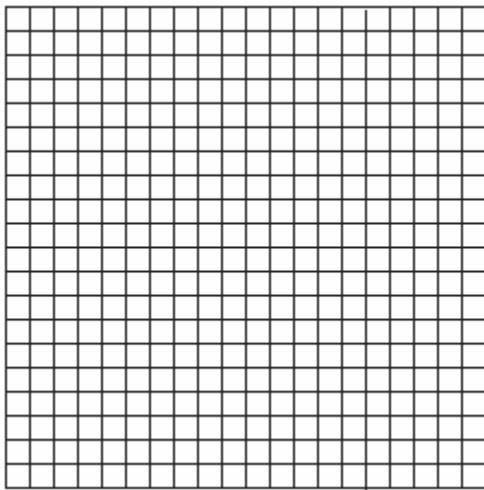


*b* Determine the maximum height,  $y$ , of the arch.

40. 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.]



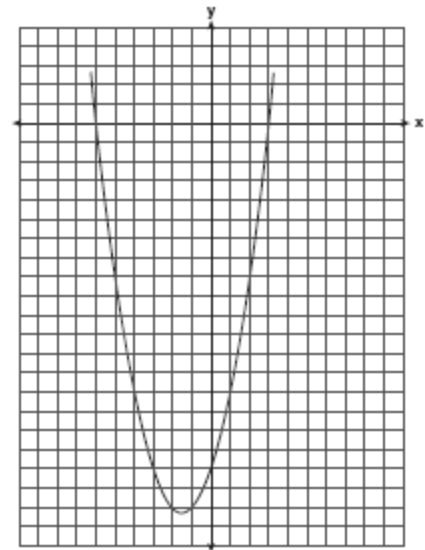
41. 080508a, P.I. A.A.8

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] 32 ft    [C] 64 ft    [D] 16 ft

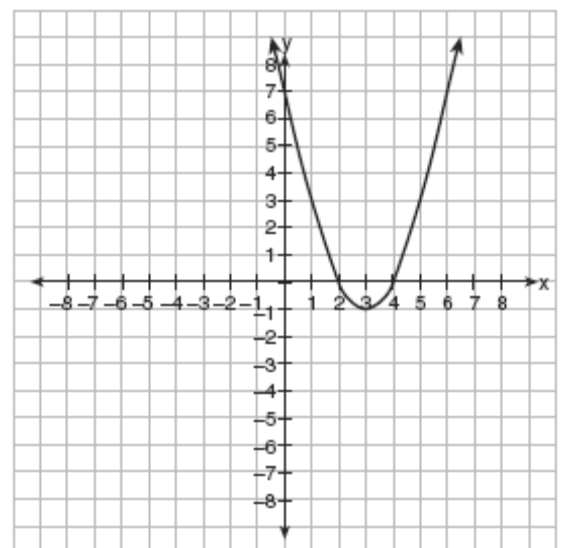
42. 010328a, P.I. A.G.4

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.



43. 010606b, P.I. A.G.10

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



[A]  $x = 2$

[B]  $x = 4$

[C]  $y = 3$

[D]  $x = 3$

44. 060514b, P.I. A.A.41

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

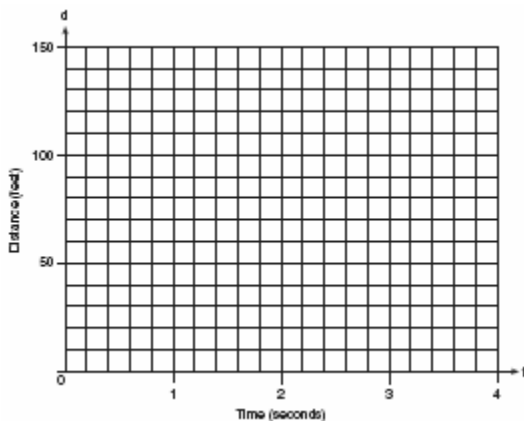
[A]  $y = -x^2 + 3x + 5$       [B]  $y = x^2 + 6x + 3$

