Name: ______________________________

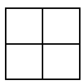
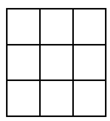
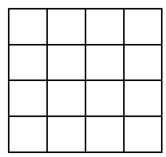
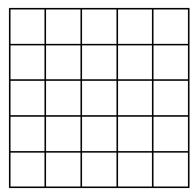
Algebra 1
Quadratic Functions
Workbook

*If found, please return to Mrs. Hester's Classroom 217.

Basic Quadratic Functions

Task 1:
Using the visual pattern, complete steps 5 and 6. Then fill in the table and write an equation for the relationship between the step number and the number of blocks in your pattern. Graph the data from your table.
*Reference *Investigating Quadratic Functions* from class if you get stuck.

The Pattern:

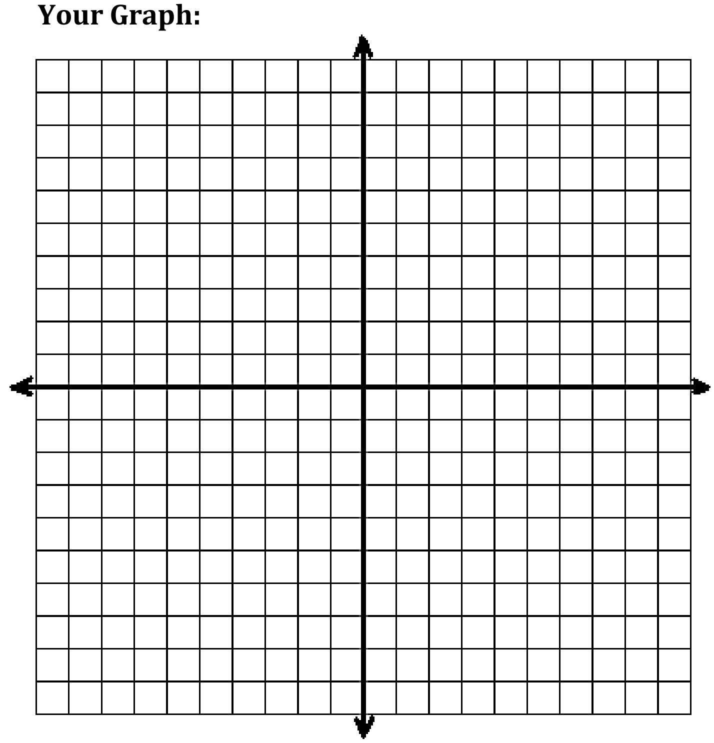
Step #	1	2	3	4	5	6
Pattern						
Total Blocks	4	9	16	25		

Your Equation:

Your Table:

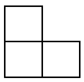
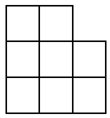
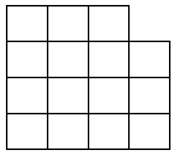
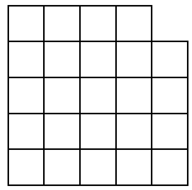
step number	number of blocks
1	
2	
3	
4	
5	
6	
n	

Your Graph:



Task 2:
Using the visual pattern, complete steps 5 and 6. Then fill in the table and write an equation for the relationship between the step number and the number of blocks in your pattern. Graph the data from your table.
*Reference *Investigating Quadratic Functions* from class if you get stuck.

The Pattern:

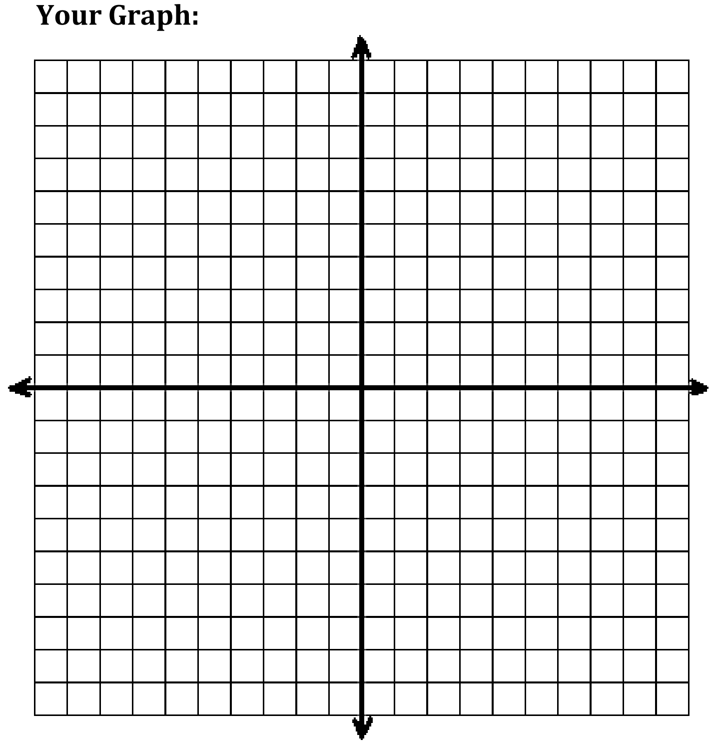
Step #	1	2	3	4	5	6
Pattern						
Total Blocks	3	8	15	24		

Your Equation:

Your Table:

step number	number of blocks
1	
2	
3	
4	
5	
6	
n	

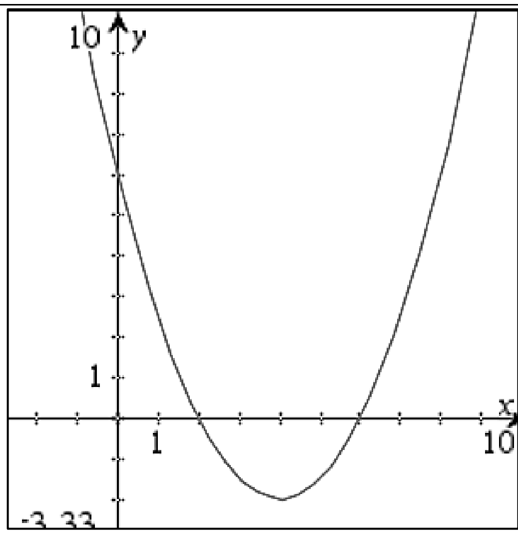
Your Graph:



Properties and Key Features of Quadratic Graphs

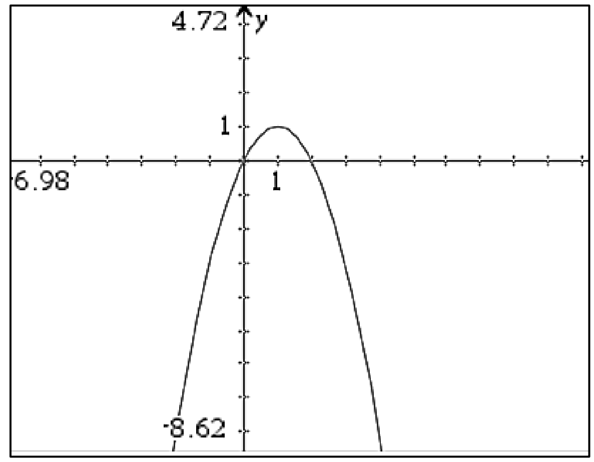
Fill in the chart for each graph.

1)

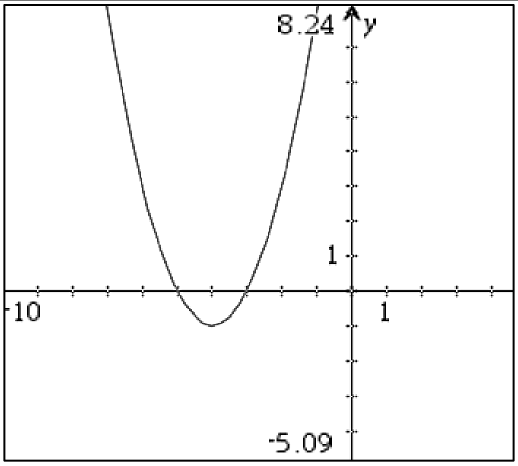


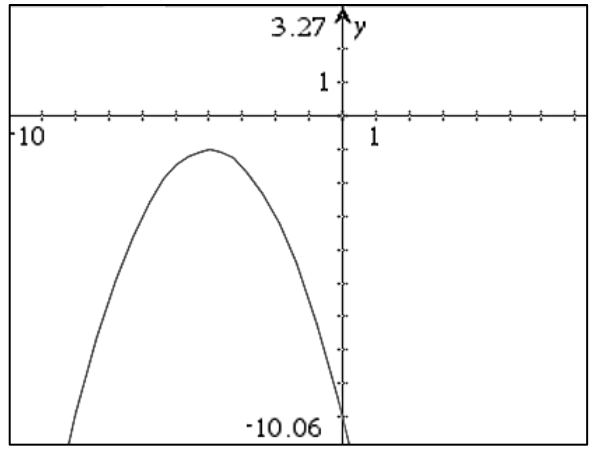
Vertex:
Axis of Symmetry:
Root(s):
Maximum value:
Maximum point:
Minimum value:
Minimum point:
Interval(s) where the graph is positive:
Interval(s) where the graph is negative:
Interval(s) where the graph is increasing:
Interval(s) where the graph is decreasing:
Domain:
Range:
Even, Odd, or Neither?
As $x \to \infty, y \to$
As $x \to -\infty, y \to$
Average ROC over the interval $[0,4]$:

2)



Vertex:
Axis of Symmetry:
Root(s):
Maximum value:
Maximum point:
Minimum value:
Minimum point:
Interval(s) where the graph is positive:
Interval(s) where the graph is negative:
Interval(s) where the graph is increasing:
Interval(s) where the graph is decreasing:
Domain:
Range:
Even, Odd, or Neither?
As $x \to \infty, y \to$
As $x \to -\infty, y \to$
Average ROC over the interval $[-1,1]$:

3)	
	
Vertex:	
Axis of Symmetry:	
Root(s):	
Maximum value:	
Maximum point:	
Minimum value:	
Minimum point:	
Interval(s) where the graph is positive:	
Interval(s) where the graph is negative:	
Interval(s) where the graph is increasing:	
Interval(s) where the graph is decreasing:	
Domain:	
Range:	
Even, Odd, or Neither?	
As $x \to \infty, y \to$	
As $x \to -\infty, y \to$	
Average ROC over the interval $[-4, -2]$:	

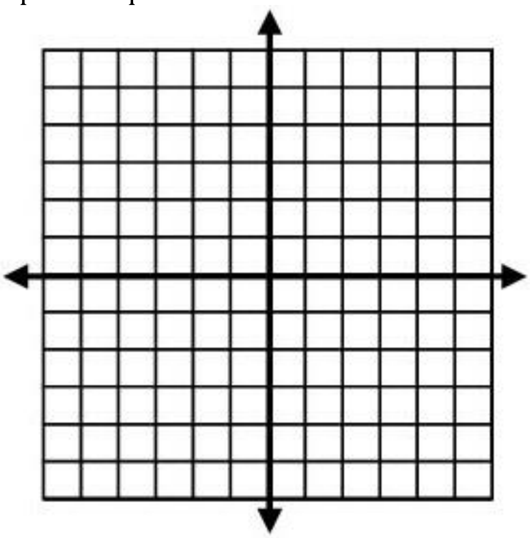
4)	
	
