Name:_______________________________

Period: _____

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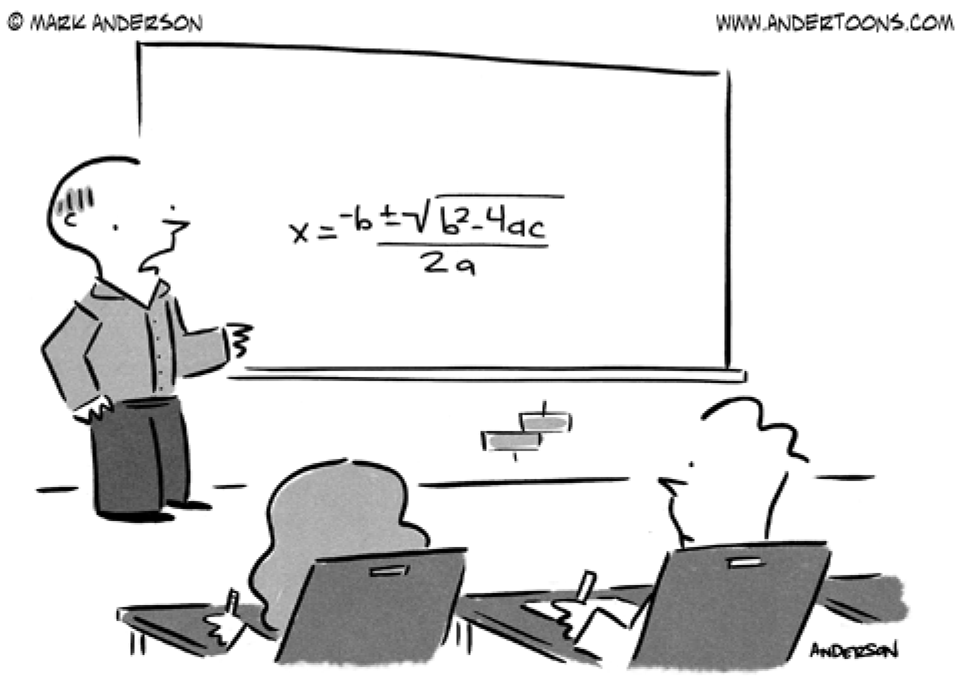
Unit 2
Modeling with Quadratics



"Trending or not, you still have to learn it."

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Common Core Standards

A.SSE.1 Interpret expressions that represent a quantity in terms of its context.«
a. Interpret parts of an expression, such as terms, factors, and coefficients.
b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $(1 + r)!$ as the product of *P* and a factor not depending on *P*.

A.SSE.2 Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$*, thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$.

A.APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

A.APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

A.CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A.REI.4 Solve Equations in One Variable b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

A.REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A.REI.11 Explain why the x--- coordinates of the points where the graphs of the *equations* $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

F.IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F.IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: *intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

F.IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. a. 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.

F.IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

Unit Description In this unit, students will continue their exploration of quadratic functions begun in Math I. Students will learn about the three different solution types for quadratic equations and how to determine what type of solution a quadratic equation has by analyzing the equation and the graph of the related function. Students will continue solving quadratic equations using inspection, square roots, and factoring. Students will be introduced to the quadratic formula and the concept of non-real solutions. Students will use the discriminant of the quadratic formula to determine the number of real solutions. Students will comprehend equivalent structures of quadratics through factoring in order to find the zeros of the graph. Students will continue to use the zeros and symmetry to find the value of the vertex of the graph, but also learn algebraic methods for finding the vertex. Students will also use quadratic functions and equations to solve real world problems, interpreting values in context.
Essential Questions **By the end of this unit, I will be able to answer the following questions:** • Evaluate which representations of a function are most useful for solving problems in different mathematical and real world settings. *Note: This statement does not have the same meaning in question format, so we left it the way it is.* • How are the key features identified, described, and interpreted from different representations of quadratic functions? • How are geometric transformations (translations, reflections, rotations, and dilations) of figures related to transformations of functions? Why is symmetry the key feature of a quadratic function and how is it revealed in the different forms of this function (graph, table, equation, and verbal)?

I can . . .

Operate with polynomials

- Determine whether an expression is a polynomial. (A-APR.1)
- Add and subtract polynomials.* (A-APR.1)
- Multiply up to three linear expressions.**

Solve quadratic equations and systems involving quadratic equations

- Create quadratic equations in one variable and use them to solve problems.
- Solve quadratic equations by inspection (e.g., $x^2 = 49$), taking square roots, the quadratic formula, and factoring.
  - Justify each step in solving a quadratic equation by factoring.
  - Use the discriminant to determine the number of real solutions of a quadratic equation and when a quadratic equation has non-real solutions.
  - Choose an appropriate solution method based on the initial form of the quadratic equation.
  - Construct a viable argument to justify a solution method.
- Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.
- Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x). Find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. (Note: Limit f(x) and g(x) to linear or quadratic functions.)
- Represent constraints by systems of linear-quadratic equations and/or inequalities based on a modeling context.
- Interpret solutions of linear-quadratic systems as viable or non-viable options in a modeling context.

Analyze quadratic functions using different representations

- Given a function in verbal, algebraic, table, or graph form, determine whether it is a quadratic function. (F-BF.1)
- Recognize equivalent forms of quadratic functions. For example, standard form $ax^2 + bx + c = 0$, and factored form $y = a(x - r_1)(x - r_2)$. (A-SSE.2)
- Identify the coefficients and constants of a quadratic function and interpret them in a contextual situation. (A-SSE.1a)
- Use the process of factoring to find the zeros of a quadratic function. (A-SSE.2; A-SSE.3)
- Find the vertex of a quadratic function algebraically and using technology.
- For a quadratic function that models a relationship between two quantities, I can interpret key features of the graph and table forms of the function in context. Key features include: intercepts; intervals where the function is increasing, decreasing, positive or negative; maximum or minimum, and symmetry.
- Construct a rough graph of a quadratic function using zeros, intercepts, the vertex and symmetry.
- Sketch the graph of a quadratic function that was graphed using technology, showing key features.
- Determine the appropriate viewing window and scale to reveal the key features of the graph of a quadratic function. (N-Q.1)
- Relate the domain of a quadratic function to its graph and, when given a context, to the quantitative relationship it describes.
- Identify the effect on the graph of a quadratic function f(x) in vertex form of replacing f(x) by f(x) + k, f(x + k) and k·f(x) for specific values of k (both positive and negative). Experiment with cases and illustrate an explanation of the effects on the graph using technology.
- Find the value of k given the graphs of a parent quadratic function and its transformation.

Use function notation

- Evaluate quadratic functions for inputs in their domains.
- Interpret statements that use function notation in terms of a context.

Build quadratic functions

Write a quadratic function that describes a relationship between two quantities. (F-BF.1)

<u>Vocabulary</u>: Define each word and give examples and notes that will help you remember the word/phrase.

Axis of Symmetry	
Example and Notes to help YOU remember:	
Discriminant	
Example and Notes to help YOU remember:	
Extrema	
Example and Notes to help YOU remember:	
Intercept Form of a Quadratic	
Example and Notes to help YOU remember:	
Maximum	
Example and Notes to help YOU remember:	
Minimum	
Example and Notes to help YOU remember:	

Parabola	
Example and Notes to help YOU remember:	
Quadratic Formula	
Example and Notes to help YOU remember:	
Quadratic Function	
Example and Notes to help YOU remember:	
Root of an Equation	
Example and Notes to help YOU remember:	
Standard Form of a Quadratic	
Example and Notes to help YOU remember:	
Vertex	
Example and Notes to help YOU remember:	

Vertex Form of a Quadratic	
Example and Notes to help YOU remember:	
X-Intercept	
Example and Notes to help YOU remember:	
Zeros of a Function	
Example and Notes to help YOU remember:	
Zero Product Property	
Example and Notes to help YOU remember:	
Example and Notes to help YOU remember:	
Example and Notes to help YOU remember:	

Solving Quadratics Algebraically Investigation : Factoring Review

Instructions: Today we will find the relationship between 2 **linear** binomials and their product which is a **quadratic** expression represented by the form $ax^2 + bx + c$. First we will generate data and the look for patterns.

Part I. Generate Data
Use the distributive property to multiply and then simplify the following binomials.

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

2. Where do you expect each of the above equations to "hit the ground"?

Chart II. Organize Data
Fill in the following chart by multiplying the factors

FACTORS	PRODUCT $ax^2 + bx + c$	a	b	c
$(x\underline{\underline{+3}})(x\underline{\underline{+5}})$				
$(x\underline{\underline{+4}})(x\underline{\underline{-2}})$				

Part III. Analyze Data
Answer the following questions given the chart you filled in above

1. Initially, what patterns do you see?

2. How is the value of "a" related to the factors you see in each problem?

3. How is the value of "b" related to the factors you see in each problem?

4. How is the value of "c" related to the factors you see in each problem?

Part IV: Application

Knowing this, fill out the values for a, b, and c in the following chart. Work backwards using your rules from part III to find 2 binomial factors for each product. Put these in the first column.

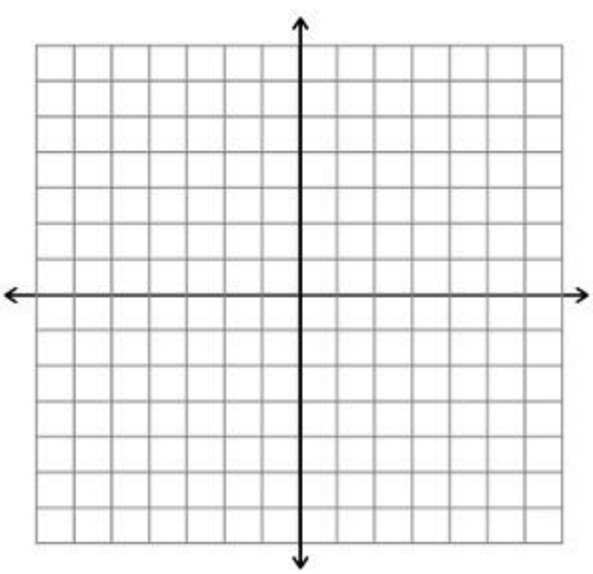
FACTORS	PRODUCT ax^2+bx+c	a	b	c	Hint: List factors of "c"
$(x+\underline{4})(x+\underline{\quad})$	x^2+6x+8				
	$x^2+7x+12$				
	$x^2+13x+12$				
	$x^2+3x-10$				
	$x^2-3x-10$				
	$x^2-15x+54$				

For each of the quadratics above, use your graphing calculator to inspect where the quadratic "hits the ground", or touches the x-axis.

1. What do you notice about the relationship between the factors and the x-intercepts?

2. Why is factoring a useful skill to learn?

3. Choose one of the quadratics above and create a rough sketch of the graph using all the information you know about quadratic equations.



PART V: Factoring Quadratics where $a \neq 1$

What if the problem has "a" value that is not equal to 1?

For example, $4x^2 + 8x + 3 = 0$:

How can we algebraically find where this graph = 0?
The concept of ***un-distributing*** is still the same!!

$$4x^2 + 8x + 3 = 0$$

In this case we need to find out what multiplies to give us $a \bullet c$ but adds to give us b.

Let's list all the factors of (4•3) or 12:

Which one of those sets of factors of 12 also add to give us the b value, 8? _______________

Rewrite the original equation using an equivalent structure:

$$4x^2 + 8x + 3 = 0$$

$$4x^2 + 6x + 2x + 3 = 0$$

Remember!! It doesn't matter which order you write the factors in!

$$(4x^2 + 6x)(+2x + 3) = 0$$

Group the first two and last two!

$$(4x^2 + 6x)(+2x + 3) = 0$$

Undistribute what is common to both terms

$$2x(2x + 3) + 1(2x + 3) = 0$$

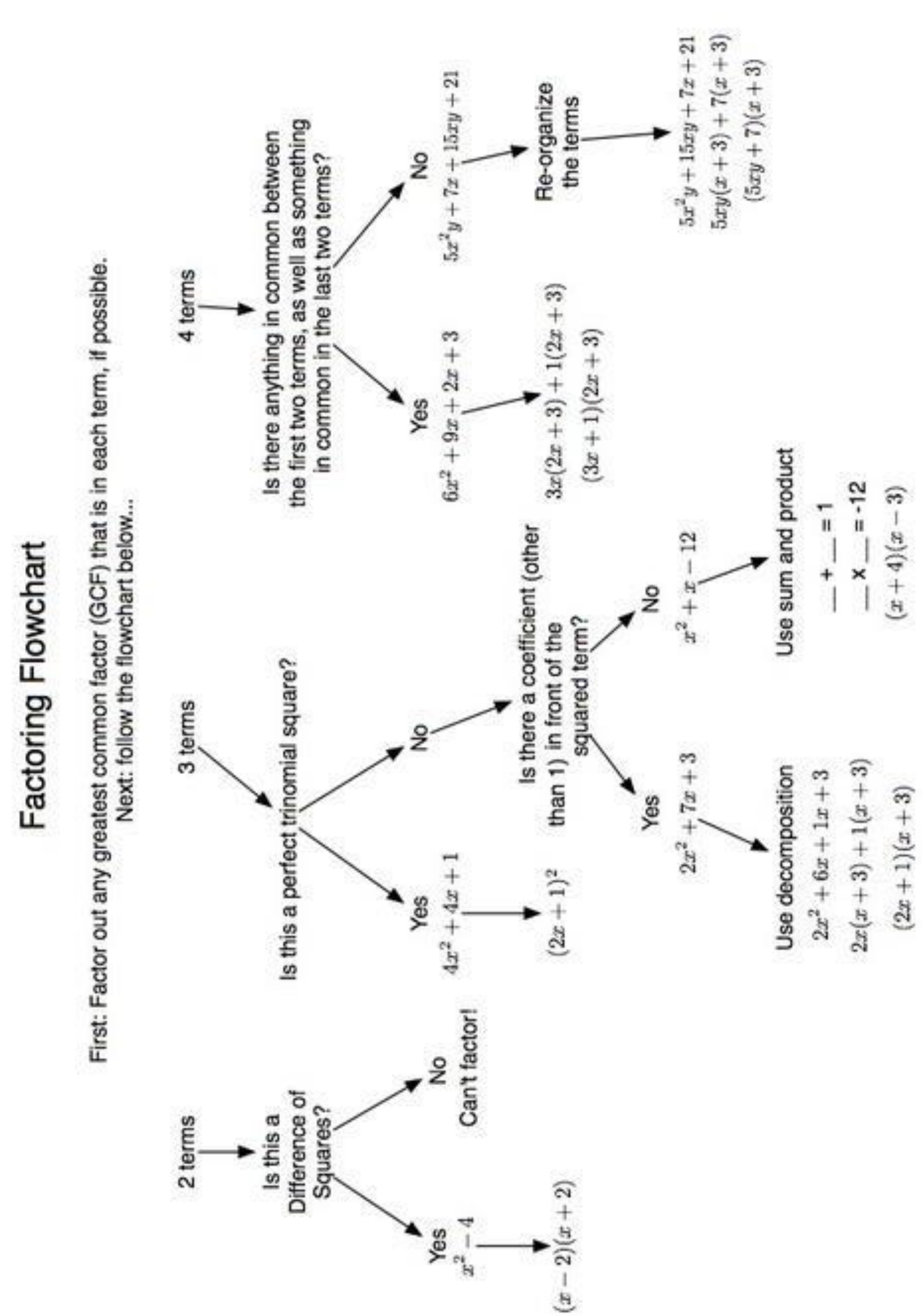
Create factors out of the repeated factor, and the undistributed factors

$$(2x + 1)(2x + 3) = 0$$

Check through multiplication (box, distribution, or FOIL) that it is equal!

Reverse Box Method of Factoring by Grouping

	ax^2	1st factor
	2nd factor	c


Factoring Flowchart
First: Factor out any greatest common factor (GCF) that is in each term, if possible.
Next: follow the flowchart below...
2 terms
Is this a Difference of Squares?
Yes
$x^2 - 4$
$(x-2)(x+2)$
No
Can't factor!
3 terms
Is this a perfect trinomial square?
Yes
$4x^2 + 4x + 1$
$(2x+1)^2$
No
Is there a coefficient (other than 1) in front of the squared term?
Yes
$2x^2 + 7x + 3$
Use decomposition
$2x^2 + 6x + 1x + 3$
$2x(x+3) + 1(x+3)$
$(2x+1)(x+3)$
No
$x^2 + x - 12$
Use sum and product
__ + __ = 1
__ x __ = -12
$(x+4)(x-3)$
4 terms
Is there anything in common between the first two terms, as well as something in common in the last two terms?
Yes
$6x^2 + 9x + 2x + 3$
$3x(2x+3) + 1(2x+3)$
$(3x+1)(2x+3)$
No
$5x^2y + 7x + 15xy + 21$
Re-organize the terms
$5x^2y + 15xy + 7x + 21$
$5xy(x+3) + 7(x+3)$
$(5xy+7)(x+3)$

HW Factoring (©Kuta Software – Infinite Algebra 2)

Factor each completely.

1) $x^2 - 7x - 18$

2) $p^2 - 5p - 14$

3) $m^2 - 9m + 8$

4) $x^2 - 16x + 63$

5) $7x^2 - 31x - 20$

6) $7k^2 + 9k$

7) $7x^2 - 45x - 28$

8) $2b^2 + 17b + 21$

9) $5p^2 - p - 18$

10) $28n^4 + 16n^3 - 80n^2$

11) $3b^3 - 5b^2 + 2b$

12) $7x^2 - 32x - 60$

13) $30n^2b - 87nb + 30b$

14) $9r^2 - 5r - 10$

15) $9p^2r + 73pr + 70r$

16) $9x^2 + 7x - 56$

17) $4x^3 + 43x^2 + 30x$

18) $10m^2 + 89m - 9$

Critical thinking questions:

19) For what values of b is the expression factorable?
$x^2 + bx + 12$

20) Name four values of b which make the expression factorable:
$x^2 - 3x + b$

What did Mrs. Zling say when Mr. Zling said he was going mountain climbing in the Himalayas?

Factor each trinomial below. Find both factors in the rectangle below and cross out each box containing a factor. You will cross out two boxes for each exercise. When you finish, print the letters from the remaining boxes in the squares at the bottom of the page.

1. $6x^2 + 19x + 3$
2. $5x^2 - 9x - 2$
3. $9x^2 + 15x + 4$
4. $7x^2 + x - 8$
5. $2x^2 - 21x + 40$
6. $15m^2 + 19m + 6$
7. $8m^2 - 5m - 3$
8. $4m^2 - 17m + 18$
9. $14m^2 + 17m - 22$
10. $3m^2 - m - 30$

TH $(4m - 9)$	AT $(3x + 1)$	PA $(m - 2)$	DO $(m - 3)$	NE $(2x - 5)$	XT $(3m - 10)$	CK $(14m - 11)$	YO $(2m - 3)$	UR $(5x + 1)$
UP $(6x + 1)$	UW $(15m + 1)$	IN $(x + 3)$	PL $(m + 2)$	AN $(x + 4)$	DA $(5m + 3)$	RE $(x - 2)$	MA $(3m + 2)$	TT $(9x + 2)$
CO $(7x + 8)$	LD $(3x + 4)$	IB $(7x + 2)$	ER $(8m + 3)$	AJ $(m + 3)$	ET $(7m + 2)$	ON $(x - 8)$	HI $(m - 1)$	GH $(x - 1)$

Quadratic Word Problems using factoring to solve

Annotating Math Word Problems - CUBES

Just like in Language Arts, we sometimes need to annotate problems to better understand them.

C – Circle important numbers
U – Underline important words
B – Box what the problem is asking you to solve
E – Equation
S – Solve

There are several standard types: problems where the formula is given, falling object problems, problems involving geometric shapes. Just to name a few. There are many other types of application problems that use quadratic equations, however, we will concentrate on these types to simplify the matter.

We must be very careful when solving these problems since sometimes we want the maximum or minimum of the quadratic, and sometimes we simply want to solve or evaluate the quadratic.

ZERO PRODUCT PROPERTY

If the _________ of two expressions is zero, then _______ or _______ of the expressions equals zero.

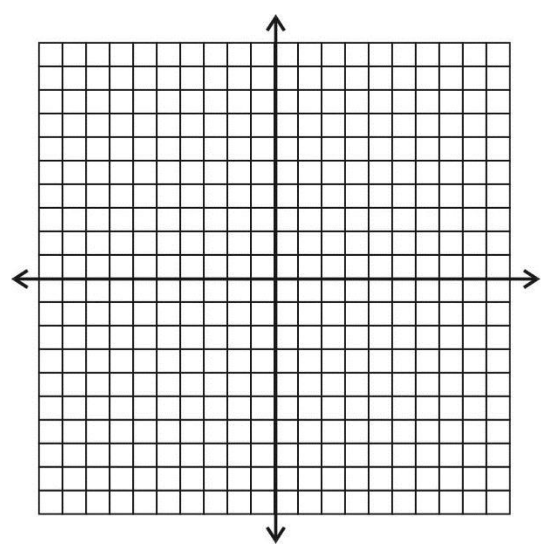
Algebra If ***A*** and ***B*** are expressions and ***AB*** = ____ , then ***A*** = _____ or ***B*** = __.

Example If $(x + 5)(x + 2) = 0$, then $x + 5 = 0$ or $x + 2 = 0$. That is, x = __________ or x = _________.

Example:

$$X^2 - 2x - 8 = 0$$

x	y
-3	
-2	
0	
1	
4	
5	

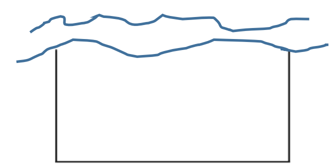


Word Problem Examples

1. Eight more than the square of a number is the same as 6 times the number. Find the number.

2. A 4 m by 6 m rug covers half of the floor area of a room and leaves a uniform strip of bare floor around the edges. What are the dimensions of the room?

3. One hundred feet of fencing is available to enclose a rectangular yard along side of the St. John's River, which is one side of the rectangle as shown. What dimensions will produce an area of 800 ft^2 ?



4. The perimeter of a rectangle is 50 ft. The area is 100 ft^2. What are the dimensions of the rectangle?

5. A company sells team photos for $10 each, and the coaches find that they sell on average 30 photographs per team. The coaches do a survey and find out for each reduction in price of $0.50, an additional two photographs will be sold. At what price will the revenue from the photographs be $150.

6. The current price of an amateur theater ticket is $10, and the venue typically sells 50 tickets. A survey found that for each $1 increase in ticket price, 2 fewer tickets are sold? When will the revenue equal $300.

HW Factoring Word Problems

1. The altitude of a triangle is 5 less than its base. The area of the triangle is 42 square inches. Find its base and altitude.

2. The length of a rectangle is 7 units more than its width. If the width is doubled and the length is increased by 2, the area is increased by 42 square units. Find the dimensions of the original rectangle.

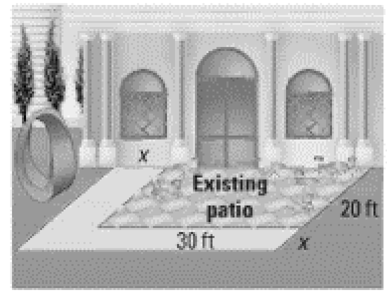
3. The ages of three family children can be expressed as consecutive integers. The square of the age of the youngest child is 4 more than eight times the age of the oldest child. Find the ages of the three children.

4. In a trapezoid, the smaller base is 3 more than the height, the larger base is 5 less than 3 times the height, and the area of the trapezoid is 45 square centimeters. Find, in centimeters, the height of the trapezoid.

5. A rectangular garden has a perimeter of 140m and an area of 1200m2. Find the dimensions of the garden.

6. Paul wants to build a dog run in his backyard using the side of the house as one side of the run. He has 80 feet of fencing. How big will the run be if the area is 600 square feet?

7. A museum has a café with a rectangular patio. The museum wants to add 464 square feet to the area of the patio by expanding the existing patio as shown.
   a.) Find the area of the existing patio.
   b.) Write an equation that you can use to find the value of *x*.
   c.) Solve the equation. By what distance *x* should the length and the width of the patio be expanded?



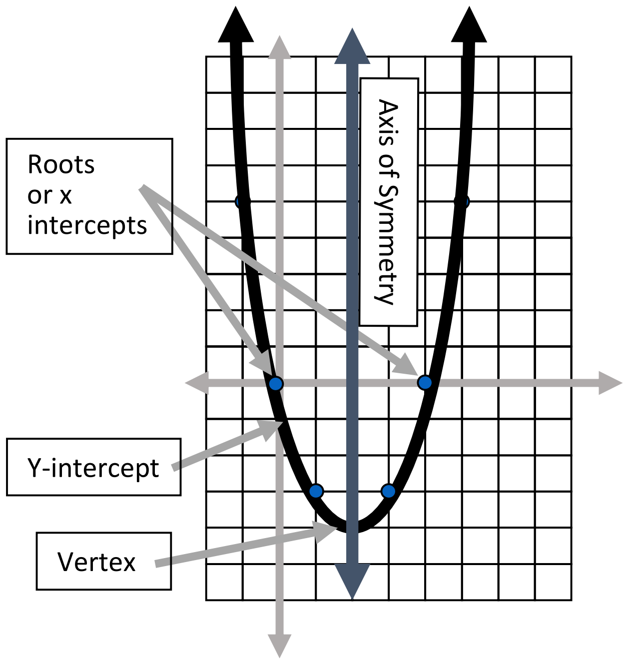
8. At last year's school fair, an 18 foot by 15 foot rectangular section of land was roped off for a dunking booth. The length and width of the section will each by increased by x feet for this year's fair in order to triple the original area. Write and solve an equation to find the value of x. What is the length of rope needed to enclose the new section?

9. A rectangular deck for a recreation center is 21 feet long by 20 feet wide. Its area is to be halved by subtracting the same distance x from the length and the width. Write and solve an equation to find the value of x. What are the deck's new dimensions?

10. A square garden has sides that are 10 feet long. A gardener wants to double the area of the garden by adding the same distance x to the length and the width. Write an equation that x must satisfy. Can you solve the equation you wrote by factoring? Explain why or why not.

Properties of Parabola

- A ____________________ is a function that can be written in the Standard Form of $y = ax^2 + bx + c$ where a, b, and c are real numbers and a ≠ 0. Ex: $y = 5x^2$ $y = -2x^2 + 7$ $y = x^2 - x - 3$
- The domain of a quadratic function is ____________________.
- The graph of a quadratic function is a U-shaped curve called a ________________.
- All parabolas have a _______________, the lowest or highest point on the graph (depending upon whether it opens up or down).
- The _______________ _______ ______________________ is an imaginary line which goes through the vertex and about which the parabola is symmetric.



__Characteristics of the Graph of a Quadratic Function:__ $y = ax^2 + bx + c$

- **Direction of Opening:** When $a > 0$, the parabola opens ________:

  When $a < 0$, the parabola opens ________:
- **Stretch:** When $|a| > 1$, the parabola is vertically ________________.

  When $|a| < 1$, the parabola is vertically ________________.
- **Axis of symmetry:** This is a vertical line passing through the vertex. Its equation is ______________.
- **Vertex:** The highest or lowest point of the parabola is called the vertex, which is on the axis of symmetry.

  To find the vertex, plug in $x = \frac{-b}{2a}$ and solve for *y*. This yields a point (________, __________)
- ***x*-intercepts:** are the 0, 1, or 2 points where the parabola crosses the *x*-axis. Plug in *y* = 0 and solve for *x*.
- ***y*-intercept:** is the point where the parabola crosses the *y*-axis. Plug in *x* = 0 and solve for y: y = c.

Without graphing the quadratic functions, complete the requested information:

1.) $f(x) = 3x^2 - 7x + 1$

What is the direction of opening? ________
Is the vertex a max or min? ________
Compare to $y = x^2$? ___________

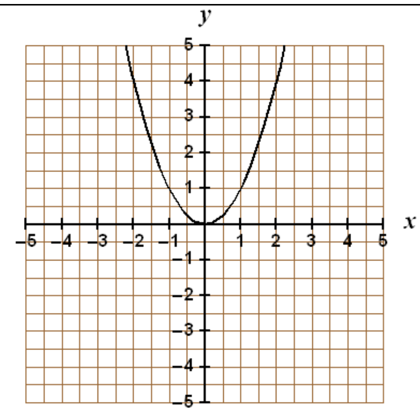
2.) $g(x) = -\frac{5}{4}x^2 + x - 3$

What is the direction of opening? ________
Is the vertex a max or min? ________
Compared to $y = x^2$? ___________

3.) The parabola $y = x^2$ is graphed to the right.

Note its vertex (___, ___) and its width.

You will be asked to compare other parabolas to this graph.

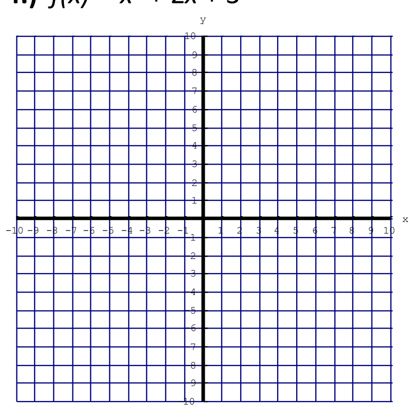


Graphing in STANDARD FORM ($y = ax^2 + bx + c$): we need to find the vertex first.

Vertex	**Graphing**
- list a =____, b =____, c =____ - find x = $\frac{-b}{2a}$ - plug this x-value into the function (table) - this point (___, ___) is the vertex of the parabola	- put the vertex you found in the center of your x-y chart. - choose 2 x-values less than and 2 x-values more than your vertex. - plug in these x values to get 4 more points. - graph all 5 points

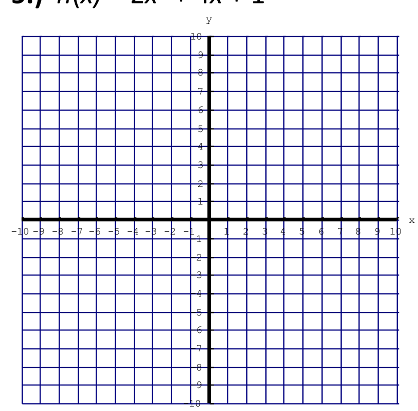
Find the vertex of each parabola. Graph the function and find the requested information

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



Vertex: ________
Max or min? ________
Direction of opening? ________
Axis of symmetry: _________
Compare to the graph of $y = x^2$?________________

5.) $h(x) = 2x^2 + 4x + 1$



Vertex: ________
Max or min? ________
Direction of opening? ________
Axis of symmetry: _________
Compare to the graph of $y = x^2$?_______________

Common Core Math 2 Unit 2 **Modeling with Quadratics**

HW Properties of Parabolas (©Kuta Software – Infinite Algebra 2)

Identify the vertex of each.

1) $y = x^2 + 16x + 64$

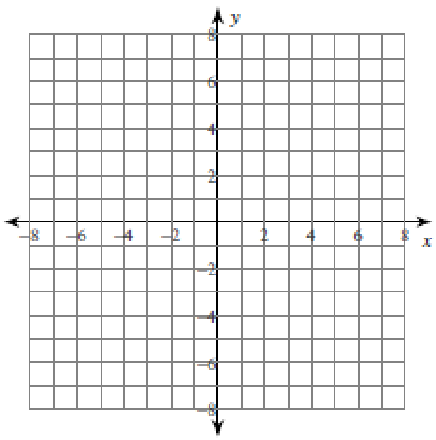
2) $y = 2x^2 - 4x - 2$

3) $y = -x^2 + 18x - 75$

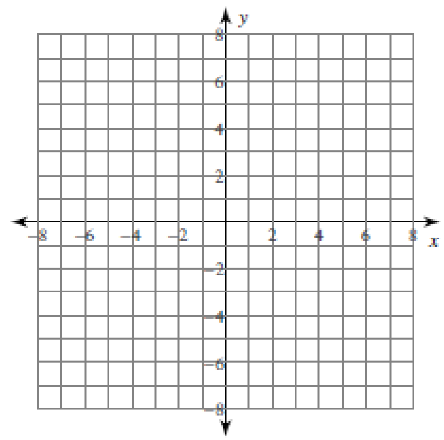
4) $y = -3x^2 + 12x - 10$

Graph each equation.

5) $y = x^2 - 2x - 3$

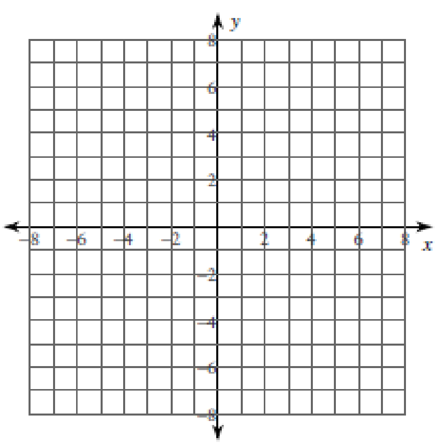


6) $y = -x^2 - 6x - 10$

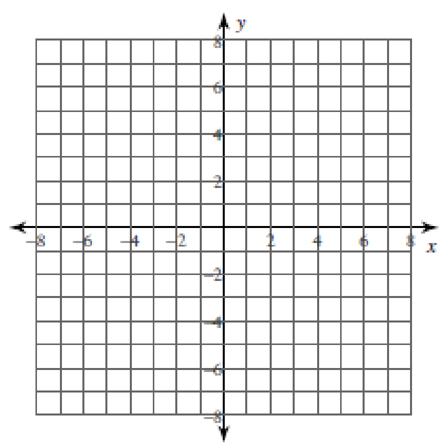


Identify the min/max value of each. Then sketch the graph.

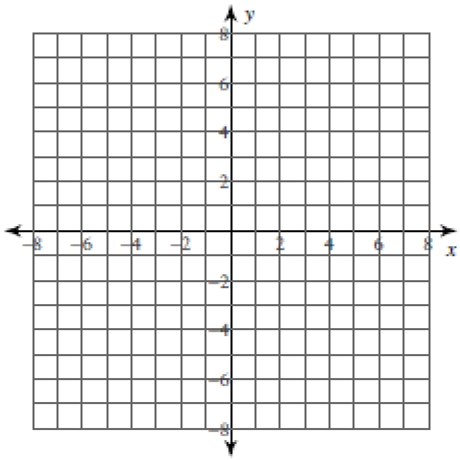
7) $f(x) = -x^2 + 8x - 20$



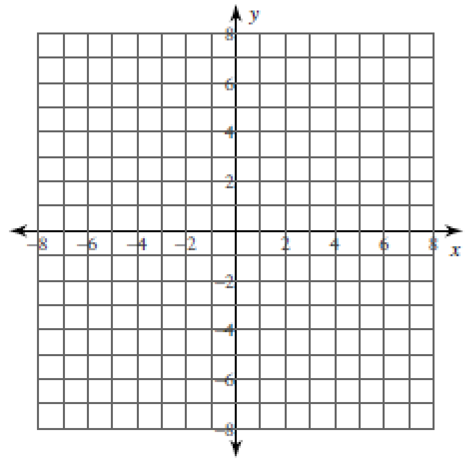
8) $f(x) = -\frac{1}{3}x^2 + \frac{4}{3}x - \frac{16}{3}$



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



10) $f(x) = -x^2 - 10x - 30$



Identify the vertex, axis of symmetry, and min/max value of each. Compare the shape to $y = x^2$.

11) $f(x) = 3x^2 - 54x + 241$

12) $f(x) = x^2 - 18x + 86$

13) $f(x) = -\frac{4}{5}x^2 + \frac{48}{5}x - \frac{114}{5}$

14) $f(x) = -2x^2 - 20x - 46$

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

16) $f(x) = x^2 - 12x + 44$

17) $f(x) = \frac{1}{4}x^2 - x + 9$

18) $f(x) = x^2 + 4x + 5$

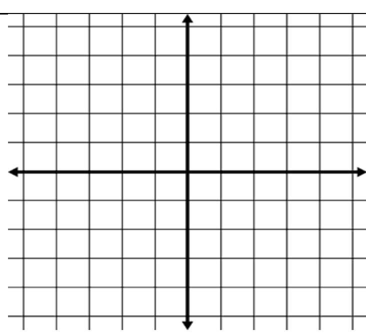
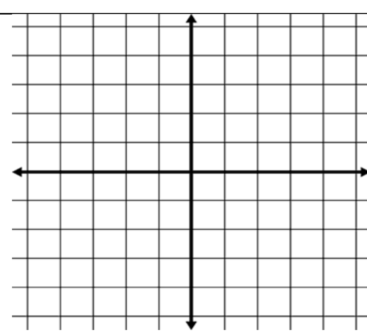
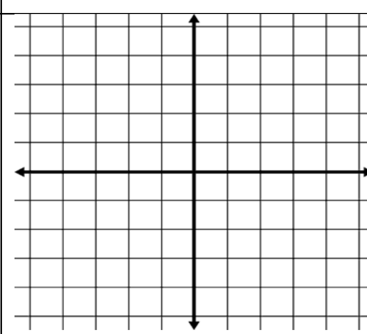
<u>Vertex Form</u>

Vertex form of the quadratic is

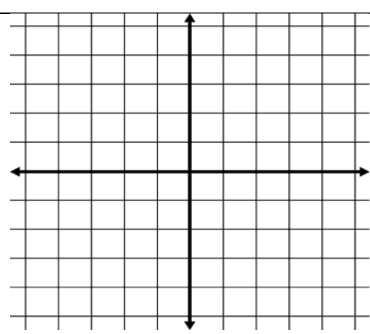
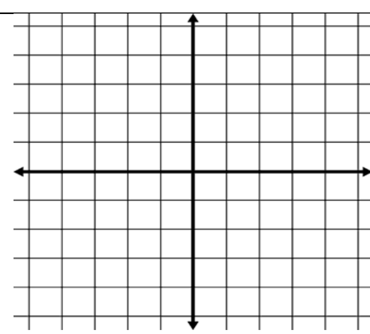
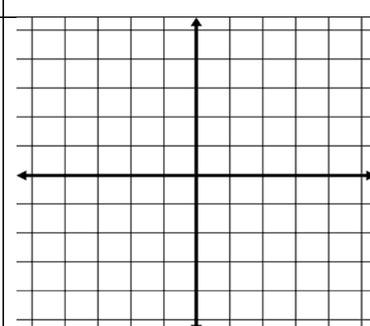
where (h, k) is the horizontal and vertical shift of the vertex of the parent function $y = x^2$.

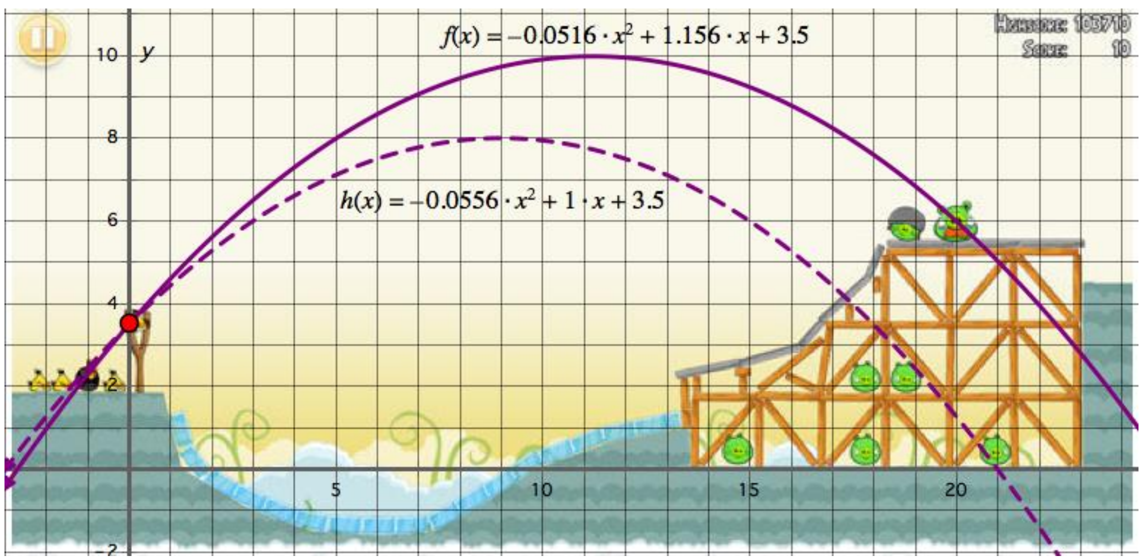
The value of "a" will determine the _____________ the parabola will open and the vertical

____________________ or __________________.

	1. $y = (x - 2)^2 - 1$	**2.** $y = -(x-1)^2 + 1$	**3.** $y = 2(x + 2)^2 - 2$
Standard Form			
Factored Form			
Solutions			
Y-Intercepts			
Axis of Symmetry			
Vertex			
Max/Min			
Graph			

Standard and Vertex form HW

	1. $y = (x+6)^2 - 4$	**2.** $y = 2(x-2)^2 - 2$	**3.** $y = -3(x+2)^2 + 3$
Standard Form			
Factored Form			
Solutions			
Y-Intercepts			
Axis of Symmetry			
Vertex			
Max/Min			
Graph			



Round 1: Projectiles and Parabolas

Look at the two trajectories above.

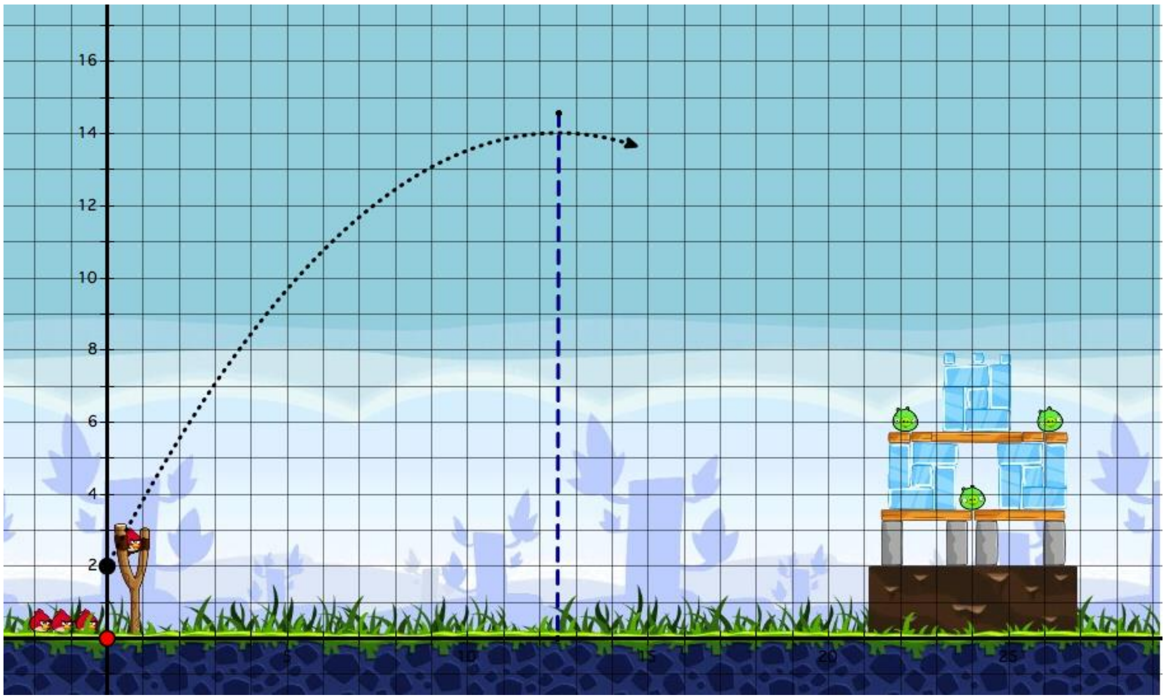
1. What is the same about the two equations?

2. What does the y-intercept represent? What part of the equation gives you the y-intercept?

3. What do the x-intercepts represent?

4. The highest part of the bird's flight is represented by what part of the parabola?

5. How far does Angry Bird fly in h(x)? How high does he go? How far away from the catapult is he when he is at his highest? When he is 15 feet away, how high is he flying?



Round 2

1. When Angry Bird is 9 feet away, how high is he flying?

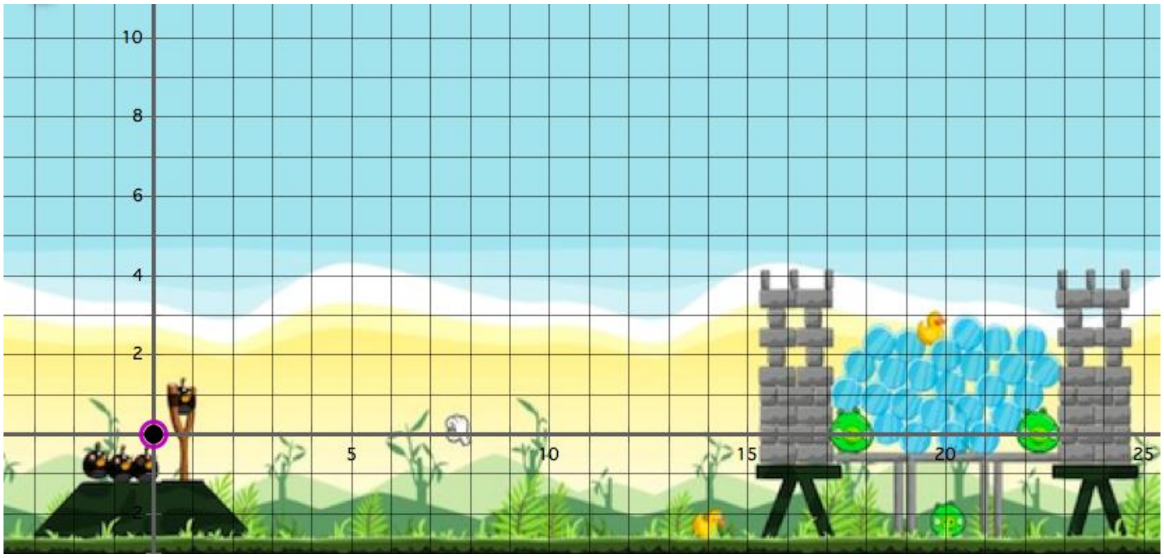
2. The axis of symmetry is provided. What part of the parabola does this pass through? What does this part represent about Angry Bird's flight?

3. How high does the bird fly?

4. Reflect points over the axis of symmetry to complete the parabola. Do you hit any pigs?

5. How far would Angry Bird fly if he did not hit any obstacles?

6. Without solving for the whole equation, what is "c" value in standard form? Is "a" positive or negative?



Round 3

1. Angry bird and hungry pig are 18 feet away from each other. If angry bird and hungry pig are at the same height (y-value) when angry bird is catapulted, at what distance away is Angry Bird the highest? Think about symmetry.

2. Angry Bird wants to hit the pig on the right. The equation representing his flight is:

$$y = -.083x^2 + 1.82x + 0$$

Using the picture, what is the y-intercept?

Using the picture, what are the x-intercepts?

Where is the axis of symmetry? You may use the picture to visualize, but show your algebraic work using: $x = \frac{-b}{2a}$ Round to the nearest integer.

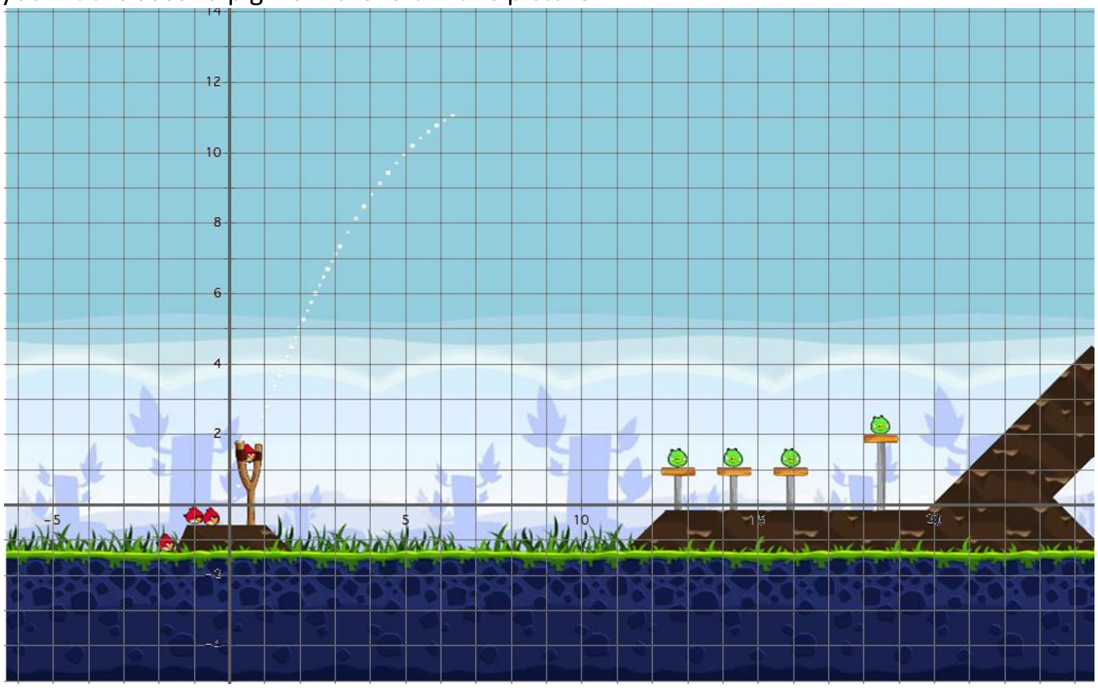
How high does Angry Bird fly (rounded to the nearest integer)?

Sketch the graph of Angry Bird's flight.

ANGRY BIRDS DAY!!!

Question: Can you make the bird hit the pigs?

Take a minute to work in small groups with the people around you. Sketch a graph that you think would make you hit the second pig from the left in this picture.

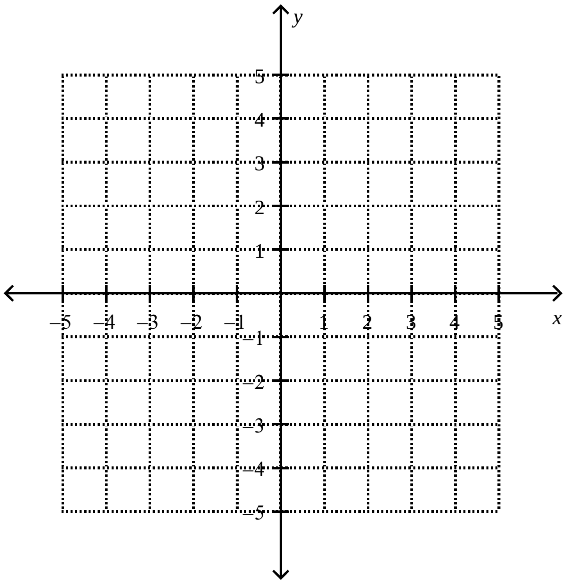


What do you think the equation to your graph would be?

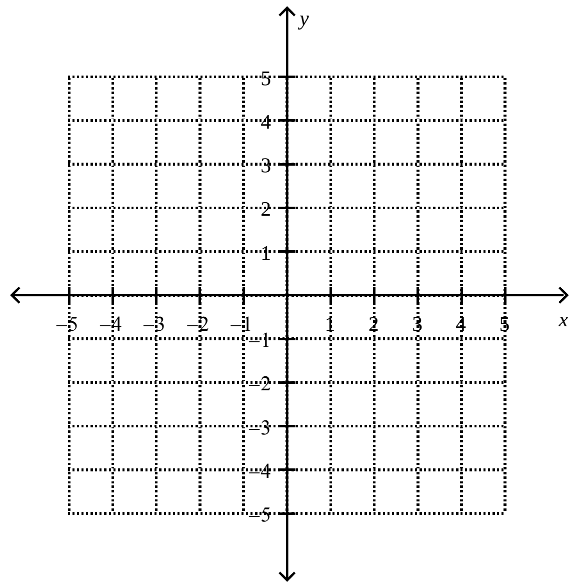
Properties of Quadratics 2

Directions: Graph the function over the given domain. Identify the intercepts, zeroes, axis of symmetry, extrema (maximum/minimum - vertex).

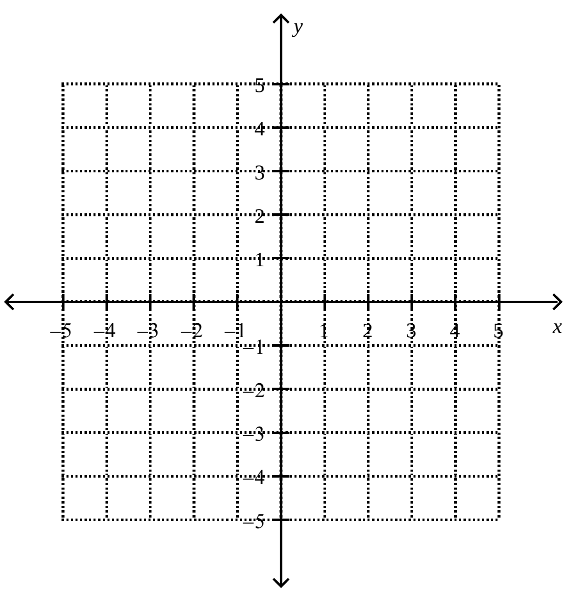
1. $f(x) = x^2 - 2x + 1; \{-\infty \leq x \leq \infty\}$



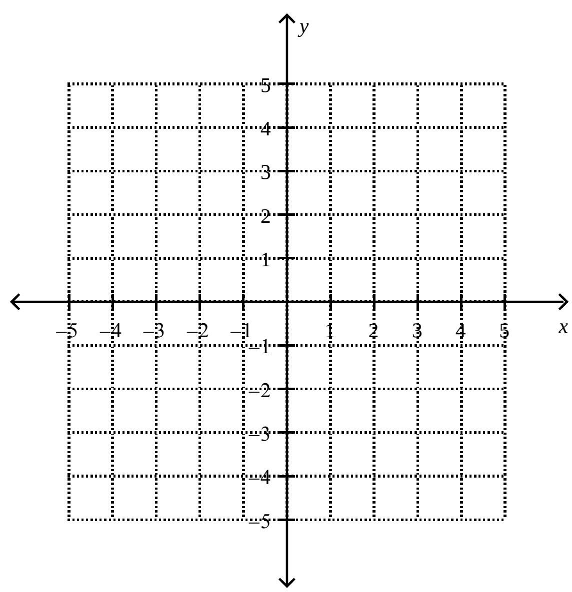
2. $g(x) = -x^2 + 1; \{-2 \leq x < 2\}$



3. $y = \frac{1}{2}x^2 + 1; \{x \geq -2\}$



4. $h(x) = x^2 + 6x + 5; \{-\infty \leq x < 0\}$

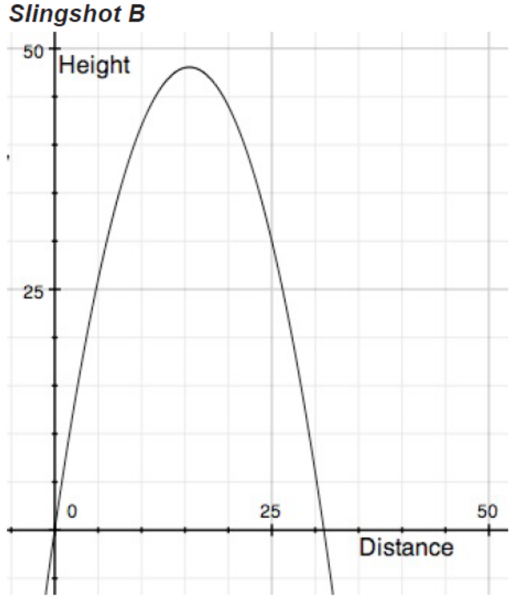


Suppose some very “Angry Birds” are attacking some “pigs” in a castle by using a slingshot to launch themselves at castle walls. Depending on the angle that they are launched at, they will either shoot long and far or high or short. The data about how each slingshot launches each bird is listed below:

Slingshot A

Distance the bird is from the slingshot (in meters)	Height of the bird (in meters)
10	20
20	30
30	30
40	20

Slingshot B



Slingshot C

$$y = -0.015x^2 + 0.975x$$

Where x is the distance the bird is from the slingshot and y is the height of the bird.

1. How “far” will each slingshot launch each bird? If the castle is far away, which slingshot should they use and why? If the castle is near, which slingshot should they use and why?

2. Analyze the slingshot data and compare to determine which slingshot shoots the birds the highest. Explain how you know.

3. If the castle walls are 30 feet tall, which slingshot should you use and why?

4. What are the pros and cons of using each Slingshot A, B, or C?

Common Core Math 2 Unit 2 **Modeling with Quadratics**

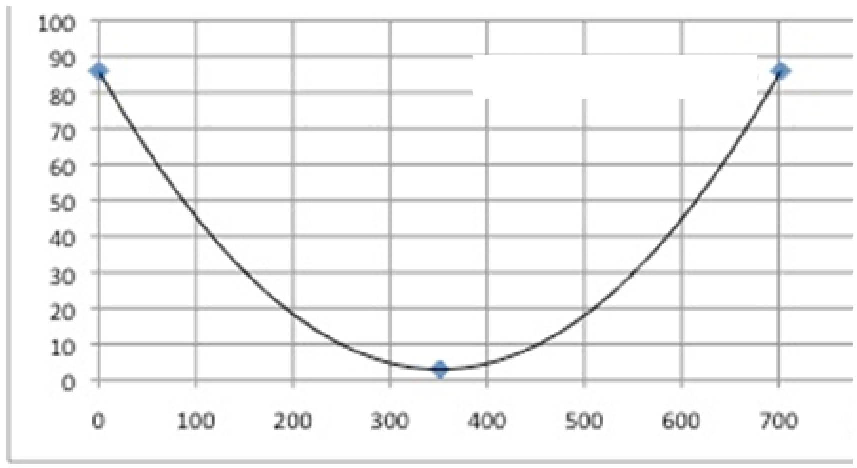
HW Comparison of Maximums/Minimums Practice

1. Three surveyors are having a discussion about bridges in New York City. The first surveyor collected data from the Verrazano Bridge, he measured the height of the cable as he drove from one end to the other. The second surveyor took a picture of the cable for the Brooklyn Bridge. The last surveyor came up with an equation to model the cable height of the Tappan Zee bridge.

Verrazano Bridge

Horizontal Distance (x)	Height of Cable (y)
0	160
100	114.4
200	77.6
300	49.6
400	30.4
500	20

Brooklyn Bridge



Tappan Zee Bridge

$$y = .00025x^2 - .2x + 100$$

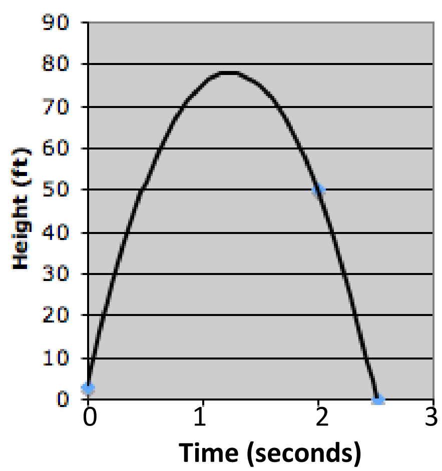
a. Using the information, determine the length of each bridge to decide which one is longest and shortest.

b. Which bridge's cable gets the closest to the road? How do you know this?

c. Analyze the data to determine which bridge a trucker should use if their truck's height is 15 ft. How did you come to this conclusion? Which bridge should he avoid and why?

2. The baseball team has decided to have a throwing contest. Below is the data for 3 different players.

<u>Joe</u>



<u>Michael</u>

$$y = -16x^2 + 50x + 5$$

<u>Henry</u>

Time (x)	Height (y)
.5	37.5
1	63
2	90
3	85

a. Whose ball was in the air the longest?

b. Who threw their ball the highest?

Quadratic Formula

Write the Quadratic Formula

The quadratic formula can ________________ be used to find the roots of a quadratic equation.

Examples:

$x^2 - 7x + 10 = 0$	$x^2 - x - 8 = 0$
$-x^2 - 3x + 10 = 0$	$2x^2 - 12x + 18 = 0$
$13 - 6x + x^2 = 0$	$-x^2 - 4x - 2 = 0$

Solve each equation with the quadratic formula.

1) $3n^2 - 5n - 8 = 0$

2) $x^2 + 10x + 21 = 0$

3) $10x^2 - 9x + 6 = 0$

4) $p^2 - 9 = 0$

5) $6x^2 - 12x + 1 = 0$

6) $6n^2 - 11 = 0$

7) $2n^2 + 5n - 9 = 0$

8) $3x^2 - 6x - 23 = 0$

9) $6k^2 + 12k - 15 = -10$

10) $8x^2 - 14 = -11$

11) $6k^2 + 2k + 9 = -3$

12) $12p^2 + 9p - 30 = -10$

13) $3x^2 = -7x + 136$

14) $3n^2 = -n + 14$

15) $6v^2 + 3 = -2v$

16) $9p^2 - 7 = 9p$

17) $11k^2 + 4k - 52 = 10k^2 - 7$

18) $-4a^2 + 18a - 15 = -7a^2 + 9a$

19) $-4n(n - 2) = 6(n + 3) - 11n^2$

20) $x(x - 3) = -7 - 10x$

Investigating the Discriminant

Type 1

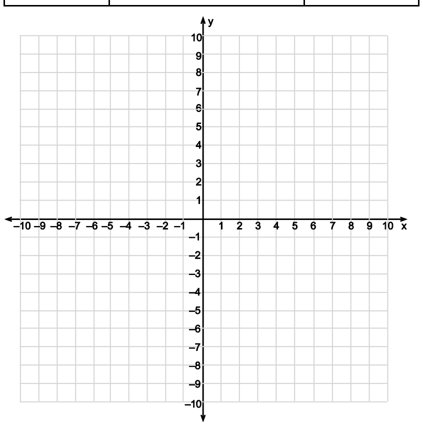
For this investigation you will be using the quadratic function **$y = x^2 + 2x + 3$** and the corresponding quadratic equation **$x^2 + 2x + 3 = 0$**.

1. Write the values for *a*, *b*, and *c*.

2. Use the quadratic formula to solve the quadratic equation.

3. Fill in the table of values below and then graph the quadratic function. (Find your vertex first.)

x	$y = x^2 + 2x + 3$	(x, y)



4. How many x-intercepts are there?

5. Does your graphical solution correspond to your algebraic solution (quadratic formula)?

Type 2

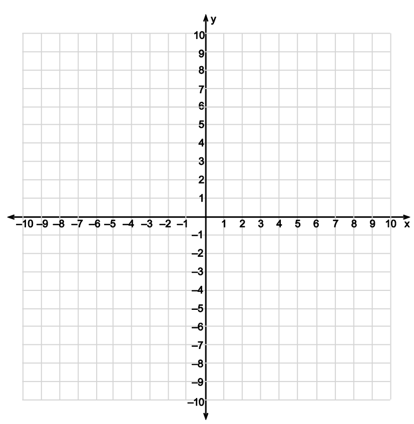
For this investigation you will be using the quadratic function **$y = x^2 – 2x + 1$** and the corresponding quadratic equation **$x^2 – 2x + 1 = 0$**.

1. Write the values for a, b, and c.

2. Use the quadratic formula to solve the quadratic equation.

3. Fill in the table of values below and then graph the quadratic function. (Find your vertex first.)

x	$y = x^2 – 2x + 1$	(x, y)



4. How many x-intercepts are there?

5. Does your graphical solution correspond to your algebraic solution (quadratic formula)?

Type 3

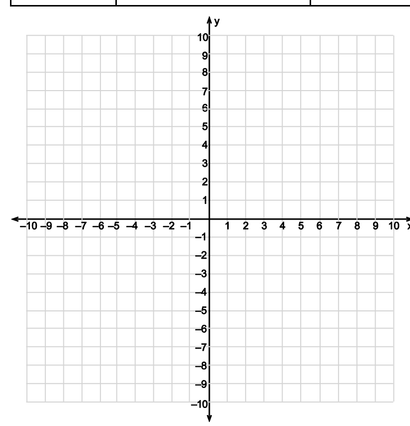
For this investigation you will be using the quadratic function **$y = x^2 – 2x – 3$** and the corresponding quadratic equation **$x^2 – 2x – 3 = 0$**.

1. Write the values for a, b, and c.

2. Use the quadratic formula to solve the quadratic equation.

3. Fill in the table of values below and then graph the quadratic function. (Find your vertex first.)

x	$y = x^2 – 2x – 3$	(x, y)



4. How many x-intercepts are there?

5. Does your graphical solution correspond to your algebraic solution (quadratic formula)?

EVERYTHING I NEED TO KNOW ABOUT QUADRATICS

Fill in the following chart based on what you need to know about quadratics

Value of the discriminant ($b^2 - 4ac$)	Number and type of roots	What does the graph look like?
$b^2 - 4ac$ is positive and a **perfect square** $b^2 - 4ac > 0$		
$b^2 - 4ac$ is positive and a **NOT perfect square** $b^2 - 4ac > 0$		
$b^2 - 4ac = 0$		
$b^2 - 4ac$ is negative $b^2 - 4ac < 0$		

Summary:

What method of solving quadratics will ALWAYS give you an answer?

How do you know when to use square roots to solve?

What are 2 other terms for the x – intercepts of a quadratic function?

Discriminant HW (©Kuta Software – Infinite Algebra 2)

Find the value of the discriminant of each quadratic equation.

1) $6p^2 - 2p - 3 = 0$

2) $-2x^2 - x - 1 = 0$

3) $-4m^2 - 4m + 5 = 0$

4) $5b^2 + b - 2 = 0$

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

6) $2p^2 + 5p - 4 = 0$

Find the discriminant of each quadratic equation then state the numberof real and imaginary solutions.

7) $9n^2 - 3n - 8 = -10$

8) $-2x^2 - 8x - 14 = -6$

9) $9m^2 + 6m + 6 = 5$

10) $4a^2 = 8a - 4$

11) $-9b^2 = -8b + 8$

12) $-x^2 - 9 = 6x$

13) $-4r^2 - 4r = 6$

14) $8b^2 - 6b + 3 = 5b^2$

Find the discriminant then state the number of rational, irrational, and imaginary solutions.

15) $-6x^2 - 6 = -7x - 9$

16) $4k^2 + 5k + 4 = -3k$

17) $-7n^2 + 16n = 8n$

18) $2x^2 = 10x + 5$

19) $-10n^2 - 3n - 9 = -2n$

20) $-9r^2 - 8r - 1 = r - r^2 - 9$

21) $-3p^2 + 10p + 5 = -8p^2$

22) $m^2 + 5m = 2m^2$

Critical thinking questions:

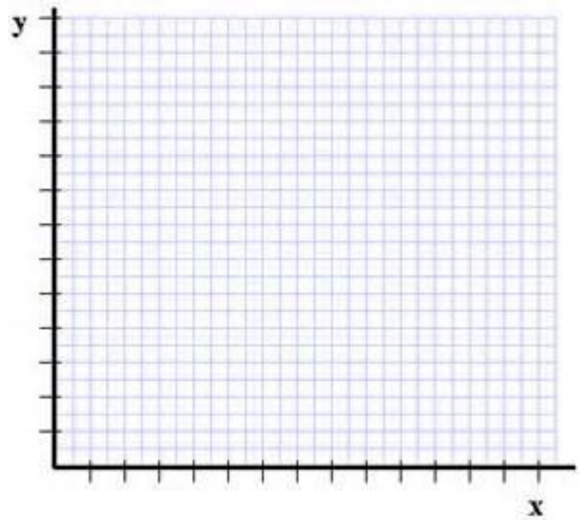
23) Write a quadratic equation that has two imaginary solutions.

24) In your own words explain why a quadratic equation can't have one imaginary solution.

Non-Linear Systems of equations

Example 1

Solve the following system: $y = 4x$ and $y = \frac{60}{x+2}$



Step 1: Set the 2 equations equal

Step 2: Find a quadratic equal to 0

Step 3: Find the zeros.

Step 4: If the problem is a real world problem, make sure the answers are valid.

Graph the equations to check the intersection point.

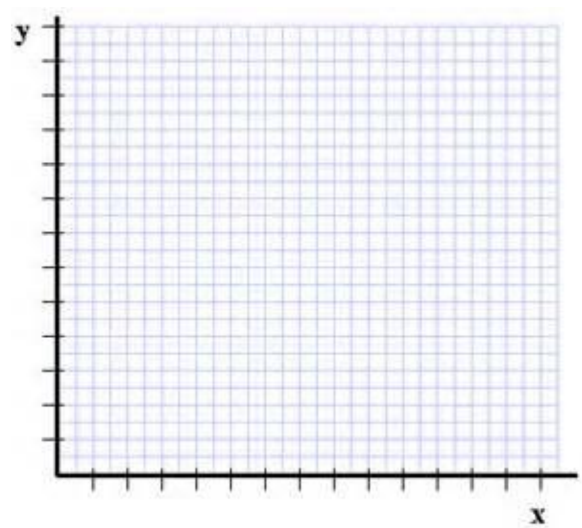
How can you use the discriminant to help you solve this?

Example 2

The student council decides to put on a concert to raise money for an after school program. They have determined that the price of the ticket will affect their profit. The functions shown below represent their potential income and cost of putting on the concert, where t represents ticket price.

Income: $I(t) = 330t - 30t^2$ Cost: $C(t) = 330 - 30t$

Use your calculator and draw the graphs.



1. Show algebraically and graphically where the break-even point. (Hint: Income = Cost)

2. Show algebraically and graphically where the cost is greater than the income.

3. Show algebraically and graphically where the income is greater than the cost.

4. Which ticket price would you use in order to maximize your profit? Where is this shown on the graph?

With a partner:

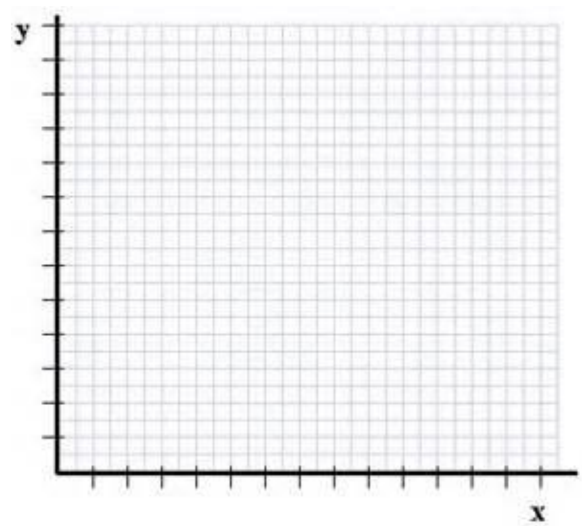
Example 1: $y = x^2 + x - 2$ and $y = -x + 1$

Example 2: $y = 2x^2 + 3$ and $y = x + 2$

What happened?

Eample 3: A ball thrown is modeled by the function: $3 + 22x – 16x^2$. Using what you know about quadratic functions, answer the following questions.

Sketch the graph, without a calculator, using what you know about quadratic functions.



Given the context of the problem, what is an appropriate domain?

Why is only the first quadrant of the coordinate plane given for you to graph?

Write an equation to show when the ball will be exactly 10 feet in the air, then solve.

Using this information, write and equation that explains when the ball will be at a height that is less than 10 feet in the air. Then explain the answer based on the previous question's answers.

Explain how you could use shading to show this solution on the graph?

Write an inequality to show when the ball will be higher than 10 feet in the air.

When will the ball by higher than 10 feet? Write the solution algebraically and graphically.

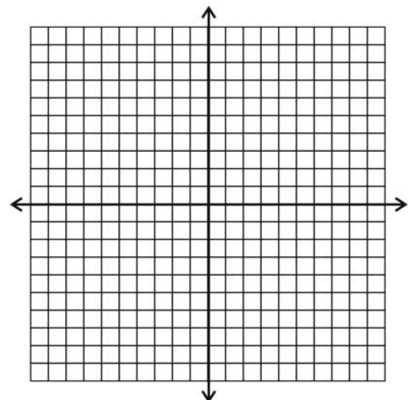
<u>Non-Linear Systems HW</u> Solve the following systems algebraically ONLY.

1. $y = 2x$ and $y = \frac{32}{x}$	2. $y = x^2+4x-2$ and $y = 2x + 1$	3. $y = x^2+2x-8$ and $y = 2x+1$

4. Consider the system of equations:

$$y = 2x^2 + 14x - 15 \text{ and } y = 3x + 25$$

Find a solution to the system of equations & graph.

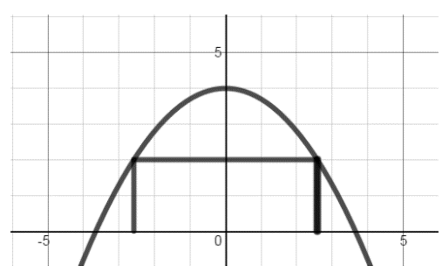


1. Each year, Ligon's arts department produces a musical. Based on previous years, the organizers decided that the Income from ticket sales, I(t) is related to ticket price *t* by the equation $I(t) = 400t - 40t^2$. *Cost* C(t) of operating the public event is also related to ticket price *t* by the equation $C(t) = 400 - 40t$.
   a. What ticket price(s) would generate the greatest income? What is the greatest income possible? Explain how you obtained the value you got.

   b. For what ticket price(s) would the operating costs be equal to the income from ticket sales? Explain how you obtained the answer.

   c. Write a rule for the Profit (Income – Cost) of the show. What is the maximum profit at what ticket price?

2. The figure shows a rectangle that is centered on the y-axis with bases on the x-axis and upper vertices defined by the function $y = -0.3x^2 + 4$ and $y = 2$. Find the area of the rectangle to the nearest hundredth.



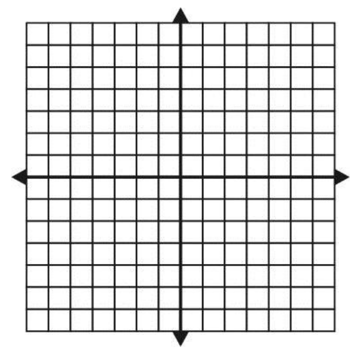
Quadratic Inequalities

Step 1 Graph the parabola with equation
$y = ax^2 + bx + c.$
Make the parabola __________ for inequalities with < or > and __________ for inequalities with ≤ or ≥.

Step 2 Test a point (x, y) _________ the parabola to determine whether the point is a solution of the inequality.

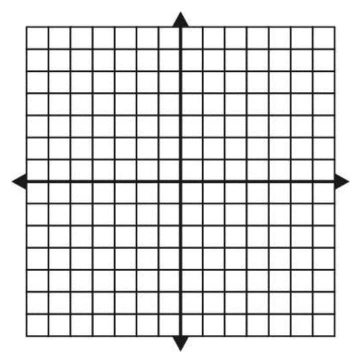
Step 3 Shade the region ____________ the parabola if the point from Step 2 is a solution. Shade the region ________________ the parabola if it is not a solution.

Example 1: Graph $y \geq x^2 - 2x - 3$.



1. Graph $y = x^2 - 2x - 3$. The inequality symbol is ≥, so make the parabola ____________ .
2. Test the point (0, 0) which is __________ the parabola.
3. Shade the region __________ the parabola

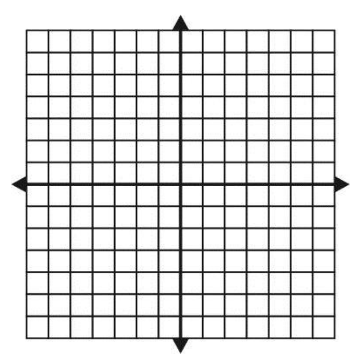
Example 2: Graph $y < x^2-2$.



1. Graph $y = x^2-2$. The inequality symbol is <, so make the parabola ____________ .
2. Test the point (0, 0) which is __________ the parabola.
3. Shade the region __________ the parabola

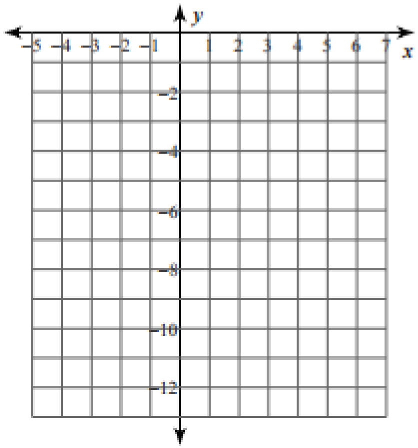
Example 3: Graph the system

$y < -x^2 + 3$ and $y \geq 2x^2 + 3x - 2$

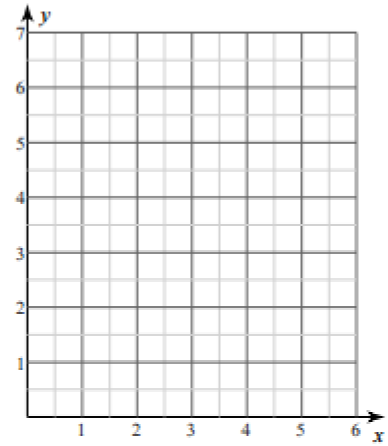


<u>Quadratic Inequalities HW</u> (©Kuta Software – Infinite Algebra 2)

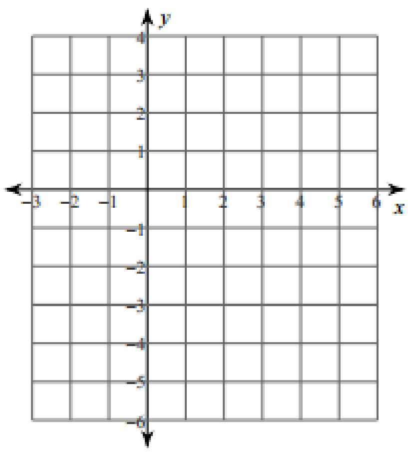
7) $y < -2x^2 - 8x - 12$



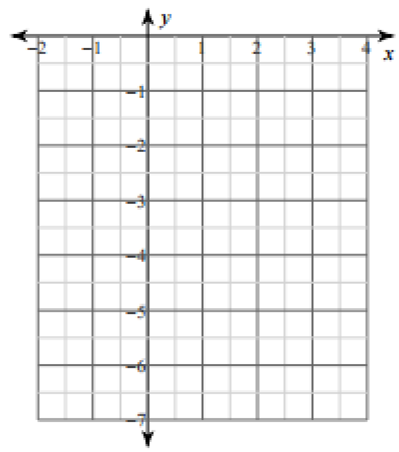
8) $y \le x^2 - 6x + 11$



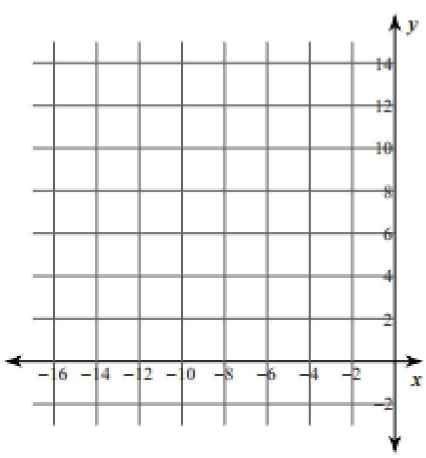
9) $y \ge -2x^2 + 16x - 29$



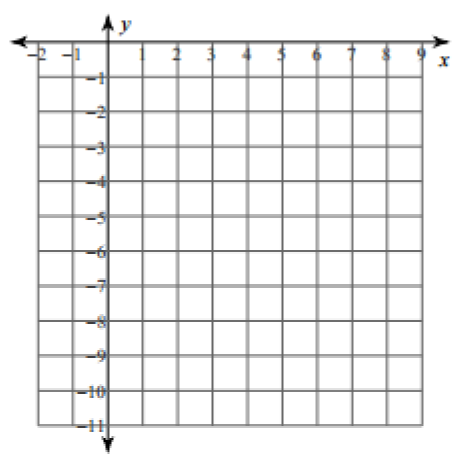
10) $y > -x^2 + 4x - 6$



11) $y \le 4x^2 + 32x + 62$



12) $y > -2x^2 + 16x - 34$



Critical thinking questions:

13) Name one solution to:
$y > x^2 + 6x + 5$

14) Name one solution to the system:
$y \ge x^2 - 2x + 2$
$y = x + 1$

Quadratic Applications:

1. A ball is thrown straight up with an initial velocity of 56 feet per second. The height of the ball t seconds after it is thrown is given by the formula $h(t) = 56t - 16t^2$.
    a. What is the height of the ball after 1 second?

    b. What is the maximum height?

    c. After how many seconds will it return to the ground?

2. An object is thrown upward into the air with an initial velocity of 128 feet per second. The equation $h(t) = 128t - 16t^2$ gives its height above the ground after t seconds. What is the height after 2 seconds? What is the maximum height reached? For how many seconds will the object be in the air?

3. The length of a rectangle is three more than twice the width. Determine the dimensions that will give the rectangle a total area of 27 m^2.

4. Lorenzo has 48 feet of fencing to make a rectangular dog pen. If a house were used for one side of the pen, what would be the length and width for the maximum area?

5. For the years of 1983 to 1990, the number of mountain bike owners m (in millions) in the US can be approximated by the model $m = 0.337t^2 - 2.265t + 3.962$, $3 \leq t \leq 10$ where t = 3 represents 1983. In which year did 2.5 million people own mountain bikes? In what year was the number of mountain bike owners at a minimum?

6. A company's weekly revenue in dollars is given by $R(x) = 2000x - 2x^2$, where x is the number of items produced during a week. What amount of items will produce the maximum revenue?

7. The height in feet of a bottle rocket is given by $h(t) = 160t - 16t^2$ where t is the time in seconds. How long will it take for the rocket to return to the ground? What is the height after 2 seconds?

8. While playing catch with his grandson yesterday Tim throws a ball as hard as possible into the air. The height h in feet of the ball is given by $h = -16t^2 + 64t + 8$, where t is in seconds. How long will it take until the ball reaches the grandson's glove if he catches it at a height of 3 feet? What is the maximum height of the ball?

9. 14. Challenge: The back yard of a home is a rectangle 15m by 20m. A garden of uniform width is to be built around the edge leaving a grass area inside. The area of the grass is to be the same as the area of the garden. What is the width of the garden?

10. 15. Challenge: Jane bought a number of watermelons at the farmers' market for \$150. If each watermelon had been \$5 more, 5 fewer could have been purchased. Find the price of each watermelon. (Hint: let x be the number of watermelons and \$y be the cost of each).

Quadratic Applications HW

1. Find the largest possible three consecutive integers such that the product of the first and the second is equal to the product of –6 and the third.

2. The length of a rectangle is 3 inches more than its width. If the length of the diagonal is 15 inches, find the dimensions of the rectangle.

3. Suppose that one leg of a right triangle is 12 inches while the hypotenuse is $4\sqrt{10}$ inches. Find the length of the other leg.

4. Suppose that one leg of a right triangle is 1 more than the other leg; and the hypotenuse is 1 less than 2 times the shorter leg. Find the lengths of all the sides.

5. When the dimensions of a cube are reduced by 4in on each side, the surface area of the new cube is 864 square inches. What were the dimensions of the original cube?

6. A rectangular pool in a water-purification plant requires a surface area of 1240 sq. ft. If the pool is situated in a room with dimensions 70 ft. by 28 ft. and the distance from the pool edge to the room wall is uniform, find the dimensions of the pool.

7. An object is launched at 19.6 meters per second (m/s) from a 58.8-meter tall platform. The equation for the object's height s at time t seconds after launch is s(t) = –4.9t2 + 19.6t + 58.8, where s is in meters.
   a) When does the object strike the ground?

   b) At what time does the object reach its maximum height?

   c) What is the maximum height of the object?

8. The height h(t) in feet of an object t seconds after it is propelled straight up from the ground with an initial velocity of 64 ft/ s2 is modeled by the equation h(t) = -16t2 + 64t.
   a) At what time will the object be at a height of 56 feet.

   b) At what time will the object reach its maximum height?

   c) When will the object hit the ground?

9. Find two positive consecutive odd integers whose product is 99.

10. The width of a rectangle is 16 feet less than 3 times the length. If the area is 35 square feet, find the dimensions of the rectangle.

11. The three sides of a right triangle form three consecutive even numbers. Find the lengths of the three sides, measured in inches.

12. The product of two consecutive positive odd integers is 1 less than four times their sum. Find the two integers.

13. Find three consecutive positive integers such that four times the sum of all three is 2 times the product of the larger two.

Test Review

Factor each quadratic expression (you do not have to "solve for x")

1) $4x^2 - 22$
2) $12x^2 + 28$
3) $6x^2 - 24$
4) $3x^2 - 15x - 42$
5) $x^2 - 100$
6) $25x^2 - 9$
7) $2v^2 - 7v - 4$
8) $3x^2 + 13x + 10$
9) $4x^2 - 25$
10) $6x^2 + 19x + 15$
11) $x^2 - 10x + 21$
12) $4x^2 + 8x - 60$

For each quadratic equation, solve for the zeros (x-intercepts), and identify the axis of symmetry, the vertex, and the y-intercept. Then sketch a graph of each function.

13) $x^2 + 15x + 26 = 0$
14) $x^2 - 4x - 32 = 0$
15) $64x^2 - 1 = 0$
16) $10x^2 - 20x - 80 = 0$
17) $20x^2 - 45 = 0$

Solve each of the following equations for x without the use of a calculator.

18) $x^2 + 5x = 0$
19) $x^2 + 6x = 7$
20) $2x^2 + 7x = -5$

21. Angry Birds: Find a quadratic function that will allow the bird to hit the pig in each of the following scenarios. Assume your bird is launched from the origin (0, 0). [Hint: Use $y = a(x-h)^2 + k$]

a. The pig is on the ground, 18 feet away from the slingshot.

b. The pig is on the ground, 23 feet away from the slingshot, but the bird needs to go at least 20 feet high.

For each quadratic equation, a) calculate the value of the discriminant; b) determine if the discriminant is positive, negative, or zero; and c) state how many (real) solutions the quadratic equation has.

22) $y = x^2 + 10x + 25 = 0$

23) $y = 2x^2 - 6x + 10 = 0$

24) $y = 3x^2 - 4x - 5 = 0$

25) Explain (in words) how to create a quadratic equation that has no (real) solutions.

Identify the transformation

26) $y = (x+2)^2 - 3$

27) $y = (x+2)^2$

28) $y = (x-9)^2$

29) $y = -4x^2$

30) $y = x^2 - 3$

31) $y = \frac{1}{3}x^2$

32) $y = 2(x-4)^2$

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

34) $y = -(x-4)^2 + 2$

35) The height of a baseball thrown up into the air is given by the function $y = -16t^2 + 80t + 6$, where time (t) is measured in seconds and the height (y) is measured in feet.
a) At what time does the ball reach its maximum height?
b) What is the ball's maximum height?
c) When is the ball 42 feet off the ground? (Hint: Once going up, and once coming down.)

36) The Widget Company's monthly profit, P, is given by the function $P = -10x^2 + 220x - 50$, where x is the price of each widget the company sells.

a. What is the maximum monthly profit the company can make?
b. How much would the company need to charge for each widget in order to make the maximum profit?
c. What would their monthly profit be if they set the price of widgets at $9.00?

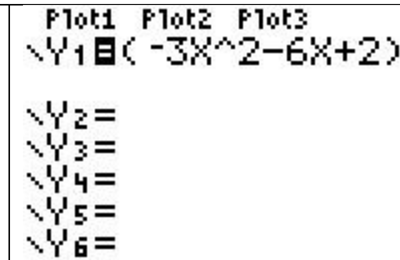
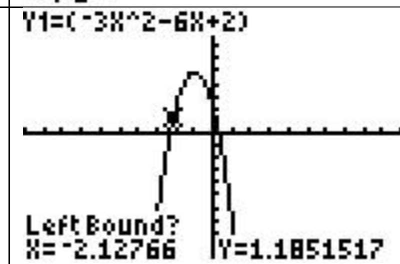
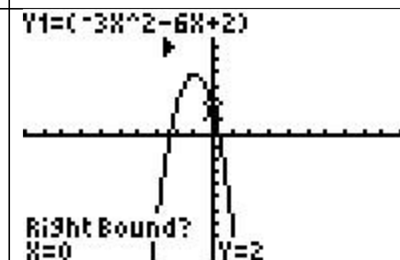
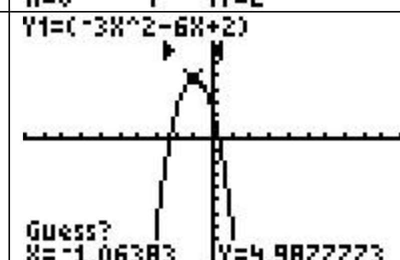
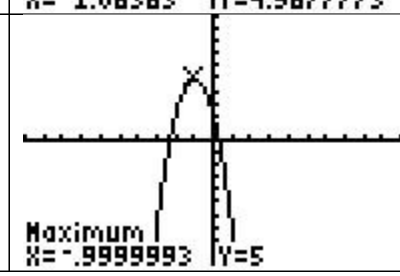
37) Consider the graph of quadratic function with x-intercepts at (-5,0) and (3,0) that opens upward.

a. Does the graph contain a minimum or maximum and what do you know about its location?

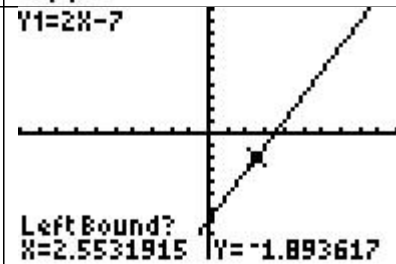
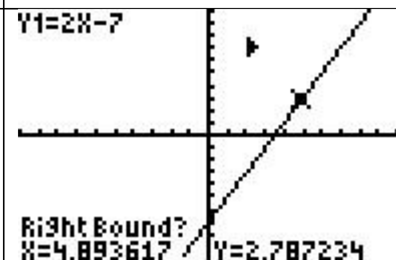
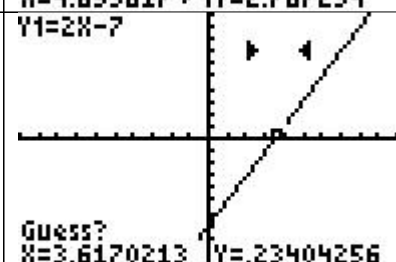
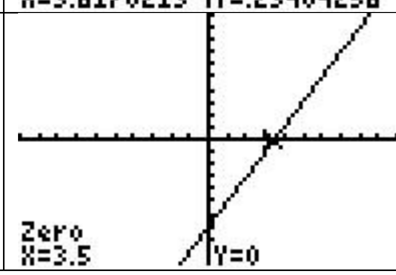
b. Write two different equations that would satisfy the given characteristics.

Appendix: Using the Calculator

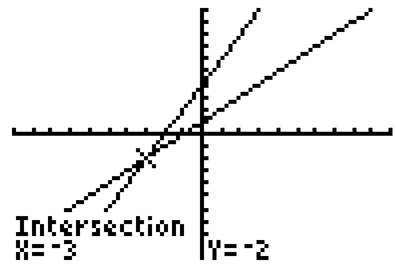
Find the maximum of the function; Ex: (-3x^2 - 6x + 2)

• Press [Y=] to access the Y= editor. For Y1, input (-3x^2-6x+2).	
• Press [GRAPH] to graph the parabola. • Press [2nd] [TRACE] [4] to select the "maximum" command from the CALC menu. • The handheld will prompt for a "Left Bound." Using the arrow keys, move the cursor to the left side of the function (past the maximum point) and press [ENTER].	
• The handheld will prompt for a "Right Bound." Using the arrow keys, move the cursor to the right side of the function (past the maximum point) and press [ENTER].	
• The handheld will prompt for a "Guess." Using the arrow keys, move the cursor as close as possible to the actual maximum point and press [ENTER].	
The handheld will display the maximum point as a coordinate pair (-.99999,5). (-.99999) is approximately equivalent to (-1).	

Find the x-intercepts of a function; Ex: 2x-7

<table>
<tr><td>• Press the [Y=] key to access the Y= Editor.
• For Y1=, input the example function. Press the [GRAPH] key to graph the function.</td><td>
</td></tr>
<tr><td>• To use the zero command, press [2nd] [TRACE] to access the CALC menu, then press [2] to select the zero command.
• The handheld will then prompt for a "Left Bound". This means the handheld wants the user to select a point on the graph that is to the left of the x-intercept. Using the arrow keys, move the cursor until it is to the left of the x-intercept. Press [ENTER] to mark this as the left bound.</td><td>
</td></tr>
<tr><td>• The handheld will then prompt for a "Right Bound". This means the handheld wants the user to select a point on the graph that is to the right of the x-intercept. Using the arrow keys, move the cursor until it is to the right of the x-intercept. Press [ENTER] to mark this as the right bound.</td><td>
</td></tr>
<tr><td>• The handheld will then prompt for a "Guess". This means the handheld wants the user to take a guess at the x-intercept. Using the arrow keys, move the cursor until it is close to or directly on the x-intercept. Press [ENTER] to mark this as the guess.</td><td>
</td></tr>
<tr><td>This will also complete the zero command and display the exact point of the x-intercept which is (3.5,0).</td><td>
</td></tr>
</table>

Finding the intersection of 2 functions; Ex: y = x+1 and y = 2x+4



1. Graph the functions:
• Press [Y=] to display the Y= Editor
• Input **x+1** next to Y_1=
• Input **2x+4** next to Y_2=
• Press [GRAPH] to display the graphs of the two functions

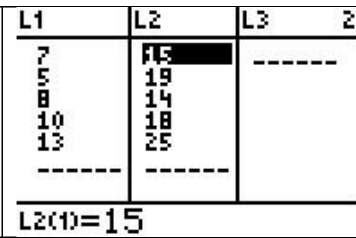
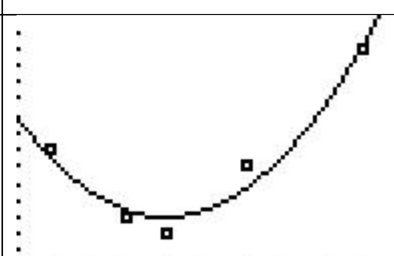
2. Find the intersection of the two lines:
• Press [2nd] [CALC] [5] to select **5:interesect** from the CALCULATE menu
• When *First curve?* is displayed, press the up and down directional keys, if necessary, to move the cursor to the first function, then press [ENTER]

• When *Second curve?* is displayed, press the up and down directional keys, if necessary, to move the cursor to the second function, then press [ENTER]

• When *Guess?* is displayed, use the left and right directional keys to move the cursor to the point that is your guess as to the location of the intersection, and then press [ENTER]

The cursor is on the solution and the coordinates are displayed, even if CoordOff format is selected. *Intersection* is displayed in the bottom-left corner. To restore the free-moving cursor, press any of the directional keys.

Quadratic Regression

Data for this example: **To enter the data:** • Press [STAT] [1] to access the STAT list editor. • Input the data in the L1 and L2 lists, pressing [ENTER] after each number. • Press [2nd] [MODE] to QUIT and return to the home screen.	
To calculate the quadratic regression (ax^2+bx+c): • Press [STAT] to access the STAT menu. • Scroll right to highlight the CALC menu. • Press [5] to select QuadReg(ax+b). • Press [2nd] [1] [,] [2nd] [2] to input L1,L2. • Press [,] [VARS], scroll right to highlight Y-VARS, then press [1] [1] to input ,Y1. • Press [ENTER] to calculate the quadratic regression. This will also copy the quadratic regression equation to the Y= Editor.	
To graph the data and the quadratic regression equation: • Press [2nd] [Y=] [1] to access the STAT PLOTS menu and edit Plot1. • Press [ENTER] to turn On Plot1. • Scroll down to Type: and press [ENTER] to select the scatter plot option. • Scroll down to Xlist and press [2nd] [1] to input L1. Scroll down to Ylist and press [2nd] [2] to input L2.	
• Press [GRAPH] to graph the data and the quadratic regression equation. • If the graphs are not displayed, press [ZOOM] [9] to perform a ZoomStat.	

Homework Answers

Factoring Review; Pages

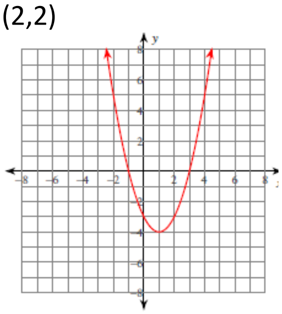
1) (x-9)(x+2)
2) (p+2)(p-7)
3) (m-1)(m-8)
4) (x-9)(x-7)
5) (7x+4)(x-5)
6) k(7k+9)
7) (7x+4)(x-7)
8) (2b+3)(b+7)
9) (5p+9)(p-2)
10) $4n^2(7n-10)(n+2)$
11) b(3b-2)(b-1)
12) (7x+10)(x-6)
13) 3b(2n-5)(5n-2)
14) Not factorable
15) r(p+7)(9p+10)
16) Not factorable
17) x(x+10)(4x+3)
18) (m+9)(10m-1)
19) 13, 8, 7, -13, -8, -7
20) Many answers: Ex 0, 2, -4, -10

Factoring Word Problems; Pages

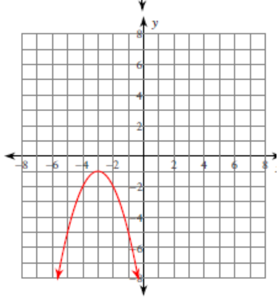
1) 12 inches
2) 3 units
3) 10, 11, 12 years
4) 5 cm
5) 30 m x 40 m
6) 10 ft x 30 ft
7) a) 600 sq ft
   b) $x^2+50x-464=0$
   c) 8 ft
8) 114 ft
9) 15 ft x 14 ft
10) $x^2-20x-100=0$
    Not factorable

Properties of Parabola; Pages

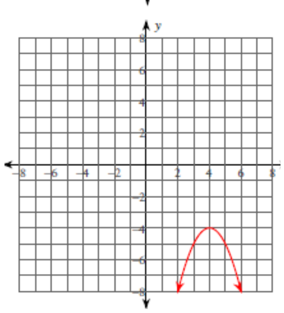
1) (-8,0)
2) (1,-4)
3) (9,6)
4) (2,2)



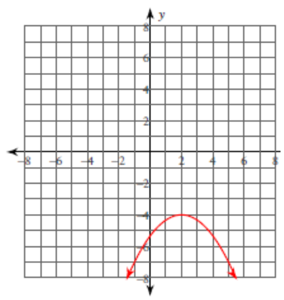
5)



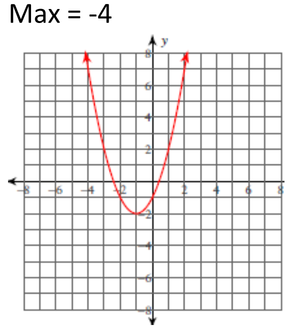
6)



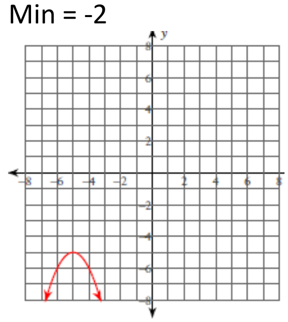
7) Max = -4



8) Max = -4



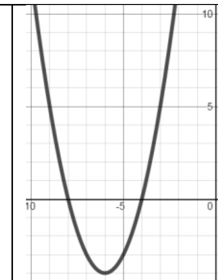
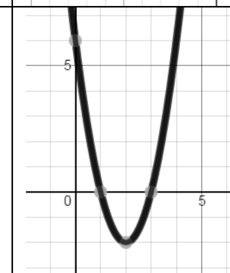
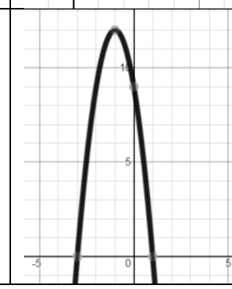
9) Min = -2



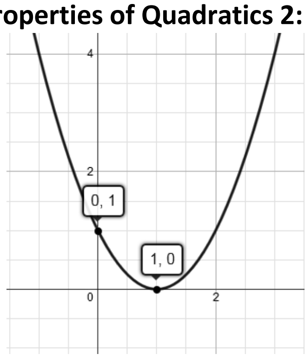
10) Min = -5

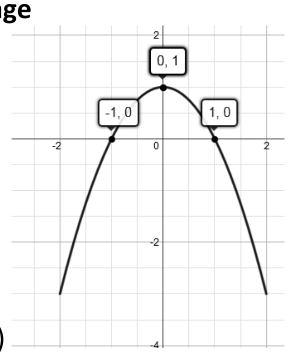
11) Vertex: (9,-2)
    AoS: x=9
    Min = -2
    Stretched Vertically
12) Vertex: (9,5)
    AoS: x=9
    Min = 5
    Same shape vertically
13) Vertex: (6,6)
    AoS: x=6
    Min = 6
    Compressed vertically
14) Vertex: (-5,4)
    AoS: x=-5
    Min = 4
    Stretched Vertically
15) Vertex: (0,7)
    AoS: x=0
    Min = 7
    Compressed Vertically
16) Vertex: (6,8)
    AoS: x=6
    Min = 8
    Same shape vertically
17) Vertex: (2,8)
    AoS: x=2
    Min = 8
    Compressed vertically
18) Vertex: (-2,1)
    AoS: x=-2
    Min = 1
    Same shape vertically

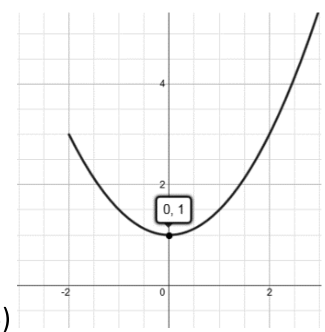
Standard and Vertex Form; Page

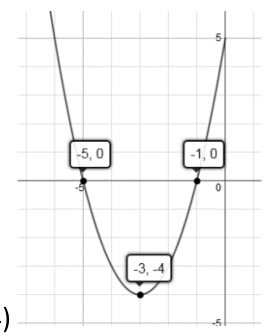
1)	y=x^2+12x+32	y=(x+8)(y+4)	(-8,0) (-4,0)	(0,32)	x=-6	(-6,4)	Min	
2)	y=2x^2-8x+6	y=2(x-3)(x-1)	(3,0) (1,0)	(0,6)	X=2	(2,-2)	Min	
3)	y=-3x^2-12x-9	y=-3(x+3)(x-1)	(-3,0) (-1,0)	(0,-9)	x=-2	(-2,3)		

Properties of Quadratics 2: Page

1) 

2) 

3) 

4) 

Comparison of Maximums/Minimums; Pages

1. a) Brooklyn bridge is the shortest since it is only 700 ft. long, the Verrazano is longest at 1250 ft. long and the Tappan Zee is 800 feet long.
b) Verrazano's cable is the shortest since it's minimum is only 3.75 ft. high, the Brooklyn bridges' minimum is about 5ft and the Tappan Zee has a minimum of 60ft.
c) He should use the Tappan Zee since he will hit the cables on the other two bridges.
2.a) Henry's ball was in the air the longest since it hit the ground after 4.7 seconds, Michaels' hit the ground after 3.2 seconds and Joe's hit the ground after 2.5 seconds.
b) Henry's ball went the highest since the max was 91.9 ft., Joe's was about 78 ft. and Michael's ball was 44.1 ft. high.
c) Answers may vary: Most students will say Henry since his ball went the highest and was in the air the longest. Some students may choose one of the other players saying maybe they don't want the ball thrown highest if someone else is going to have to catch it.

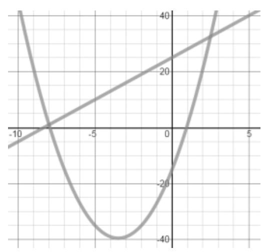
Quadratic Formula; Page

1) $\left\{2\frac{2}{3}, -1\right\}$
2) $\{-3, -7\}$
3) No solution.
4) $\{3, -3\}$
5) $\left\{\frac{6+\sqrt{30}}{6}, \frac{6-\sqrt{30}}{6}\right\}$
6) $\left\{\frac{\sqrt{66}}{6}, -\frac{\sqrt{66}}{6}\right\}$
7) $\left\{\frac{-5+\sqrt{97}}{4}, \frac{-5-\sqrt{97}}{4}\right\}$
8) $\left\{\frac{3+\sqrt{78}}{3}, \frac{3-\sqrt{78}}{3}\right\}$
9) $\left\{\frac{-6+\sqrt{66}}{6}, \frac{-6-\sqrt{66}}{6}\right\}$
10) $\left\{\frac{\sqrt{6}}{4}, -\frac{\sqrt{6}}{4}\right\}$
11) No solution.
12) $\left\{\frac{-9+\sqrt{1041}}{24}, \frac{-9-\sqrt{1041}}{24}\right\}$
13) $\left\{5\frac{2}{3}, -8\right\}$
14) $\left\{2, -2\frac{1}{3}\right\}$
15) No solution.
16) $\left\{\frac{3+\sqrt{37}}{6}, \frac{3-\sqrt{37}}{6}\right\}$
17) $\{5, -9\}$
18) $\left\{\frac{-3+\sqrt{29}}{2}, \frac{-3-\sqrt{29}}{2}\right\}$
19) $\{\frac{-1+\sqrt{127}}{7}, \frac{-1-\sqrt{127}}{7}\}$
20) $\{\frac{-7+\sqrt{21}}{2}, \frac{-7-\sqrt{21}}{2}\}$

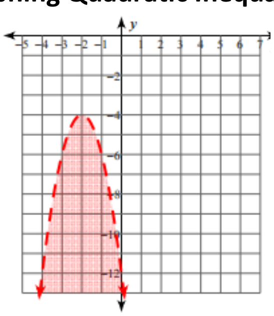
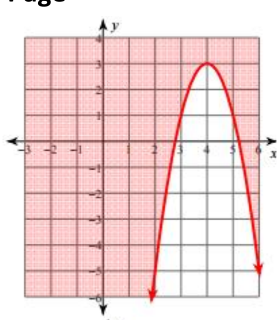
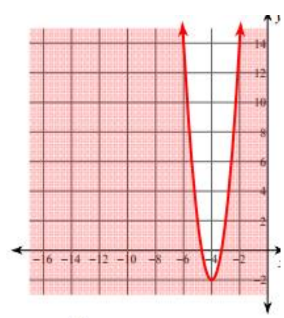
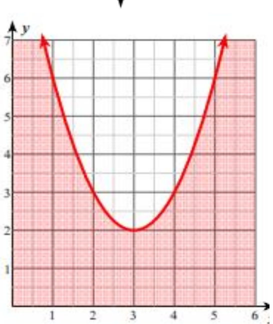
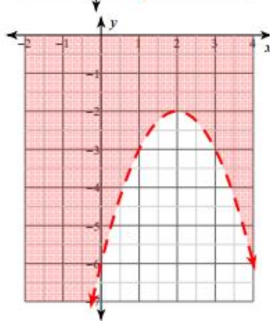
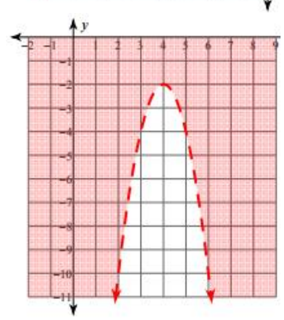
Discriminant; Pages

1) 76
2) -7
3) 96
4) 41
5) 17
6) 57
7) -63; two imaginary
8) 0; one real
9) 0; one real
10) 0; one real
11) -224; two imaginary
12) 0; one real
13) 121; two rational
14) 0; one rational
15) 121; two rational
16) 0; one rational
17) 64; two rational
18) 140; two irrational
19) -359; two imaginary
20) 337; two irrational
21) 0; one rational
22) 25; two rational
23) Many answers; ex: $x^2+x+1=0$
24) Answers vary

Non-Linear Systems; Page

1) (4,8) (-4,-8)
2) (1,3) (-3,-5)
3) (3, 7) (-3, 5)
4) 
(-8,1)(2.5,32.5)
5) a) $5, $1000, Vertex of I(t)
b) $1 or $10, I(t) = C(t)
c) $810 at $5.50 ticket
6) 10.32 units

Graphing Quadratic Inequalities; Page

7) 
9) 
11) 
13) Various; ex (-3,0)
14) Various; ex (1,2) or (2,3)
8) 
10) 
12) 

Quadratic Applications; Pages

1) -3, -2, -1
2) 9 x 12 inches
3) 4 inches
4) 3, 4, 5
5) 16 by 16 by 16 inches
6) 20 x 62 feet
7) a) 6 seconds,
   b) 2 seconds,
   c) 78.4 meters
8) a) $\frac{4\pm\sqrt{2}}{2}$ seconds,
   b) 2 seconds,
   c) 4 seconds
9) 9, 11
10) 5 x 7 feet
11) 6, 8, 10 inches
12) 7, 9
13) 4, 5, 6
14) 2.5 meters
15) $10

Test Review; Pages

1) 2(2x2-11)
2) 4(3x2+7)
3) 6(x+2)(x-2)
4) 3(x-7)(x+2)
5) (x-10) (x+10)
6) (5x+3)(5x-3)
7) (2v+1)(v-4)
8) (3x+10)(x+1)
9) (2x+5)(2x-5)
10) (2x+3)(3x+5)
11) (x-7) (x-3)
12) 4(x+5)(x-3)
13) x=-13 or x=-2,
    v=(-7.5, -30.25),
    AOS: x=-7.5,
    y-int.: y=26
14) x=-4 or x=8,
    v= (2, -36)
    AOS: x=2,
    y-intercept: -32
15) x=1/8 or x=-1/8,
    v= (0, -1)
    AOS: x=0,
    y-intercept: -1
16) x=-2 or x=4,
    v= (1, -90)
    AOS: x=1,
    y-intercept: -80
17) x=3/2 or x=-3/2,
    v= (0, -45)
    AOS: x=0,
    y-intercept: -45
18) x=0, x=-5
19) x = 1, x = -7
20) x = -1, x = -5/2
21) Note that there are many possible functions that would satisfy each of the given conditions, and some will satisfy them more closely than others. I found my functions by drawing a sketch of what I wanted my parabola to look like and then identifying my AOS. Then I **used the vertex form** of the quadratic function, **chose a suitable vertex point**, and entered my function into my graphing calculator with an "a" value of -1. Then I adjusted my "a" value on my graphing calculator until I got a parabola that went thru (or close to) the point where the pig was.
    a) y = -.15(x-9)2 + 12
    b) $y = -.15(x-11.5)^2 + 20$
22) a) 0,
    b) zero,
    c) one solution
23) a) -44,
    b) negative,
    c) no (real) solutions
24) a) 76,
    b) positive,
    c) two solutions
25) Here's one possible answer: In order to have no real solutions, b2-4ac must be negative, which means 4ac must be greater than b2. So just pick values for a, b, and c that will make 4ac > b2; there are plenty that will work, e.g., a=4, b=2, & c=9.
26) translate left 2, down 3
27) translate left 2
28) translate right 9
29) vert stretch, vert. refl
30) translate down 3
31) vert compression
32) vert stretch, translate right 4
33) vert compression, vert reflection, translate up 1
34) vert reflection, translate right 4, up 2
35) a) at t = 2.5 seconds
    b) 106 feet
    c) at *t* = .5 seconds and again at *t* = 4.5 seconds
36) a) $1160
    b) $11
    c) $1120
37) 41. a) min; the x-coordinate of the minimum point must be x= -1.
    b) y = 2(x+5)(x-3); y = 17(x+5)(x-3) [there are many others, but note that "a" must be positive]