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

### Section 13-3: Finding Roots from a Graph

45. 080234a, P.I. A.A.27

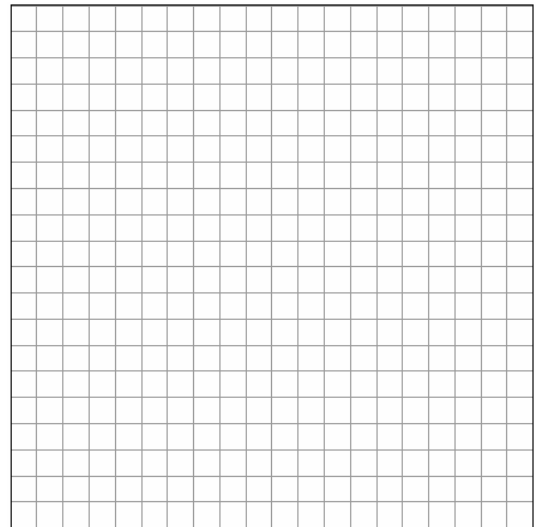
Greg is in a car at the top of a roller-coaster ride. The distance,  $d$ , of the car from the ground as the car descends is determined by the equation  $d = 144 - 16t^2$ , where  $t$  is the number of seconds it takes the car to travel down to each point on the ride. How many seconds will it take Greg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



46. 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.

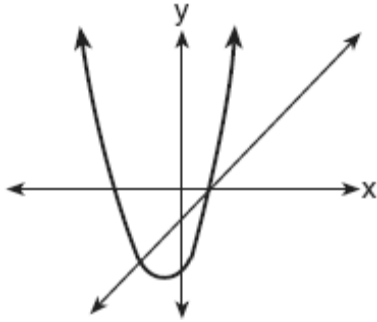




### Section 13-4: Graphic Solution of a Quadratic-Linear System

47. 060507a

The accompanying diagram shows the graphs of a linear equation and a quadratic equation.



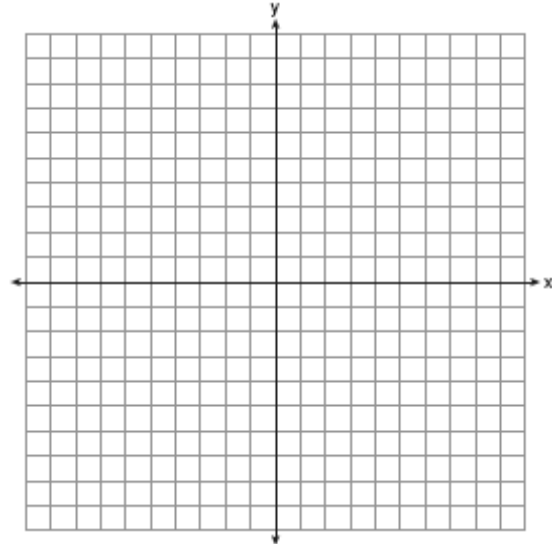
How many solutions are there to this system of equations?

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

48. fall0738ia, P.I. A.G.9

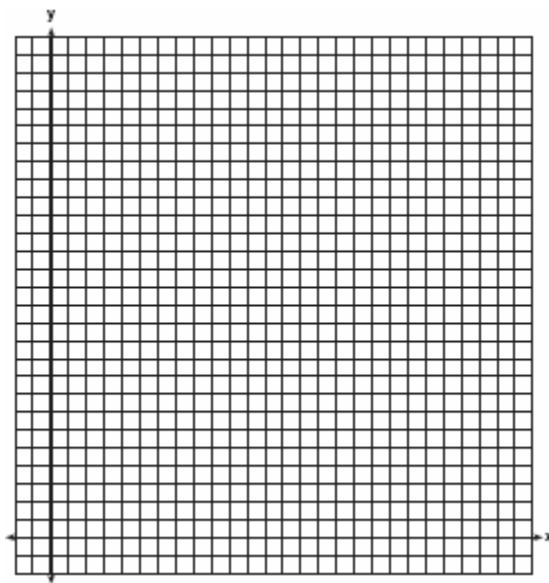
Solve the following systems of equations graphically, on the set of axes below, and state the coordinate(s) of the point(s) in the solution set.

