Honors Algebra 1

Unit 3:
Modeling and Analyzing Quadratic Functions

Name:____

Fall 2019

Dr. Oldham

GRAPHING QUADRATIC FUNCTIONS

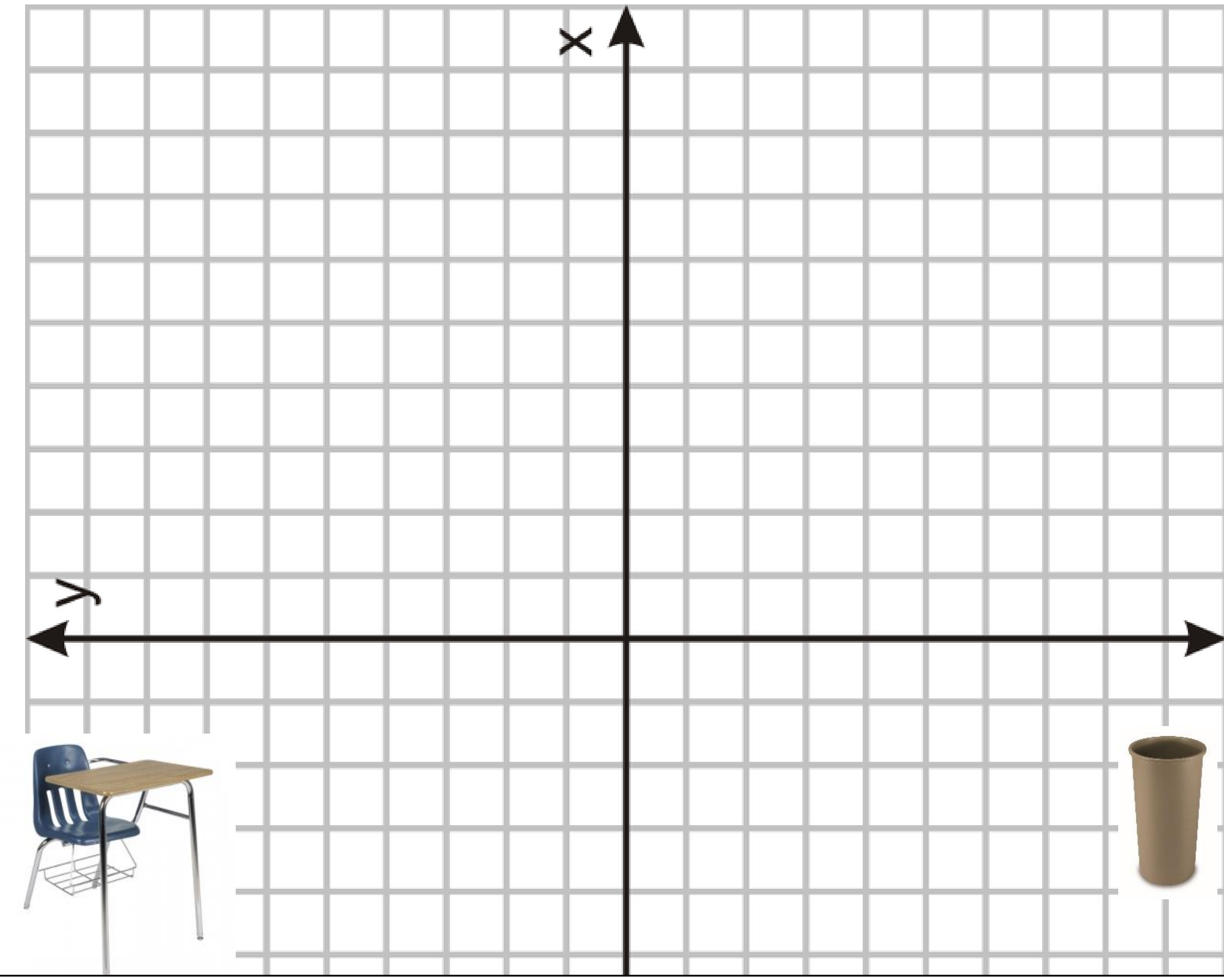
A.CED.2: Create quadratic equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
F.BF.3: Identify the effect on the graph of replacing $f(x)$, by $f(x) + k$, $f(x) - k$, $kf(x)$, $f(k + x)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
F.IF.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function $h(n)$ gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain of the function
F.IF.7: Graph functions expressed algebraically and show key features of the graph both by hand and by using technology
F.IF.7a: Graph quadratic functions and show intercepts, maxima, and minima (as determined by the function or by the context)
F.IF.8a: Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. *For example, compare and contrast quadratic functions in standard, vertex, and intercept forms*.

It was a normal Friday morning in Dr. Oldham's math class. Her 3rd block math class entered the room and started working on their warm-up. Or at least some of them did. As Dr. Oldham gently reminded Calvin and Erich to pick up a warm -up and get started, Ginger realized that she needed to throw something away but since she couldn't walk to the trash can she decided to throw away the piece of paper by balling it up and tossing it into the trashcan from her desk. Before she threw it a conversation ensued.

Caitlin: You'll never make the shot.
Alex: I've got $5 for you if you do.
Andalyn: Your angle of trajectory is off; you'll never make it.
Ava: I think it'll arc in and land right in the trash can.
Maria: I already learned this – the projectile is going to follow the path $f(x) = -.125x^2 - .125x + 7$.
Gavin: What does that even mean…is she going to make the shot or not?
Just as they all began to ponder the possibilities of Ginger making the shot, Dr. Oldham came to the front of the class to start the lesson
Dr. Oldham began class by saying,
"Today class, we are going to learn about quadratic functions and projectile motion. Let's take for example, the path that a small projectile would take from Ginger's seat to the trash can which can be given by $f(x) = -.125x^2 - .125x + 7$."

The path of a projectile can be modeled with the graph of a quadratic equation. Make a table of values for the following function:

X	$f(x) = -.125x^2 - .125x + 7$	X	
-8		1	
-7		2	
-6		3	
-5		4	
-4		5	
-3		6	
-2		7	
-1		8	
0			



What are the zeros of the graph?

What do the zeros represent in this situation?

Will Amy make the shot?

How could we change the situation so Amy WOULD make the shot?

What is the highest amount the paper ball will reach? How do you know?

How long will it take for the ball to hit the floor? How do you know?

1) Determine the Axis of Symmetry for each of the following

a. $f(x) = 2x^2 + 16x + 33$

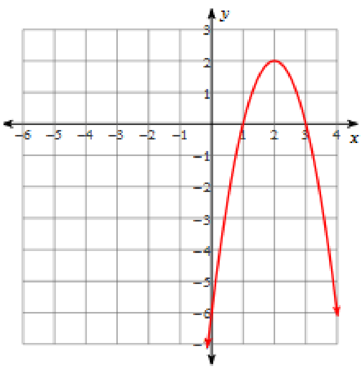
b. $f(x) = -2x^2 + 12x + 15$

c. $f(x) = -2x^2 - 16x - 34$

d. $f(x) = -x^2 - 4x - 8$

2) Determine either the axis of symmetry, the vertex, and the zeros for each of the graphs

a.

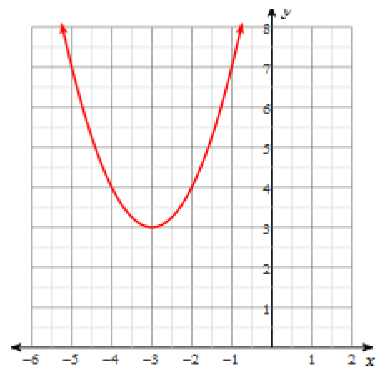


Axis of symmetry:___________

Vertex:____________________

Zeros:_____________________

b.

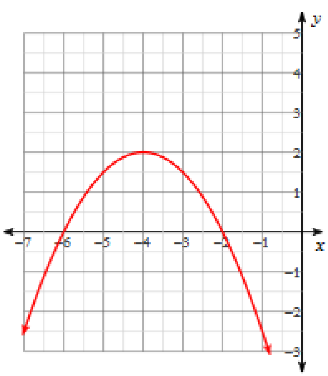


Axis of symmetry:___________

Vertex:____________________

Zeros:_____________________

c.

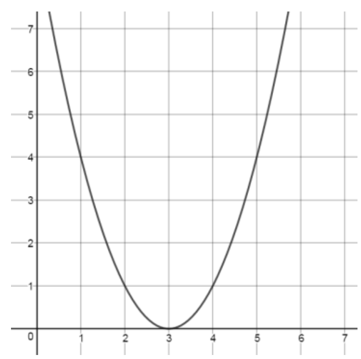


Axis of symmetry:___________

Vertex:____________________

Zeros:_____________________

d.



