# Lesson 12: Graphing the Standard Form (Part 1)

- Let's see how the numbers in expressions like $-3x^2 + 4$ affect their graph.

12.1: Matching Graphs to Linear Equations

Graphs A, B, and C represent 3 linear equations: $y = 2x + 4$, $y = 3 - x$, and $y = 3x - 2$. Which graph corresponds to which equation? Explain your reasoning.
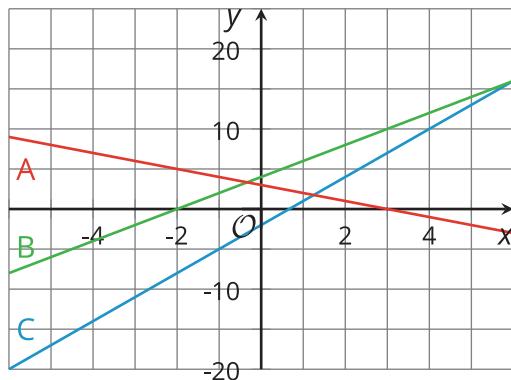
12.2: Quadratic Graphs Galore

Using graphing technology, graph $y = x^2$, and then experiment with each of the following changes to the function. Record your observations (include sketches, if helpful).

1. Adding different constant terms to x^2 (for example: $x^2 + 5$, $x^2 + 10$, $x^2 - 3$, etc.)

2. Multiplying x^2 by different positive coefficients greater than 1 (for example: $3x^2$, $7.5x^2$, etc.)

3. Multiplying x^2 by different negative coefficients less than or equal to -1 (for example: $-x^2$, $-4x^2$, etc.)

4. Multiplying x^2 by different coefficients between -1 and 1 (for example: $\frac{1}{2}x^2$, $-0.25x^2$, etc.)

Are you ready for more?
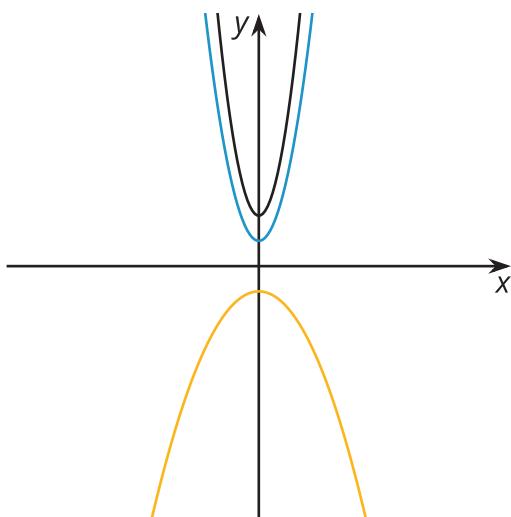
Here are the graphs of three quadratic functions. What can you say about the coefficients of x^2 in the expressions that define f (in black at the top), g (in blue in the middle), and h (in yellow at the bottom)? Can you identify them? How do they compare?

12.3: What Do These Tables Reveal?

1. a. Complete the table with values of $x^2 + 10$ and $x^2 - 3$ at different values of x. (You may also use a spreadsheet tool, if available.)

x	-3	-2	-1	0	1	2	3
x^2	9	4	1	0	1	4	9
$x^2 + 10$							
$x^2 - 3$							

   b. Earlier, you observed the effects on the graph of adding or subtracting a constant term from x^2. Study the values in the table. Use them to explain why the graphs changed they way they did when a constant term is added or subtracted.

2. a. Complete the table with values of $2x^2$, $\frac{1}{2}x^2$, and $-2x^2$ at different values of x. (You may also use a spreadsheet tool, if available.)

x	-3	-2	-1	0	1	2	3
x^2	9	4	1	0	1	4	9
$2x^2$							
$\frac{1}{2}x^2$							
$-2x^2$							

   b. You also observed the effects on the graph of multiplying x^2 by different coefficients. Study the values in the table. Use them to explain why the graphs changed they way they did when x^2 is multiplied by a number greater than 1, by a negative number less than or equal to -1, and by numbers between -1 and 1.

12.4: Card Sort: Representations of Quadratic Functions

Your teacher will give your group a set of cards. Each card contains a graph or an equation.

- Take turns with your partner to sort the cards into sets so that each set contains two equations and a graph that all represent the same quadratic function.

- For each set of cards that you put together, explain to your partner how you know they belong together.

- For each set that your partner puts together, listen carefully to their explanation. If you disagree, discuss your thinking and work to reach an agreement.

- Once all the cards are sorted and discussed, record the equivalent equations, sketch the corresponding graph, and write a brief note or explanation about why the representations were grouped together.