Vertex:	
Axis of Symmetry:	
Root(s):	
Maximum value:	
Maximum point:	
Minimum value:	
Minimum point:	
Interval(s) where the graph is positive:	
Interval(s) where the graph is negative:	
Interval(s) where the graph is increasing:	
Interval(s) where the graph is decreasing:	
Domain:	
Range:	
Even, Odd, or Neither?	
As $x \to \infty, y \to$	
As $x \to -\infty, y \to$	
Average ROC over the interval $[-4,0]$:	

Graphing with Transformations

If you know that $a = 4$, $h = 2$, and $k = -4$,

1. Write the equation for the quadratic function.

2. Graph the equation.



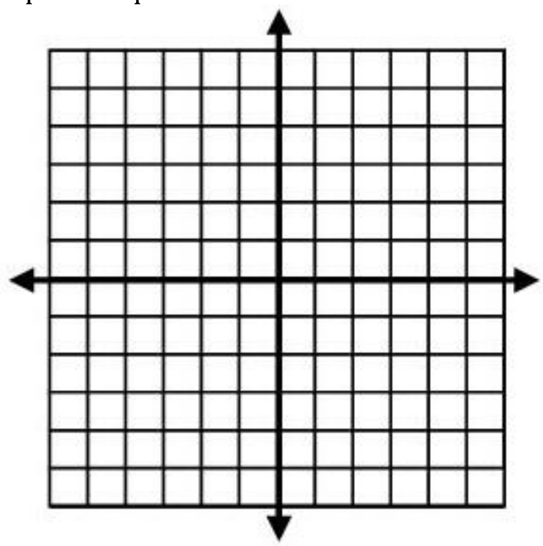
3. Translate the graph up two units and left two units. Redraw this graph in a different color.

4. Rewrite the new equation for the new graph.

If you know that $a = -\frac{1}{2}$, $h = -2$, and $k = 1$,

5. Write the equation for the quadratic function.

6. Graph the equation.



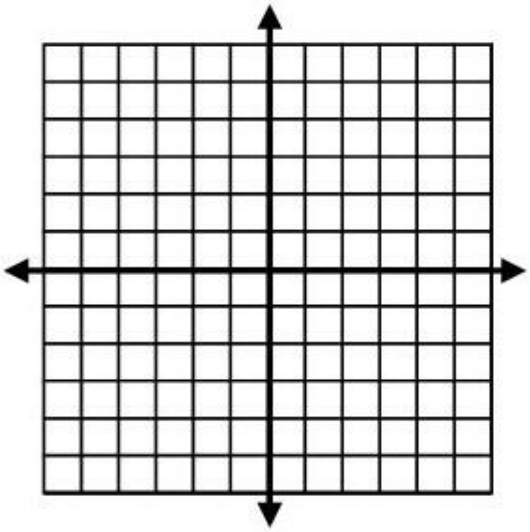
7. Translate the graph down one unit and right four units. Redraw this graph in a different color.

8. Rewrite the new equation for the new graph.

If you know that $a = -3$, $h = 1$, and $k = 0$,

9. Write the equation for the quadratic function.

10. Graph the equation.



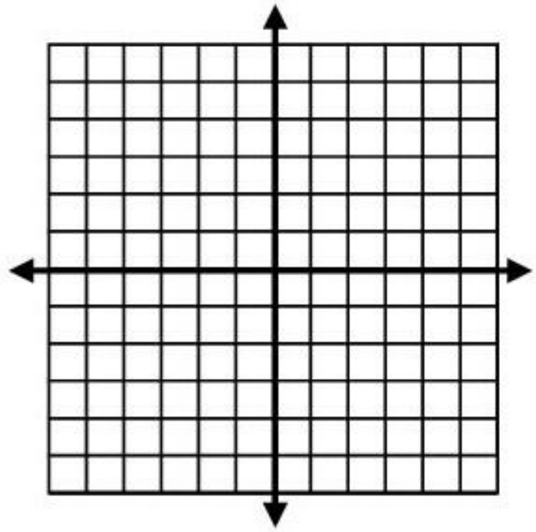
11. Translate the graph up three units and left one units. Redraw this graph in a different color.

12. Rewrite the new equation for the new graph.

If you know that $a = \frac{1}{3}$, $h = 3$, and $k = 2$,

13. Write the equation for the quadratic function.

14. Graph the equation.



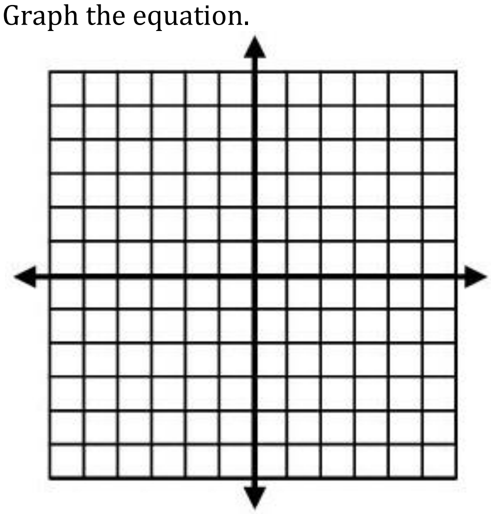
15. Reflect the graph over the x-axis and translate left one unit. Redraw this graph in a different color.

