Grade Level/Course: High School/Algebra 1
Lesson/Unit Plan Name: Graph square root and cube root functions.
Rationale/Lesson Abstract: To use the parent graph of square root and cube root functions and to understand the similarities and differences between the two graphs. To write equations depending on the vertical and horizontal shifts, as well as, compressed and stretched graphs. Finally, to graph square root and cube root equations.
Timeframe: 1-2 day lesson – Depending on comfort level with parent graphs and shifts.
Common Core Standard(s): F.IF.7b – Graph square root and cube root functions.
Instructional Resources/Materials: Print out lesson and handout of notes.

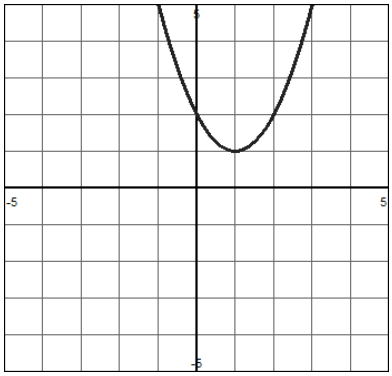
Activity/Lesson:

Warm Up:

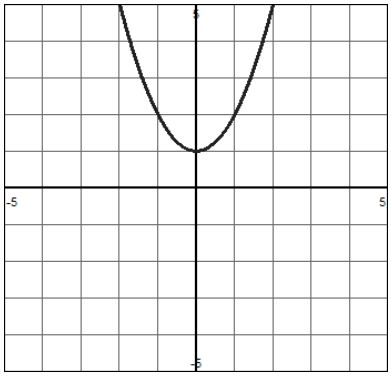
Match the following equations with their graphs and write an equation for the others.

a. $y = 2x^2$	b. $y = (x-1)^3$	c. $y = \frac{1}{2}x^3$	d. $y = (x-1)^2 + 1$

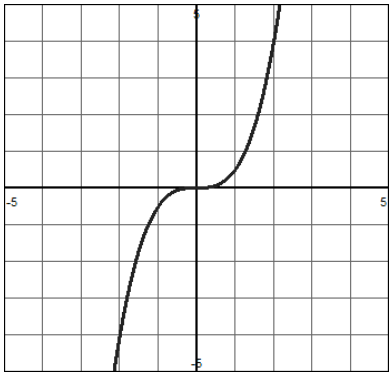
1. **D**



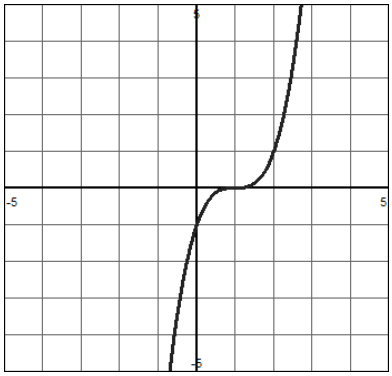
2. $y = x^2 + 1$



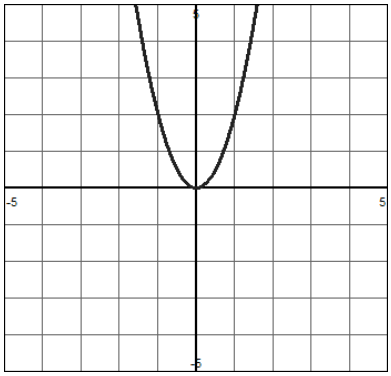
3. **C**



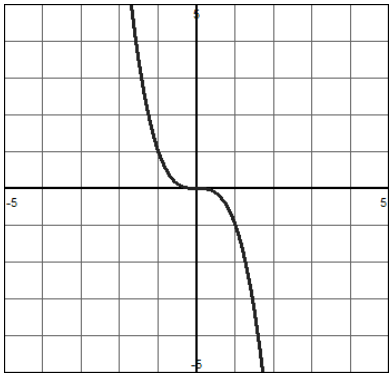
4. **B**



5. **A**



6. $y = -x^3$



Complete the given chart:

x	$x^2 = x \cdot x$	$x^3 = x \cdot x \cdot x$
-3	$(-3)^2 = (-3)(-3) = 9$	$(-3)^3 = (-3)(-3)(-3) = -27$
-2	$(-2)^2 = (-2)(-2) = 4$	$(-2)^3 = (-2)(-2)(-2) = -8$
-1	$(-1)^2 = (-1)(-1) = 1$	$(-1)^3 = (-1)(-1)(-1) = -1$
0	$(0)^2 = (0)(0) = 0$	$(0)^3 = (0)(0)(0) = 0$
1	$(1)^2 = (1)(1) = 1$	$(1)^3 = (1)(1)(1) = 1$
2	$(2)^2 = (2)(2) = 4$	$(2)^3 = (2)(2)(2) = 8$
3	$(3)^2 = (3)(3) = 9$	$(3)^3 = (3)(3)(3) = 27$

Describe the similarities and differences between squared and cubed numbers. Also, explain anything you notice.

The square numbers are positive while the cube numbers have negatives.

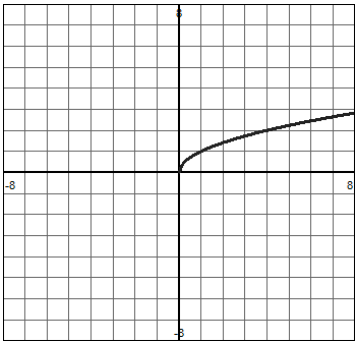
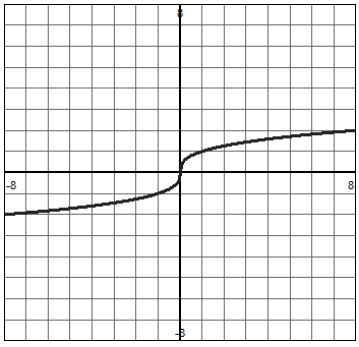
The square numbers match up around 0, while the cube numbers are opposites around 0.

Fill in the tables below using your observation above to choose appropriate values for x:

x	$y = \sqrt{x}$	y	(x, y)
0	$y = \sqrt{0}$	0	$(0,0)$
1	$y = \sqrt{1}$	1	$(1,1)$
4	$y = \sqrt{4}$	2	$(4,2)$
9	$y = \sqrt{9}$	3	$(9,3)$
16	$y = \sqrt{16}$	4	$(16,4)$

x	$y = \sqrt[3]{x}$	y	(x, y)
-8	$y = \sqrt[3]{-8}$	-2	$(-8,-2)$
-1	$y = \sqrt[3]{-1}$	-1	$(-1,-1)$
0	$y = \sqrt[3]{0}$	0	$(0, 0)$
1	$y = \sqrt[3]{1}$	1	$(1, 1)$
8	$y = \sqrt[3]{8}$	2	$(8, 2)$

Graph the following functions using your tables above.

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

Identify the graphs key features in the shape and the particular points around the origin. Write down the similarities and differences between square root and cube root graphs.

Quadrant 1 of the graphs have the same curved shape, but different values. The cube root function has negative and positive values for x and y, while the square root function only has positive values for x and y.

