

Warm - up

On the Boards...

Name all transformations and sketch

$$y=2(x-4)^2+8$$

$$y=0.5(x+8)^2-4$$

V. Stretch
H. Translation right 4
V. Translation up 8

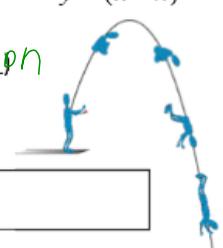
VERTEX FORM OF QUADRATIC RELATIONS

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

The Quadratic Relation $y = a(x-h)^2 + k$ Putting It All Together

So far we've looked at properties for quadratic relations $y = x^2$, $y = ax^2$, $y = x^2 + k$, and $y = (x-h)^2$. We've also discovered what happens to the graphs when we change the values of:

- a (V. Stretch, V. Compression, V. Reflection)
- k (V. Translation (up/down) and
- h (H. Translation (left/right))



Now we put it all together as we consider the quadratic relation

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

EFFECTS OF CHANGES IN 'a', 'h', 'k'

Using properties from the other quadratic relations we've studied fill in the blanks below:

For any quadratic relation of the form $y = a(x-h)^2 + k$, relative to the graph of $y = x^2$:

How Changes in 'a' Affect the Graph

The value of a determines the stretch and compression of the parabola.

If a is positive, the parabola opens up

If a is negative, the parabola opens down (flipped)

If $|a| > 1$, the graph is stretch (~~skinny~~) (taller)

If $-1 < |a| < 1$, the graph is compression (~~wide~~) (shorter)

How Changes in 'k' Affect the Graph

If k is positive, the vertex shifts up

If k is negative, the vertex shifts down

How Changes in 'h' Affect the Graph

($x+5$)
If h is positive, the vertex shifts left

If h is negative, the vertex shifts right
($x-5$)

VERTEX COORDINATES
Coordinates of the vertex can be easily found by looking at the equation of the relation:

Relation	Vertex	Examples
$y = x^2 + k$	$(0, k)$	$y = x^2 + 3$ $(0, 3)$ $y = x^2 - 11$ $(0, -11)$
$y = (x - h)^2$	$(h, 0)$	$y = (x - 2)^2$ $(2, 0)$ $y = (x + 9)^2$ $(-9, 0)$
$y = a(x - h)^2 + k$	(h, k)	$y = a(x - 3)^2 + 2$ $(3, 2)$ $y = 2(x - 7)^2 - 4$ $(7, -4)$ $y = a(x + 5)^2 + 8$ $(-5, 8)$ $y = -3(x + 1)^2 - 2$ $(-1, -2)$

$y = x^2 + 3 = (x + 0)^2 + 3$ $y = (x - 2)^2 + 0$

$y = a(x - 3)^2 + 2$
 right 3 up 2

Transformations take a long time.

Is there a better / faster way of drawing a parabola?

<http://www.mathwarehouse.com/quadratic/parabola/interactive-parabola.php>

Step Pattern

When $a = 1$		1, 3, 5	
$a = 2$	$2 \times$	1, 3, 5	2, 6, 10
$a = 3$	$3 \times$	1, 3, 5	3, 9, 15
$a = 0.5$	$0.5 \times$	1, 3, 5	0.5, 1.5, 2.5
$a = -2$	$-2 \times$	1, 3, 5	-2, -6, -10
		↑	↑
		opens down	down

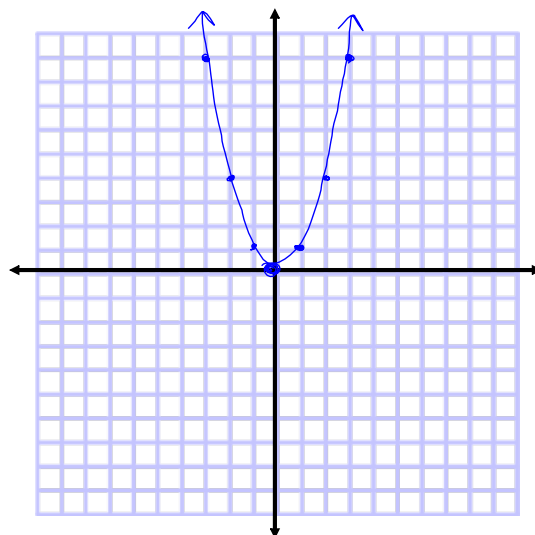
Using the Step Pattern

$$y = x^2$$

What is the vertex? $(0, 0)$

Does the parabola open up or down? up

What is the step pattern? $a = 1$
 $\therefore 1, 3, 5$

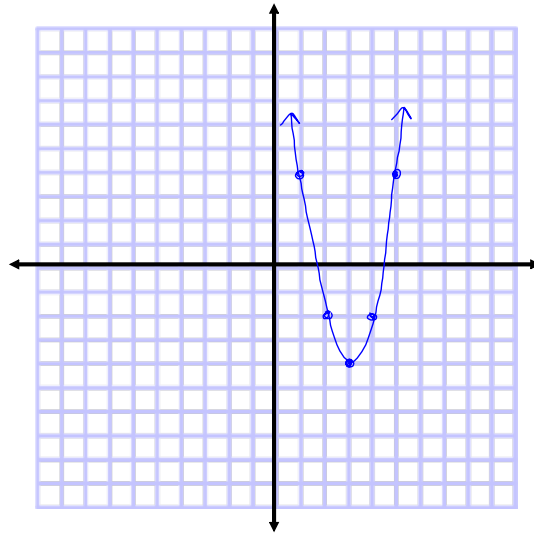


$$y = 2(x-3)^2 - 4$$

What is the vertex? $(3, -4)$

Does the parabola open up or down? up

What is the step pattern? $a = 2 \therefore 2, 6, 10$



Let's go to **your parabolas**.

Using your knowledge of transformations, find the equation of your parabola.

Do you know

- vertex
- other points
- step pattern?

Can you find

- "a" value
- equation in vertex form

Seatwork / Homework

MBF3C

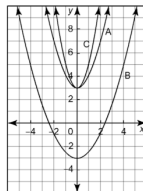
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The Quadratic Relation $y = a(x-h)^2 + k$ Practice

- Circle the shape and orientation of each parabola and indicate the vertex.
 - a) $y = -0.5x^2 + 2$ opens up / down stretched / compressed vertex (0, 2)
 - b) $y = 2(x-1)^2$ opens up / down stretched / compressed vertex (1, 0)
 - c) $y = -0.1x^2 - 6$ opens up / down stretched / compressed vertex (0, -6)
 - d) $y = (x+5)^2 + 4$ opens up / down stretched / compressed vertex (,)
 - e) $y = -3x^2 - 5$ opens up / down stretched / compressed vertex (,)
 - f) $y = 0.1(x-1)^2 + 2$ opens up / down stretched / compressed vertex (,)
 - g) $y = 8(x+5)^2$ opens up / down stretched / compressed vertex (,)
 - h) $y = -0.7x^2 - 3$ opens up / down stretched / compressed vertex (,)

- Match each relation with its corresponding graph.

- a) $y = 2x^2 + 3$ **A**
- b) $y = 0.5x^2 - 3$ **B**
- c) $y = x^2 + 3$ **C**



- In each case, the parabola $y = x^2$ is transformed as indicated. Write the equation of the new parabola in the form $y = a(x-h)^2 + k$.
 - a) The parabola is stretched vertically by a factor of 4 and translated to the left 3 units.
 $y = 4(x+3)^2$
 - b) The parabola is compressed vertically by a factor of 0.3, translated up 1 unit and to the right 3 units.
 $y = 0.3(x-3)^2 + 1$
 - c) The parabola is stretched vertically by a factor of 3 and then translated up 4 units.
 $y = 3(x)^2 + 4$
 - d) The parabola is reflected in the x-axis and then translated down 3 units.
 $y = -x^2 - 3$

MBF3C

Date: _____

Graphing Quadratic Equations – STEP Method Practice

- Use the step method to graph $y = x^2 + 2$

Equation	$y = x^2 + 2$	Graph the equation. 																
What is the vertex?	(0, 2)																	
Direction of Opening?	up																	
What is the Step Pattern?	1, 3, 5																	
Complete the table of values to CONFIRM the points on your graph	<table border="1"> <thead> <tr> <th>x</th> <th>$y = x^2 + 2$</th> </tr> </thead> <tbody> <tr><td>-3</td><td></td></tr> <tr><td>-2</td><td></td></tr> <tr><td>-1</td><td></td></tr> <tr><td>0</td><td></td></tr> <tr><td>1</td><td></td></tr> <tr><td>2</td><td></td></tr> <tr><td>3</td><td></td></tr> </tbody> </table>	x	$y = x^2 + 2$	-3		-2		-1		0		1		2		3		
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3																		

- Use the step method to graph $y = -\frac{1}{4}x^2 + 1$ ($y = -0.25x^2 + 1$)

Equation	$y = -\frac{1}{4}x^2 + 1$	Graph the equation. 																
Vertex?	(0, 1)																	
Direction of Opening?	down																	
Step Pattern?	$-\frac{1}{4}, -\frac{3}{4}, -\frac{5}{4}$																	
Complete the table of values to CONFIRM the points on your graph	<table border="1"> <thead> <tr> <th>x</th> <th>$y = -0.25x^2 + 1$</th> </tr> </thead> <tbody> <tr><td>-3</td><td></td></tr> <tr><td>-2</td><td></td></tr> <tr><td>-1</td><td></td></tr> <tr><td>0</td><td></td></tr> <tr><td>1</td><td></td></tr> <tr><td>2</td><td></td></tr> <tr><td>3</td><td></td></tr> </tbody> </table>	x	$y = -0.25x^2 + 1$	-3		-2		-1		0		1		2		3		
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Adapted from OAME Support Resources for MBF3C – Quadratics I

4. Complete the table

Equation	Vertex	Step Pattern	Direction of Opening
$y = -(x+4)^2 + 6$	$(-4, 6)$	$-1, -3, -5$	down
$y = 4(x-4)^2 - 8$			
$y = 3(x+7)^2 - 4$	$(-7, -4)$	$3, 9, 15$	up
$y = -2(x-6)^2 + 10$			
$y = 2(x+3)^2 - 3$	$(-3, -3)$	$2, 6, 10$	Up
$y = -(x-7)^2 - 1$	$(7, -1)$	$-1, -3, -5$	Down
$y = 0.5(x+5)^2$	$(-5, 0)$	$0.5, 1.5, 2.5$	Up

5. Sketch the graphs of any four of the quadratics from the table above. Remember to label each graph with the appropriate equation.