Axis of symmetry:___________

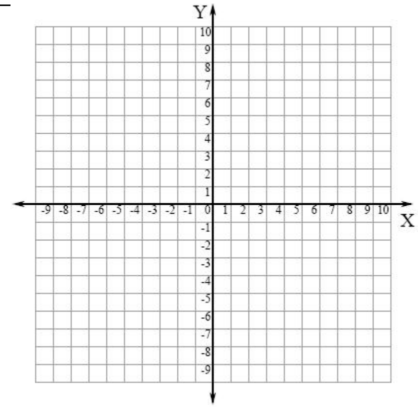
Vertex:____________________

Zeros:_____________________

3) Graph each of the following quadratic functions

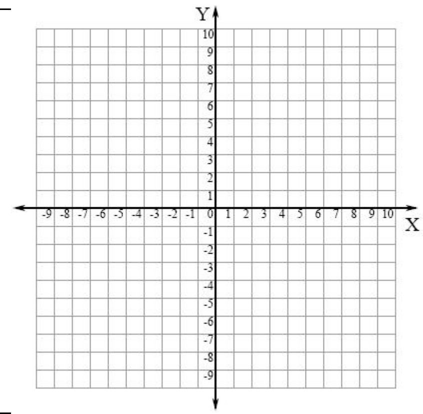
a. $f(x) = 2x^2 + 16x + 33$

x	y



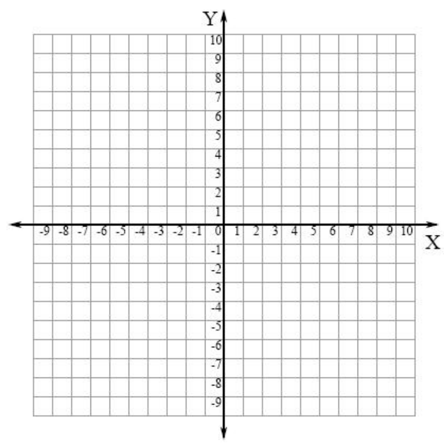
b. $f(x) = -2x^2 + 12x + 15$

x	y



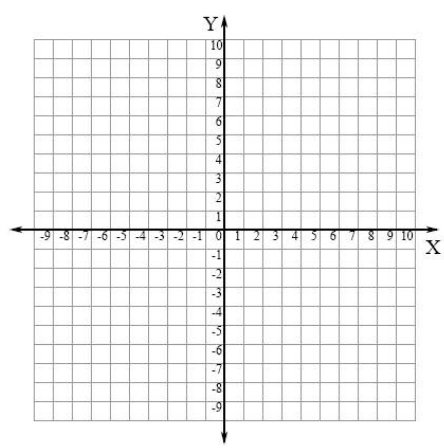
c. $f(x) = -2x^2 - 16x - 34$

x	y



d. $f(x) = -x^2 - 4x - 8$

x	y

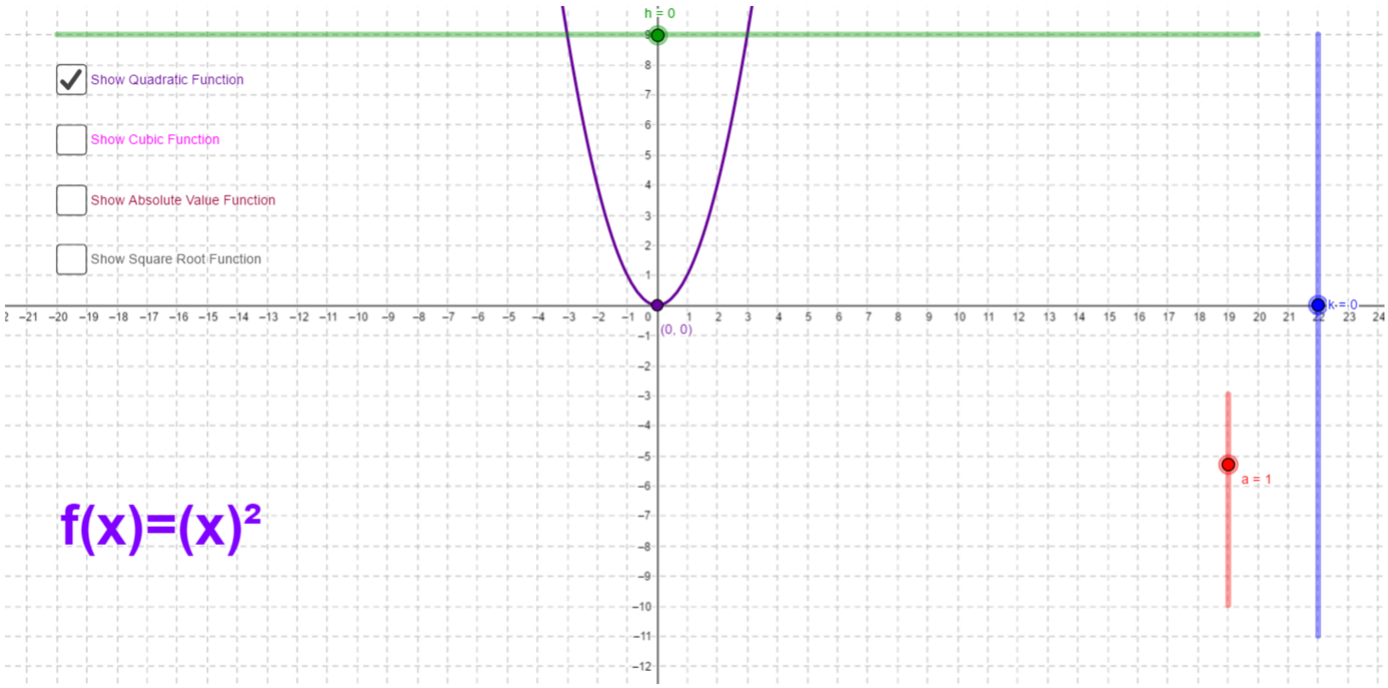


Exploration into Quadratic Graphs

Go to the following link (OR go to today's date on the blog and click on the link)

https://www.geogebra.org/m/kstGD8uR

You will see a screen that looks like this



The parabola is the equation **f(x) = x^2** and it is the **PARENT function** of a quadratic (meaning the most basic because lets be honest--- parents are basic).

There are three sliders the green (h) at the top, the blue (k) on the right, and the skinny red a

I want you to explore how the parent function changes when you move the sliders and make some hypothesis about graphing quadratic functions. Play around with the sliders and look at how the **graph AND the function** change and answer the following questions

1) How can you make the graph move horizontally?

2) How can you make the graph move vertically?

3) How can you make the graph flip upside down?

4) Write the equation of the quadratic function that moved 2 spaces to the right

5) Write the equation of the quadratic function that is 5 spaces to the left

6) Write the equation of the quadratic function that is 1 space up

7) Write the equation of the quadratic function that is 6 spaces down.

8) Write the equation of a quadratic function that didn't move left or right but did flip upside down

9) Write the equation of a quadratic function that moved 5 spaces right AND 2 spaces down

10) Write the equation of a quadratic function that is upside down and 3 spaces left.

11) What would be the equation of a graph that did not move left or right but did shrink by a factor of 2?

12) Write your own equation and explain how it have moved from the parent function

Graphing Quadratics in Vertex Form

1) Determine the vertex of each of the following

a. $f(x) = (x-5)^2 + 1$

b. $f(x) = -3(x+1)^2 + 2$

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

d. $f(x) = 3x^2 - 4$

2) Match the graph with the equation

$f(x) = (x-3)^2 + 1$ _____

$f(x) = (x+3)^2 + 1$ _____

$f(x) = (x-3)^2 - 1$ _____

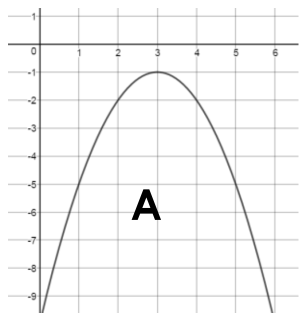
$f(x) = (x+3)^2 - 1$ _____

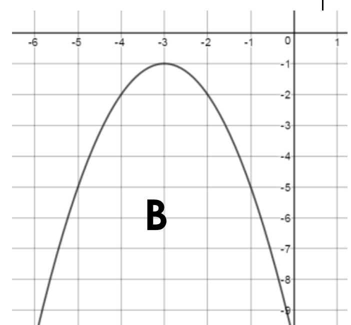
$f(x) = -(x-3)^2 + 1$ _____

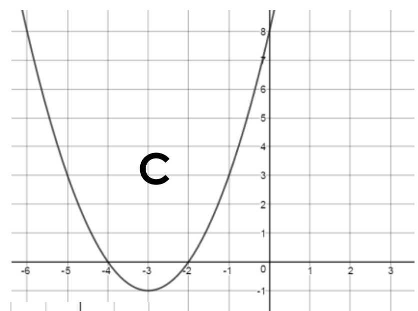
$f(x) = -(x+3)^2 + 1$ _____

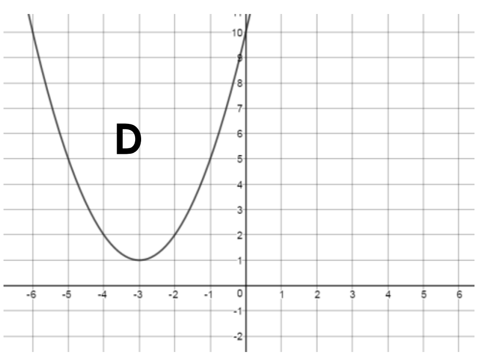
$f(x) = -(x-3)^2 - 1$ _____

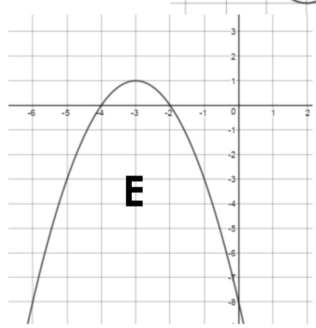
$f(x) = -(x+3)^2 - 1$ _____

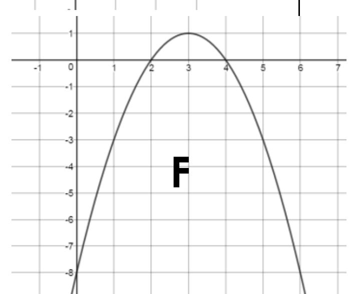


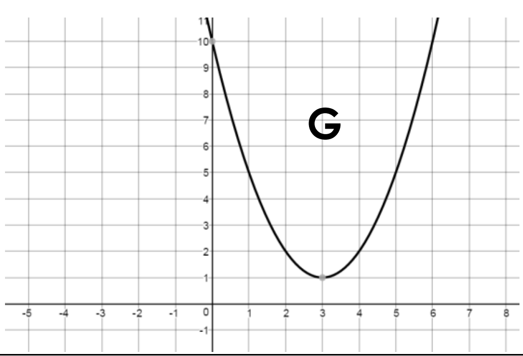


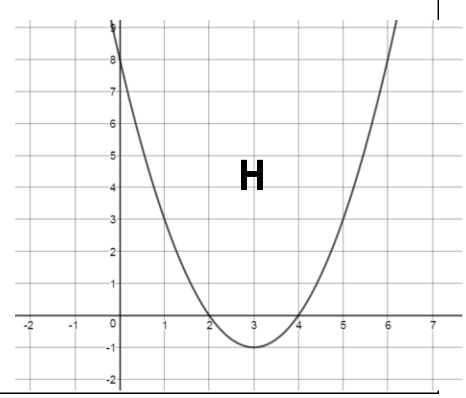








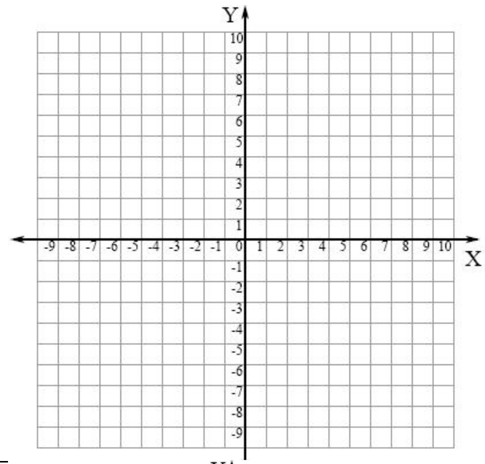




3) Graph each of the following quadratic functions

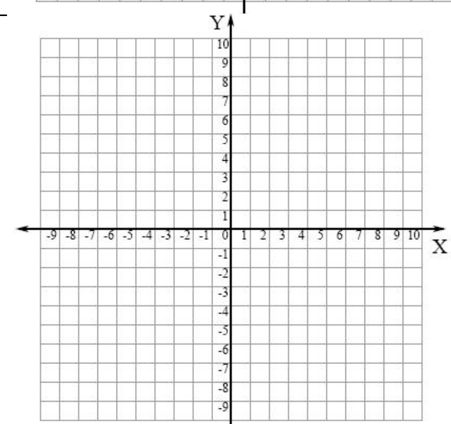
a. $f(x) = -(x+2)^2 + 1$

x	y



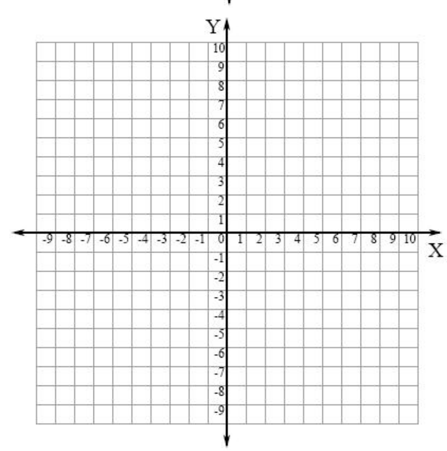
b. $f(x) = (x-1)^2 + 1$

x	y



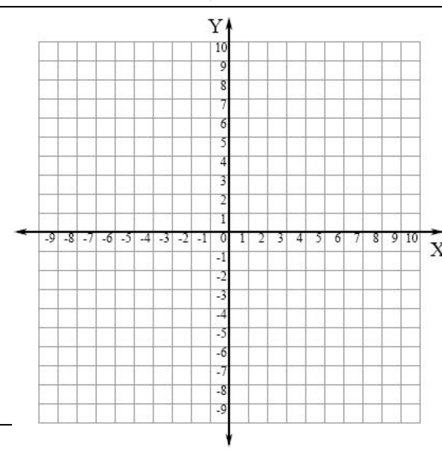
c. $f(x) = 2(x-1)^2 - 2$

x	y



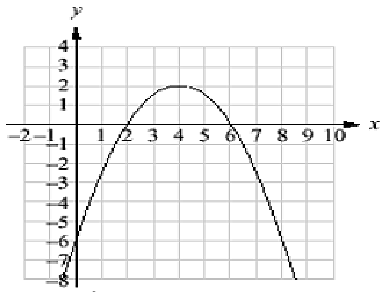
d. $f(x) = 2x^2 - 4$

x	y



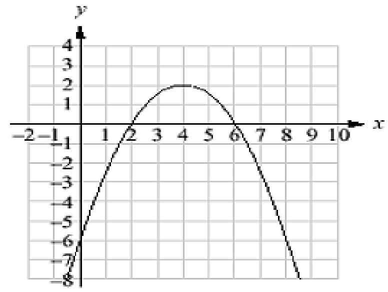
Characteristics of Quadratic Functions

Vertex:



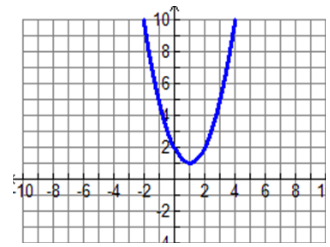
If it asks for vertex your answer will be **(x, y)**

Maximum



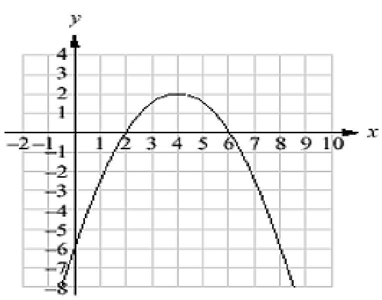
If it asks for maximum your answer will be **(x, y)**

Minimum



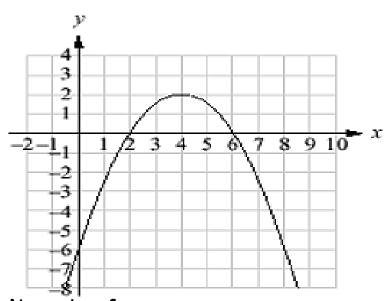
If it asks for minimum your answer will be **(x, y)**

Axis of symmetry:



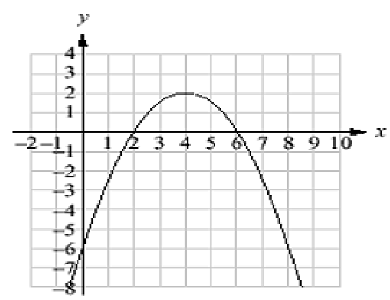
If it asks for axis of symmetry your answer will be **x = #**

Zeros:



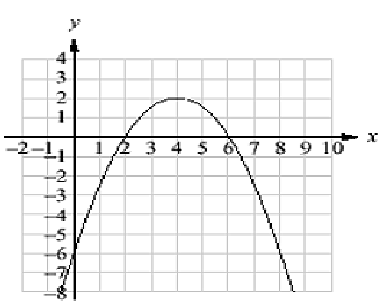
If it asks for zeros your answer will be: **(x, 0) and (x, 0)**

Y-Intercept:



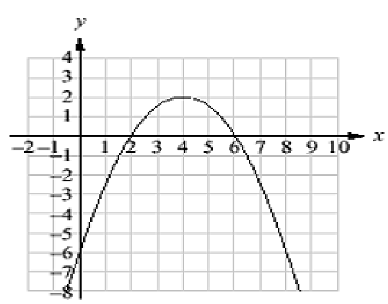
If it asks for y-intercept your answer will be **(0,y)**

Interval of Increase:



If it asks for interval of increase your answer will be **(-∞, #) or (#, ∞)**

Interval of Decrease:



If it asks for interval of decrease your answer will be **(-∞, #) or (#, ∞)**

Graph and identify the following

$y = -x^2 + 2x + 3$

Vertex:__________

Maximum/Minimum?: _________

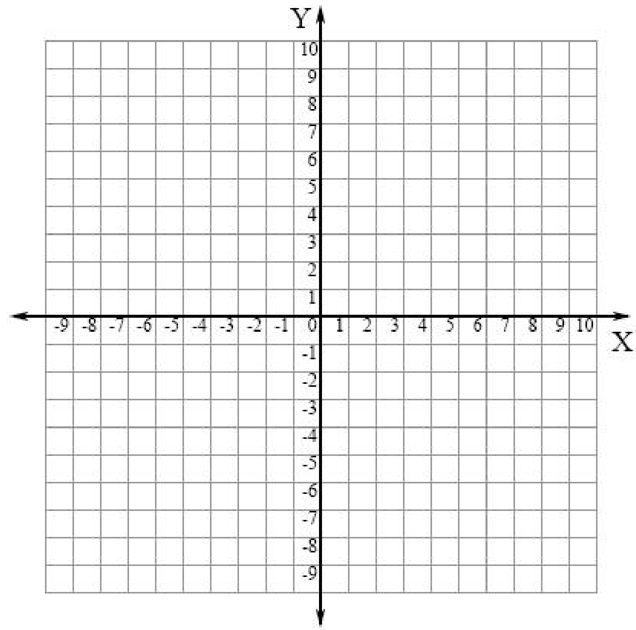
Axis of Symmetry: __________

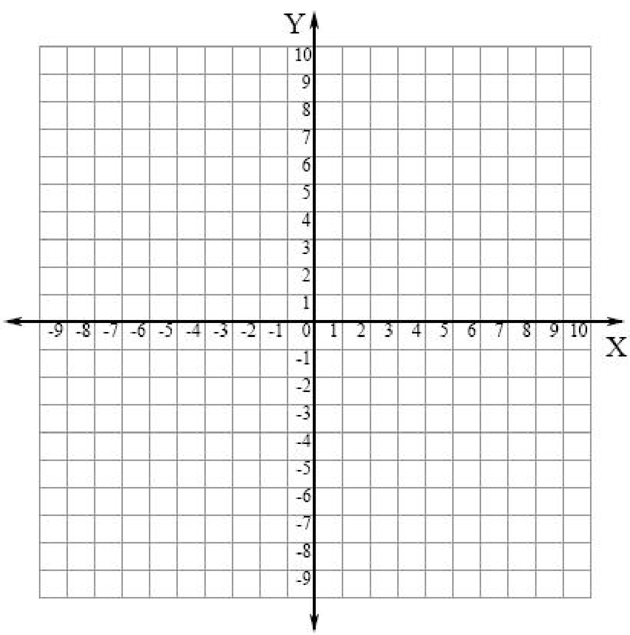
Zeros: __________

Y-intercept: __________

Interval of increase: __________

Interval of decrease: __________





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

Vertex:__________

Maximum/Minimum: _________

Axis of Symmetry: __________

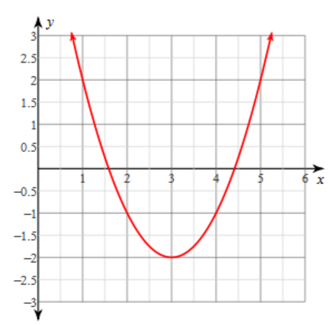
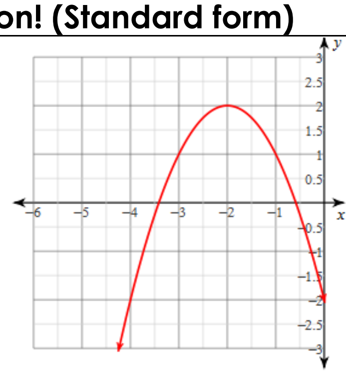
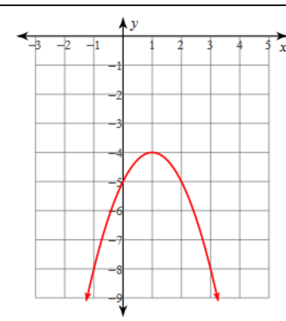
Zeros: __________

Y-intercept: __________

Interval of increase: __________

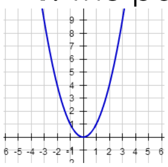
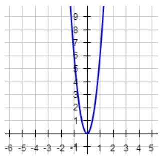
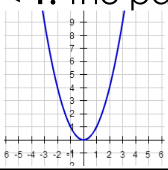
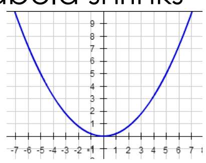
Interval of decrease: __________

Match the graph with the equation! (Standard form)

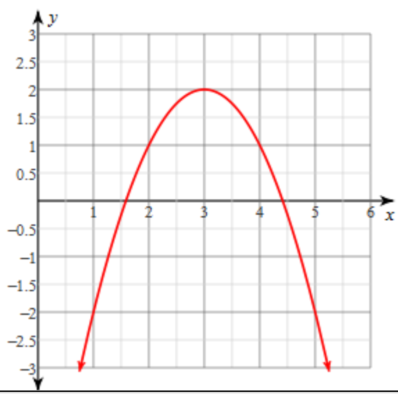
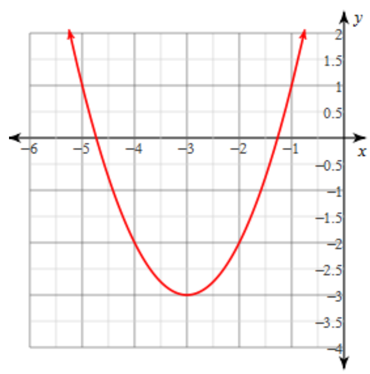
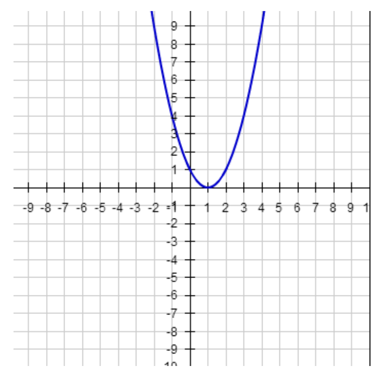
		
A. $-x^2 + 2x - 5$	B. $-x^2 - 4x - 2$	C. $f(x) = x^2 - 6x + 7$

How does vertex form move?

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

a	**h**	**k**
Positive: Up like a cup! • Has a minimum **Negative:** Down like a frown • Has a maximum (reflection over the x-axis)	h = horizontal! (x **– h**)^2 • Moves to right (x **+ h**)^2 • Moves to left	k = vertical **+ k** • Moves up **– k** • Moves down
a > 1: The parabola stretches   **a < 1:** The parabola shrinks  		

Write the equation of the graph! (Vertex form)