The square root function has key points at $(0,0), (1,1)$, and $(4,2)$. The cube root function has key points at $(-1,-1), (0, 0)$, and $(1, 1)$.

You only plug in 0 and positive values for x in the square root function, but negative, 0 and positive values in the cube root function. It's best to plug in numbers that are squared and cubed to get integer values.

Using the parent graph of a square root function, name the constant, coefficient and argument and describe how it will affect the graph of the equation below:

The argument is the expression inside the radical. In the given function, $f(x)=\sqrt{x}$, "x" is the argument.

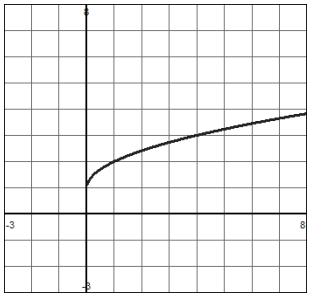
$f(x)=8\sqrt{x+5}-3$

Specifically:	In General:
Constant = -3, shifts down 3 *Coefficient = 8, vertical stretch, values are 8 times bigger* *Argument = $x+5$, shifts to the left 5, since $-5+5=0$*	*Constant: Vertical shift, Up if +, Down if -* *Coefficient: Stretch, vertical if greater than 1, horizontal if between 0 and 1.* *Argument: Horizontal shift, right if a value is subtracting from x, left if a value is added to x. This happens because we are looking for when the argument is 0.*

Use the following equations to match to the given graphs below and write an equation for the others. Describe how the graph changes from the parent graph and how that effects the equations constant, coefficient or argument. Finally, find 5 values that you would put in your t-table.

a. $y=\sqrt[3]{x-2}$	b. $y=\sqrt{x}+1$	c. $y=2\sqrt[3]{x}$	d. $y=\frac{1}{2}\sqrt{x}$

1.



Description: Square root

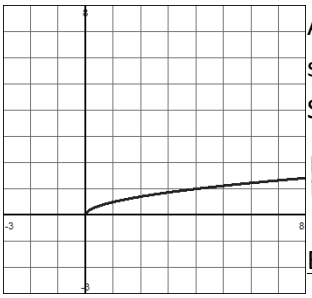
Vertical shift up 1, so the constant is +1.

Shape is the same.

Equation: $y=\sqrt{x}+1$

x values: 0, 1, 4, 9, 16, ….

2.



Description: Square root

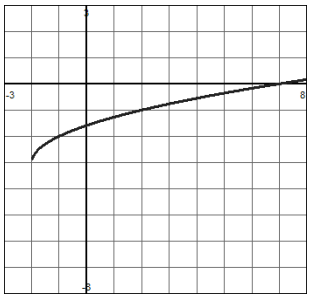
At origin, no vertical or horizontal shift.

Shape is compressed horizontally $\left(1,\frac{1}{2}\right)$, so coefficient is $\frac{1}{2}$.

Equation: $y=\frac{1}{2}\sqrt{x}$

x values: 0, 1, 4, 9, 16, ….

3.



Description: Square root

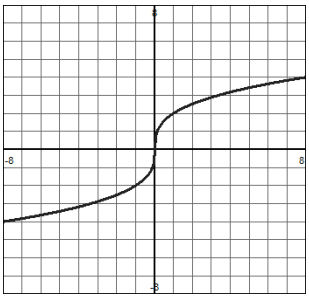
Vertical shift down 3, so -3 is the constant. Horizontal shift left 2, so x+2 is the argument.

Shape is the same.

Equation: $y=\sqrt{x+2}-3$

x values: -2, -1, 2, 7, 14, …. Subtract 2

4.



Description: Cube root

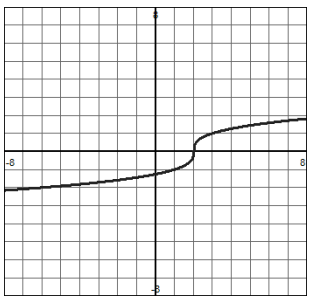
At origin, no vertical or horizontal shift.

Shape is stretched vertically $(1,2)$, so coefficient is 2.

Equation: $y=2\sqrt[3]{x}$

x values: -27, -8, -1, 0, 1, 8, 27, ….

5.



Description: Cube root

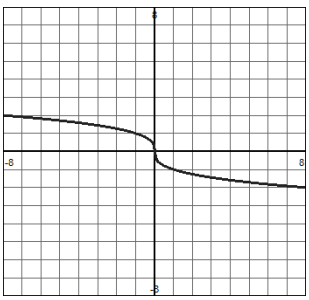
Horizontal shift right 2, so x-2 is the argument.

Shape is the same.

Equation: $y=\sqrt[3]{x-2}$

x values: -25, -6, -3, 2, 3, 10, 29, …. Add 2

6.



Description: Cube root

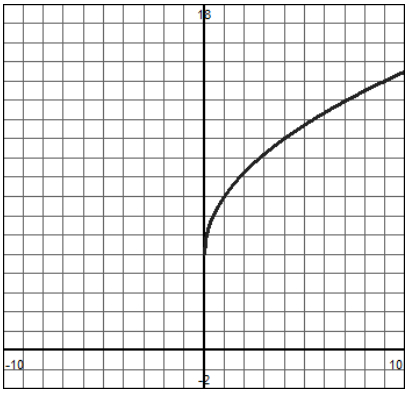
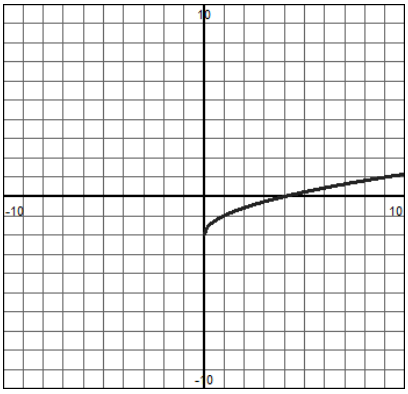
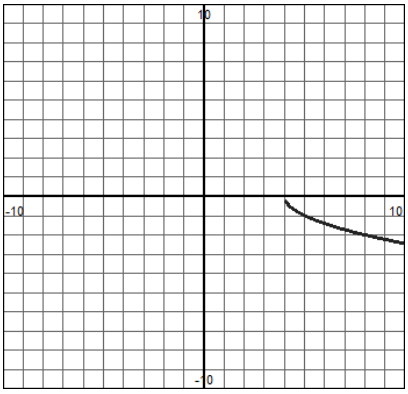
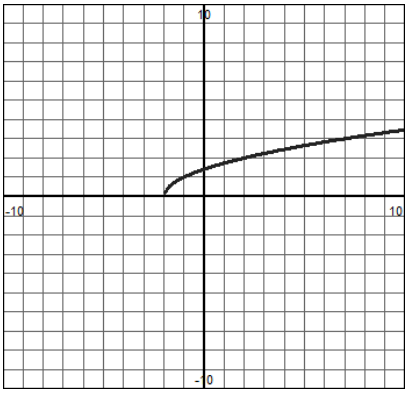
At origin, no vertical or horizontal shift.