$$y = x^2 - 6x + 5$$
$$2x + y = 5$$



49. 060235a, P.I. A.G.9

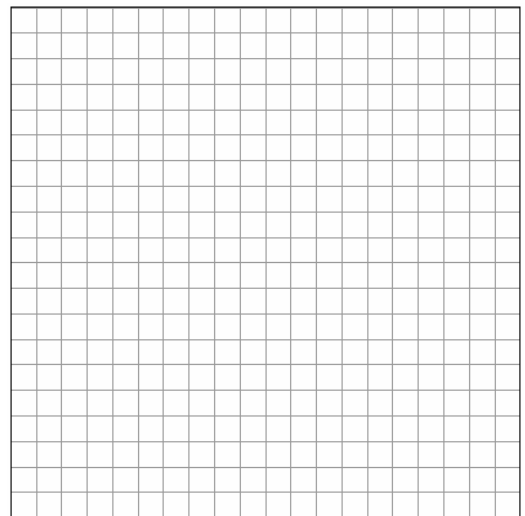
A rocket is launched from the ground and follows a parabolic path represented by the equation  $y = -x^2 + 10x$ . At the same time, a flare is launched from a height of 10 feet and follows a straight path represented by the equation  $y = -x + 10$ . Using the accompanying set of axes, graph the equations that represent the paths of the rocket and the flare, and find the coordinates of the point or points where the paths intersect.



50. 060328b, P.I. G.G.70

The price of a stock,  $A(x)$ , over a 12-month period decreased and then increased according to the equation

$A(x) = 0.75x^2 - 6x + 20$ , where  $x$  equals the number of months. The price of another stock,  $B(x)$ , increased according to the equation  $B(x) = 2.75x + 1.50$  over the same 12-month period. Graph and label both equations on the accompanying grid. State all prices, to the *nearest dollar*, when both stock values were the same.



### Section 13-5: Algebraic Solution of a Quadratic-Linear System

51. 060018a, P.I. A.A.11

The graphs of the equations  $y = x^2 + 4x - 1$  and  $y + 3 = x$  are drawn on the same set of axes. At which point do the graphs intersect?

- |             |              |
|-------------|--------------|
| [A] (1, -2) | [B] (1, 4)   |
| [C] (-2, 1) | [D] (-2, -5) |

52. 080135a, P.I. A.A.11

Solve the following system of equations algebraically:

$$y = x^2 + 4x - 2$$

$$y = 2x + 1$$

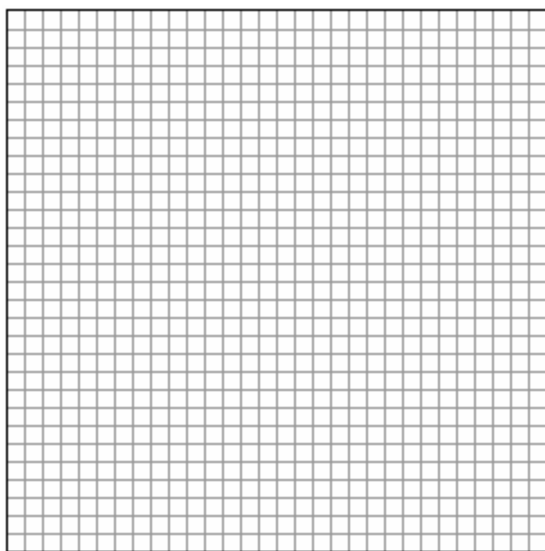
53. 080538a, P.I. A.A.11

Solve the following system of equations:

$$y = x^2 + 4x + 1$$

$$y = 5x + 3$$

[The use of the grid is optional.]