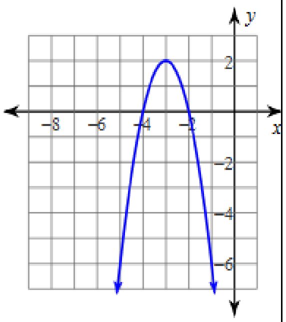
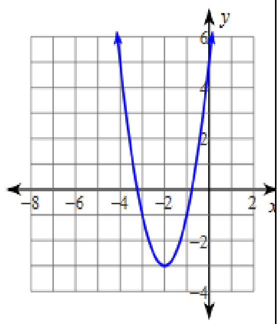
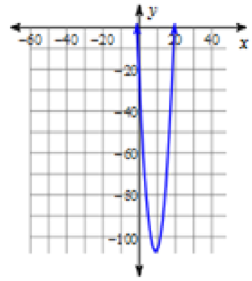
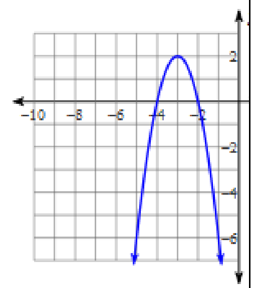
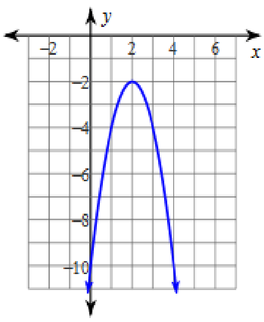
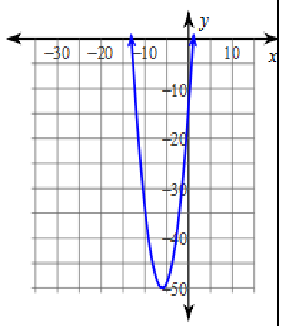
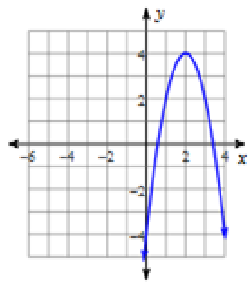
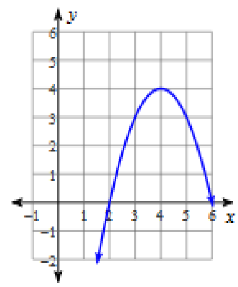
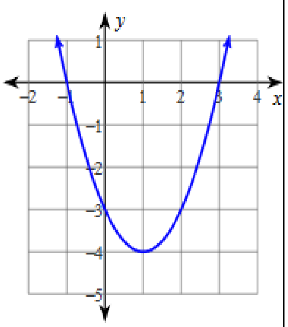
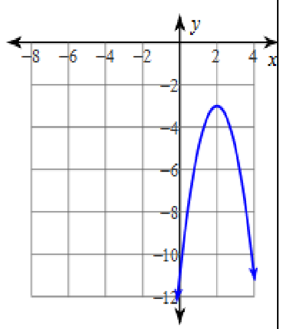
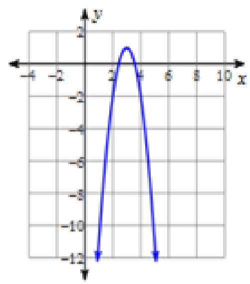
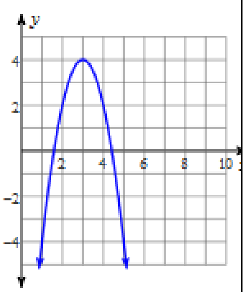
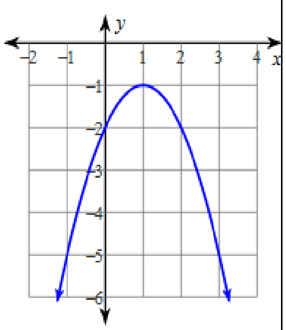
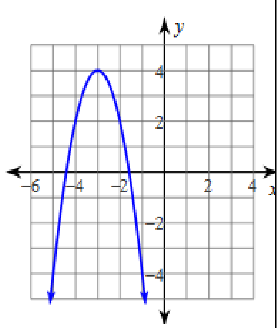
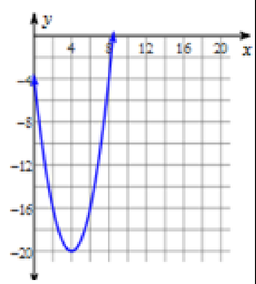
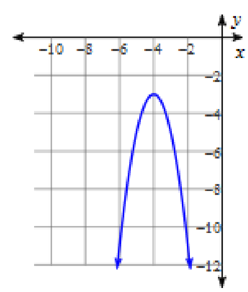
		

Describe the transformations of the following

f(x) = -(x + 3)^2	f(x) = x^2 – 3	f(x) = 2(x + 4)^2 + 2

Convert into Standard Form (hint just distribute and combine like terms!)

$f(x) = (x-3)^2 + 2$	$f(x) = -(x-2)^2 - 1$	$f(x) = 2(x+5)^2 + 3$

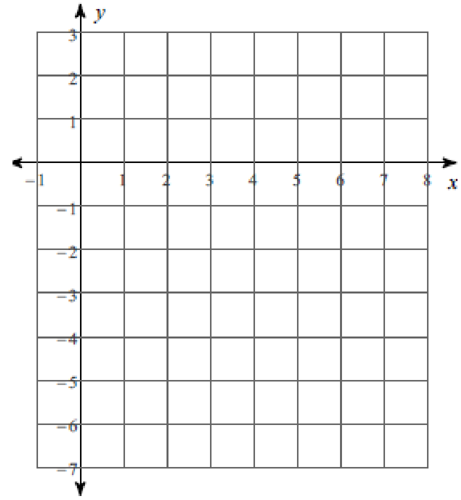
1) $y = -x^2 + 2x - 2$	$y = 2x^2 + 8x + 5$	$= -3x^2 + 18x - 26$	$y = -2x^2 + 12x - 14$
A) 	A) 	A) 	A) 
B) 	B) 	B) 	B) 
C) 	C) 	C) 	C) 
D) 	D) 	D) 	D) 

Which graph matches the standard form equation? (Hint: Find the vertex)

1. $y = -2(x-4)^2 + 2$

Vertex:____________________
Max/Min: _________________
A.O.S.: ____________________
Zeros: _____________________
Int of increase:____________
Intl of decrease: __________

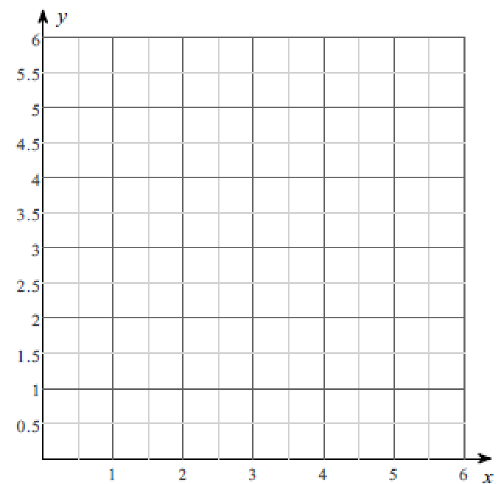
Reflection?:__________
Stretch/Shrink:________
Horizontal:___________
Vertical:_____________



2. $y = (x-3)^2 + 1$

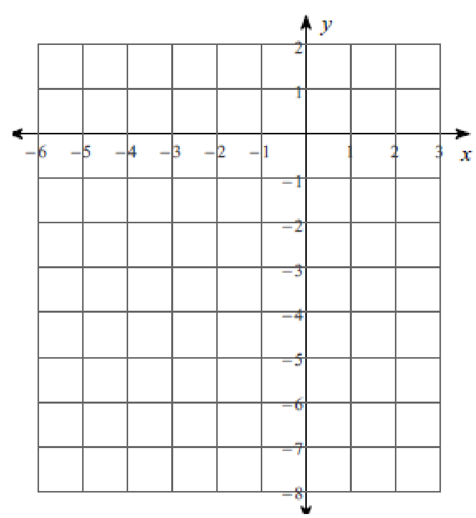
Vertex:____________________
Max/Min: _________________
A.O.S.: ____________________
Zeros: _____________________
Int of increase:____________
Intl of decrease: __________

Reflection?:__________
Stretch/Shrink:________
Horizontal:___________
Vertical:_____________



3. $f(x) = -2x^2 - 16x - 31$

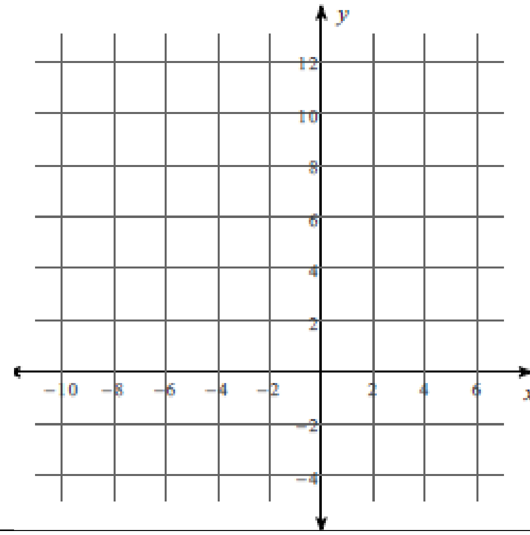
Vertex:____________________
Max/Min: _________________
A.O.S.: ____________________
Int of increase:____________
Intl of decrease: __________



Graph each function, describe the transformations, and analyze the characteristics

4. $y = 4x^2 + 24x + 32$

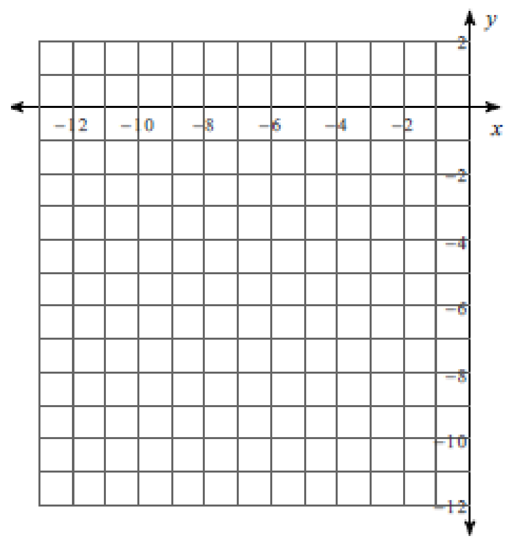
Vertex:____________________
Max/Min: _________________
A.O.S.: ___________________
Zeros: ____________________
Int of increase:____________
Intl of decrease: __________



5. $f(x) = -3(x+4)^2 + 1$

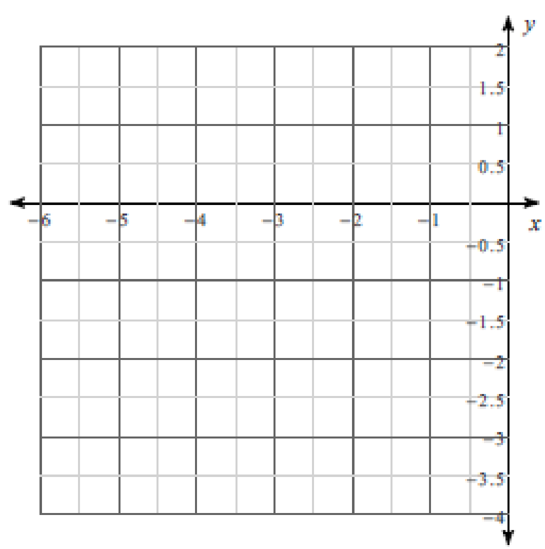
Vertex:____________________
Max/Min: _________________
A.O.S.: ___________________
Int of increase:____________
Intl of decrease: __________

Reflection?:__________
Stretch/Shrink:________
Horizontal:___________
Vertical:_____________



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

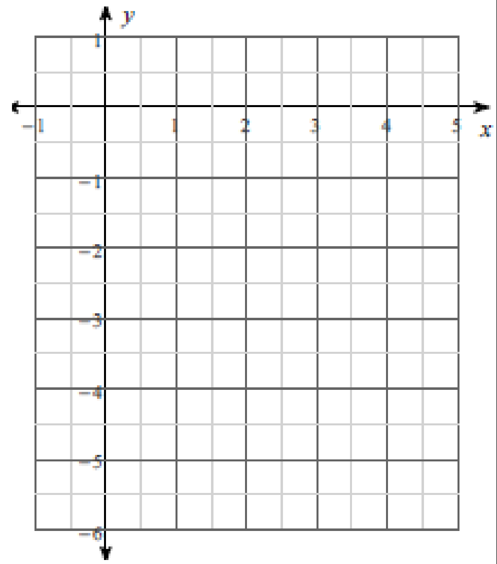
Vertex:____________________
Max/Min: _________________
A.O.S.: ___________________
Y-intercept: _______________
Int of increase:____________
Intl of decrease: __________



7. $f(x)=\frac{1}{2}(x-2)^2-4$

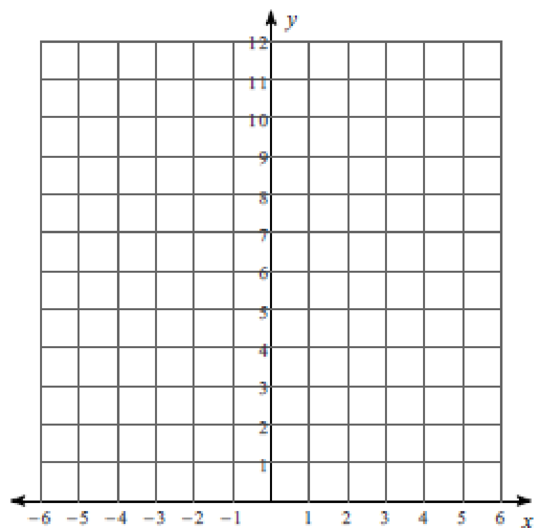
Vertex:____________________
Max/Min: _________________
A.O.S.: ____________________
Y-intercept: _______________
Int of increase:_____________
Intl of decrease: ___________