Shape is the same, but opposites for y. Coefficient is -1.

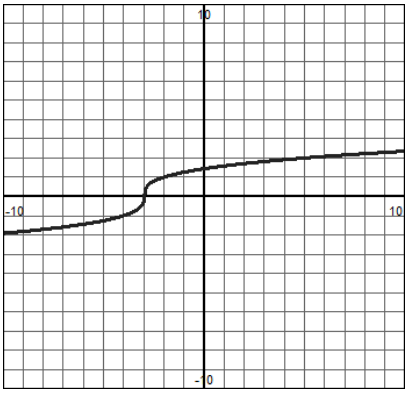
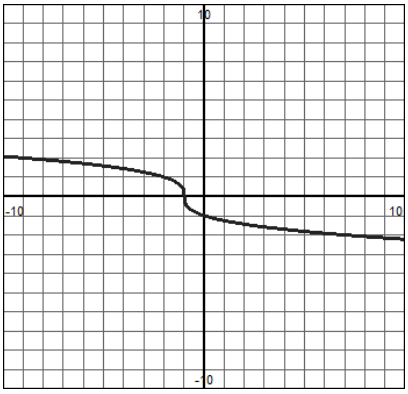
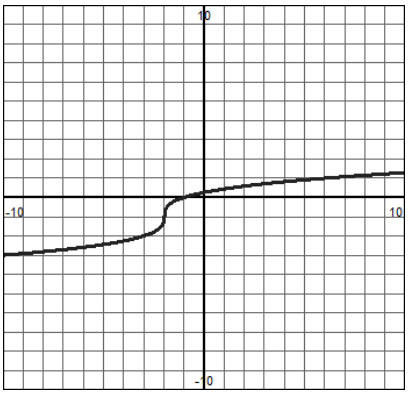
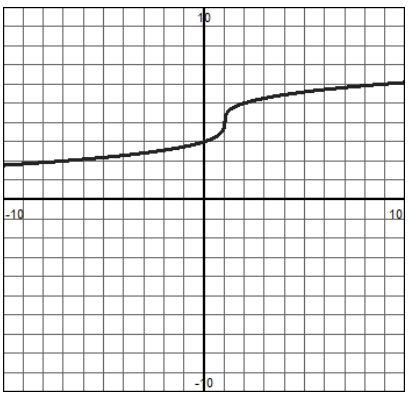
Equation: $y=-\sqrt[3]{x}$

x values: -27, -8, -1, 0, 1, 8, 27, ….

Fill in the chart below to graph the given equations:

Equation:	Description:	T-table:	Graph:
1. $y = 3\sqrt{x} + 5$ Parent Graph: Square root	Coefficient is 3, so vertical stretch. Argument is x. No horizontal shift, so squared values stay the same for x. Constant is + 5, vertical shifts up 5.	x | $y = 3\sqrt{x} + 5$ | y | (x, y) 0 | $y = 3\sqrt{0} + 5 = 3(0) + 5$ | 5 | $(0, 5)$ 1 | $y = 3\sqrt{1} + 5 = 3(1) + 5$ | 8 | $(1, 8)$ 4 | $y = 3\sqrt{4} + 5 = 3(2) + 5$ | 11 | $(4, 11)$ 9 | $y = 3\sqrt{9} + 5 = 3(3) + 5$ | 14 | $(9, 14)$	
YOU Try: 2. $y = \sqrt{x} - 2$ Parent Graph: Square root	Argument is x. No horizontal shift, so squared values stay the same for x. Constant is - 2, vertical shifts down 2.	x | $y = \sqrt{x} - 2$ | y | (x, y) 0 | $y = \sqrt{0} - 2 = 0 - 2$ | -2 | $(0, -2)$ 1 | $y = \sqrt{1} - 2 = 1 - 2$ | -1 | $(1, -1)$ 4 | $y = \sqrt{4} - 2 = 2 - 2$ | 0 | $(4, 0)$ 9 | $y = \sqrt{9} - 2 = 3 - 2$ | 1 | $(9, 1)$	
3. $y = -\sqrt{x - 4}$ Parent Graph: Square root	Coefficient is -1, so opposite values for y. Argument is x-4, shifts right 4, so add 4 to squared numbers. (0, 1, 4, 9, 16, …)	x | $y = -\sqrt{x - 4}$ | y | (x, y) 4 | $y = -\sqrt{4 - 4} = -\sqrt{0}$ | 0 | $(4, 0)$ 5 | $y = -\sqrt{5 - 4} = -\sqrt{1}$ | -1 | $(5, -1)$ 8 | $y = -\sqrt{8 - 4} = -\sqrt{4}$ | -2 | $(8, -2)$ 13 | $y = -\sqrt{13 - 4} = -\sqrt{9}$ | -3 | $(13, -3)$	
YOU Try: 4. $y = \sqrt{x + 2}$ Parent Graph: Square root	Argument is x+2, shifts left 2, so subtract 2 to squared numbers. (0, 1, 4, 9, 16, …)	x | $y = \sqrt{x + 2}$ | y | (x, y) -2 | $y = \sqrt{-2 + 2} = \sqrt{0}$ | 0 | $(-2, 0)$ -1 | $y = \sqrt{-1 + 2} = \sqrt{1}$ | 1 | $(-1, 1)$ 2 | $y = \sqrt{2 + 2} = \sqrt{4}$ | 2 | $(2, 2)$ 7 | $y = \sqrt{7 + 2} = \sqrt{9}$ | 3 | $(7, 3)$	

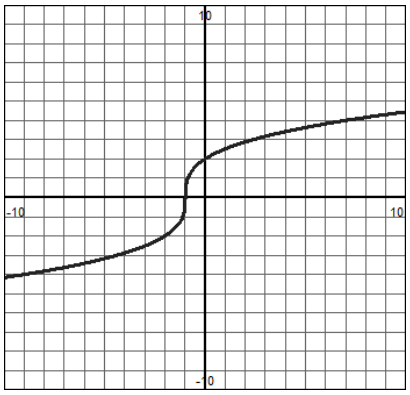
Fill in the chart below to graph the given equations:

