Day 1: Graphing Absolute Value

Warm-Up:

1) Write down all the transformations of the graph of $y = x^2$.

a. $y = (x + h)^2$ moves the graph of $y = x^2$ h left

b. $y = (x - h)^2$ moves the graph of $y = x^2$ h right

c. $y = (x)^2 + k$ moves the graph of $y = x^2$ k up

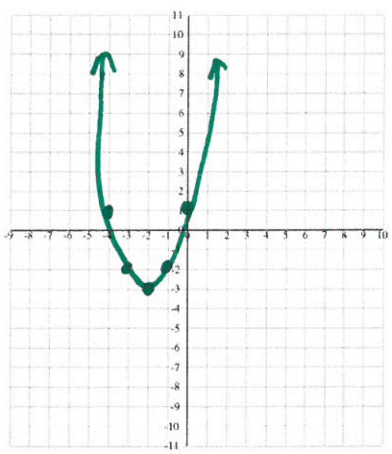
d. $y = (x)^2 - k$ moves the graph of $y = x^2$ k down

Graph each function. Be as accurate as you can. Remember to graph at least 5 points. Then indicate the transformations from the parent graph.

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

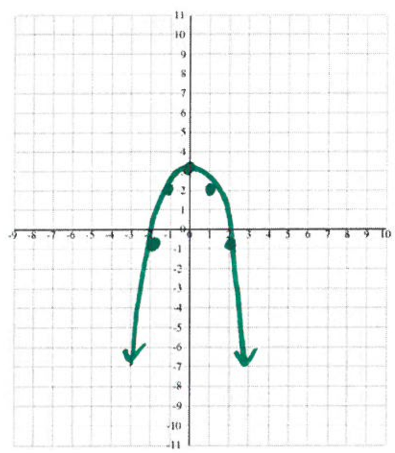
-4	1
-3	-2
-2	-3
-1	-2
0	1

A.of S.
x = -2



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

-2	-1
-1	2
0	3
1	2
2	-1



Graphing Absolute Value Functions

A function of the form $f(x) = | mx + b | + c$, where $m \neq 0$ is an **absolute value function**.

$$|x| = \begin{cases} -x, & \text{if } x<0 \\ x, & \text{if } x=0 \\ x, & \text{if } x>0 \end{cases}$$

Let's play in our calculator with graphing absolute value functions.

Calculator Instructions (picture directions on the Day 1 Power Point)

1. Go to **Y_1** =

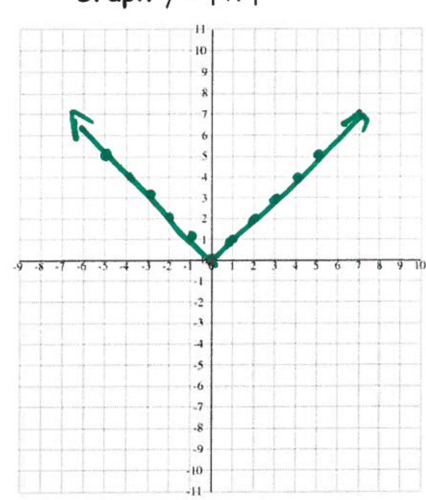
2. Then hit **MATH**

3. Scroll left to **NUM**

4. Hit Enter on **1: abs(**

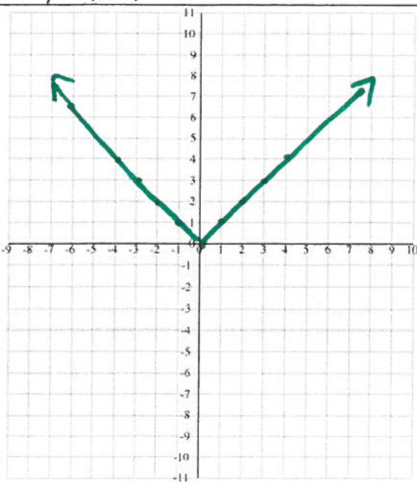
5. Type in equation. Example $y = | x |$ should look like **abs(x)**.
   Hit the graph key and adjust the window as needed.

Graph $y = | x |$

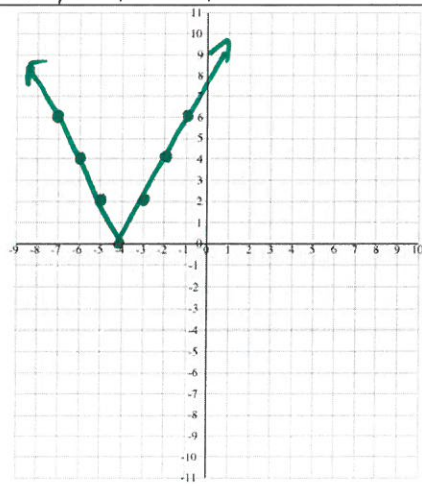


Graph the following in your calculator, use the list function to plot points and sketch the graph.

