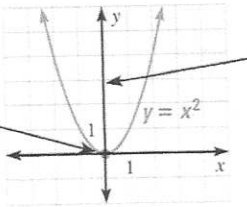
4.1 – Graph Quadratic Functions in Standard Form

Standard Form of a Quadratic Function: $y = ax^2 + bx + c$

KEY CONCEPT *For Your Notebook*

Parent Function for Quadratic Functions

The parent function for the family of all quadratic functions is $f(x) = x^2$. The graph of $f(x) = x^2$ is the parabola shown below.



The axis of symmetry divides the parabola into mirror images and passes through the vertex.

The lowest or highest point on a parabola is the vertex. The vertex for $f(x) = x^2$ is (0, 0).

For $f(x) = x^2$, and for any quadratic function $g(x) = ax^2 + bx + c$ where $b = 0$, the vertex lies on the y-axis and the axis of symmetry is $x = 0$.

Example 1 Graph Using a Table of Values

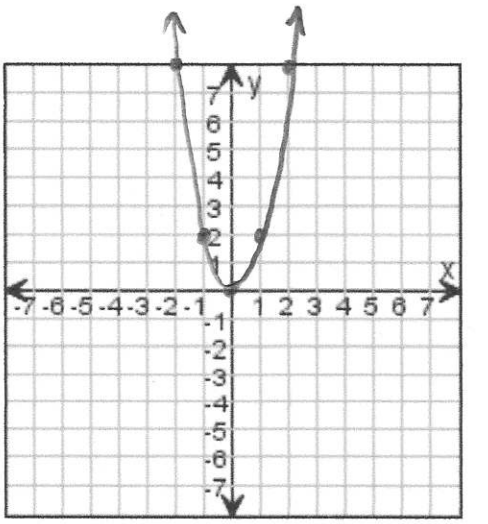
Graph $y = 2x^2$. Compare to the graph of $y = x^2$

S1 – make a table of values

x	-2	-1	0	1	2
y	8	2	0	2	8

S2 – plot the points from the table

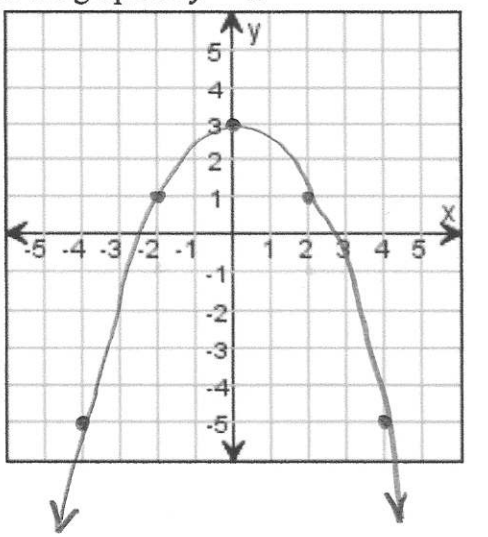
S3 – connect the points with a smooth curve



MINIMUM

Example 2 Graph the function $y = -\frac{1}{2}x^2 + 3$. Compare to the graph of $y = x^2$

x	-4	-2	0	2	4
y	-5	1	3	1	-5



MAXIMUM

The ***Axis of Symmetry*** (*aos*) divides the parabola in two symmetrical halves

The ***Vertex*** is either the minimum or maximum value of a parabola

Finding the axis of symmetry: $x = -\frac{b}{2a}$

Finding the vertex: plug *aos* x-value into original function to get a y-value

Example 3 Graph $y = 2x^2 - 8x + 6$

Step 1	Identify the coefficients a, b, and c
Step 2	Find the axis of symmetry, and draw the line
Step 3	Find the vertex, and plot the point
Step 4	Find the y-intercept, and plot the point (0, c)
Step 5	Find one more point on the same side of the axis of symmetry as the y-intercept, and plot the point
Step 6	Reflect the points across the axis of symmetry and connect them with a smooth curve