Equation:	Description:	T-table:	Graph:
5. $y=\sqrt[3]{x+3}$ Parent Graph: Cube root	Argument is $x+3$, shifts left 3, so subtract 3 to cubed numbers. (…, -27, -8, -1, 0, 1, 8, 27, …)	x | $y=\sqrt[3]{x+3}$ | y | (x,y) -4 | $y=\sqrt[3]{-4+3}=\sqrt[3]{-1}$ | -1 | $(-4,-1)$ -3 | $y=\sqrt[3]{-3+3}=\sqrt[3]{0}$ | 0 | $(-3,0)$ -2 | $y=\sqrt[3]{-2+3}=\sqrt[3]{1}$ | 1 | $(-2,1)$ 5 | $y=\sqrt[3]{5+3}=\sqrt[3]{8}$ | 2 | $(5,2)$	
YOU Try: 6. $y=-\sqrt[3]{x+1}$ Parent Graph: Cube root	Argument is $x+1$, shifts left 1, so subtract 1 to cubed numbers. (…, -27, -8, -1, 0, 1, 8, 27, …) Coefficient is -1, so opposite values for y	x | $y=-\sqrt[3]{x+1}$ | y | (x,y) -2 | $y=-\sqrt[3]{-2+1}=-\sqrt[3]{-1}$ | 1 | $(-2,1)$ -1 | $y=-\sqrt[3]{-1+1}=-\sqrt[3]{0}$ | 0 | $(-1,0)$ 0 | $y=-\sqrt[3]{0+1}=-\sqrt[3]{1}$ | -1 | $(0,-1)$ 7 | $y=-\sqrt[3]{7+1}=-\sqrt[3]{8}$ | -2 | $(7,-2)$	
7. $y=\sqrt[3]{x+2}-1$ Parent Graph: Cube root	Argument is $x+2$, shifts left 2, so subtract 2 to cubed numbers. (…, -27, -8, -1, 0, 1, 8, 27, …) Constant is -1, vertical shift down 1.	x | $y=\sqrt[3]{x+2}-1$ | y | (x,y) -3 | $y=\sqrt[3]{-3+2}-1=\sqrt[3]{-1}-1$ | -2 | $(-3,-2)$ -2 | $y=\sqrt[3]{-2+2}-1=\sqrt[3]{0}-1$ | -1 | $(-2,-1)$ -1 | $y=\sqrt[3]{-1+2}-1=\sqrt[3]{1}-1$ | 0 | $(-1,0)$ 6 | $y=\sqrt[3]{6+2}-1=\sqrt[3]{8}-1$ | 1 | $(6,1)$	
YOU Try: 8. $y=\sqrt[3]{x-1}+4$ Parent Graph: Cube root	Argument is x-1, shifts right 1, so add 1 to cubed numbers. (…, -27, -8, -1, 0, 1, 8, 27, …) Constant is +4, vertical shift up 4.	x | $y=\sqrt[3]{x-1}+4$ | y | (x,y) -7 | $y=\sqrt[3]{-7-1}+4=\sqrt[3]{-8}+4$ | 2 | $(-7,-2)$ 0 | $y=\sqrt[3]{0-1}+4=\sqrt[3]{-1}+4$ | 3 | $(0,3)$ 1 | $y=\sqrt[3]{1-1}+4=\sqrt[3]{0}+4$ | 4 | $(1,4)$ 2 | $y=\sqrt[3]{2-1}+4=\sqrt[3]{1}+4$ | 5 | $(2,5)$	

Homework (day 1): Use the following equations to match to the given graphs below and write an equation for the others. Describe how the graph changes from the parent graph and how that effects the equations constant, coefficient or argument. Finally, find 5 values that you would put in your t-table.

a. $y=\sqrt[3]{x}+3$	b. $y=\sqrt{x}+6$	c. $y=2\sqrt[3]{x+1}$	d. $y=\sqrt{x+8}-3$

1.



Description: Cube root. Left shift 1, argument is x+1.

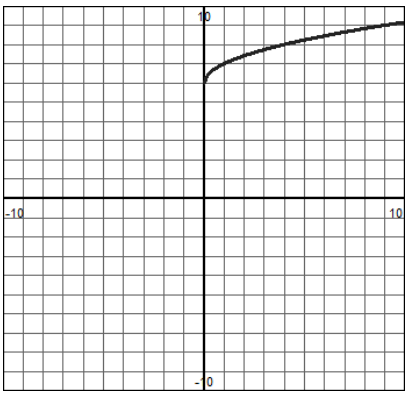
Shape has vertical shift, coefficient of 2.

Equation: C

$y=2\sqrt[3]{x+1}$

x - values: Subtract 1; -1, 0, 3, 8, 15

2.



Description: Square root.

Vertical shift, up 6. Constant is +6

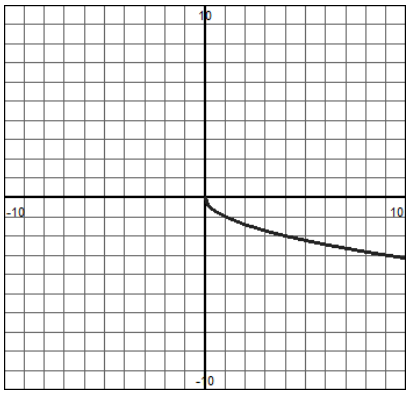
Shape is the same

Equation: B

$y=\sqrt{x}+6$

x - values: No Change; 0, 1, 4, 9, 16

3.



Description: Square root. No shifts.

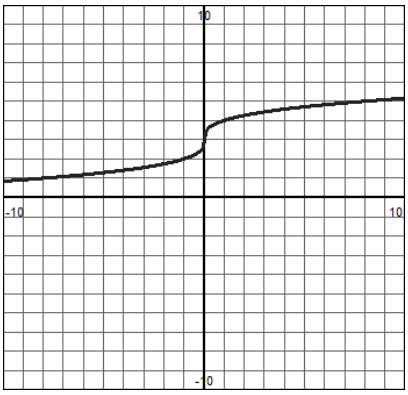
Opposite values for y. Coefficient is -1.

Shape is the same.

Equation: $y=-\sqrt{x}$

x - values: No Change; 0, 1, 4, 9, 16

4.



Description: Cube root

Vertical shift up 3, so constant +3.

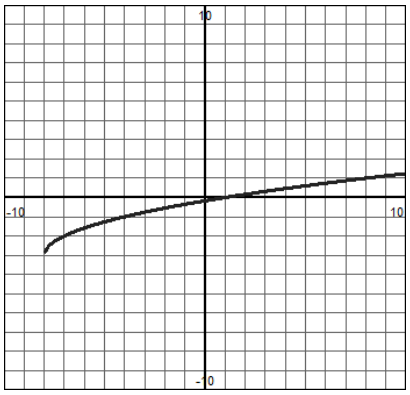
Shape is the same.

Equation: A

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

x - values: No Change; -8,-1,0,1,8

5.



Description: Square root. Vertical shift down3, so constant is -3.

Shift left 8, so argument is x+8.

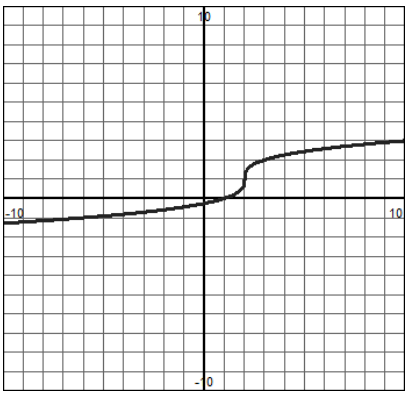
Shape is the same

Equation: D

$y=\sqrt{x+8}-3$

x - values: Subtract 8; -8, -7, -4, -1, 8

6.



Description: Cube root

Vertical shift up 1, constant is +1.

Shift right 2, so argument is x-2.