16. Rewrite the new equation for the new graph.

If you know that $a = \frac{3}{4}$, $h = -1$, and $k = 3$,

17. Write the equation for the quadratic function.

18. Graph the equation.

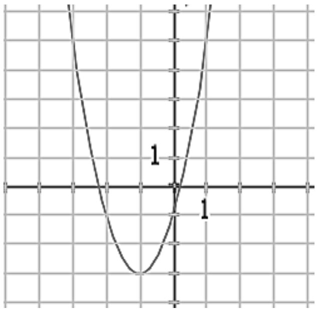


19. Reflect the graph over the x-axis and translate up on unit and right two units. Redraw this graph in a different color.

20. Rewrite the new equation for the new graph.

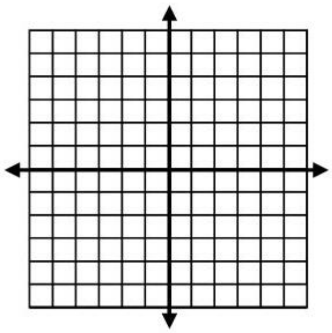
Graphing Quadratic Functions and Reading Quadratic Graphs

1. Write the equation for the function shown.

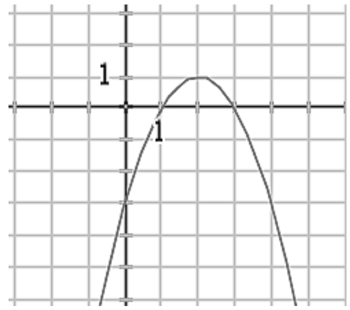


2. Graph the function:

$$f(x) = \frac{1}{2}x^2 - 3$$

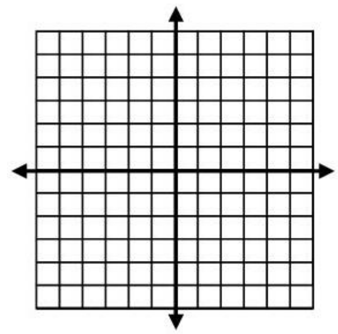


3. Write the equation for the function shown.

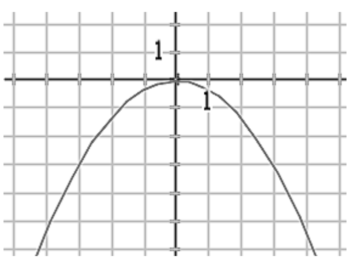


4. Graph the function:

$$f(x) = -(x+1)^2 + 2$$

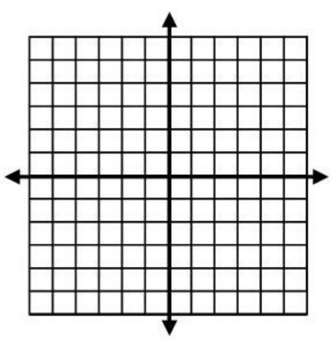


5. Write the equation for the function shown.

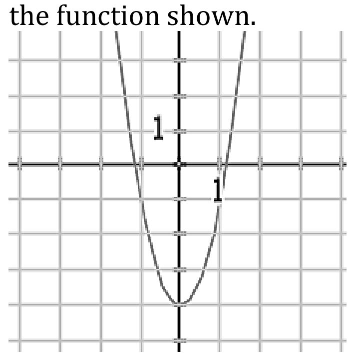


6. Graph the function:

$$f(x) = 2(x-4)^2$$

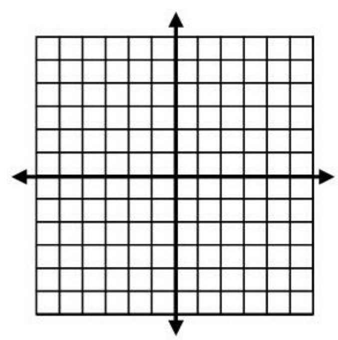


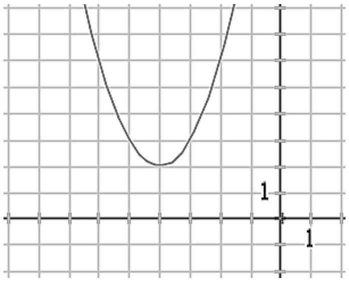
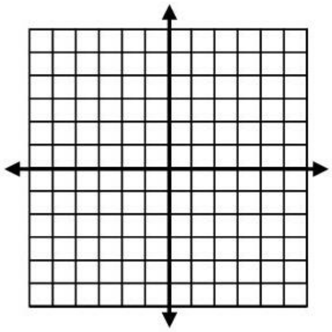
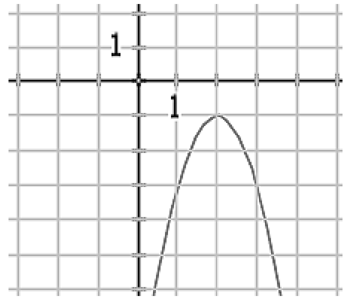
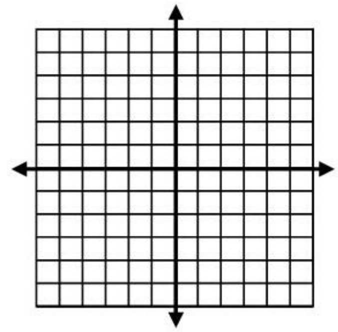
7. Write the equation for the function shown.



8. Graph the function:

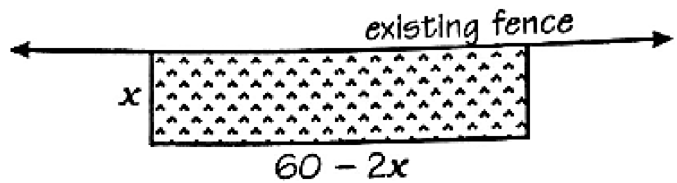
$$f(x) = -3(x-2)^2 - 3$$



9. Write the equation for the function shown.  	10. Graph the function: $f(x) = -\frac{1}{4}(x+3)^2 + 2$ 	11. Write the equation for the function shown.  	12. Graph the function: $f(x) = (x-3)^2$ 

Applications and Properties of Quadratics

Shaman has 60 yards of fencing to build a rectangular corral for his horse. He already has a fence along one side of this property, and he plans to use part of this existing fence for one side of the corral. For the other three sides he plans to use 60 yards of fencing that he currently owns. Picture shown to the right.