Reflection?:__________
Stretch/Shrink:________
Horizontal:____________
Vertical:______________



8. $f(x)=2x^2+4x+5$

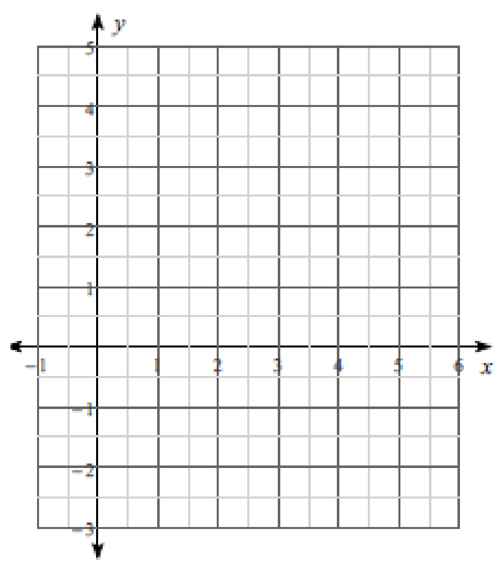
Vertex:____________________
Max/Min: _________________
A.O.S.: ____________________
Zeros: _____________________
Y-intercept: _______________
Int of increase:_____________
Intl of decrease: ___________



9. $y=(x-4)^2-1$

Vertex:____________________
Max/Min: _________________
A.O.S.: ____________________
Zeros: _____________________
Int of increase:_____________
Intl of decrease: ___________

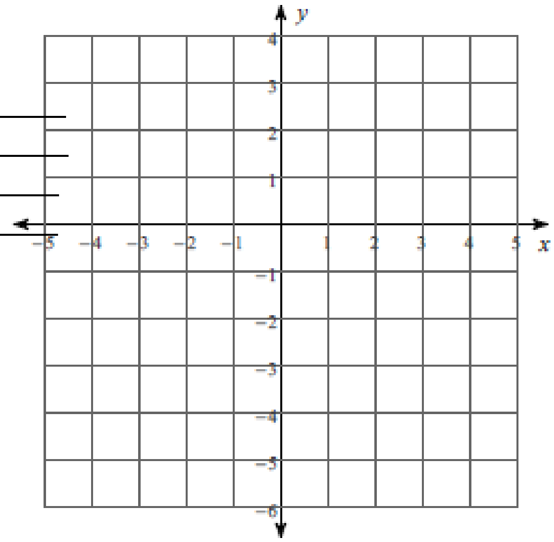
Reflection?:__________
Stretch/Shrink:________
Horizontal:____________
Vertical:______________



10. $y=-2x^2+12x-15$

Vertex:__________________
Max/Min: ________________
A.O.S.: __________________
Int of increase:___________
Intl of decrease: _________

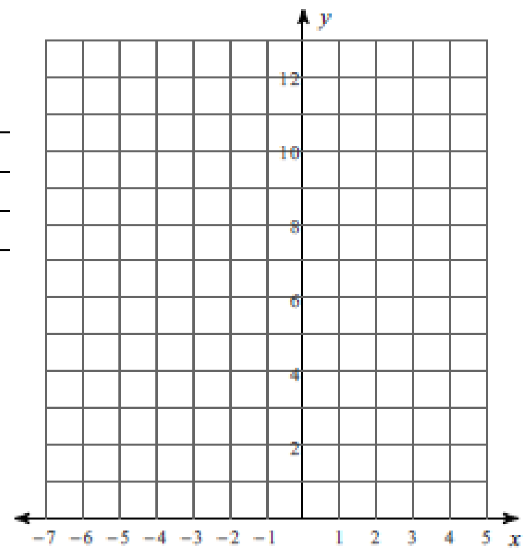
Reflection?:__________
Stretch/Shrink:________
Horizontal:___________
Vertical:____________



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

Vertex:__________________
Max/Min: ________________
A.O.S.: __________________
Zeros: ___________________
Y-intercept: _____________
Int of increase:___________
Intl of decrease: _________

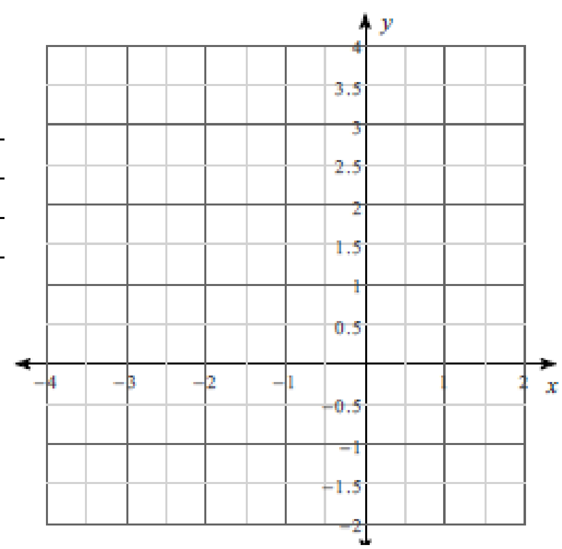
Reflection?:_________
Stretch/Shrink:_______
Horizontal:__________
Vertical:____________



12. $f(x)=-\frac{1}{2}(x+2)^2+2$

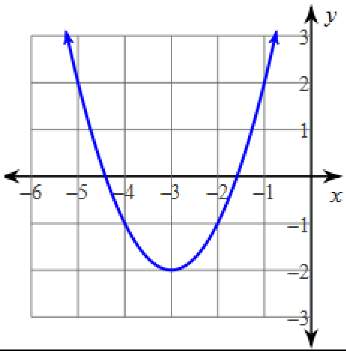
Vertex:__________________
Max/Min: ________________
A.O.S.: __________________
Zeros: ___________________
Y-intercept: _____________
Int of increase:___________
Intl of decrease: _________

Reflection?:_______
Stretch/Shrink:_____
Horizontal:________
Vertical:__________



Write the Vertex Form of the equation for the following graphs.

1.



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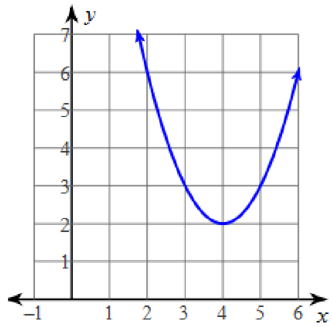

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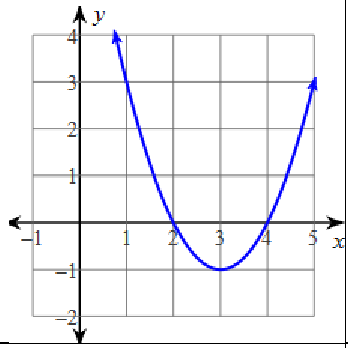

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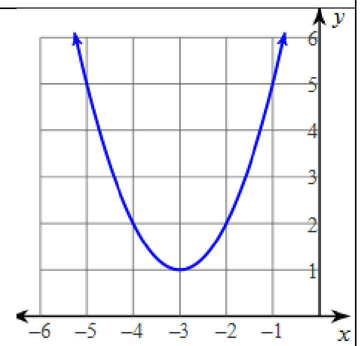
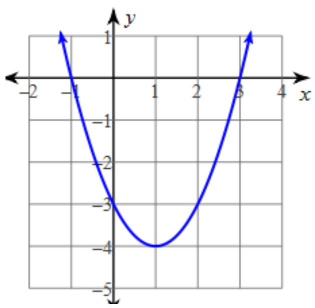


5.



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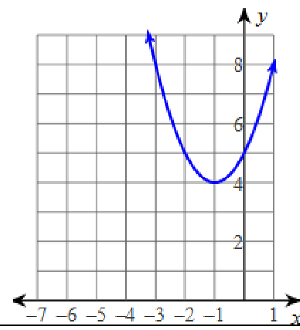
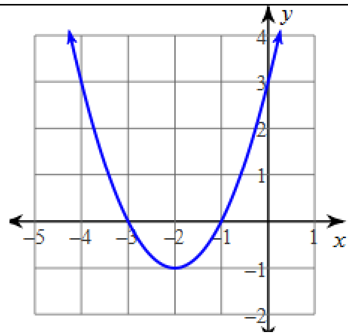
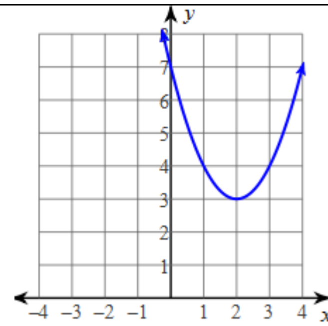


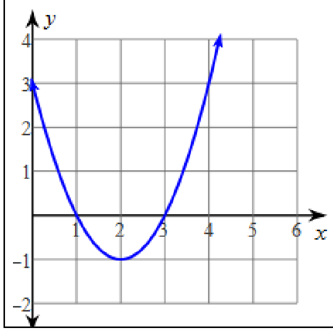
7.



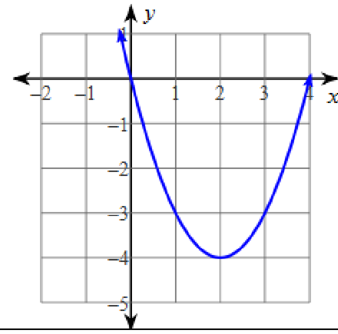
8.



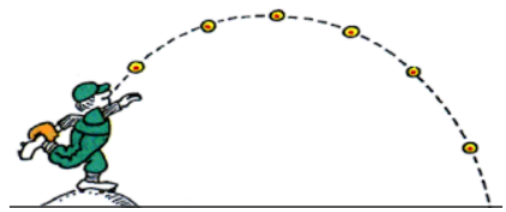
9.



10.



Quadratic Application



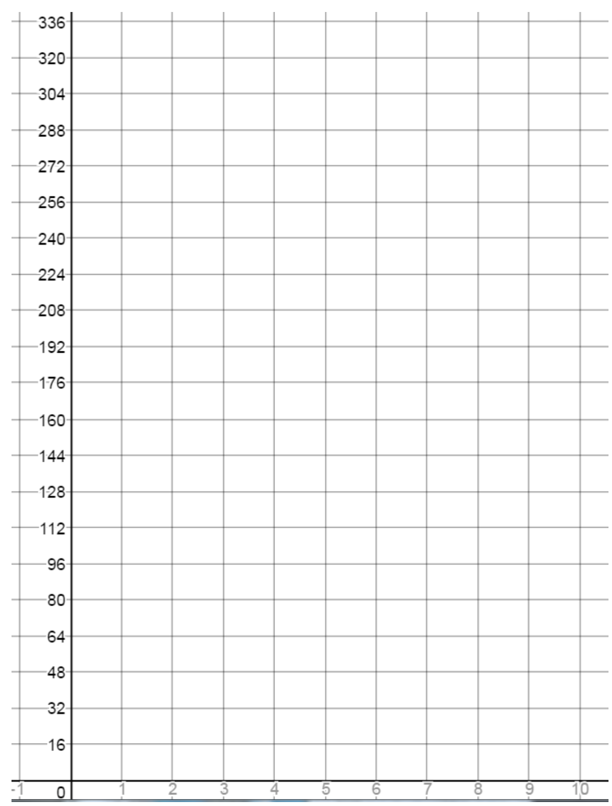
1. After *t* seconds, a ball tossed in the air from the ground level reaches a height of *h* feet given by the equation $\mathbf{h = 144t - 16t^2}$.

   a. What is the height of the ball after 3 second?

   b. What is the maximum height the ball will reach?

   c. Find the number of seconds the ball is in the air when it reaches a height of 224 feet.

   d. After how many seconds will the ball hit the ground?