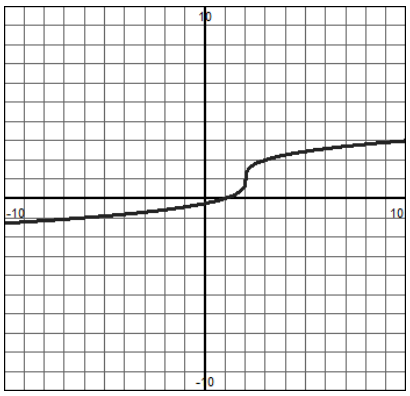
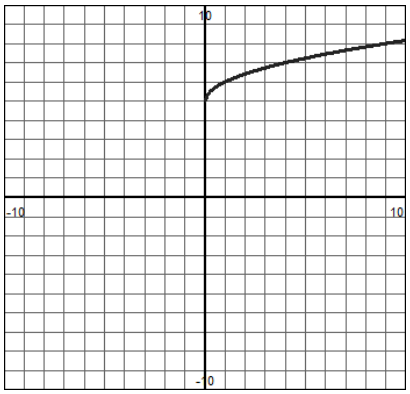
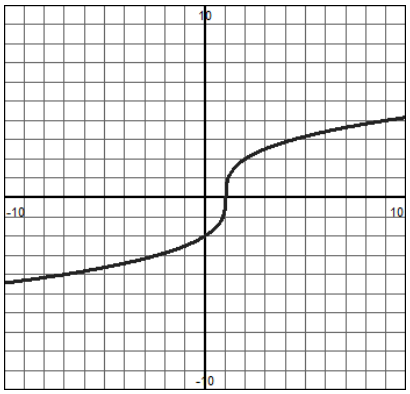
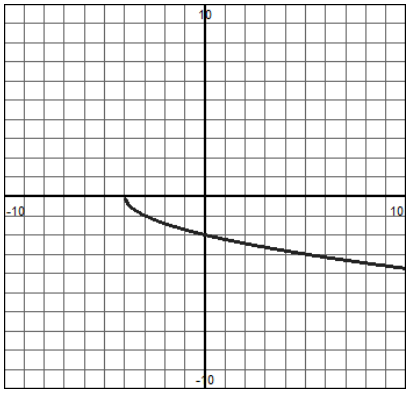
Shape is the same.

Equation:

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

x - values: Add 2, -6, 1, 2, 3, 10

Homework (day 2): Graph the given equations:

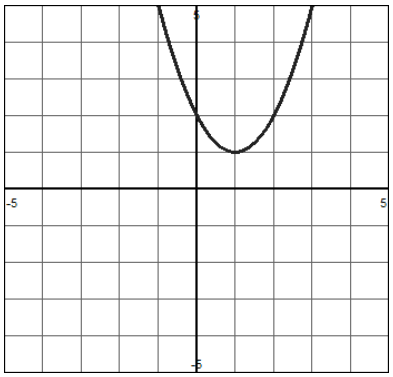
Equation:	Description:	T-table:	Graph:
1. $y=\sqrt[3]{x-2}+1$ Parent Graph: Cube root	Argument is x-2, shifts right 2, so add 2 to cubed numbers. (…, -27, -8, -1, 0, 1, 8, 27, …) Constant is +1, vertical shift up 1.	x | $y=\sqrt[3]{x-2}+1$ | y | (x,y) -6 | $y=\sqrt[3]{-6-2}+1=\sqrt[3]{-8}+1$ | -1 | $(-6,-1)$ 1 | $y=\sqrt[3]{1-2}+1=\sqrt[3]{-1}+1$ | 0 | $(1,0)$ 2 | $y=\sqrt[3]{2-2}+1=\sqrt[3]{0}+1$ | 1 | $(2,1)$ 3 | $y=\sqrt[3]{3-2}+1=\sqrt[3]{1}+1$ | 2 | $(3,2)$	
2. $y=\sqrt{x}+5$ Parent Graph: Square root	Argument is x. No horizontal shift, so squared values stay the same for x. Constant is + 5, vertical shifts up 5.	x | $y=\sqrt{x}+5$ | y | (x,y) 0 | $y=\sqrt{0}+5=0+5$ | 5 | $(0,5)$ 1 | $y=\sqrt{1}+5=1+5$ | 6 | $(1,6)$ 4 | $y=\sqrt{4}+5=2+5$ | 7 | $(4,7)$ 9 | $y=\sqrt{9}+5=3+5$ | 8 | $(9,8)$	
3. $y=2\sqrt[3]{x-1}$ Parent Graph: Cube root	Argument is x-1, shifts right 1, so add 1 to cubed numbers. (…, -27, -8, -1, 0, 1, 8, 27, …) Coefficient is 2, so vertical stretch.	x | $y=2\sqrt[3]{x-1}$ | y | (x,y) -7 | $y=2\sqrt[3]{-7-1}=2\left(\sqrt[3]{-8}\right)$ | -4 | $(-11,-2)$ 0 | $y=2\sqrt[3]{0-1}=2\left(\sqrt[3]{-1}\right)$ | -2 | $(0,-2)$ 1 | $y=2\sqrt[3]{1-1}=2\left(\sqrt[3]{0}\right)$ | 0 | $(1,0)$ 2 | $y=2\sqrt[3]{2-1}=2\left(\sqrt[3]{1}\right)$ | 2 | $(2,2)$	
4. $y=-\sqrt{x+4}$ Parent Graph: Square root	Argument is x+4, shifts left 4, so subtract 4 to squared numbers. (0, 1, 4, 9, 16, …) Coefficient is -1, so opposite values for y	x | $y=-\sqrt{x+4}$ | y | (x,y) -4 | $y=-\sqrt{-4+4}=-\sqrt{0}$ | 0 | $(-4,0)$ -3 | $y=-\sqrt{-3+4}=-\sqrt{1}$ | -1 | $(-3,-1)$ 0 | $y=-\sqrt{0+4}=-\sqrt{4}$ | -2 | $(0,-2)$ 5 | $y=-\sqrt{5+4}=-\sqrt{9}$ | -3 | $(5,-3)$	

Warm Up:

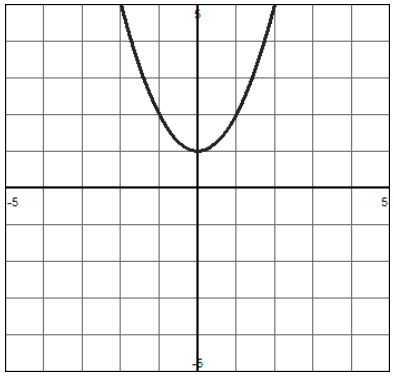
Match the following equations with their graphs and write an equation for the others.

a. $y = 2x^2$	b. $y = (x-1)^3$	c. $y = \frac{1}{2}x^3$	d. $y = (x-1)^2 + 1$

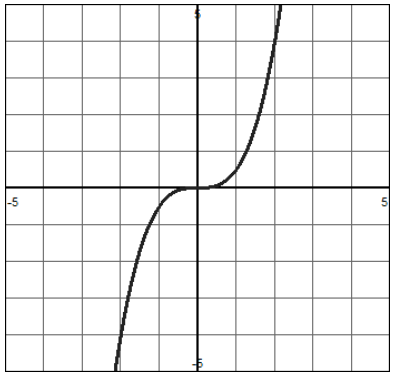
1.