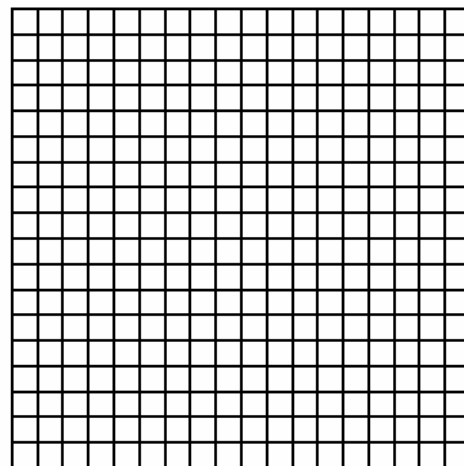


54. 069935a, P.I. A.A.11

Solve the following system of equations algebraically or graphically for  $x$  and  $y$ :

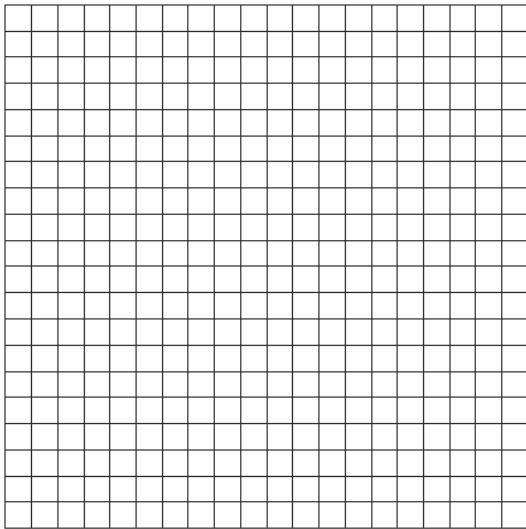
$$y = x^2 + 2x - 1$$

$$y = 3x + 5$$



55. 060228b, P.I. A.A.11

A pelican flying in the air over water drops a crab from a height of 30 feet. The distance the crab is from the water as it falls can be represented by the function  $h(t) = -16t^2 + 30$ , where  $t$  is time, in seconds. To catch the crab as it falls, a gull flies along a path represented by the function  $g(t) = -8t + 15$ . Can the gull catch the crab before the crab hits the water? Justify your answer. [The use of the accompanying grid is optional.]



[1] D

[2] C

[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

[3] incorrect procedure.

[4] A

[5] B

[6] A

[7] D

[8] D

[9] C

[10] A

[11] D

[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

[12] 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

[13] 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

[14] obviously incorrect procedure.

[15] A

[16] D

[17] C

[18] C

[19] D

[20] A

[21] C

[22] D

[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

[23] incorrect procedure.

[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

[24] 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

[25] incorrect procedure.

[26] A

[27] C

- [4] 16 and appropriate work is shown, such as  $W(W + 2) = 15$ .
- [3] Appropriate work is shown, but one computational error is made.  
or [3]  $L = 5$ ,  $W = 3$ , and the perimeter = 16, but no work is shown.
- [2] Appropriate work is shown, but more than one computational error is made.  
or [2]  $L = 5$ ,  $W = 3$ , and appropriate work is shown, but the perimeter is not found.  
or [2] The length and width are incorrect, but the perimeter is computed appropriately.
- [1] Length and width are appropriately defined in terms of a single variable.  
or [1] 16 but no work is shown.
- [0]  $L = 5$  and  $W = 3$  but no work is shown, and the perimeter is not found.  
or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
- 
- [28]
- [4] Width = 20 and length = 25 and an appropriate algebraic equation is shown, such as  $x^2 + 5x - 500 = 0$ .
- [3] A correct quadratic equation is shown, but one error is made.  
or [3] A correct quadratic equation is shown, but solved for only one dimension.
- [2] An appropriate solution is shown, but the student fails to reject the negative root and finds two sets of dimensions.  
or [2] The quadratic equation  $(5x)(x) = 500$  is solved appropriately for both dimensions,  $x = 10$  and  $5x = 50$ .
- [1] The student writes only the correct quadratic equation or only the equation  $x(x + 5) = 500$  or fails to solve the equation correctly.  
or [1] The student writes a linear equation from  $x(x + 5) = 500$ , such as  $2x + 5x = 500$ , but solves that equation appropriately.  
or [1] A correct equation is shown for the perimeter and solved appropriately.  
or [1]  $(5x)(x) = 500$  is solved correctly for only one dimension.  
or [1] 20 and 25 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]