FACTORING AND SOLVING QUADRATICS

A.SSE.3: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

a. Factor any quadratic expression to reveal the zeros of the function defined by the expression

b. Complete the square in a quadratic expression to reveal the maximum and minimum value of the function defined by the expression

A.CED.1: Create equations and inequalities in one variable and use them to solve problems. Include equations arising from quadratic functions. A) solve quadratic equations by inspection (e.g., for x2 = 49), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation

A. REI. 4: Solve quadratic equations in one variable:

a. Use the method of completing the square to transform any quadratic equation in x^2 into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from $ax^2 + bx – c = 0$

F.IF.8a: Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. *For example, compare and contrast quadratic functions in standard, vertex, and intercept forms*.

F.FIF.9: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one function and an algebraic expression for another, say which has the larger maximum.*

Factor the common factor out of each expression.

1) $-24 - 21x$

2) $8n^2 + 12n$

3) $36v^2 + 9$

4) $6p - 18p^3$

5) $-12a^3 - 21a$

6) $-12 + 6a^2 + 3a^3$

7) $2n^2 + 10n + 4$

8) $-18x^5 + 18x^2 - 45$

9) $14m^6 + 56m^5 - 63m^3$

10) $20a^2 - 10a + 50$

11) $3v^2 - 21v$

12) $12r^3 - 2r^2$

13) $-90x^8 + 100x^4 + 90x^2$

14) $35v^2 - 5v - 5$

15) $4x^3 - 8x^2 - 2x$

16) $3m^4 - 9m^3 + 9$

17) $50m^3 + 5m^2 - 50m + 25$

18) $28x^4 - 56x^2 + 14x + 21$

Factor each completely.

1) $40r^3 + 56r^2 - 25r - 35$

2) $48b^3 + 30b^2 - 40b - 25$

3) $42a^3 + 6a^2 + 35a + 5$

4) $21a^3 + 24a^2 + 35a + 40$

5) $35x^3 + 56x^2 - 25x - 40$

6) $16x^3 - 28x^2 - 20x + 35$

7) $25x^3 + 40x^2 - 150x - 240$

8) $8k^3 - 7k^2 - 40k + 35$

9) $2n^3 + n^2 + 6n + 3$

10) $30n^3 + 24n^2 - 75n - 60$

11) $40k^3 - 48k^2 + 5k - 6$

12) $28m^3 + 140m^2 - 20m - 100$

13) $20n^3 + 10n^2 - 32n - 16$

14) $6v^3 - 10v^2 + 9v - 15$

15) $5n^3 - 15n^2 + 7n - 21$

16) $4r^3 - 14r^2 - 14r + 49$

5.4 Finding the Numbers

The next kind of factoring we will do requires thinking of two numbers with a certain sum and a certain product.

Example 5: Which two numbers have a sum of 8 and a product of 12? In other words, what pair of numbers would answer both equations?

$\_\_\_\_ + \_\_\_\_ = 8$ and $\_\_\_\_ \times \_\_\_\_ = 12$

You may think $4 + 4 = 8$, but 4×4 does not equal 12.
Or you may think $7 + 1 = 8$, but 7×1 does not equal 12.

$6 + 2 = 8$ and $6 \times 2 = 12$, so 6 and 2 are the pair of numbers that will work in both equations.

For each problem below, find one pair of numbers that will solve both equations.

1. $\_\_\_\_ + \_\_\_\_ = 13$ and $\_\_\_\_ \times \_\_\_\_ = 40$
2. $\_\_\_\_ + \_\_\_\_ = 11$ and $\_\_\_\_ \times \_\_\_\_ = 24$
3. $\_\_\_\_ + \_\_\_\_ = 12$ and $\_\_\_\_ \times \_\_\_\_ = 27$
4. $\_\_\_\_ + \_\_\_\_ = 9$ and $\_\_\_\_ \times \_\_\_\_ = 20$
5. $\_\_\_\_ + \_\_\_\_ = 8$ and $\_\_\_\_ \times \_\_\_\_ = 12$
6. $\_\_\_\_ + \_\_\_\_ = 11$ and $\_\_\_\_ \times \_\_\_\_ = 28$
7. $\_\_\_\_ + \_\_\_\_ = 9$ and $\_\_\_\_ \times \_\_\_\_ = 18$
8. $\_\_\_\_ + \_\_\_\_ = 13$ and $\_\_\_\_ \times \_\_\_\_ = 42$
9. $\_\_\_\_ + \_\_\_\_ = 12$ and $\_\_\_\_ \times \_\_\_\_ = 32$
10. $\_\_\_\_ + \_\_\_\_ = 16$ and $\_\_\_\_ \times \_\_\_\_ = 64$
11. $\_\_\_\_ + \_\_\_\_ = 15$ and $\_\_\_\_ \times \_\_\_\_ = 54$
12. $\_\_\_\_ + \_\_\_\_ = 11$ and $\_\_\_\_ \times \_\_\_\_ = 30$
13. $\_\_\_\_ + \_\_\_\_ = 14$ and $\_\_\_\_ \times \_\_\_\_ = 40$
14. $\_\_\_\_ + \_\_\_\_ = 17$ and $\_\_\_\_ \times \_\_\_\_ = 66$
15. $\_\_\_\_ + \_\_\_\_ = 10$ and $\_\_\_\_ \times \_\_\_\_ = 24$
16. $\_\_\_\_ + \_\_\_\_ = 10$ and $\_\_\_\_ \times \_\_\_\_ = 16$
17. $\_\_\_\_ + \_\_\_\_ = 15$ and $\_\_\_\_ \times \_\_\_\_ = 44$
18. $\_\_\_\_ + \_\_\_\_ = 13$ and $\_\_\_\_ \times \_\_\_\_ = 36$
19. $\_\_\_\_ + \_\_\_\_ = 15$ and $\_\_\_\_ \times \_\_\_\_ = 26$
20. $\_\_\_\_ + \_\_\_\_ = 10$ and $\_\_\_\_ \times \_\_\_\_ = 21$

5.5 More Finding the Numbers

...at you have mastered positive numbers, take up the challenge of finding pairs of negative ...ers or pairs where one number is negative and one is positive.

...mple 6: Which two numbers have a sum of -3 and a product of -40? In other words, what pair of numbers would answer both equations?

____ + ____ = -3 and ____ × ____ = -40

It is faster to look at the factors of 40 first. 8 and 5 and 10 and 4 are possibilities. 8 and 5 have a difference of 3, and in fact, $5 + (-8) = -3$ and $5 \times (-8) = -40$. This pair of numbers, 5 and -8, will satisfy both equations.

...ach problem below, find one pair of numbers that will solve both equations.

____	+	____	=	3	and	____	×	____	=	-40
____	+	____	=	-1	and	____	×	____	=	-6
____	+	____	=	-5	and	____	×	____	=	-14
____	+	____	=	0	and	____	×	____	=	-9
____	+	____	=	-3	and	____	×	____	=	-54
____	+	____	=	2	and	____	×	____	=	-15
____	+	____	=	-1	and	____	×	____	=	-12
____	+	____	=	-3	and	____	×	____	=	-10
____	+	____	=	5	and	____	×	____	=	-14
____	+	____	=	9	and	____	×	____	=	8
____	+	____	=	6	and	____	×	____	=	5
____	+	____	=	6	and	____	×	____	=	-16
____	+	____	=	-1	and	____	×	____	=	-2
____	+	____	=	1	and	____	×	____	=	-20
____	+	____	=	8	and	____	×	____	=	12
____	+	____	=	6	and	____	×	____	=	-16
____	+	____	=	7	and	____	×	____	=	-18
____	+	____	=	-3	and	____	×	____	=	-4
____	+	____	=	4	and	____	×	____	=	-32
____	+	____	=	6	and	____	×	____	=	8

Why Is It Better to Be Married to a Successful Broadway Producer Than a Plumber?

Write the expression in factored form. Find your answer below the exercise. Then write the letter of the exercise in the box that contains the number of the answer.

E. $a^2 + 6a - 7$

A. $a^2 + 3a - 10$

L. $a^2 - 5a - 6$

U. $a^2 - 2a - 15$

S. $a^2 + 9a - 22$

O. $a^2 + 4a - 12$

H. $a^2 - 23a - 50$

Answers

17. $(a-2)(a+7)$
5. $(a+1)(a-6)$
3. $(a-5)(a+10)$
9. $(a-2)(a+6)$
15. $(a-1)(a+7)$
13. $(a+1)(a-10)$
24. $(a+3)(a-5)$
20. $(a-2)(a+5)$
26. $(a+2)(a-25)$
22. $(a-1)(a+5)$
18. $(a-2)(a+11)$

F. $k^2 - 7k - 18$

U. $k^2 + 13k - 30$

A. $k^2 - 5k - 24$

E. $k^2 + 34k - 35$

S. $k^2 - 3k - 28$

L. $k^2 + k - 72$

T. $k^2 - 8k - 65$

Answers

25. $(k+4)(k-7)$
4. $(k-3)(k+10)$
1. $(k+3)(k-8)$
14. $(k+2)(k-14)$
17. $(k+5)(k-13)$
3. $(k+2)(k-9)$
12. $(k-1)(k+35)$
23. $(k+3)(k-6)$
6. $(k-8)(k+9)$
10. $(k-2)(k+15)$
16. $(k+5)(k-7)$

B. $x^2 + 8xy - 20y^2$

L. $x^2 - 8xy - 33y^2$

H. $x^2 + 11xy - 80y^2$

A. $x^2 - 9xy - 36y^2$

S. $x^2 + 5xy - 36y^2$

U. $x^2 - 16xy - 36y^2$

F. $x^2 - 36y^2$

Answers

8. $(x-5y)(x+16y)$
19. $(x-4y)(x+5y)$
4. $(x+2y)(x-18y)$
23. $(x+3y)(x-11y)$
21. $(x-3y)(x+11y)$
16. $(x+3y)(x-12y)$
22. $(x+6y)(x-6y)$
14. $(x-2y)(x+10y)$
13. $(x+y)(x-36y)$
11. $(x-4y)(x+9y)$
7. $(x+8y)(x-10y)$

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

Factor each completely.

