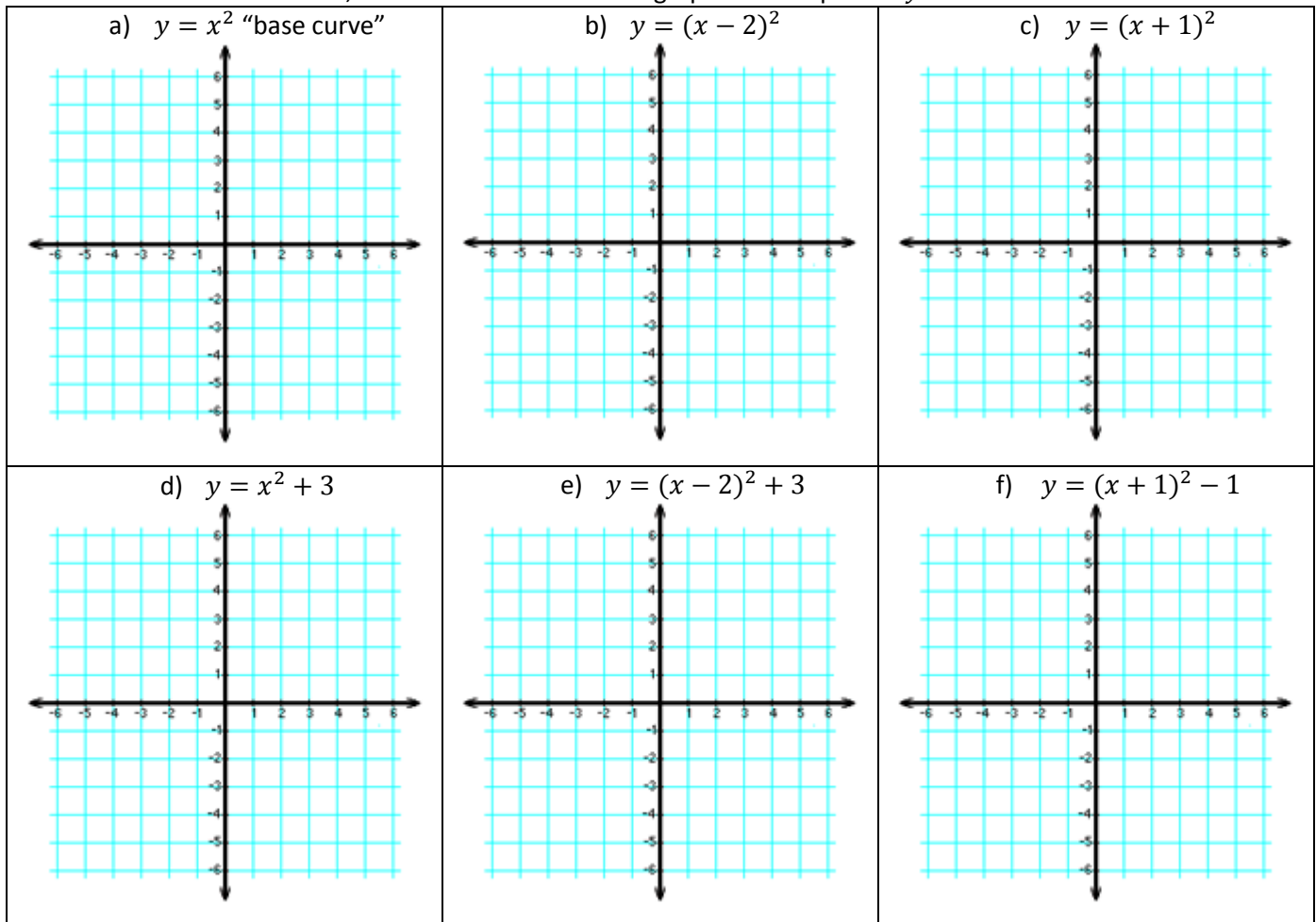Purpose: To explore translations of functions to determine how graphs can be shifted and flipped.

1) Accurately sketch these polynomials on the coordinate planes below. State the locations of their vertices. Notice how all the sketches resemble, but are different than the graph of the equation $y = x^2$.

a) $y = x^2$ "base curve"	b) $y = (x - 2)^2$	c) $y = (x + 1)^2$
d) $y = x^2 + 3$	e) $y = (x - 2)^2 + 3$	f) $y = (x + 1)^2 - 1$

2) Without graphing these polynomials, describe how the graph of $y = x^2$ can be shifted to get a sketch of their graphs by filling in the blanks.

a) $y = (x - 1)^2 + 3$	b) $y = (x + 2)^2 - 1$	c) $y = (x + 1)^2$
"Move the graph of $y = x^2$ _____ units to the right and _____ units up."	"Move the graph of $y = x^2$ two units to the _____ and one unit down."	"Move the graph of $y = x^2$ _____ units to the _____ and _____ unit _____."

3) Without graphing these polynomials, describe how the graph of $y = x^3$ can be shifted to get a sketch of their graphs by filling in the blanks.

a) $y = (x + 1)^3 - 2$	b) $y = (x + 5)^3 - 3$	c) $y = (x - 7)^3 + 8$
"Move the graph of $y = x^3$ _____ units to the left and _____ units down."	"Move the graph of $y = x^3$ five units to the _____ and three units down."	"Move the graph of $y = x^3$ _____ units to the _____ and _____ units _____."

4) Graph equation #1: $y = x^3 - x$ and #2: $y = -x^3 + x$ to help you respond to these problems using complete sentences:

    a) Explain how the equations are different.

    b) Explain how the graphs are different.

5) Graph equation #3: $y = x^3 + 1$ and #4: $y = -x^3 - 2$ to help you respond to these problems using complete sentences:

    c) Explain how the graph of $y = x^3$ would have to be shifted to graph equation #3.

    d) Explain how the graph of $y = x^3$ would have to be flipped and sifted to graph equation #4.

    e) Why does the graph of equation #3 not involve a flip?

6) Use the following comments to write an equation that exactly matches each comment.

"Move the graph of $y = x^2$ 10 units to the right and 8 units up."	"Move the graph of $y = x^3$ 3 units to the left and 5 units up."	"Flip the graph of $y = x^4$ over the x-axis, move it 3 units to the left and 18 units down."
$y = (x \quad)$	$y = (x \quad)$	$y = (x \quad)$

7) Write a brief summary how knowledge of equations can be used to acquire the shapes of curves using shifts and flips using two of your own examples.