- [4]  $x(x+10) = 144$  or an equivalent equation and  $8 = \text{width}$  and  $18 = \text{length}$ , and appropriate work is shown.
- [3] Appropriate work is shown, but one computational error is made.
- or [3] A correct equation is used and a correct solution is found, but only one dimension is identified.
- [2] An appropriate solution is found to an incorrect equation of equal difficulty.
- or [2] A correct equation set equal to zero is shown, with no further work or incorrect work.
- [1] A conceptual error is made, such as writing the equation  $2x + 2(x+10) = 144$ , but the dimensions are found appropriately.
- or [1]  $x(x+10) = 144$  and  $8 = \text{width}$  and  $18 = \text{length}$ , 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.
- [30] \_\_\_\_\_

- [4]  $w(w+3) = 40$ ,  $\text{width} = 5$ , and  $\text{length} = 8$ , and appropriate work is shown.
- [3]  $w(w+3) = 40$  and appropriate work is shown, but one computational error is made in finding the length and width.
- or [3]  $w(w+3) = 40$  and appropriate work is shown, but only the width is found.
- [2]  $w(w+3) = 40$  and appropriate work is shown, but the length and width are not identified.
- or [2]  $w(w+3) = 40$  and appropriate work is shown, but more than one computational error is made in finding the length and width.
- or [2] An incorrect equation of equal difficulty is solved appropriately for the length and width.
- [1]  $w(w+3) = 40$ , but no further correct work is shown.
- or [1] Appropriate work is shown, but one conceptual error is made, such as solving the equation  $2w + 2w + 6 = 40$ .
- or [1]  $w(w+3) = 40$ ,  $\text{width} = 5$ , and  $\text{length} = 8$ , 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.
- [31] \_\_\_\_\_
- [32] C \_\_\_\_\_
- [33] A \_\_\_\_\_
- [34] C \_\_\_\_\_
- [35] 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 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 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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- [38]

- 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.
- 
- [39]
- [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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- [40]

- [41] B

[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

[42] incorrect procedure.

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[43] D

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[44] C

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[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

[45] incorrect procedure.

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[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

[46] incorrect procedure.

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[47] D

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[4] Correct graphs are drawn, and  $(0,5)$  and  $(4,-3)$  are stated.

[3] Both equations are graphed, but one graphing error is made, but appropriate solutions are stated.

or [3] Both graphs are drawn correctly, but only one solution is stated.

[2] Both graphs are drawn correctly, but no solutions are stated.

or [2] Both equations are graphed, but two or more graphing errors are made, but appropriate solutions are stated.

or [2] Appropriate work is shown to find (0,5) and (4,-3), but a method other than graphing is used.

or [2] Both equations are graphed, but one conceptual error is made.

[1] Both equations are graphed, but one conceptual error and one graphing error are made.

or [1] (0,5) and (4,-3) are stated, but no work is shown.

[0] (0,5) or (4,-3) is stated, 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

[48] obviously incorrect procedure.

[4] (10,0) and (1,9), and both graphs are drawn correctly.

[3] Both graphs are drawn correctly, but only one solution is stated correctly.

or [3] One graph of equal difficulty is drawn incorrectly, but the solutions are appropriate, based on the graphs.

[2] (10,0) and (1,9), but the problem is solved algebraically instead of graphically.

or [2] One graph of equal difficulty is drawn incorrectly, and only one solution is appropriate, based on the graphs.

