

9-5 Transforming Quadratic Functions

$$f(x) = ax^2 + bx + c$$

Graph the functions.

1. $f(x) = x^2$

2. $g(x) = \frac{1}{2}x^2$

3. $h(x) = 3x^2$

4. $j(x) = -3x^2$

What effect does changing "a" have on the graph?

$0 < 1$, $a > 0$ WIDER

$a > 1$ NARROWER

$-a$ OPENS DOWNWARD

Graph the functions.

1. $f(x) = x^2$

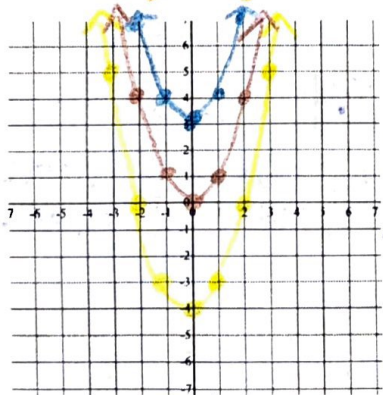
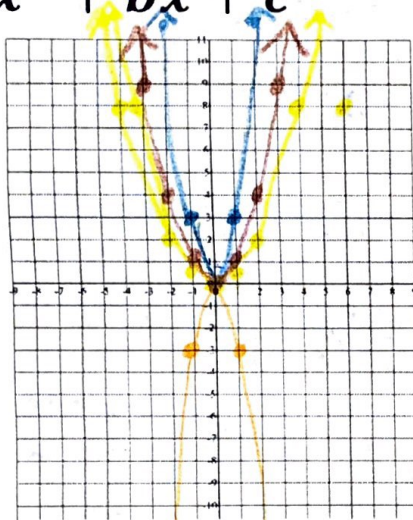
2. $g(x) = x^2 - 4$

3. $h(x) = x^2 + 3$

What effect does changing "c" have on the graph?

SHIFTS THE PARABOLA UP OR DOWN. $+ \uparrow$, $- \downarrow$

* AFFECTS y-INTERCEPT



EXAMPLES:

1. Order the functions from narrowest to widest.

$f(x) = 3x^2$

$g(x) = -\frac{1}{3}x^2$

$h(x) = x^2 + 4$

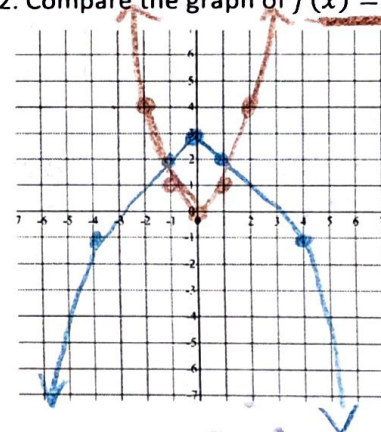
①

③

②

$f(x)$, $h(x)$, $g(x)$

2. Compare the graph of $f(x) = x^2$ to the graph of $g(x) = -\frac{1}{4}x^2 + 3$.



$$g(x) = -\frac{1}{4}x^2 + 0x + 3$$

x	g(x)	y
0		3
1		≈ 2
4		-1

$$-\frac{1}{4} + \frac{12}{4} = \frac{11}{4}$$

- 1) WIDTH: $g(x)$ IS WIDER THAN $f(x)$.
- 2) OPENS $\uparrow \downarrow$: $f(x)$ OPENS UPWARD. $g(x)$ OPENS DOWNWARD.
- 3) AOS: SAME
- 4) VERTEX / SHIFT UP/DOWN:
 - THE VERTEX OF $f(x)$ IS $(0, 0)$.
 - THE VERTEX OF $g(x)$ IS $(0, 3)$.

STANDARD FORM $y = ax^2 + bx + c$

(Transforming Quadratic Functions Continued)

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

a	width - vertical stretch (narrower) or shrink (wider) <ul style="list-style-type: none"> • a BETWEEN 0 AND 1 - SHRINK ↖ ↗ • a GREATER THAN 1 - STRETCH ↖ ↗ • -a reflect/flip ACROSS X-AXIS ↕
h	horizontal shift (left/right) <ul style="list-style-type: none"> • *opposite of sign inside parentheses • -h SHIFTS RIGHT • +h SHIFTS LEFT
k	vertical shift (up/down) <ul style="list-style-type: none"> • + SHIFT UP • - SHIFT DOWN
vertex	(h, k) (x, y) <ul style="list-style-type: none"> • *h is the opposite of what's inside the parentheses

EXAMPLES:

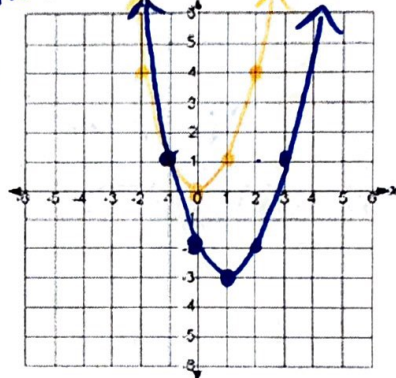
Compare the functions in vertex form to the parent function $y = x^2$.

1. $y = (x - 4)^2 + 5$
 NO STRETCH/SHRINK
 VERTEX: (4, 5)
 ALL POINTS SHIFTED 4 RIGHT AND UP 5.

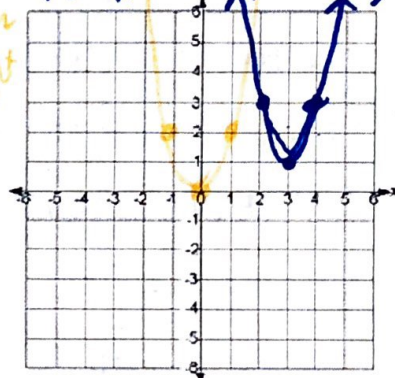
2. $f(x) = 3(x + 2)^2 - 4$
 STRETCHED BY A FACTOR OF 3
 VERTEX: (-2, -4)
 ALL POINTS SHIFTED 2 LEFT AND DOWN 4.

Graph the functions.

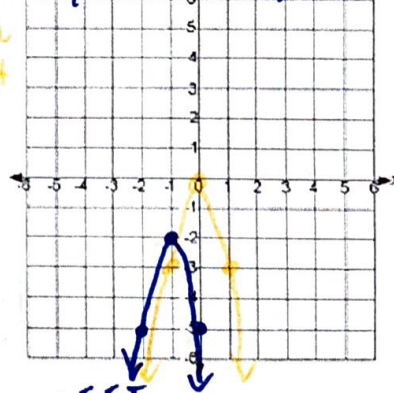
3. $y = (x - 1)^2 - 3$
 NO STRETCH → (1, -3)
 ↘ 1, ↙ 3



4. $y = 2(x - 3)^2 + 1$
 STRETCH → (3, 1)
 ↘ 3, ↙ 1



5. $y = -3(x + 1)^2 - 2$
 STRETCH/FLIP ← (-1, -2)
 ↘ 1, ↙ 2



6. $y = \frac{1}{2}(x - 2)^2 + 3$
 SHRINK → (2, 3)
 ↘ 2, ↙ 3