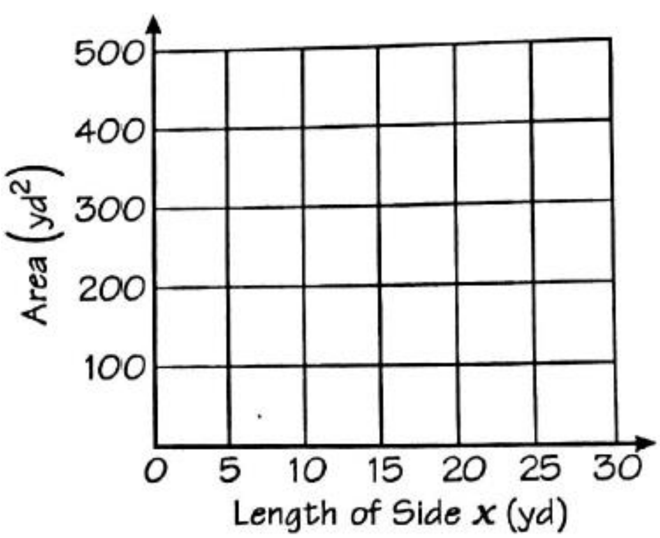
1. If Shaman let x represent the distance the corral extends away from the existing fence, explain why it makes sense that other length would be represented as $60 - 2x$.

2. Write an equation for the area of Shaman's corral.

3. Using your equation, complete the chart below based on different x lengths. Show your work.

$x\ (yd)$	$A\ (yd^2)$
5	
10	
15	
20	
25	

4. Graph your data from #3.

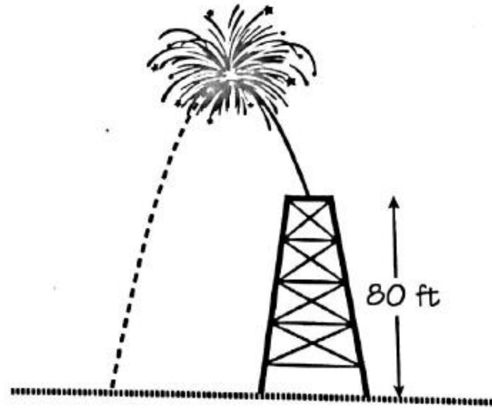


5. State the vertex of the graph. What does it mean in the context of the scenario?

6. State the maximum value. What does it mean in the context of the scenario?

7. State the maximum point. What does it mean in the context of the scenario?

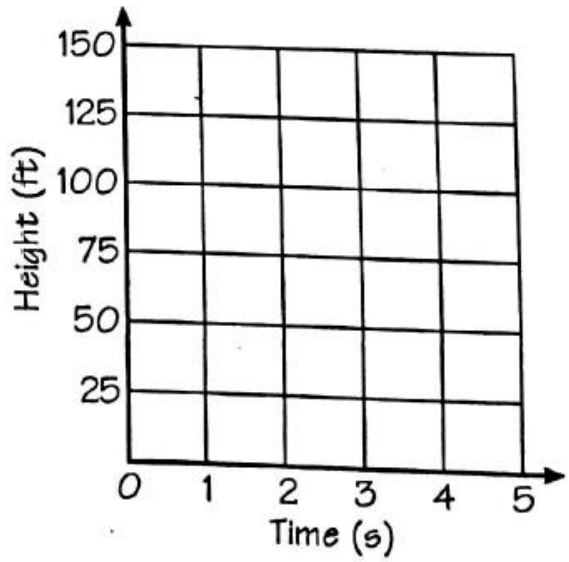
To celebrate the Fourth of July, the town of Trigon has hired Pyro Tech INC. to launch fireworks from an 80-foot tower in the center of town. The rockets will be fired with an initial upward velocity of 64 feet per second. Pyro Tech uses a function that estimates the rocket's height above the ground (h) in terms of time since the launch (t). If t is measured in seconds and h in feet, then the function is:



$$h(t) = -16t^2 + 64t + 80$$

8. Use the function to complete the table of values and graph the function.

$t\ (sec)$	$h\ (ft)$
0	
1	
2	
3	
4	
5	



9. How long will it take for a rocket to reach its highest point? How do you know?

10. How high will the rocket go? How do you know?

11. How long after the launch will rocket debris hit the ground? How do you know?

12. Does your graph show the flight path of a rocket? Why or why not?

13. What is the domain of the function? What does it mean in context?

14. What is the range of the function? What does it mean in context?

15. What are the roots of the graph? What do they mean in context?

16. Does the graph have an axis of symmetry? Justify your reasoning. If so, what does it mean in context?

Applications of Quadratic Functions

A farmer has 1,000 feet of fencing to enclose a rectangular field along a river. If the side along the river is not being fenced, what dimensions for length and width will yield the maximum area?

1. Sketch the problem.

2. Write a function for the situation.

3. Graph the function.

A blanket-maker has 16 feet of lace to use as a border around a rectangular blanket. What dimensions of the blanket will maximum its area if the entire blanket needs a border?

4. Sketch the problem.

5. Write a function for the situation.

6. Graph the function.

A rancher has 800 feet of fencing to enclose two adjacent (side-by-side) corrals of equal size. What dimensions will maximize the area of the corrals?