1) $5n^2 + 37n - 72$

2) $5x^2 + x - 18$

3) $2n^2 + 17n + 30$

4) $5k^2 - 28k - 12$

5) $7p^2 - 16p + 4$

6) $7r^2 + 27r - 4$

7) $30x^2 - 138x - 252$

8) $25x^2 - 160x + 60$

9) $9n^2 - 75n + 150$

10) $35x^2 - 220x + 225$

11) $9a^2 + 77a + 40$

12) $9x^2 + 36x + 32$

13) $6p^2 - 29p + 30$

14) $6a^2 + 19a + 15$

15) $6x^2 - 25x + 14$

16) $10b^2 + 23b - 5$

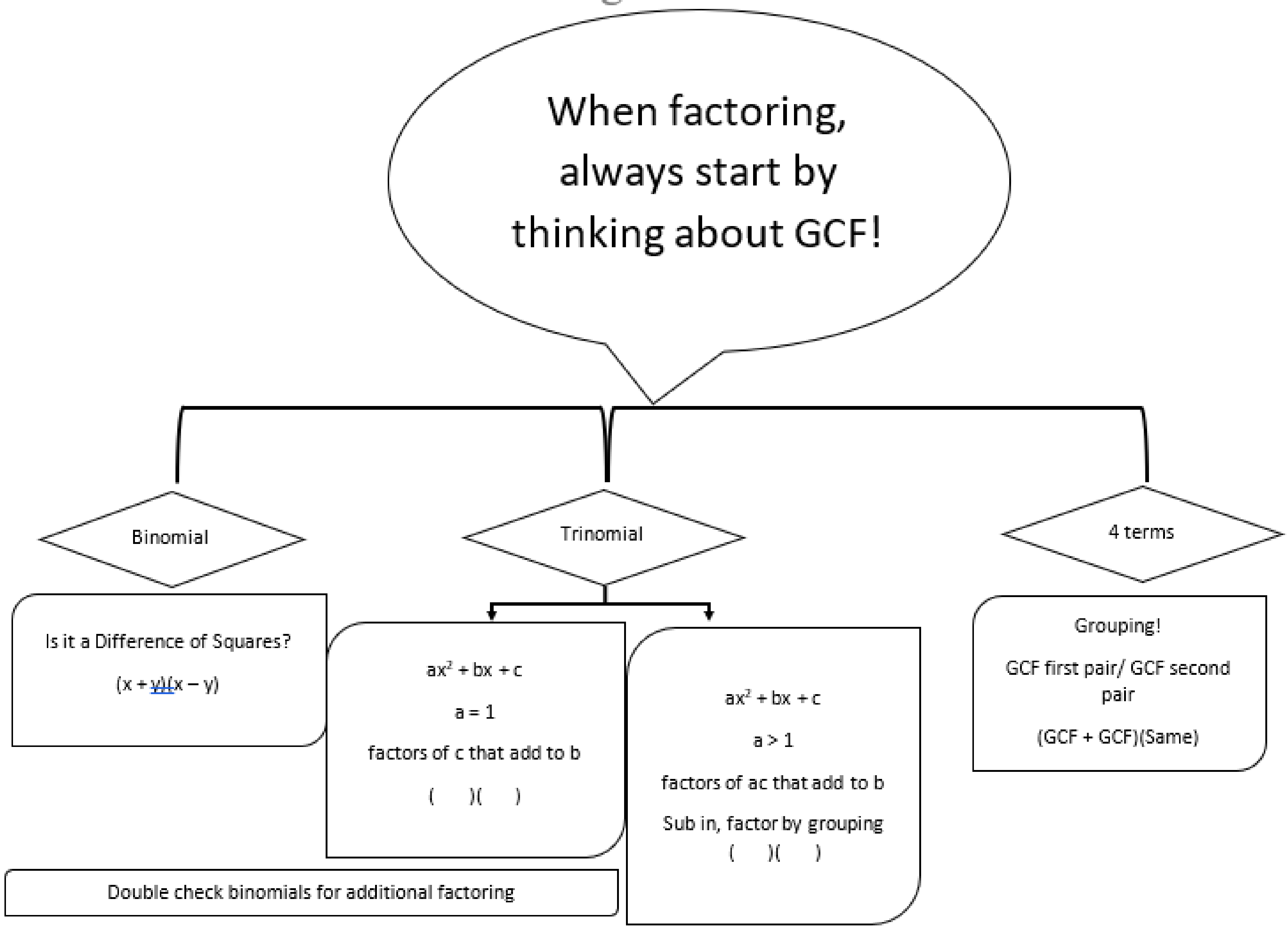
17) $48x^2 + 282x + 210$

18) $54n^2 - 582n + 420$

19) $18v^2 - 159v + 120$

20) $45k^2 + 90k + 25$

Factoring Decision Tree

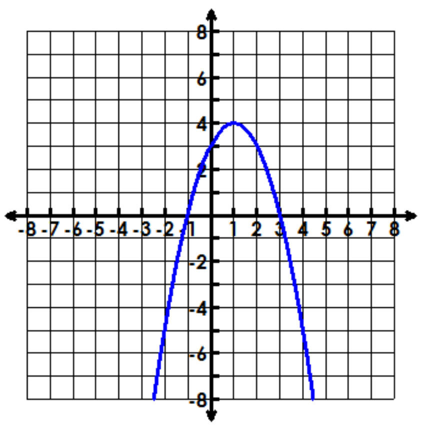


Solving Quadratics by Graphing and Factoring

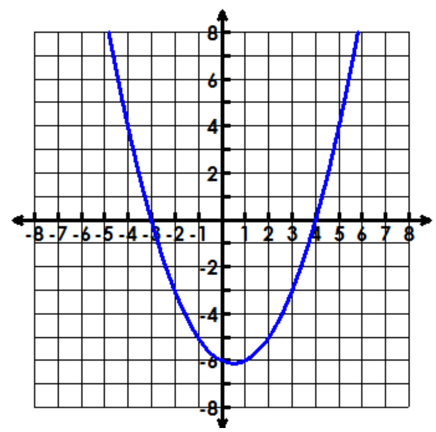
Solve a Quadratic by Graphing

To solve a quadratic by graphing is to find where the parabola crosses the x-axis.
We call these the __________, ______________, ________________, ***or*** _______________.

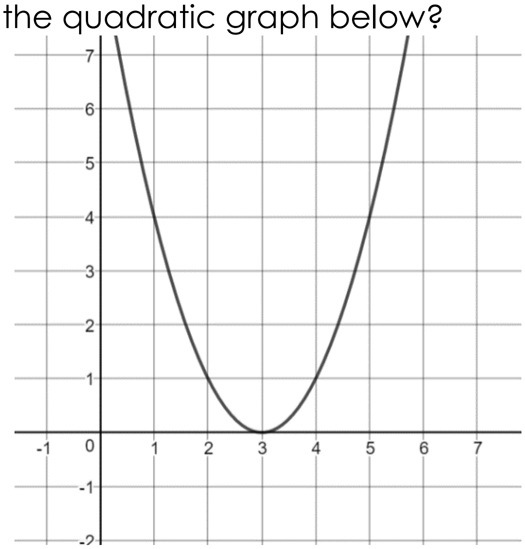
Example 1: Find the roots.



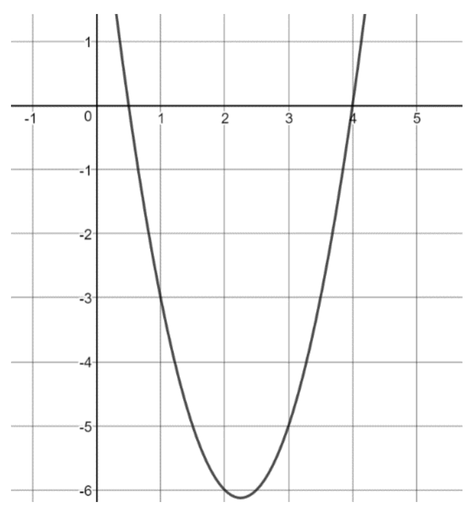
Example 2: Find the solutions



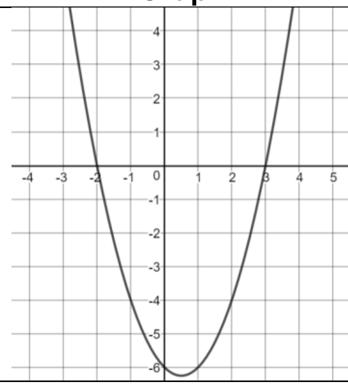
Example 3: What are the solutions to the quadratic graph below?



Example 4: What are the x- intercepts of the quadratic function?

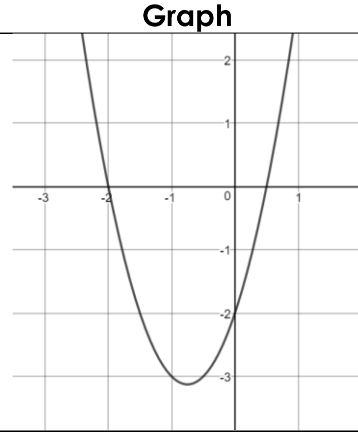


How is the **graph** of a quadratic function related to the **factored function** AND to the **solutions?**

Factored Quadratic Function	Graph	Solutions
$(x - 3)(x + 2)$		

Describe the connection between the factored form and the solution:

How is the **graph** of a quadratic function related to the **factored function** AND to the **solutions?**

Factored Quadratic Function	Graph	Solutions
$(2x - 1)(x + 2)$		

Describe the connection between the factored form and the solution:

Given the following equations *already in factored form* what would be the zeros?

1) $(x - 4)(x - 3)$
2) $(x + 2)(x - 1)$
3) $(4x - 1)(5x + 2)$

The difference between FACTORING and SOLVING

Factoring	Solving

Solve a Quadratic Algebraically by Factoring

1. Move everything to one side in standard form so that the ____________ term is POSITIVE and it is set equal to zero.
2. _______________!
3. Write out solutions as _______________. Remember to write as opposites. If there is a number in front of x, that number becomes the ________________________ in your solution

Example 3:
$(x - 10)(3x + 2) = 0$

Example 4:
$x^2 - 6x - 12 = 0$

Example 5:
$5x^2 + 31x + = -6$

Example 6:
$2x^2 - 6 = x$

(go to back for extra practice!)

Try It: Find the zeros of the function by factoring.

1. $0 = x^2 + 6x + 9$

2. $2x^2 + 9x + 4 = 0$

Try It: Find the roots of each equation by factoring.

3. $9x^2 + 4 = 12x$

4. $16x^2 - 9 =$

Solve each quadratic equation.

1. $x^2 + 4 = 29$

2. $3x^2 - 7 = 47$

3. $x^2 + 11 = 16$

4. $(x+4)^2 = 121$

5. $(x-3)^2 = 9$

6. $(x-7)^2 = 99$

7. $(x+3)^2 + 6 = 18$

8. $3(x+4)^2 = 9$

9. $(x+4)^2 + 8 = 9$

10. $2(x-4)^2 - 3 = 37$

11. $2(x-1)^2 - 6 = 30$

12. $5(x-3)^2 = 20$

Waterfalls: Angel Falls in Venezuela is the tallest waterfall in the world. Water falls uninterrupted for 2421 feet before entering the river below. The height *h* above the river in feet of water going over the edge of the waterfall is modeled by $h = -16t^2 + h_0$, where *t* is the time in seconds after the initial fall.

A. Write an equation that models how long it will take for the water to hit the river at the bottom

B. Estimate the time it takes for the water to reach the river.

C. Ribbon Falls in California has a height of **1612 ft**. Approximately **how much longer does** it take water to reach the bottom when going over Angel Falls than when going over Ribbon Falls?

There are multiple ways to solve a quadratic (x^2) function

METHOD 1: Solve by Factoring

-

Example: $x^2 + 14x = -33$

METHOD 2: Solve by Taking Square Roots

-

-

Example: $(x + 3)^2 = 16$	***Example: $x^2 - 12 = 0$***

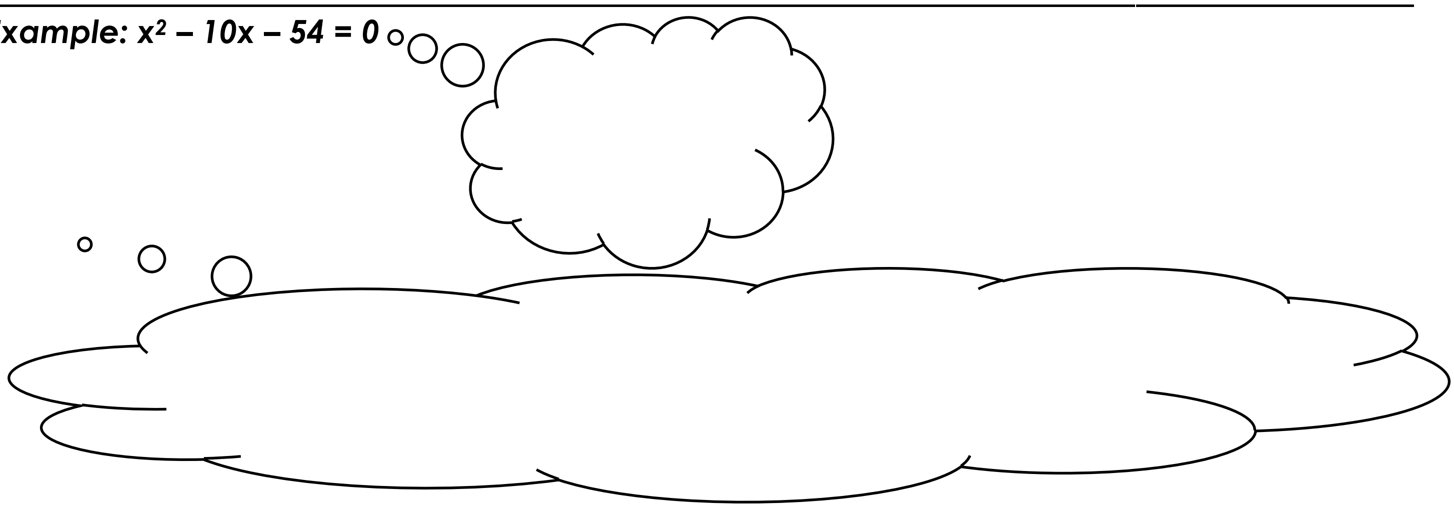
NEW: Method 3: Completing the Square

____

____

____

Example: $x^2 - 10x - 54 = 0$



METHOD 3: Completing the Square	
Algebra	Steps/explanation
$x^2 - 10x - 54 = 0$	

Practice!