Standard form:
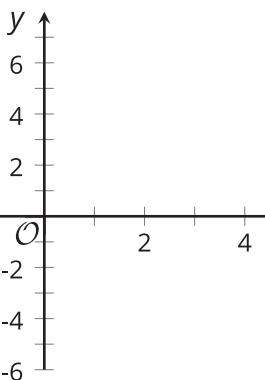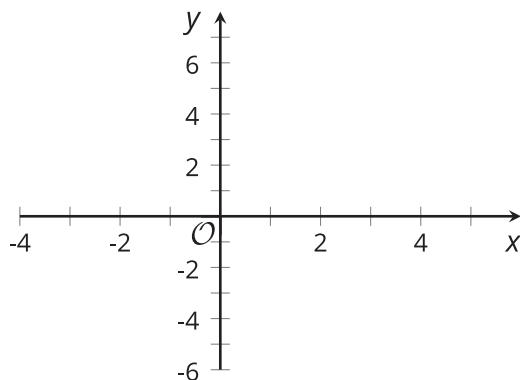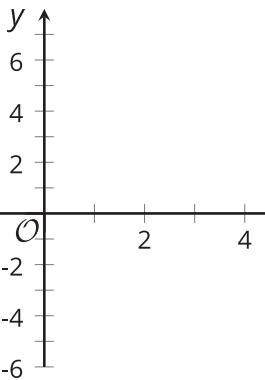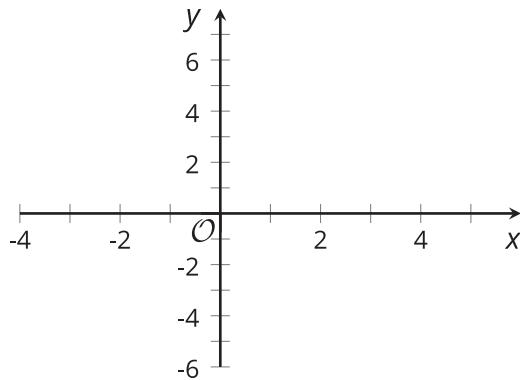
Factored form:

Explanation:

Standard form:

Factored form:

Explanation:
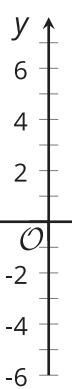
Standard form:

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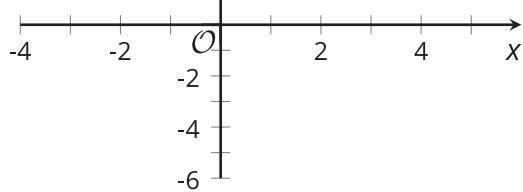
Explanation:

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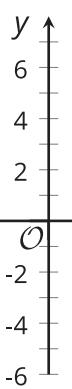
Factored form:

Explanation:
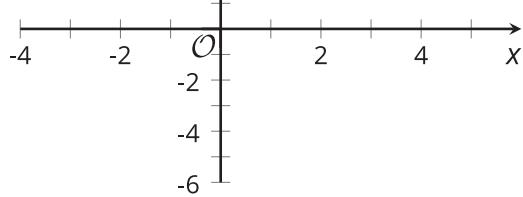
Lesson 12 Summary

Remember that the graph representing any quadratic function is a shape called a *parabola*. People often say that a parabola "opens upward" when the lowest point on the graph is the vertex (where the graph changes direction), and "opens downward" when the highest point on the graph is the vertex. Each coefficient in a quadratic expression written in standard form $ax^2 + bx + c$ tells us something important about the graph that represents it.

The graph of $y = x^2$ is a parabola opening upward with vertex at $(0,0)$. Adding a constant term 5 gives $y = x^2 + 5$ and raises the graph by 5 units. Subtracting 4 from x^2 gives $y = x^2 - 4$ and moves the graph 4 units down.