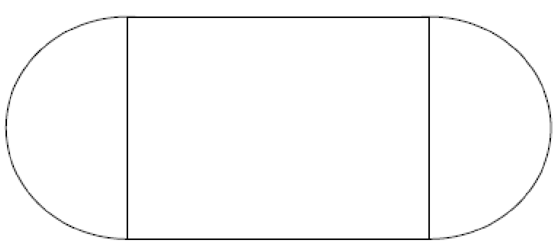
7. Sketch the problem.

8. Write a function for the situation.

9. Graph the function.

Most running tracks area designed around two semi-circles at opposite ends of a rectangular region (see figure). If one lap is 400 meters long, what is the maximum area of the rectangular region?

10. Sketch the problem.



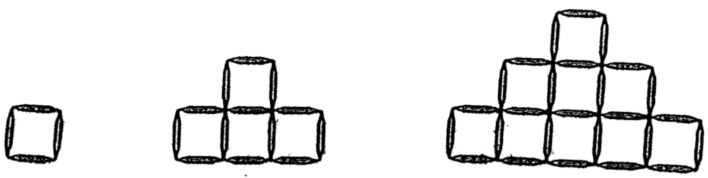
11. Write a function for the situation.

12. Graph the function.

Quadratic Function Tasks

Task #1

Use the following picture to answers part A, B, and C.



1 #2 #3

Examine the pictures above, which show 3 polygons constructed out of toothpicks. Each polygon is made up of some number of small squares, and each small square is one toothpick long on each side.

Part A

1. If this sequence of polygons continues, draw the next figure. How many toothpicks would be in the perimeter of polygon #4? Create a t-table.

2. Write a rule that lets you predict how many are in the perimeter of any polygon in the sequence (using your pattern and t-table). Is this linear, quadratic, or exponential? Explain.

3. Use your rule to find the perimeter of the 25^{th} polygon in this sequence.

Part B

1. How many 1 by 1 squares would be needed to construct polygons #4, #5, and #6? Create a t-table.

2. Find and write a rule that lets you predict how many small squares would be in any polygon in this sequence, say #n. Is this linear, quadratic, or exponential? Explain.

3. Use your rule to find the total number of squares in the 30^{th} polygon.

4. How many rows would the polygon have if it contained 256 small squares?

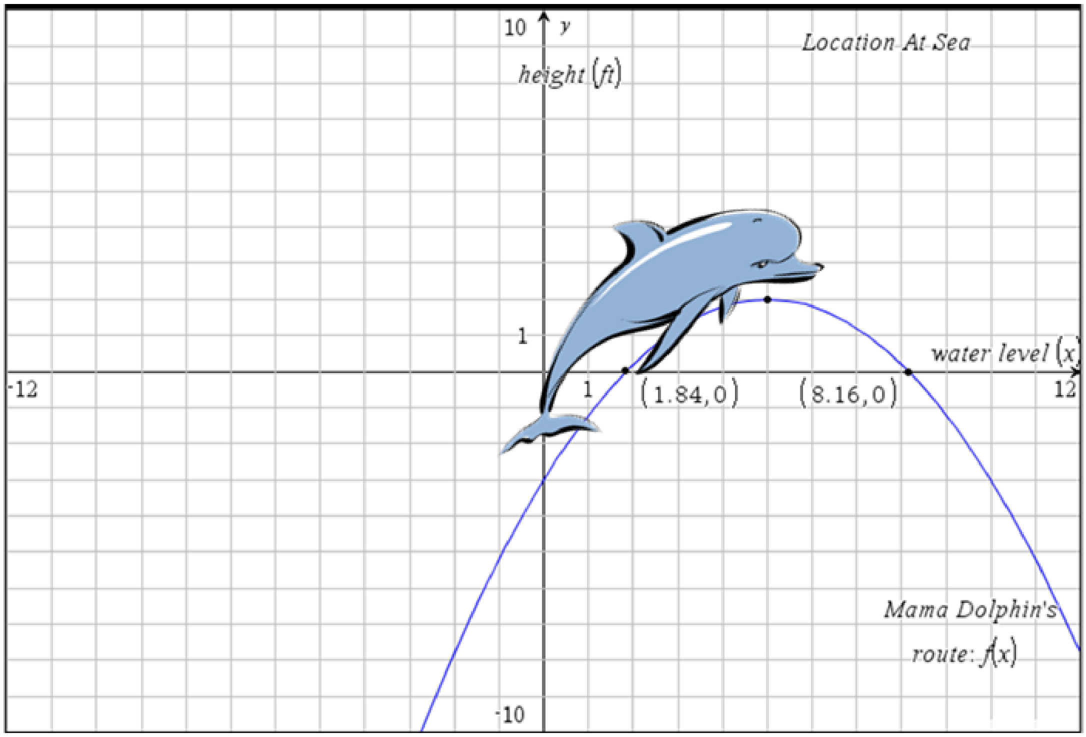
Part C

1. Based on the number of toothpicks used in each figure, can you predict the number of toothpicks needed to construct the 5^{th} polygon?

2. Create a t-table and determine a rule that lets you predict the number of toothpicks in square #n. Is this linear, quadratic, or exponential? Explain.

Task 2:

The following graph, f(x), depicts the path of a dolphin out at sea. The x-axis is the water level and the y-axis is the height in feet. The grid represents the location at sea.