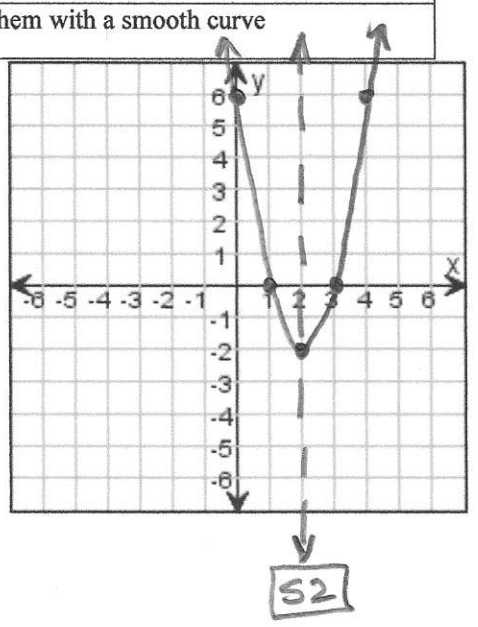
S1 - $a = 2$ $b = -8$ $c = 6$

S2 - $\left[x = -\frac{b}{2a} = -\frac{-8}{2(2)} = \frac{8}{4} = 2\right]$

S3 - $y = 2(2)^2 - 8(2) + 6$

$= 8 - 16 + 6$

$\boxed{y = -2} \longrightarrow V(2, -2)$



S4 - y-int. $= c$, $x = 0$

$(0, 6)$

S5 - let $\underline{x = 1}$ $y = 2(1)^2 - 8(1) + 6$

$= 2 - 8 + 6$

$\boxed{(1, 0)}$ $y = 0$

HW: (1-3), (5-29 e.o.o.)

1. **VOCABULARY** Copy and complete: The graph of a quadratic function is called a(n) __?__.

2. ★ **WRITING** *Describe* how to determine whether a quadratic function has a minimum value or a maximum value.

EXAMPLE 1 on p. 236 for Exs. 3–12

USING A TABLE **Copy and complete the table of values for the function.**

3. $y = 4x^2$

x	−2	−1	0	1	2
y	?	?	?	?	?

4. $y = -3x^2$

x	−2	−1	0	1	2
y	?	?	?	?	?

5. $y = \frac{1}{2}x^2$

x	−4	−2	0	2	4
y	?	?	?	?	?

6. $y = -\frac{1}{3}x^2$

x	−6	−3	0	3	6
y	?	?	?	?	?

MAKING A GRAPH **Graph the function.** ***Compare*** **the graph with the graph of $y = x^2$.**

7. $y = 3x^2$
8. $y = 5x^2$
9. $y = -2x^2$
10. $y = -x^2$
11. $f(x) = \frac{1}{3}x^2$
12. $g(x) = -\frac{1}{4}x^2$

EXAMPLE 2 on p. 237 for Exs. 13–18

13. $y = 5x^2 + 1$
14. $y = 4x^2 + 1$
15. $f(x) = -x^2 + 2$
16. $g(x) = -2x^2 - 5$
17. $f(x) = \frac{3}{4}x^2 - 5$
18. $g(x) = -\frac{1}{5}x^2 - 2$

ERROR ANALYSIS ***Describe*** **and correct the error in analyzing the graph of $y = 4x^2 + 24x - 7$.**

19.

The x-coordinate of the vertex is:

$x = \frac{b}{2a} = \frac{24}{2(4)} = 3$ ✗

20.

The y-intercept of the graph is the value of c, which is 7. ✗

EXAMPLE 3 on p. 238 for Exs. 21–32

MAKING A GRAPH **Graph the function. Label the vertex and axis of symmetry.**

21. $y = x^2 + 2x + 1$
22. $y = 3x^2 - 6x + 4$
23. $y = -4x^2 + 8x + 2$
24. $y = -2x^2 - 6x + 3$
25. $g(x) = -x^2 - 2x - 1$
26. $f(x) = -6x^2 - 4x - 5$
27. $y = \frac{2}{3}x^2 - 3x + 6$
28. $y = -\frac{3}{4}x^2 - 4x - 1$
29. $g(x) = -\frac{3}{5}x^2 + 2x + 2$
30. $f(x) = \frac{1}{2}x^2 + x - 3$
31. $y = \frac{8}{5}x^2 - 4x + 5$
32. $y = -\frac{5}{3}x^2 - x - 4$