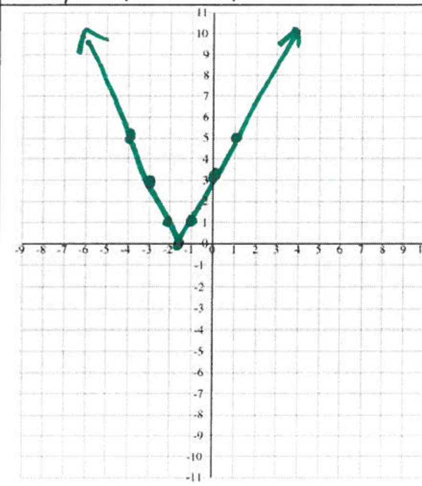
1. $y = |x|$



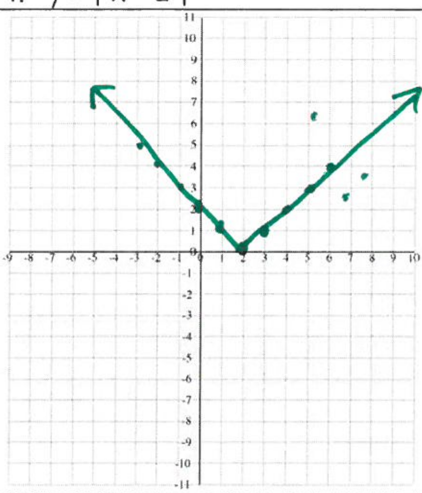
2. $y = 2|x + 4|$



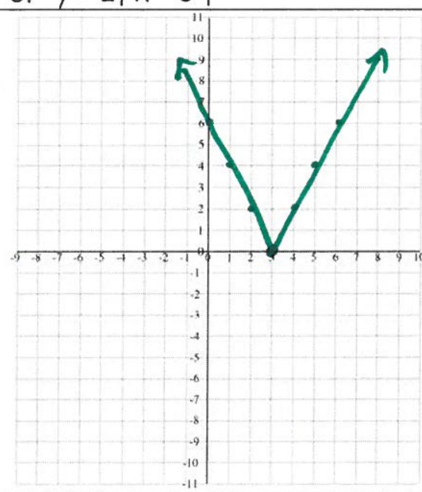
3. $y = 2|x + 1.5|$



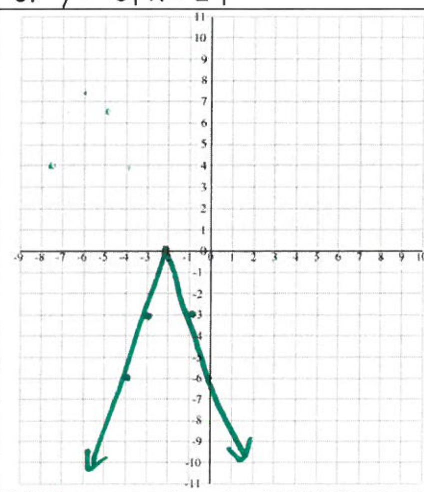
4. $y = |x - 2|$



5. $y = 2|x - 3|$



6. $y = -3|x + 2|$



7. What is a zero of a function? Where are the zeros on each of the above graphs?

A zero is the x-intercept, where it hits the x-axis. ↳ the zeros are at the vertex

8. Where is the vertex of each graph?

1. $y = \|x\|$	(0,0)	4. $y = \|x - 2\|$	(2,0)
2. $y = 2\|x + 4\|$	(-4,0)	5. $y = 2\|x - 3\|$	(3,0)
3. $y = 2\|x + 1.5\|$	(-1.5,0)	6. $y = -3\|x + 2\|$	(-2,0)

9. Using the pattern, what is the vertex of $y = a|x - h|$?

(h,0)

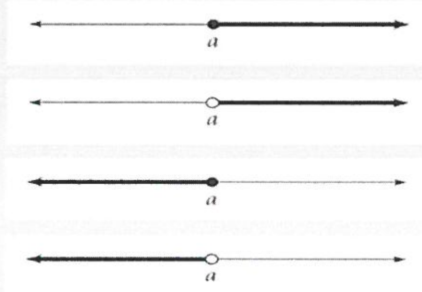
10. How does "a" affect the graph?

"a" affects the slope of each side

Expressing Domain and Range with Interval Notation

Infinite Intervals

Interval Notation	Set Notation	Graph	Type
$[a, \infty)$	$\{x \mid x \geq a\}$		Closed
(a, ∞)	$\{x \mid x > a\}$		Open
$(-\infty, a]$	$\{x \mid x \leq a\}$		Closed
$(-\infty, a)$	$\{x \mid x < a\}$		Open



Express the values of x in interval notation.