[1] Both the parabola and the line are graphed incorrectly, but the solutions are appropriate, based on the graphs.

or [1] Incorrect solutions result from an algebraic method.

or  $[1] (10,0)$  and  $(1,9)$ , 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] 9 and 26, and appropriate work is shown, such as graphing and labeling the equations and identifying the points of intersection.
- [3] Both functions are graphed correctly, and the points of intersection are indicated, but the prices are not stated.
- or [3] The parabola is graphed correctly, but the line is graphed incorrectly, but appropriate prices are stated.
- [2] The line and the parabola are graphed and labeled, but a conceptual error is made, such as only one price is found because the graph of the parabola is incomplete.
- or [2] The line is graphed correctly, but the parabola is graphed incorrectly, but appropriate prices are stated.
- or [2] 9 and 26, but only an algebraic solution is shown.
- [1] Both the line and the parabola are graphed incorrectly, but appropriate prices are stated.
- or [1] 9 and 26, but no work is shown.
- [0] 9 or 26, 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.
- [50] \_\_\_\_\_
- [51] D \_\_\_\_\_
- [4]  $(-3, -5)$  and  $(1, 3)$ , and appropriate algebraic work is shown.
- [3] Appropriate algebraic work is shown, but  $x = -3$  and  $x = 1$  are given as the solution.
- or [3] Appropriate algebraic work is shown, but only one correct solution is given, such as  $(1, 3)$ .
- [2]  $(-3, -5)$  and  $(1, 3)$ , but a graphic solution is shown.
- or [2] Correct substitution and an algebraic equation set equal to zero are shown, but the result is not factored, such as  $x^2 + 2x - 3 = 0$ .
- [1] Any correct substitution is shown, such as  $2x + 1 = x^2 + 3x - 2$ .
- or [1]  $(-3, -5)$  and  $(1, 3)$ , but no algebraic 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.
- [52] \_\_\_\_\_

[4] (-1,-2) and (2,13), and appropriate work is shown, such as an algebraic or graphic solution or trial and error with at least three trials and appropriate checks.

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

or [3] Appropriate work is shown, but only one solution is found or only the x- or the y-values are 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 trial-and-error method is used to find the correct solutions, but only two trials and appropriate checks are shown.

or [2] The trial-and-error method is attempted and at least six systematic trials and appropriate checks are shown, but no solution is found.

or [2] Both equations are graphed correctly, but neither ordered pair is identified.

or [2] Only one equation is graphed correctly, but an appropriate solution is found.

or [2] An incorrect quadratic equation of equal difficulty is solved appropriately, and appropriate solutions are found.

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

or [1] One equation is graphed correctly, but no further correct work is shown.

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

or [1] A correct substitution is made and the system of equations is simplified to a single quadratic equation set equal to zero, but no further correct work is shown.

or [1] (-1,-2) and (2,13), but no work or only one trial with an appropriate check is shown.

[0] (-1,-2) or (2,13), 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

[53] obviously incorrect procedure.

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[4] (3,14) and (-2,-1) and either an algebraic or a graphic solution is shown.

[3] An appropriate method is shown, but only one correct ordered pair is identified.

or [3] An appropriate method is shown, but one computational mistake is made.

or [3] An appropriate method is shown, but values are given only for x.

[2] The substitution is correct, but the quadratic produced is not factored correctly.

or [2] Both equations are graphed correctly, but neither ordered pair is identified.

[1] Only one equation is graphed correctly.

or [1] The substitution is incorrect, but it produces a linear equation that is solved correctly.

or [1] Only the substitution is correct.

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

[54] incorrect procedure.

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[4] Yes, and appropriate work is shown, and an appropriate justification is given.

[3] Appropriate work is shown, and an appropriate justification is given, but one computational error is made, or the negative value of t is not rejected.

[2] An appropriate graph or equation is shown, such as  $16t^2 - 8t - 15 = 0$ .

[1] An incorrect graph or equation of equal difficulty is used, but an appropriate solution is found.

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

[55] incorrect procedure.

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