1.a) Outline Mama Dolphin's route in **blue**. Determine the equation of $f(x)$, Mama Dolphin's route, in vertex form:

$$y = a(x-h)^2 + k.$$

b) What is mama dolphin's maximum height?

c) State the interval when $f(x)$ is increasing? State the meaning in this context.

d) State the interval when $f(x)$ is decreasing? State the meaning in this context.

e) State the interval when $f(x)$ is positive? State the meaning in this context.

f) State the interval when $f(x)$ is negative? State the meaning in this context.

g) State the solution(s) of $f(x)$ and its meaning in this context.

2. a) Baby dolphin is following mama dolphin and trying to keep up with her movements. His path is $f(-x)$. Draw baby dolphin's path using **red** on the same graph as mama dolphin, $f(x)$. Label this $f(-x)$.

b) Determine the equation of $f(-x)$, Baby Dolphin's route, in vertex form: $y = a(x-h)^2 + k$.

c) What is baby dolphin's maximum height?

d) State the interval when $f(-x)$ is increasing? State the meaning in this context.

e) State the interval when $f(-x)$ is decreasing? State the meaning in this context.

f) State the interval when $f(-x)$ is positive? State the meaning in this context.

g) State the interval when $f(-x)$ is negative? State the meaning in this context.

h) State the solution(s) of $f(-x)$ and its meaning in this context.

3. a) A mama seagul from the air sees a fish in the water and swoops down to get it. Her path is $-f(x)$. Draw mama seagul's path using **black** on the same graph as mama dolphin, $f(x)$. Label this $-f(x)$.

b) Determine the equation of $-f(x)$, Mama Seagul's route, in vertex form: $y = a(x-h)^2 + k$.

c) What is mama seagul's minimum height?

d) State the interval when $-f(x)$ is increasing? State the meaning in this context.

e) State the interval when $-f(x)$ is decreasing? State the meaning in this context.

f) State the interval when $-f(x)$ is positive? State the meaning in this context.

g) State the interval when $-f(x)$ is negative? State the meaning in this context.

h) State the solution(s) of $-f(x)$ and its meaning in this context.

4. a) A baby seagul from the air follows his mother's lead and swoops down to get a fish as well. His path is $-f(-x)$. Draw baby seagul's path using **orange** on the same graph as mama dolphin, $f(x)$. Label this $-f(-x)$.

b) Determine the equation of $-f(-x)$, Baby Seagul's route, in vertex form: $y = a(x-h)^2 + k$.

c) What is baby seagul's minimum height?

d) State the interval when $-f(-x)$ is increasing? State the meaning in this context.

e) State the interval when $-f(-x)$ is decreasing? State the meaning in this context.

f) State the interval when $-f(-x)$ is positive? State the meaning in this context.

g) State the interval when $-f(-x)$ is negative? State the meaning in this context.

h) State the solution(s) of $-f(-x)$ and its meaning in this context.

Brain Flex!!

For each problem, write two numbers on the sides of the “X” that *multiply* together to get the *top* number of the “X” and are *added* together to get the *bottom* number of the “X.” #1 is done for you as an example.

1.

9

-3 -3

-6

$-3 * -3 = 9$
$-3 + -3 = -6$

2.

4

4

3.

-84

5

4.

-30

-13

5.

-24

-5

6.

6

-5

7.

-75

-10

8.

12

7

9.

-12

-11

10.

7

8

11.

-8

7

12.

12

-7

13.
2
-3

14.
-72
-21

15.
-1
0

16.
13
-14

17.
-34
15

18.
9
6

19.
-48
-13

20.
-36
0

21.
-42
-1

22.
-70
9

23.
28
11

24.
34
19

25.
51
20

26.
-36
-16

27.
25
10

DID YOU HEAR . . .

1.	2.	3.	4.	5.	6.	7.
8.	9.	10.	11.	12.	13.	14. ?

Solve the equation by factoring. Write the word next to the answer in the box that contains the exercise number.

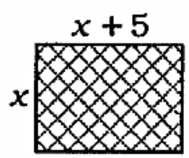
1. $a^2 - 8a = -15$
2. $y^2 + 6y = 7$
3. $k^2 - 10 = 9k$
4. $w^2 = 13w$
5. $11x = -x^2 - 24$
6. $d^2 = 50 - 23d$
7. $3p^2 - 14p = 5$
8. $2m^2 + 14 = 11m$
9. $8 - 3t = 5t^2$
10. $16h^2 = 25$
11. $25b + 11 = -6b^2$
12. $36u = 9u^2$
13. $12q^2 = 17q + 5$
14. $9 = 12x - 4x^2$

- $\{-5, -2\}$ CIRCUS
- $\{0, 13\}$ OF
- $\left\{\pm\frac{5}{4}\right\}$ SCARED
- $\left\{2, \frac{7}{2}\right\}$ WHO
- $\{3, 5\}$ THE
- $\left\{-\frac{1}{4}, \frac{5}{3}\right\}$ DEATH
- $\left\{-\frac{11}{2}, \frac{1}{3}\right\}$ BY
- $\{-8, -3\}$ THE
- $\left\{\frac{3}{2}\right\}$ TWICE
- $\{-1, 10\}$ STORY
- $\{4, 5\}$ JUMPED
- $\left\{-\frac{8}{5}, 1\right\}$ WAS
- $\left\{\frac{1}{3}, \frac{5}{4}\right\}$ HER
- $\left\{-\frac{1}{3}, 5\right\}$ LADY
- $\{0, 4\}$ TO
- $\{1, -7\}$ SAD
- $\{-12, 2\}$ CRAZY
- $\left\{-\frac{11}{3}, -\frac{1}{2}\right\}$ HALF
- $\left\{1, \frac{5}{3}\right\}$ CLOWN
- $\{-25, 2\}$ UNFORTUNATE

From What Malady Do Politicians Often Suffer?