x	-3	-2	-1	0	1	2	3
x^2	9	4	1	0	1	4	9
$x^2 + 5$	14	9	6	5	6	9	14
$x^2 - 4$	5	0	-3	-4	-3	0	5
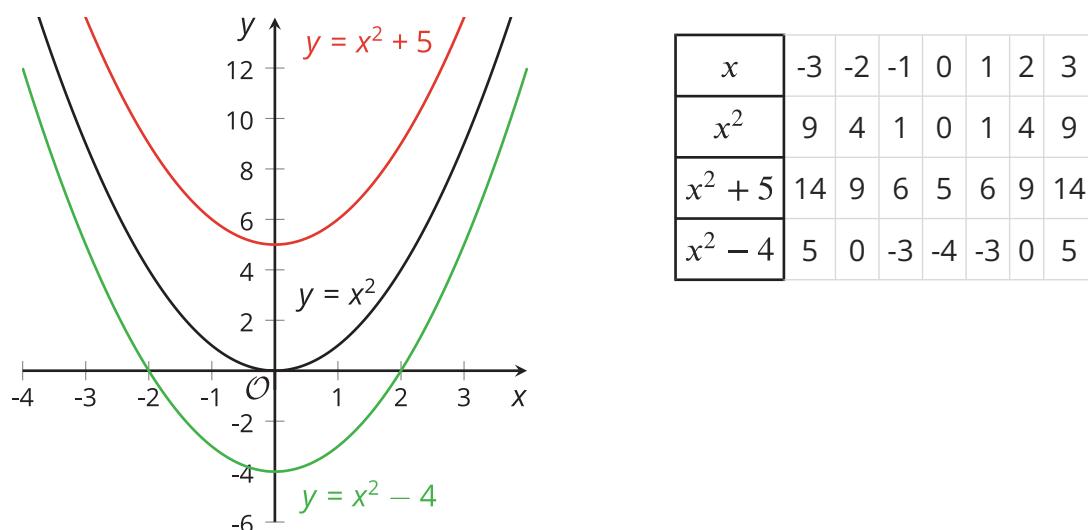
A table of values can help us see that adding 5 to x^2 increases all the output values of $y = x^2$ by 5, which explains why the graph moves up 5 units. Subtracting 4 from x^2 decreases all the output values of $y = x^2$ by 4, which explains why the graph shifts down by 4 units.

In general, the constant term of a quadratic expression in standard form influences the vertical position of the graph. An expression with no constant term (such as x^2 or $x^2 + 9x$) means that the constant term is 0, so the y-intercept of the graph is on the x-axis. It's not shifted up or down relative to the x-axis.

The coefficient of the squared term in a quadratic function also tells us something about its graph. The coefficient of the squared term in $y = x^2$ is 1. Its graph is a parabola that opens upward.

- Multiplying x^2 by a number greater than 1 makes the graph steeper, so the parabola is narrower than that representing x^2.

- Multiplying x^2 by a number less than 1 but greater than 0 makes the graph less steep, so the parabola is wider than that representing x^2.

- Multiplying x^2 by a number less than 0 makes the parabola open downward.

x	-3	-2	-1	0	1	2	3
x^2	9	4	1	0	1	4	9
$2x^2$	18	8	2	0	2	8	18
$-2x^2$	-18	-8	-2	0	-2	-8	-18
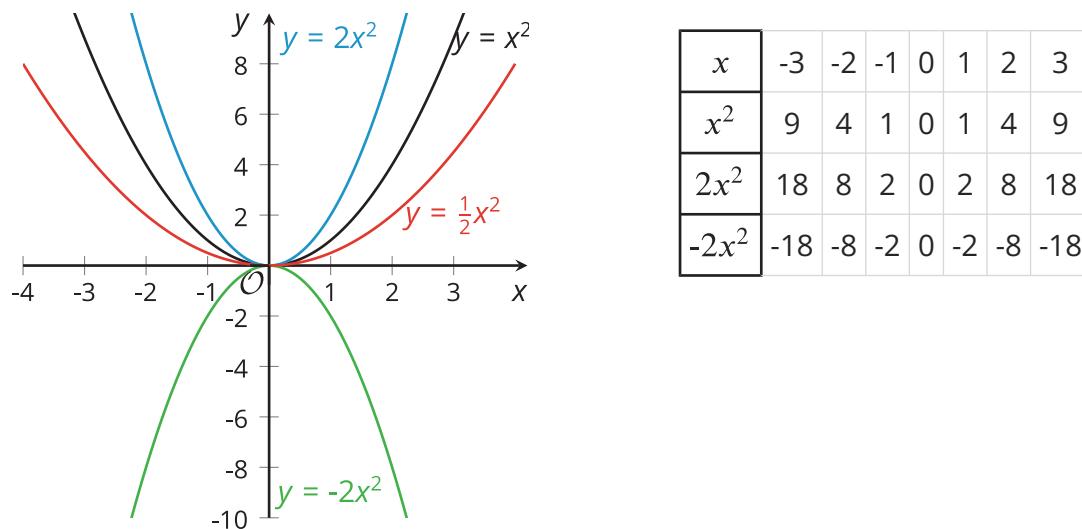
If we compare the output values of $2x^2$ and $-2x^2$, we see that they are opposites, which suggests that one graph would be a reflection of the other across the x-axis.