Solve the following quadratic equation by using the completing the square method

$x^2 + 20x - 6 = 54$

Write the missing information in the squares and write the trinomial:

1)

5X	X^2
	5X

2)

7P	P^2
	7P

3)

12X	
X^2	12X

3)

13X	X^2
	13X

4)

P^2	2P
2P	

5)

4X	
X^2	4X

6)

	9A
9A	A^2

	10M
10M	M^2

9Y	
Y^2	9Y

10)

2Y	Y^2
	2Y

11)

T^2	3T
3T	

12)

15G	G^2
	15G

Question 1: What values would be placed in the boxes to create perfect square trinomials?

a. $x^2 - 16x + \square$ b. $m^2 + 3m + \square$ c. $q^2 - 20q + \square$

Solve by completing the square:

1) $a^2 + 2a - 3 = 0$

2) $a^2 - 2a - 8 = 0$

3) $p^2 + 16p - 22 = 0$

4) $k^2 + 8k + 12 = 0$

5) $r^2 + 2r - 33 = 0$

6) $a^2 - 2a - 48 = 0$

7) $m^2 - 12m + 26 = 0$

8) $x^2 + 12x + 20 = 0$

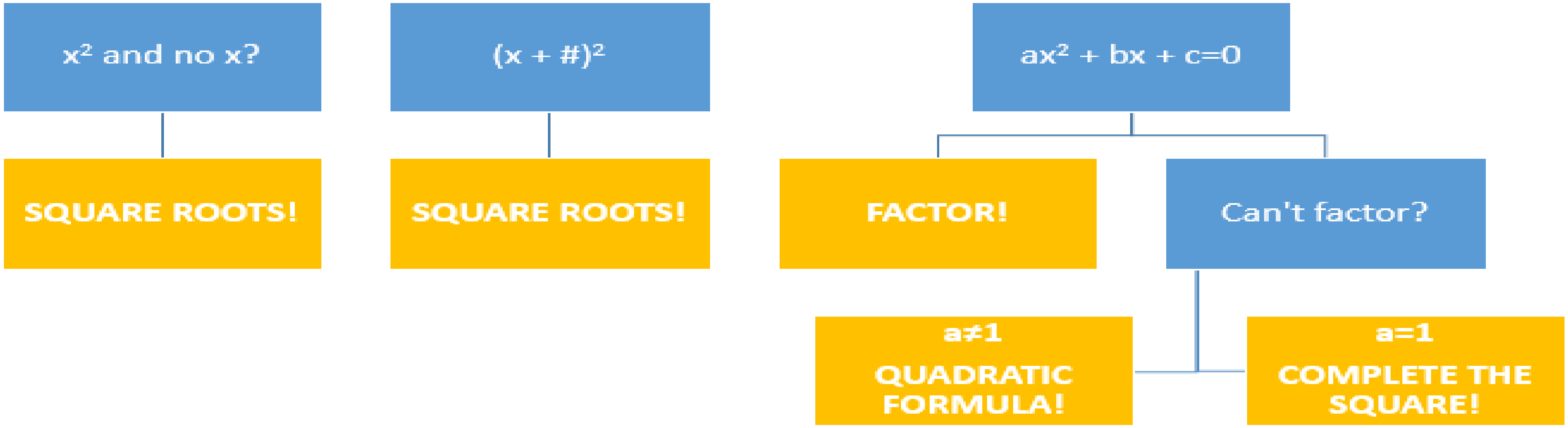
9) $k^2 - 8k - 48 = 0$

10) $p^2 + 2p - 63 = 0$

11) $m^2 + 2m - 48 = -6$

12) $p^2 - 8p + 21 = 6$

NOTES: The Quadratic Formula



Example: $-16x^2 + 256 = 0$	Method:	Example: $(x-4)^2 + 5 = 29$	Method:
Example: $x^2 - 10x + 24 = 0$	Method	Example: $x^2 - 10x - 26 = 0$	Method:

The Quadratic Formula: This magic formula will solve ANY QUADRATIC EQUATION. No. Matter. What. When in doubt of which method to use, *you can always use the quadratic formula*

The standard form of a quadratic equation is $ax^2 + bx + c$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Example 1: The radical will **NOT SIMPLIFY**	Example 2: The radical **WILL SIMPLIFY**	Example 3: The radical is a **PERFECT SQUARE!**
$3x^2 + 5x + 1 = 0$	$4x^2 + 4x - 14 = 0$	$3x^2 + 5x - 12 = 0$

Solve each equation with the quadratic formula.

1) $3r^2 + 12r - 11 = 0$

2) $12x^2 + 3x - 4 = 0$

3) $5n^2 - 8n - 85 = 0$

4) $4n^2 - 10n - 6 = 0$

5) $9b^2 + 12b - 9 = 0$

6) $7x^2 + x - 11 = 0$

Factoring *Mixed Review*

Part I: Greatest Common Factor (GCF)

13) $7x^4 - 14xy$	14) $3ab^2 - 6a^2b$	15) $5x^3 + 6xy$
16) $12x^7y - 4xy$	17) $81r^3s - 9$	18) $xyz + 3x^2y^2z^2$

Part II: Difference of Two Perfect Squares (DOTS)

19) $x^2 - 225$	20) $x^4 - 49$	21) $100 - x^6$	22) $16x^2 - 25$
23) $25x^8 - 144y^2$	24) $4b^2 - 169y^2$	25) $x^4 - y^2$	26) $x^2 + 49$

Part III: Factoring Trinomials

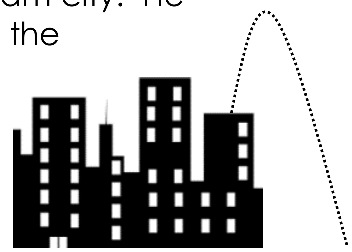
27) $y^2 + 6y + 5$	28) $x^2 - 9x + 20$	29) $x^2 + 7x + 12$
30) $m^2 - 2m - 15$	31) $x^2 + 6x + 8$	32) $x^2 + 9x - 36$

Part IV: Factoring Completely AND SOLVING

1) $4x^2 + 8 = 0$	2) $3x^2 - 48 = 0$	3) $2x^3 – 50x = 0$
4) $2x^3 – 2x^2 – 12x = 0$	5) $3x^2 – 18x = - 24$	6) $x^4 - 81 = 0$
7) $6x^2 + 30x + 36$	8) $y^5 + 4y^4 + 3y^3 = 0$	9) $3x^2 - 75 = 0$
10) $7m^6 - 7m^2 = 0$	11) $X^2 = 100$	12) $5x^3 + 55x^2 + 120x = 0$
13) $X^2 + 61 = 1 - 17$	14) $2X^2 + 7X = 42-X$	15) 2x3 – 50x

16) $12X^2 + 17X = 5$	17) $X^2 - 121 = 0$	18) $X^2 + 5X = 0$
19) $2X^2 + 128 = 32X$	20) $8X^2 - 2X = 15$	21) $9X^2 - 6 = 10$
22) $12X^2 - 26X - 7 = 3X + 1$	23) $3X^2 + 11^2 = 2X^2 + 22X$	24) $25X^2 = 20X - 4$

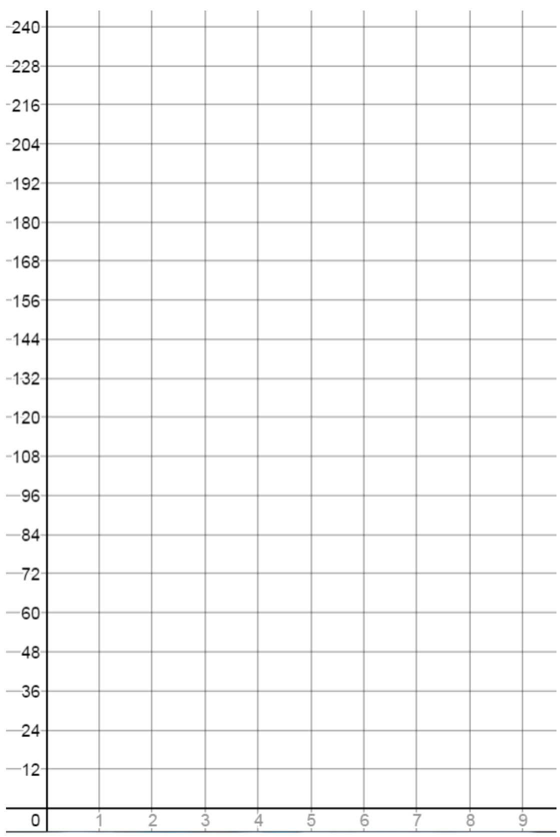
Batman is standing on stop of a building in Gotham city. He throws a batarang in an arc to hit a sewer lid on the ground. The path of the batarang can be modeled by the equation $\mathbf{d = -16t^2 + 96t + 100.}$



a. How tall is the building that Batman throws his batarang from?

b. What is the maximum height his batarang will reach and how long will it take for it to reach that height?

c. How many seconds will it take for the batarang to hit the sewer?



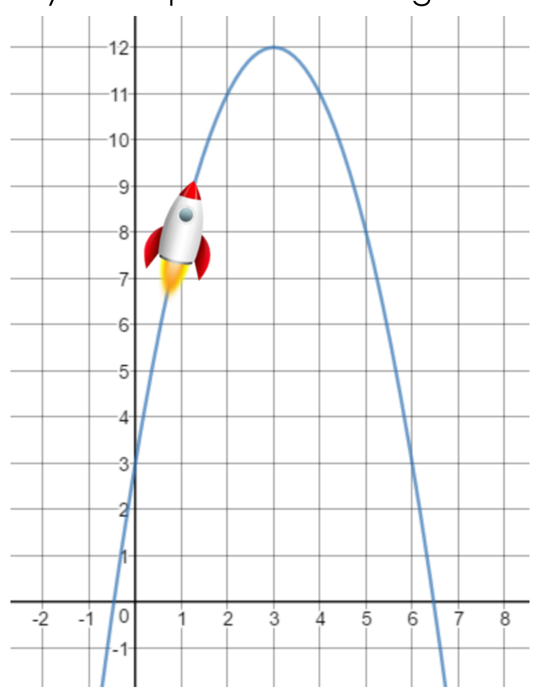
1) Lighting hit the top of a cell tower and knocked off the satellite dish. The satellite dish then crashed to the ground. The time it takes for the satellite to hit the ground can be modeled by the equation $h(x) = -16x^2 + 128$. How many seconds did it take for the satellite to hit the ground?

2) Elena is starting her own business selling custom sneakers and is going to the bank for a loan. In her business plan, she predicts the number of shoes she must sell per week to make a profit can be modeled by the equation $f(x) = x^2 - 12x - 45$

a) How many pairs of shoes must she sell per week to break even?

b) How many pairs of shoes must she sell per week to make $175 profit?

3) Below is a graph that models a rocket being shot from the top of a raised platform Where the x axis represents the time in seconds and the y-axis represents the height of the rocket



a) What is the height of the platform that the rocket is on?

b) What is the maximum height that the rocket reaches?

c) At what TIME does the rocket reach that height?

d) How long does it take for the rocket to hit the ground?