Solve the equation or problem by factoring. Find your solution at the bottom of the page and cross out the letter under it. When you finish, the answer to the title question will remain.

1. $u^2 + 19u = -60$
2. $3d^2 = 10 - 13d$
3. $7x^2 - 10x = 6x^2 - 21$
4. $3a^2 + a = a^2 + 10a + 11$
5. $n(n + 3) = 70$
6. $b(5b - 4) = 12$
7. $(w + 5)(w + 2) = 40$
8. $4t^2 - 9t + 16 = 15 - 4t^2$
9. $(2k + 4)(2k + 9) = 3k^2 + 11k$
10. $5 + 6y(y + 2) = 5y + 8$
11. $(m - 3)^2 = 64$
12. The length of a rectangle is 5 cm more than the width. The area is 84 cm^2. Find the dimensions of the rectangle.



13. A square banner had 4 ft added to its width and 2 ft subtracted from its height. The banner then had an area of 91 ft^2. How long was a side of the original square banner?
14. The dimensions of a rectangular garden were 3 m by 10 m. When both dimensions were increased by the same amount, the area of the garden doubled. Find the dimensions of the new garden.

Answers – Odd-Numbered Exercises

$\{-5, 11\}$	$\{-2, 15\}$	$\{-3, -12\}$	$\{3, 7\}$	$\{-9, -4\}$	$\{-15, -4\}$	8 ft	$\{-10, 3\}$	9 ft	$\{-10, -7\}$	$\{-3, 7\}$	$\{-10, 7\}$
S	T	O	P	R	E	U	P	S	T	H	E

Answers – Even-Numbered Exercises

$\{-\frac{1}{2}, 1\}$	5 × 12 m	$\{\frac{11}{2}, -1\}$	$\{\frac{5}{3}, -2\}$	$\{-\frac{3}{2}, \frac{1}{3}\}$	8 × 13 cm	$\{-\frac{6}{5}, 2\}$	7 × 12 cm	$\{8, -1\}$	$\{\frac{2}{3}, -5\}$	$\{\frac{1}{8}, 1\}$	4 × 15 m
D	O	S	E	I	C	K	N	A	M	E	Y

Solving Quadratics by Completing the Square

Determine the values that need to be used as the zero property to complete each square.

1. $x^2 + 2x +$ ______ $-$ ______

2. $x^2 - 6x +$ ______ $-$ ______

3. $2x^2 - 8x +$ ______ $-$ ______

4. $5x^2 + 10x +$ ______ $-$ ______

5. $-4x^2 + 32x +$ ______ $-$ ______

6. $-3x^2 - 18x +$ ______ $-$ ______

Solve by completing the square. Check your answer using the original equation.

7. $x^2 + 8x = 0$

8. $x^2 - 4x = 5$

9. $x^2 + 8x + 6 = 0$

10. $2x^2 - 4x = 8$

11. $3x^2 + 12x + 6 = 0$

12. $-2x^2 + 8x = -8$

Solve by completing the square. Check the reasonableness of your answer.

13. The rectangular rug is $x + 8$ feet wide and $3x$ feet long. What are the dimensions if the area of the rug is $540\ ft^2$?

14. The price of a high-tech stock can be modeled with $P(t) = t^2 - 2t + 50$, where $P(t)$ is the price t weeks after the purchase.
(a) What is the price at $t = 0$ and what does this solution represent?
(b) What is the price at $t = 6$ and what does this solution represent?
(c) What is the vertex and what does this point represent?

15. A firework fired into the air can be modeled by $h(t) = -16t^2 + 80t$, where $h(t)$ is the height t seconds after launch.
(a) What is the maximum height reached by the firework? How long does it take to reach that height?
(b) Find the zeros. What do these two points represent?

What Happened When the Ghost DISAPPEARED In a FOG?

Solve using the quadratic formula, then cross out the letter pair next to your answer. When rounding square roots or final solutions, round to the nearest hundredth. For each letter pair that you DON'T cross out, write the uppercase letter in the box with the lowercase letter.

1 $2x^2 + 7x + 6 = 0$

2 $5b^2 - 11b - 12 = 0$

3 $m^2 - 7m + 2 = 0$

4 $2h^2 - 5h - 11 = 0$

5 $3x^2 + 2x = 8$

6 $n^2 + 8 = 15n$

7 $4a^2 + 9a + 1 = 0$

8 $5k^2 = 2k + 18$

9 $8t^2 + 6t = 35$

10 $3y^2 + 7 = 2y$

11 $2q^2 = 14 - q$

12 $0.5x^2 - 3x - 9.4 = 0$

Answers 1-4

c • L	3, −0.8
f • A	6, −1
d • S	3.91, −1.41
g • R	−1.5, −2
l • T	−2, 6
e • O	6.7, 0.3
b • I	5.44, −1.24

Answers 5-8

c • T	1.83, −2.43
h • G	2.11, −1.71
i • L	1.33, −2
g • S	12.75, 2.25
a • N	−0.12, −2.13
j • I	0.67, −4
k • E	14.45, 0.56

Answers 9-12

i • M	7.64, −3.44
h • T	*no solution*
k • S	3.16, −1.56
m • H	8.27, −2.27
k • N	1.75, −2.5
i • D	2.41, −2.91
e • W	1.5, −2.25

a	b	c	d	e	f	g	h	i	j	k	l	m

EXTRA: Can You Stop In Time?

When a driver needs to stop a car, the approximate stopping distance d (in feet) is given by the formula: $d = 0.05v^2 + 2.2v$, where v is the speed of the car (in miles per hour). Suppose a car travels 200 feet before stopping ($d = 200$). How fast was the car traveling?

Derive the Quadratic Formula beginning with Standard Form: