

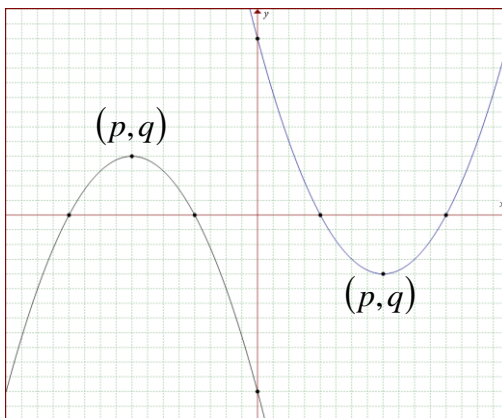
Vertex form of Quadratic Relations

The expression $y = a(x - p)^2 + q$ defines a quadratic relation called the **vertex form** with a horizontal translation of p units and vertical translation of q units.

The vertex of the quadratic relation is (p, q) and axis of symmetry is at $x = a$.

A quadratic relation in vertex form $y = a(x - p)^2 + q$ can be converted to standard form $y = ax^2 + bx + c$ by expanding and collecting like terms.

$y = a(x - p)^2 + q$
 $p < 0$ & $q > 0$
 Vertex : (p, q)
 Axis of Symmetry : $x = p$
 $a < 0$ Concaves down
 Reflects about x -axis



$y = a(x - p)^2 + q$
 $p > 0$ & $q < 0$
 Vertex : (p, q)
 Axis of Symmetry : $x = p$
 $a > 0$ Concave up

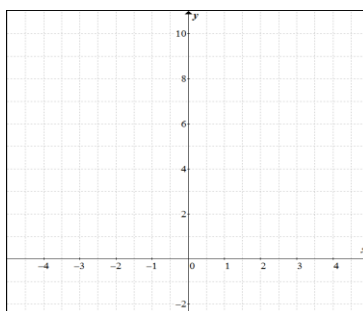
x - intercepts
 $x = p \pm \sqrt{\frac{-q}{a}}$

y - intercept
 $y = ap^2 + q$

Basic Points of a Quadratic Relation (Parabola)

$y = x^2$

x	y
-3	
-2	
-1	
0	
1	
2	
3	



Step Patterns:

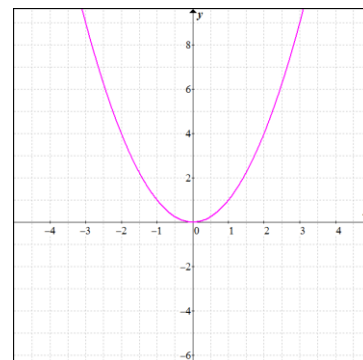
Example 1: Parabola with a Vertical Translation

Given the quadratic relation, determine the x - intercepts , y - intercept, direction of opening, axis of symmetry and the vertex. Determine a mapping rule and a sketch of the relation on the given grid.

Describe the translation.

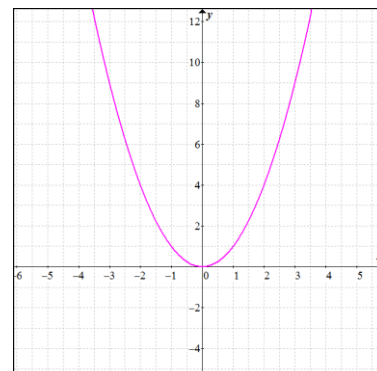
a) $y = x^2 - 4$

$(x, y) \rightarrow$	
x	y
-3	
-2	
-1	
0	
1	
2	
3	



b) $y = x^2 + 2$

$(x, y) \rightarrow$	
x	y
-3	
-2	
-1	
0	
1	
2	
3	

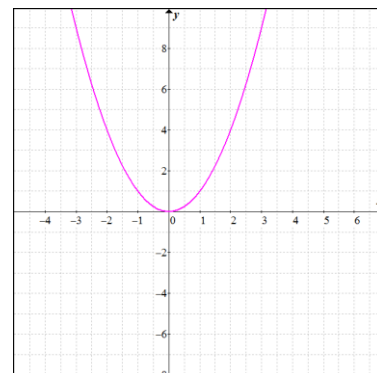


Example 2: Parabola with a Horizontal Translation

Given the quadratic relation, determine the x – intercepts , y – intercept, direction of opening, axis of symmetry and the vertex. Determine a mapping rule and a sketch of the relation on the given grid. Describe the translation.

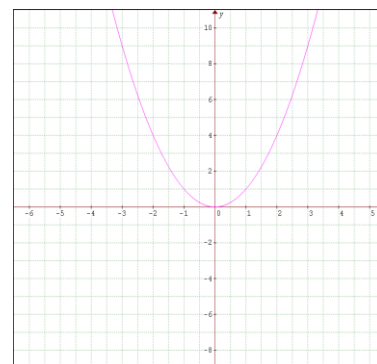
a) $y = (x - 3)^2$

$(x, y) \rightarrow$	
x	y



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

$(x, y) \rightarrow$	
x	y



The Quadratic Function (Vertex Form): Translations

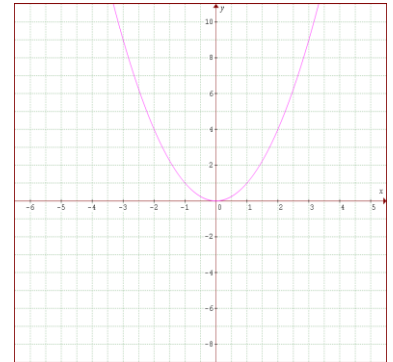
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Example 3: Parabola with Translations

Given the quadratic relation, determine a mapping rule and a sketch of the relation on the given grid. Describe the translation.

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

$(x, y) \rightarrow$	
x	y



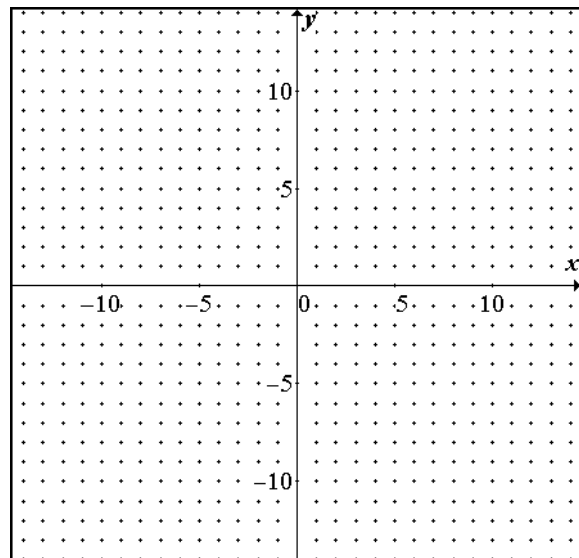
Exercise

1. Complete the chart:

Equation	vertex	x-intercepts (if any)	y-intercept	direction that curve opens	equation of axis of symmetry
a) $y = x^2$					
b) $y = x^2 + 4$					
c) $y = x^2 + 7$					
d) $y = x^2 - 2$					
e) $y = x^2 - 5$					
f) $y = x^2 + 1$					

2. Graph the following equations on the same set of axes using the answers you found in question 1. Label each parabola with its corresponding equation.

- a) $y = x^2$
- b) $y = x^2 + 4$
- c) $y = x^2 + 7$
- d) $y = x^2 - 2$
- e) $y = x^2 - 5$
- f) $y = x^2 + 1$



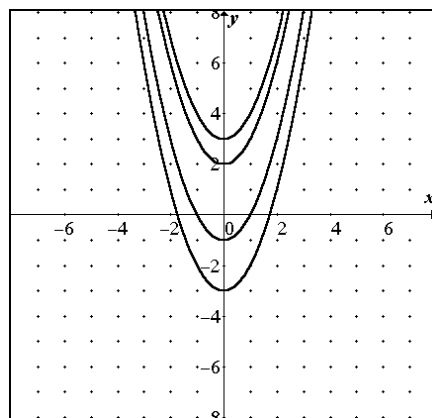
The Quadratic Function (Vertex Form): Translations

Date: _____

3. Describe the effect of various values of "q" on the graph of $y = x^2 + q$

4. Which graph best represents each of the following. (Label the graph with the appropriate letter)

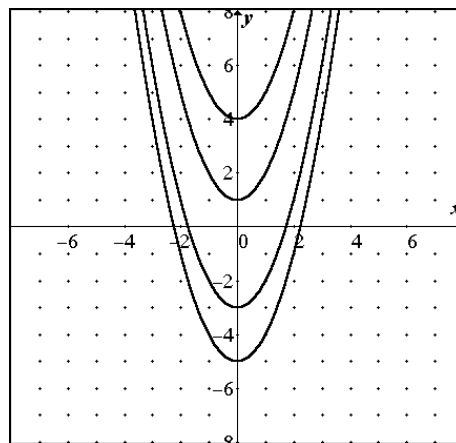
- a) $y = x^2 + 3$
- b) $y = x^2 - 3$
- c) $y = x^2 - 1$
- d) $y = x^2 + 2$



5. Write an equation that could correspond to each graph:

- a) _____
- b) _____
- c) _____
- d) _____

a b c d



6. Fill in the following chart:

Equation	direction of opening	coordinates of vertex	x-intercepts (if any)	y-intercept
$y = x^2 + 5$				
$y = x^2 - 3$				
$y = x^2 + 2$				
$y = x^2 + 4$				

7. For the general quadratic $y = x^2 + q$:

- a) What are the co-ordinates of the vertex? _____
- b) What restriction on the value of 'q' exists in order for x-intercepts to exist? _____

The Quadratic Function (Vertex Form): Translations

Date:

8. Complete the chart for each equation.

Equation	vertex	equation of axis of symmetry	x-intercepts (if any)	y-intercept
a) $y = x^2$				
b) $y = (x - 2)^2$				
c) $y = (x + 4)^2$				
d) $y = (x + 3)^2$				
e) $y = (x - 6)^2$				
f) $y = (x - 4)^2$				
g) $y = (x + 6)^2$				

9. Graph the following equations on the same set of axes using the answers you found in question 8. Label each parabola with its corresponding equation.

a) $y = x^2$

b) $y = (x - 2)^2$

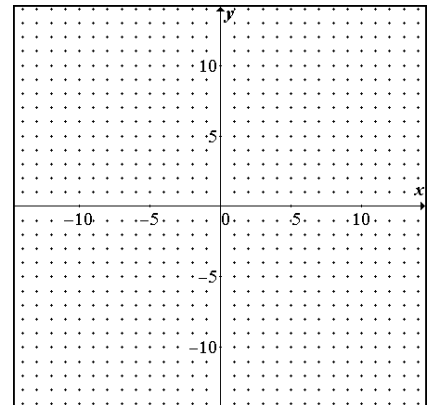
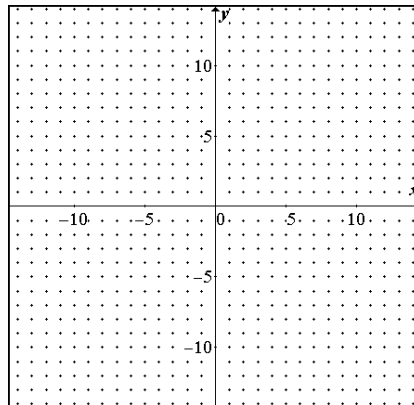
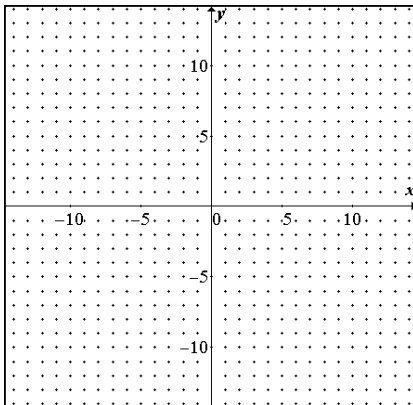
c) $y = (x + 4)^2$

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

e) $y = (x - 6)^2$

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

g) $y = (x + 6)^2$



10. Compare the graphs of $y = x^2$ and $y = (x - p)^2$ when:

a) $p > 0$

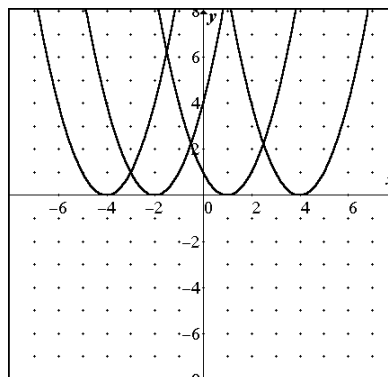
b) $p < 0$

The Quadratic Function (Vertex Form): Translations

Date:

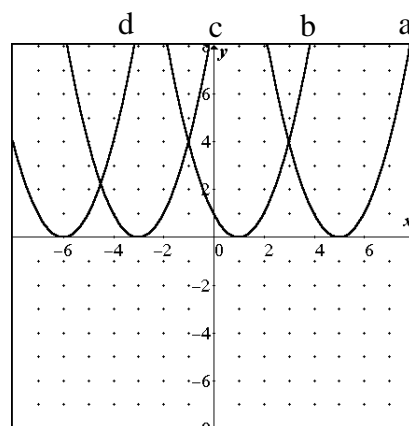
11. Which graph best represents each of the following. Label with appropriate letter.

- a) $y = (x - 1)^2$
- b) $y = (x + 2)^2$
- c) $y = (x + 4)^2$
- d) $y = (x - 4)^2$



12. Write an equation that could correspond to each graph:

- a) _____
- b) _____
- c) _____
- d) _____



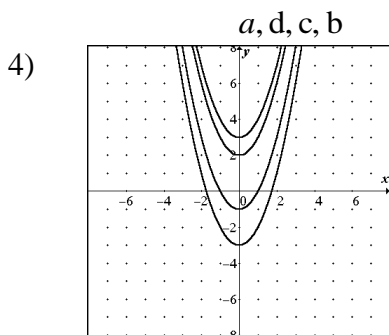
13. Complete the following chart:

Equation	co-ordinates of vertex	equation of axis of symmetry	direction of opening	x-intercept (if any)	y-intercept
a) $y = x^2$					
b) $y = (x + 3)^2$					
c) $y = -(x - 8)^2$					
d) $y = (x - 2)^2$					
e) $y = -(x + 4)^2$					

Answers

- 1a) Vertex: (0,0), x-int: 0, y-int: 0, opens up, $x = 0$
- b) Vertex: (0,4), x-int: NA, y-int: 4, opens up, $x = 0$
- c) Vertex: (0,7), x-int: NA, y-int: 7, opens up, $x = 0$
- d) Vertex: (0,-2), x-int: $\pm\sqrt{2}$, y-int: -2, opens up, $x = 0$
- e) Vertex: (0,-5), x-int: $\pm\sqrt{5}$, y-int: -5, opens up, $x = 0$
- f) Vertex: (0,1), x-int: NA, y-int: 1, opens up, $x = 0$

3) Vertical translations by q units



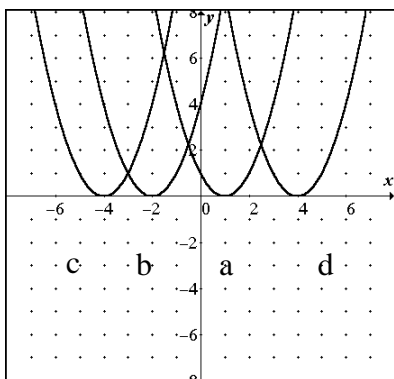
- 5)
- a) $y = x^2 - 5$
 - b) $y = x^2 - 3$
 - c) $y = x^2 + 4$
 - d) $y = x^2 + 1$

- 6a) Opens up, Vertex: (0,5), x-int: NA, y-int: 5
- 7a) (0, q) b) $q < 0$
- b) Opens up, Vertex: (0,-3), x-int: $\pm\sqrt{3}$, y-int: -3
- c) Opens up, Vertex: (0,2), x-int: NA, y-int: 2
- d) Opens up, Vertex: (0,4), x-int: NA, y-int: 4

- 8a) Vertex: (0,0), $x = 0$, x-int: 0, y-int: 0
- b) Vertex: (2,0), $x = 2$, x-int: 2, y-int: 4
- c) Vertex: (-4,0), $x = -4$, x-int: -4, y-int: 16
- d) Vertex: (-3,0), $x = -3$, x-int: -3, y-int: 9
- e) Vertex: (6,0), $x = 6$, x-int: 6, y-int: 36
- f) Vertex: (4,0), $x = 4$, x-int: 4, y-int: 16
- g) Vertex: (-6,0), $x = -6$, x-int: -6, y-int: 36

- 10. a) $p > 0$ Right by p .
- b) $p < 0$ Left by p

11.



- 12)
- a) $y = (x - 5)^2$
 - b) $y = (x - 1)^2$
 - c) $y = (x + 3)^2$
 - d) $y = (x + 6)^2$

- 13a) Vertex: (0,0), $x = 0$, opens up, x-int: 0, y-int: 0
- b) Vertex: (-3,0), $x = -3$, opens up, x-int: -3, y-int: 9
- c) Vertex: (8,0), $x = 8$, opens down, x-int: 8, y-int: -64
- d) Vertex: (2,0), $x = 2$, opens up, x-int: 2, y-int: 4
- e) Vertex: (-4,0), $x = -4$, opens down, x-int: -4, y-int: -16