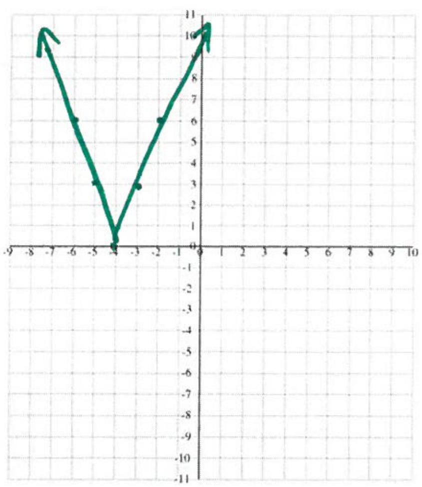
1) $x \geq 5$ $[5, \infty)$

2) x is all real numbers $(-\infty, \infty)$

3) $-1 < x \leq 8$ $(-1, 8]$

4) $x \leq -3$ *or* $x > 6$ $(-\infty, -3] \cup (6, \infty)$

Example: Graph y = 3| x + 4 | without your calculator.



Step 1: Identify the vertex.

Step 2: Make a table of values (be sure that the x value from step 1 and values around that x-value are included:

x	-8	-6	-4	-2	0	2
y	12	6	0	6	12	18

Step 3: Graph the function using the table

Domain: $(-\infty, \infty)$ Range: $[0, \infty)$

Example: The graph at the right models a car traveling at a constant speed.

a. Describe the relation shown in the graph.

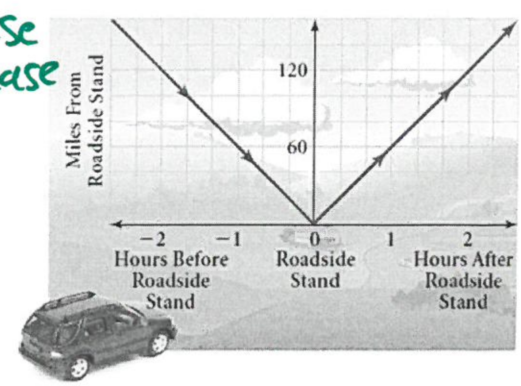
miles from the roadside stand increase as hours from roadside stand increase

b. Which equation best represents the relation?

a. y = |60x|
b. y = |x + 60|
c. y = |60 - x|
d. y = |x| + 60

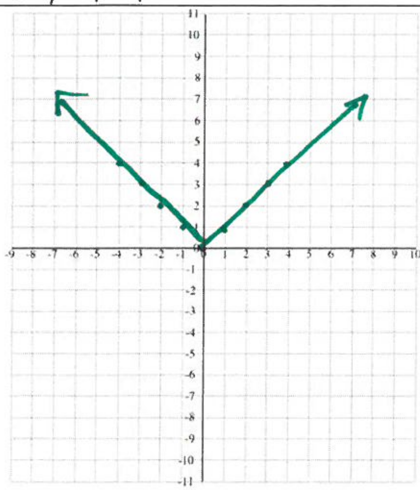
$m = \frac{rise}{run} = \frac{60}{1}$

v: (0,0)



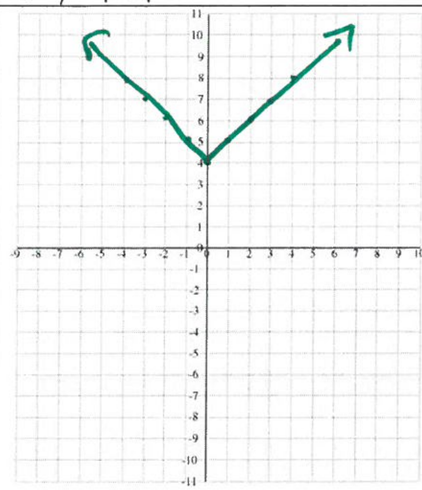
Graph the following in your calculator, use the list function to plot points and sketch the graph. Then determine the domain and range in interval notation!!

1. $y = |x|$



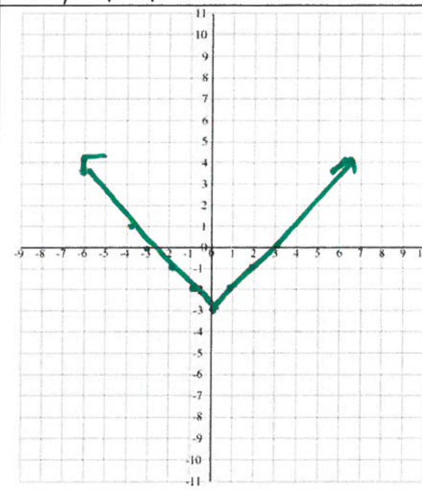
Domain: $(-\infty, \infty)$
Range: $[0, \infty)$

2. $y = |x| + 4$



Domain: $(-\infty, \infty)$
Range: $[4, \infty)$

3. $y = |x| - 3$



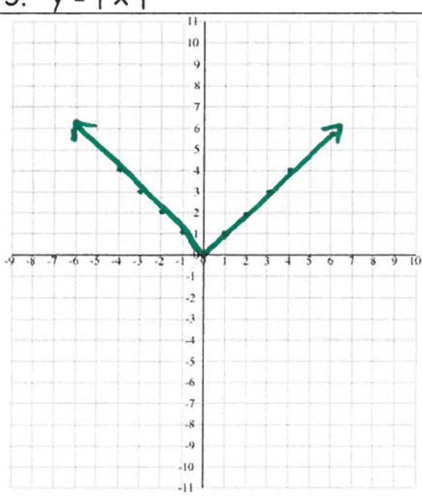
Domain: $(-\infty, \infty)$
Range: $[3, \infty)$

4. Compare the graphs of the 3 functions. What does the "k" do in the graph $y = a|x - h| + k$?

- k moves the graph up and down
- k is the y value of the vertex of the graph

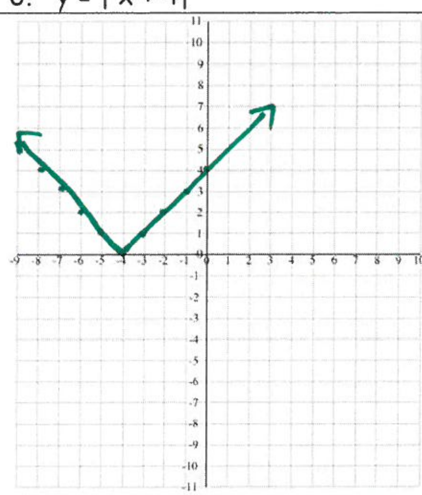
Graph the following in your calculator, use the list function to plot points and sketch the graph. Then determine the domain and range in interval notation!!

5. $y = |x|$



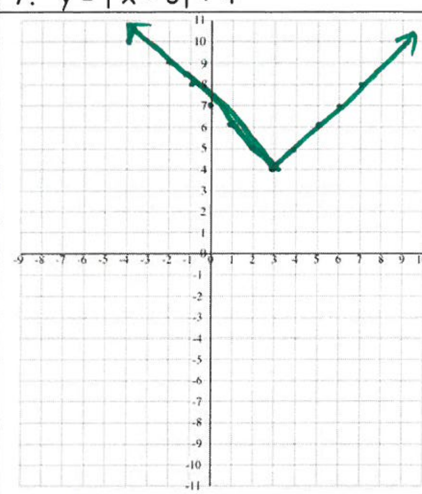
Domain: (∞, ∞)
Range: $[0, \infty)$

6. $y = |x + 4|$



Domain: $(-\infty, \infty)$
Range: $[0, \infty)$

7. $y = |x - 3| + 4$



Domain: $(-\infty, \infty)$
Range: $[4, \infty)$

8. Compare the graphs of the 3 functions. What does the "h" do in the graph $y = a|x - h| + k$

- h moves the graph left and right
- h gives the x-value of the vertex of the graph

Transformations

$$y = -a\,|x - h| + k$$

reflect over x-axis

a > 1, then vertical stretch
a < 1, then vert. compression

moves left or right
+ −

moves up or down
+ −

Remember that (h, k) is your vertex

Identify the transformations from the parent. Also determine the domain and range for each function.

1. $y = 3|x + 2| - 3$ left 2, down 3, vertical stretch by 3

   Domain: $(-\infty, \infty)$ Range: $[-3, \infty)$

2. $y = |x - 1| + 2$ right 1, up 2

   Domain: $(-\infty, \infty)$ Range: $[2, \infty)$

3. $y = 2|x + 3| - 1$ left 3, down 1, vertical stretch by 3

   Domain: $(-\infty, \infty)$ Range: $[-1, \infty)$

4. $y = -1/3|x - 2| + 1$ right 2, up 1, vertical compression by 1/3, reflect over x-axis

   Domain: $(-\infty, \infty)$ Range: $(-\infty, 1]$

What can we do if an equation is not in vertex form? $y = |3x + 6| - 4$ $y = 3|x + 2| - 4$
factor GCF!

What would the slope be? $m = 3$

We'll use that as our GCF. Factor it out, then we can have vertex form! ☺

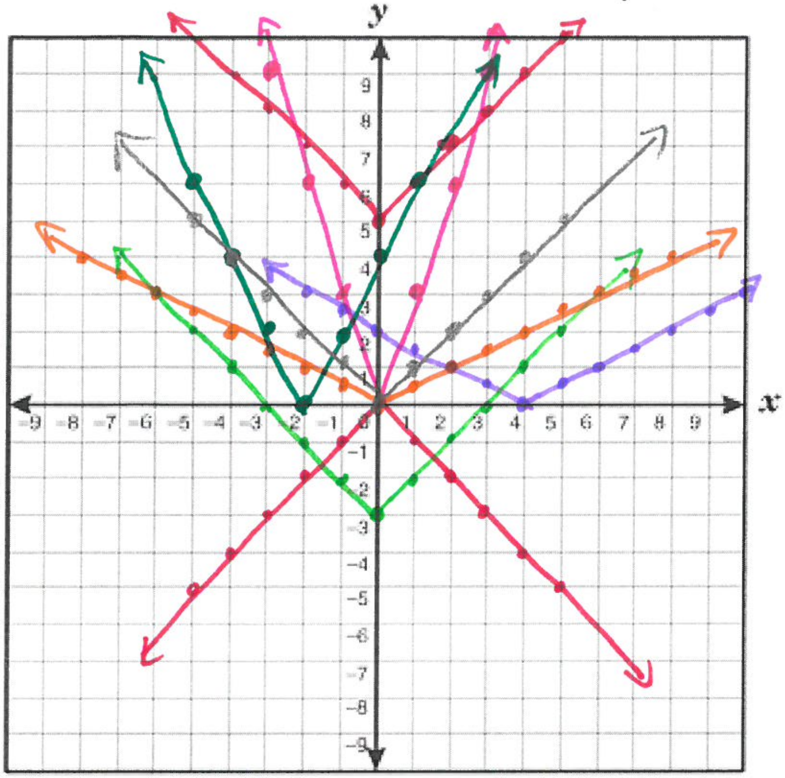
What is our vertex? $(-2, -4)$

How is it transformed from the parent? left 2, down 4, vertical stretch by 3

What is the domain? $(-\infty, \infty)$

What is the range? $[-4, \infty)$

Practice: Absolute Value Graphs & Transformations NO Calculators! ☺



Function:	Colored Pencil:
1) $f(x) = \lvert x\rvert$	**Regular Pencil!**
2) $f(x) = \lvert 2x + 4\rvert$	$f(x) = 2\lvert x+2\rvert$
3) $f(x) = \lvert 1/2x - 2\rvert$	$f(x) = \frac{1}{2}\lvert x-4\rvert$
4) $f(x) = \lvert x\rvert + 5$	$f(x) = \lvert x\rvert + 5$
5) $f(x) = \lvert x\rvert - 3$	$f(x) = \lvert x\rvert - 3$
6) $f(x) = 3\lvert x\rvert$	$f(x) = 3\lvert x\rvert$
7) $f(x) = ½\lvert x\rvert$	$f(x) = \frac{1}{2}\lvert x\rvert$
8) $f(x) = -\lvert x\rvert$	$f(x) = -\lvert x\rvert$

Description of Transformation and Domain & Range

1. Parent Function!	**Domain:** $(-\infty,\infty)$	**Range:** $[0,\infty)$
2. left 2, vertical stretch by 2	**Domain:** $(-\infty,\infty)$	**Range:** $[0,\infty)$
3. right 4, vertical compression by $\frac{1}{2}$	**Domain:** $(-\infty,\infty)$	**Range:** $[0,\infty)$
4. up 5	**Domain:** $(-\infty,\infty)$	**Range:** $[5,\infty)$
5. down 3	**Domain:** $(-\infty,\infty)$	**Range:** $[-3,\infty)$
6. vertical stretch by 3	**Domain:** $(-\infty,\infty)$	**Range:** $[0,\infty)$
7. vertical compression by 1/2	**Domain:** $(-\infty,\infty)$	**Range:** $[0,\infty)$
8. reflect over x-axis	**Domain:** $(-\infty,\infty)$	**Range:** $(-\infty, 0]$

Day 2: Graphing Square and Cube Roots

Warm-Up

1. Write down all the transformations of the graph of $y = x^2$.

a. $y = (x+h)^2$ moves the graph of $y = x^2$ h left

b. $y = (x-h)^2$ moves the graph of $y = x^2$ h right

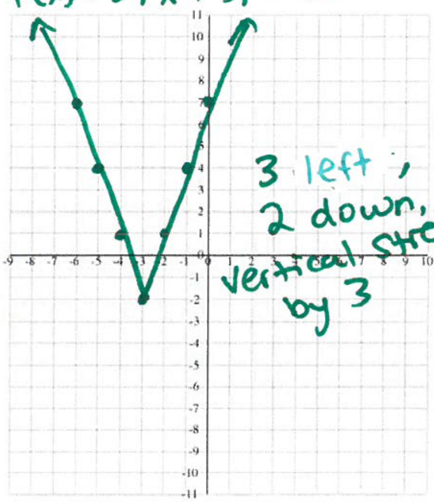
c. $y = (x)^2 + k$ moves the graph of $y = x^2$ k up

d. $y = (x)^2 - k$ moves the graph of $y = x^2$ k down

Graph each function then describe the transformations from the parent graph.

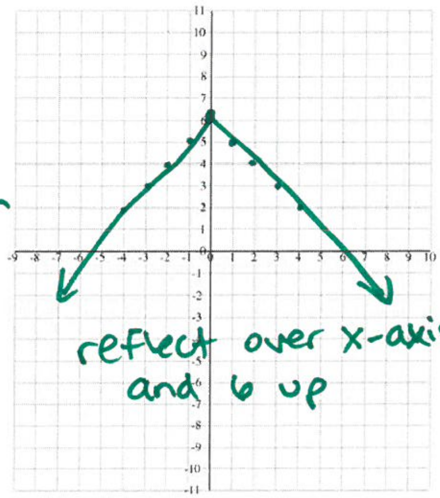
2) $f(x) = |3x + 9| - 2$

$f(x) = 3|x+3| - 2$



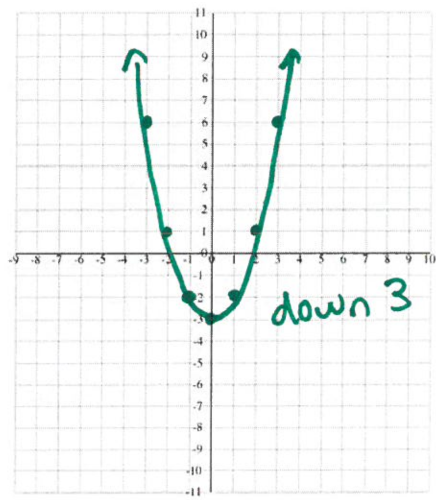
3 left, 2 down, vertical stretch by 3

3) $y = -|x| + 6$



reflect over x-axis and 6 up

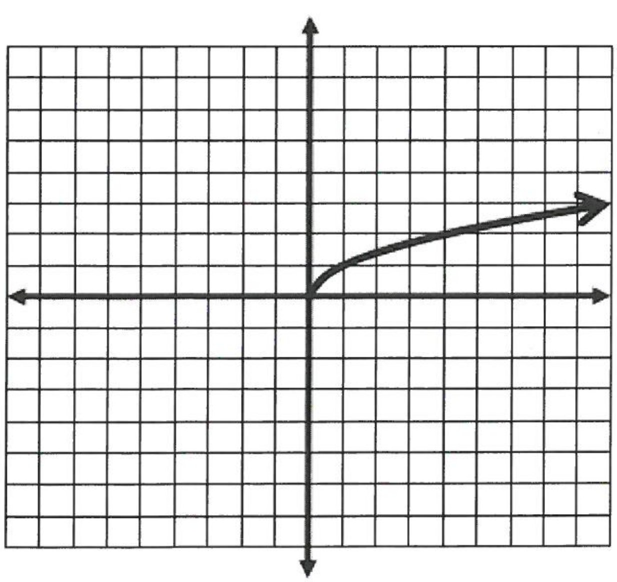
4) $f(x) = x^2 - 3$



down 3

Graphing the square root function:

$f(x) = \sqrt{x}$



Characteristics of the graph

Vertex : (0,0)

End Behavior As x goes to zero, y goes to zero. As x approaches ∞, y approaches ∞.

Domain [0, ∞)

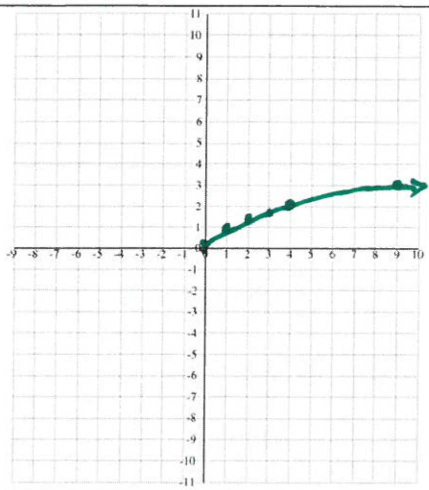
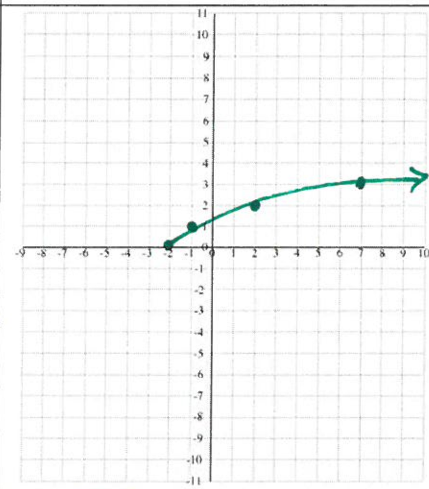
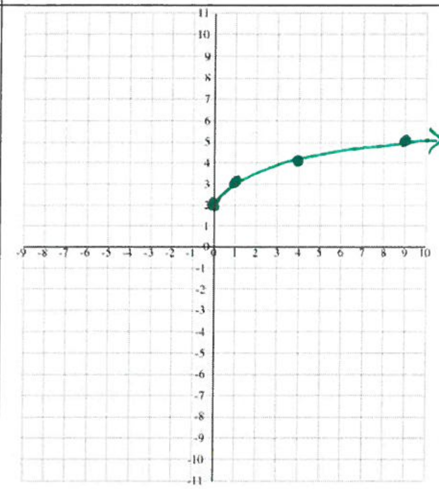
Range [0, ∞)

Symmetry none

Pattern Increasing over time

* use table in calculator for exact points

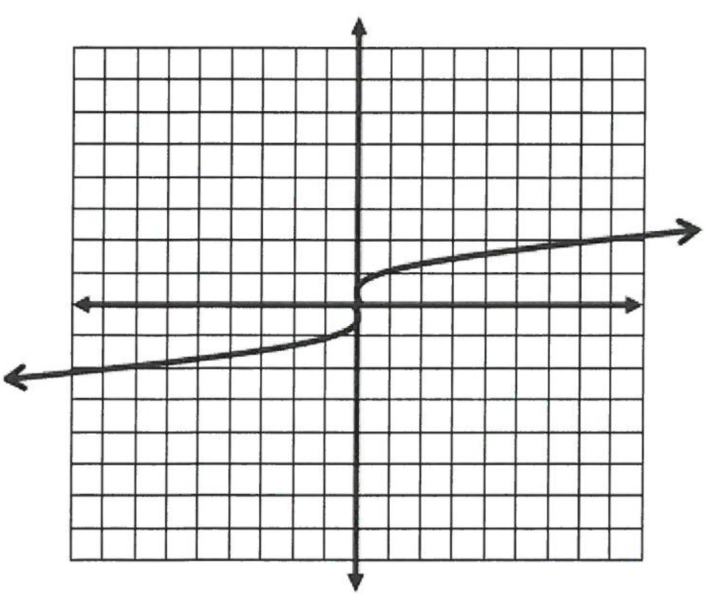
Graph the following in your calculator, use the list function to plot points and sketch the graph. Note the domain and range in interval notation.

1. $y=\sqrt{x}$	2. $y=\sqrt{x+2}$	3. $y=\sqrt{x}+2$
		
Domain: $[0,\infty)$ Range: $[0,\infty)$	Domain: $[-2,\infty)$ Range: $[0,\infty)$	Domain: $[0,\infty)$ Range: $[2,\infty)$

4. What happens when the 2 is under the radical? What happens when it is not? Have we seen this before?

- It translates left or right   - It translates up or down

The result: $f(x)=\sqrt[3]{x}$



Characteristics of the graph

Vertex : $(0,0)$

End Behavior As x goes to $-\infty$, y goes to $-\infty$. As x goes to ∞, y goes to $+\infty$,

Domain $(-\infty,\infty)$

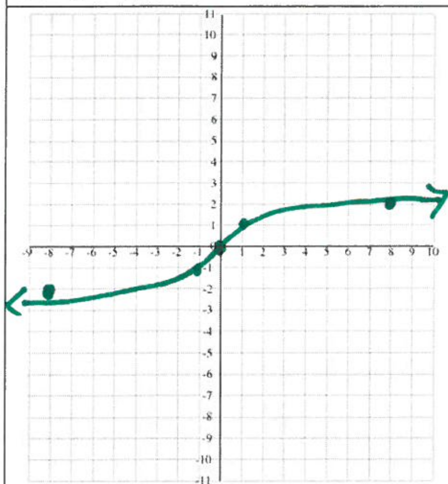
Range $(-\infty,\infty)$

Symmetry About the origin (rotation)

Pattern Increasing when $x>0$ Decreasing when $x<0$

Graph the following in your calculator, use the list function to plot points and sketch the graph. Note the domain and range in interval notation.

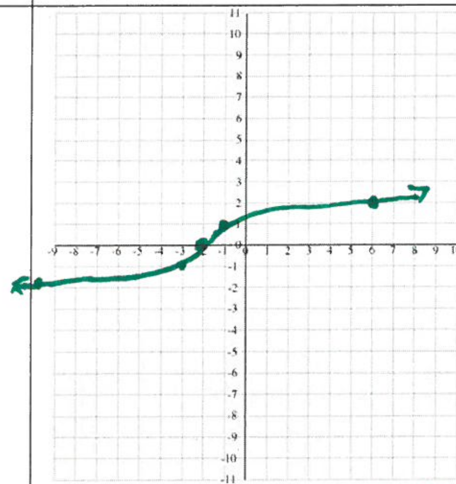
5. $y=\sqrt[3]{x}$



Domain: ℝ $(-\infty,\infty)$

Range: ℝ

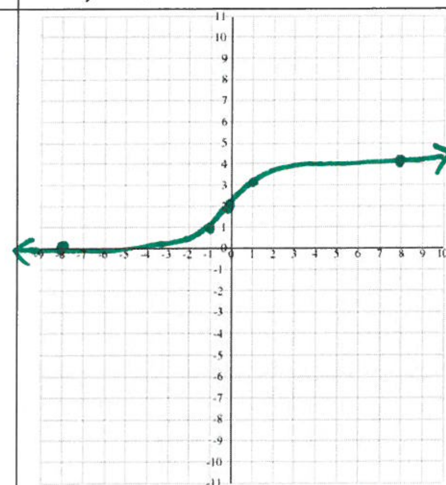
6. $y=\sqrt[3]{x+2}$



Domain: ℝ

Range: ℝ

7. $y=\sqrt[3]{x}+2$

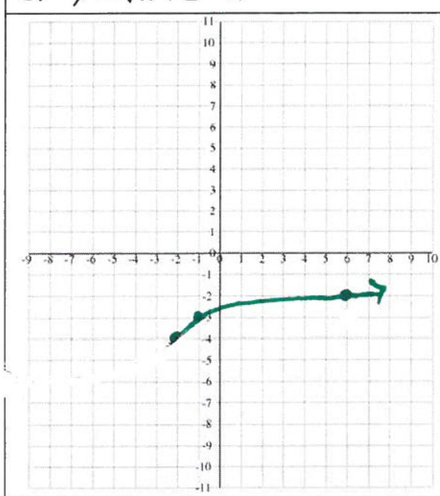


Domain: ℝ

Range: ℝ

Based on your knowledge of transformations and the shape of $y=\sqrt{x}$ and $y=\sqrt[3]{x}$, graph the following by hand. Note the domain and range in interval notation.

8. $y=\sqrt{x+2}-4$

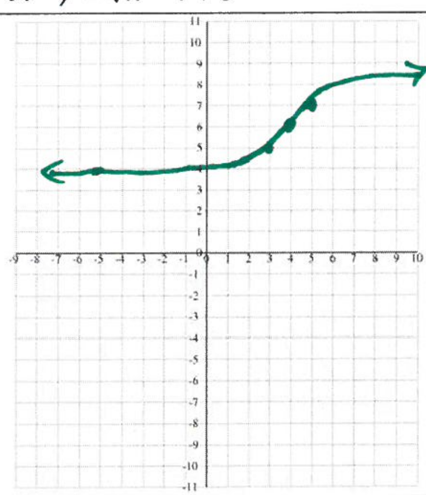


Domain: $[-2,\infty)$

Range: $[-4,\infty)$

Translate left 2 and down 4

9. $y=\sqrt[3]{x-4}+6$

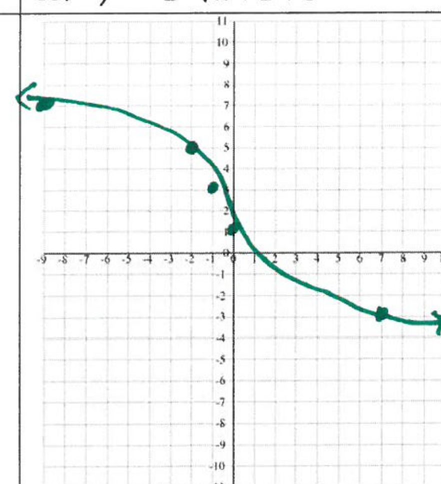


Domain: ℝ

Range: ℝ

Translate right 4 and up 6

10. $y=-2\cdot\sqrt[3]{x+1}+3$



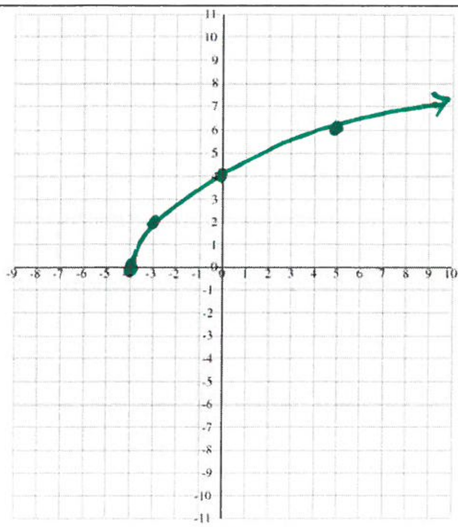
Domain: ℝ

Range: ℝ

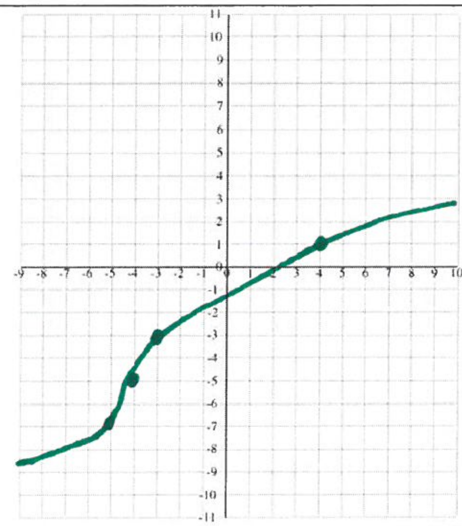
Reflect over x-axis, vertical stretch by 2, left 1, up 3

Rewrite $y=\sqrt{4x+16}$ to make it easy to graph using a translation (hint...get it in the form $y=a\sqrt{x-h}$).
*Use this hint for #12 too!

11. $y=\sqrt{4x+16}$



12. $y=\sqrt[3]{8x+32}-5$



$y=\sqrt{4x+16}$

$y=\sqrt{4(x+4)}$

$y=2\sqrt{x+4}$

x	y
-4	0
-3	2
0	4
5	6

$y=\sqrt[3]{8x+32}-5$

$y=\sqrt[3]{8(x+4)}-5$

$y=2\sqrt[3]{x+4}-5$

x	y
-5	-7
-4	-5
-3	-3
4	1