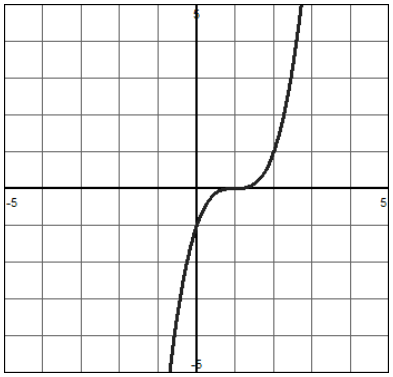
2.



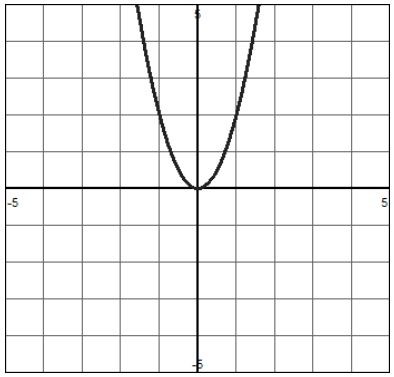
3.



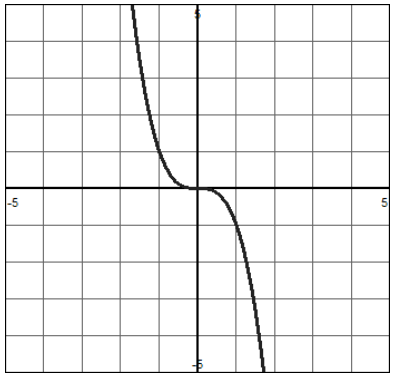
4.



5.



6.



Complete the given chart:

x	$x^2 = x \cdot x$	$x^3 = x \cdot x \cdot x$
-3		
-2		
-1		
0		
1		
2		
3		

Describe the similarities and differences between squared and cubed numbers. Also, explain anything you notice.

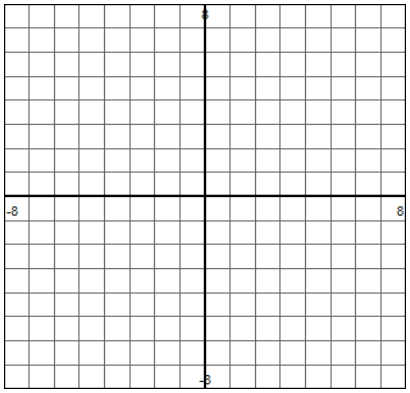
Fill in the tables below using your observation above to choose appropriate values for x:

x	$y = \sqrt{x}$	y	(x, y)

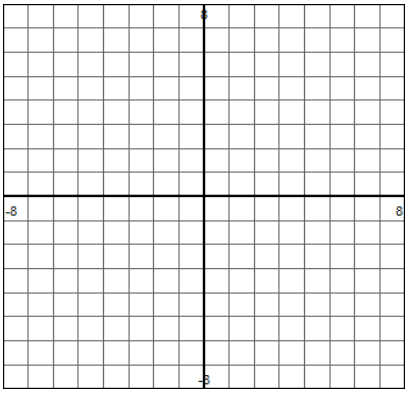
x	$y = \sqrt[3]{x}$	y	(x, y)

Graph the following functions using your tables above.

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



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



Identify the graphs key features in the shape and the particular points around the origin. Write down the similarities and differences between square root and cube root graphs.

Using the parent graph of a square root function, name the constant, coefficient and argument and describe how it will affect the graph of the equation below:

The argument is the expression inside the radical. In the given function, $f(x)=\sqrt{x}$, "x" is the argument.

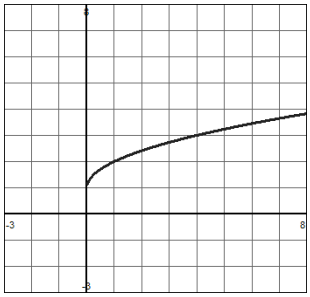
$f(x)=8\sqrt{x+5}-3$

Specifically:	In General:

Use the following equations to match to the given graphs below and write an equation for the others. Describe how the graph changes from the parent graph and how that effects the equations constant, coefficient or argument. Find 5 values that you would put in your t-table.

a. $y=\sqrt[3]{x-2}$	b. $y=\sqrt{x}+1$	c. $y=2\sqrt[3]{x}$	d. $y=\frac{1}{2}\sqrt{x}$

1.

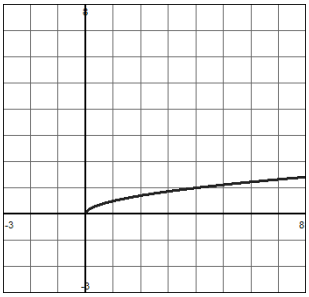


Description:

Equation:

x values:

2.

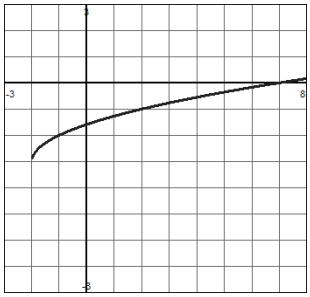


Description:

Equation:

x values:

3.

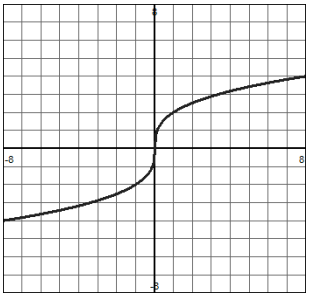


Description:

Equation:

x values:

4.

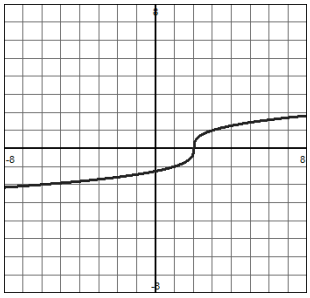


Description:

Equation:

x values:

5.

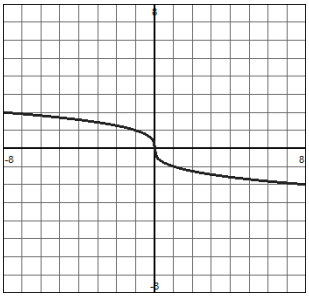


Description:

Equation:

x values:

6.

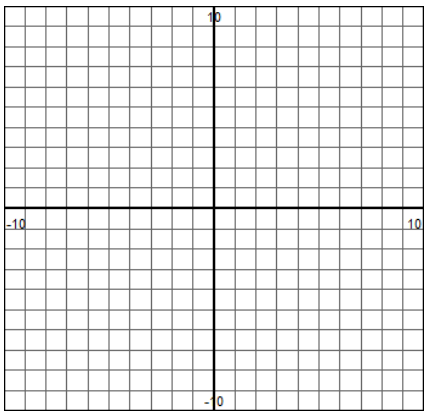
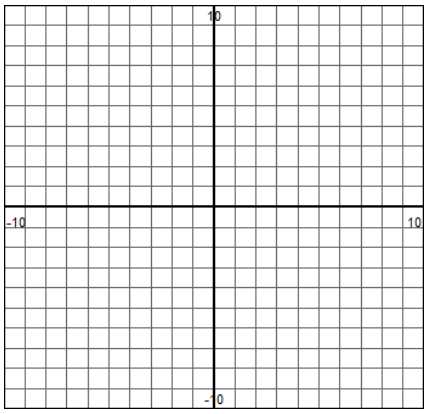
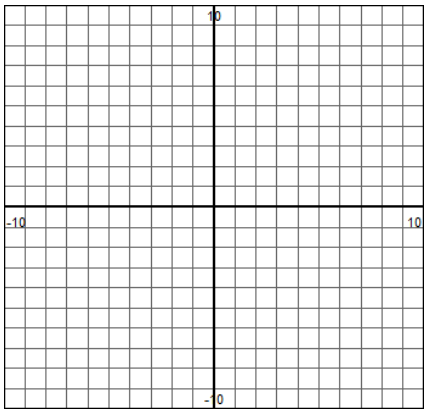
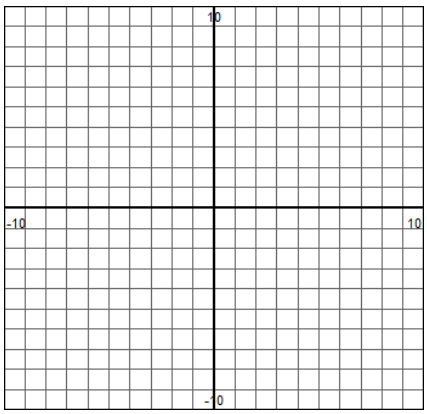


Description:

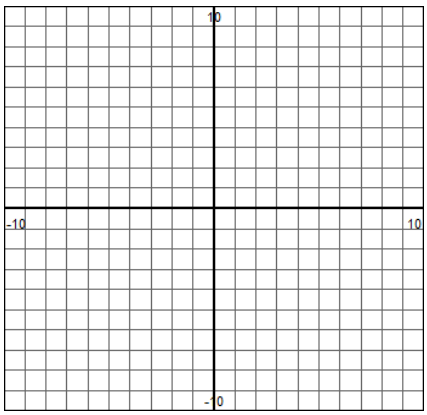
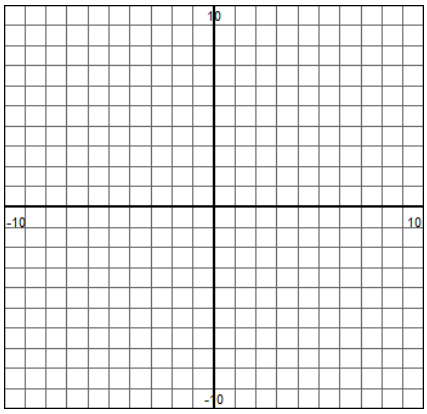
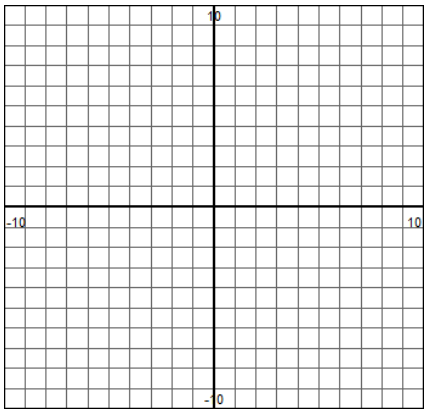
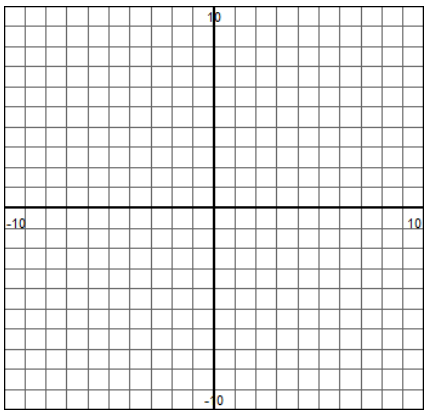
Equation:

x values:

Graph the given equations.

Equation:	Description:	T-table:	Graph:
1. $y = 3\sqrt{x} + 5$ Parent Graph:			
YOU Try: 2. $y = \sqrt{x} - 2$ Parent Graph:			
3. $y = -\sqrt{x-4}$ Parent Graph:			
YOU Try: 4. $y = \sqrt{x+2}$ Parent Graph:			

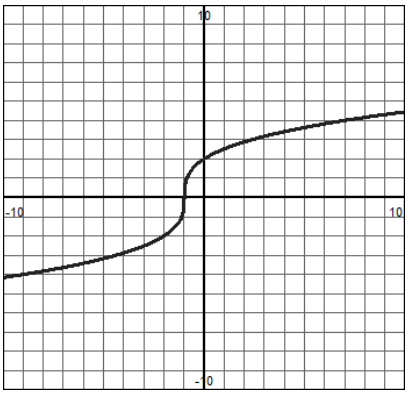
Graph the given equations.

Equation:	Description:	T-table:	Graph:
5. $y = \sqrt[3]{x+3}$ Parent Graph:			
YOU Try: 6. $y = -\sqrt[3]{x+1}$ Parent Graph:			
7. $y = \sqrt[3]{x+2} - 1$ Parent Graph:			
YOU Try: 8. $y = \sqrt[3]{x-1} + 4$ Parent Graph:			

Homework (day 1): Use the following equations to match to the given graphs below and write an equation for the others. Describe how the graph changes from the parent graph and how that effects the equations constant, coefficient or argument. Finally, find 5 values that you would put in your t-table.

a. $y=\sqrt[3]{x}+3$	b. $y=\sqrt{x}+6$	c. $y=2\sqrt[3]{x+1}$	d. $y=\sqrt{x+8}-3$

1.

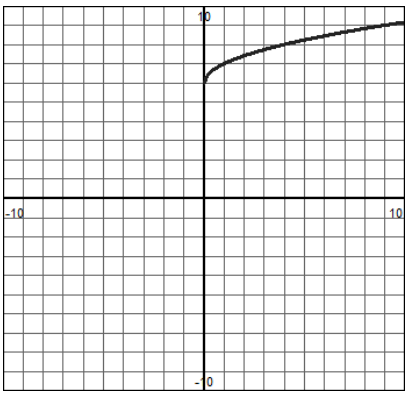


Description:

Equation:

x - values:

2.

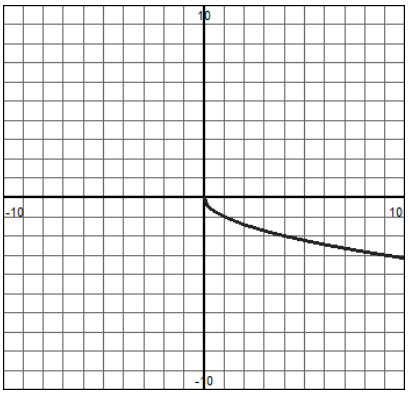


Description:

Equation:

x - values:

3.

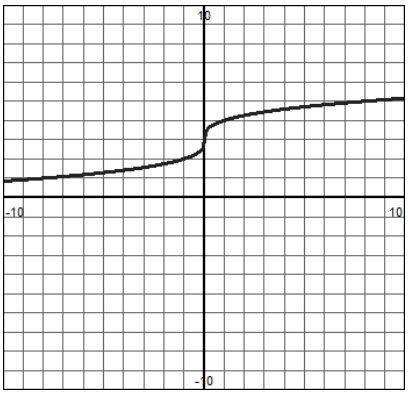


Description:

Equation:

x - values:

4.

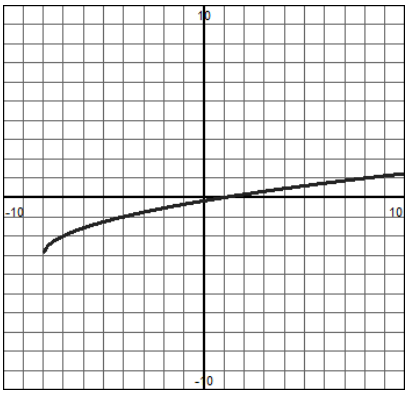


Description:

Equation:

x - values:

5.

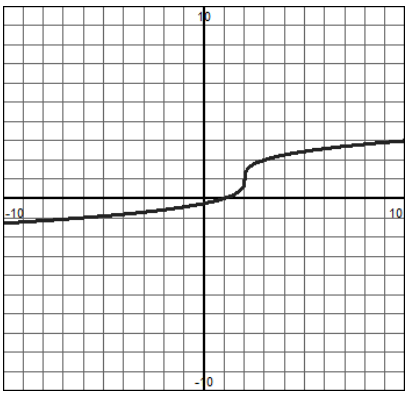


Description:

Equation:

x - values:

6.

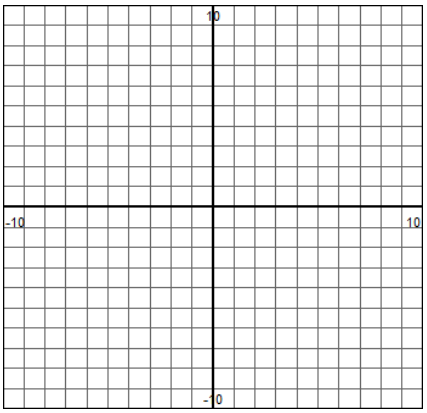
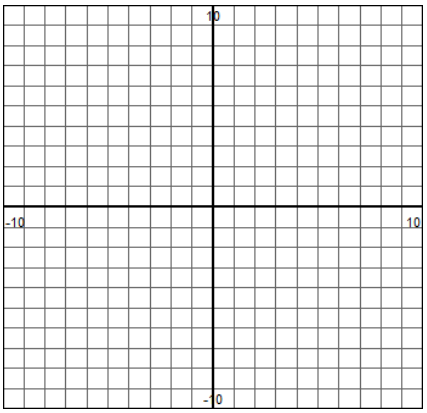
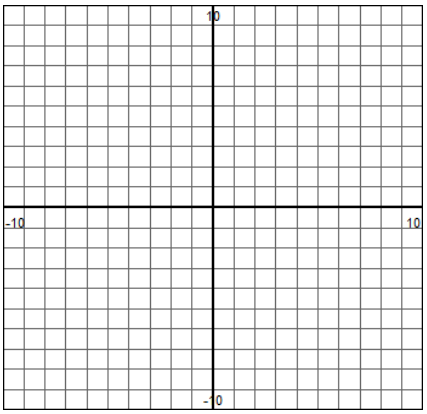
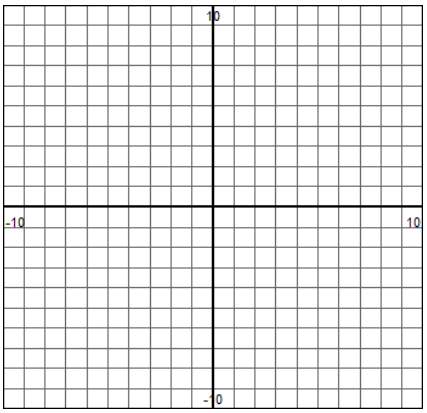


Description:

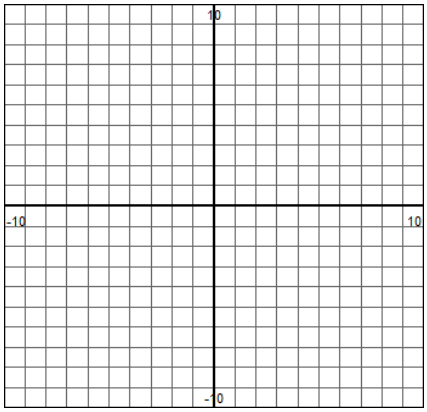
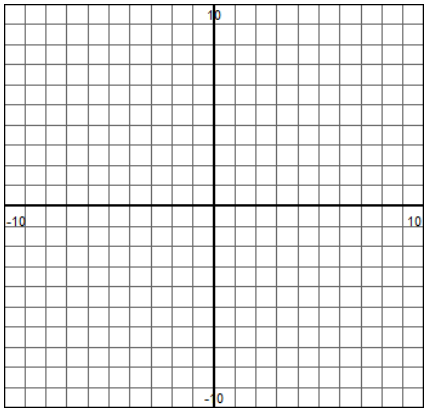
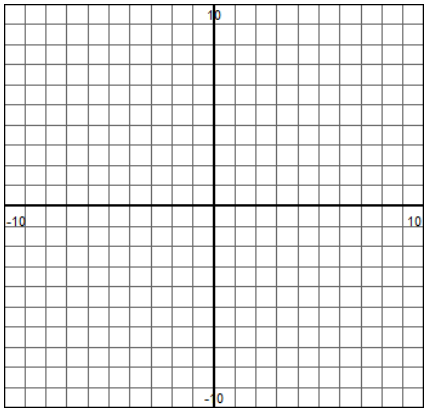
Equation:

x - values:

Homework (day 2): Graph the given equations.

Equation:	Description:	T-table:	Graph:
1. $y = \sqrt[3]{x-2}+1$ Parent Graph:			
2. $y = \sqrt{x}+5$ Parent Graph:			
3. $y = 2\sqrt[3]{x-1}$ Parent Graph:			
4. $y = -\sqrt{x+4}$ Parent Graph:			

Graph the given equations.

Equation:	Description:	T-table:	Graph:
Parent Graph:			
YOU Try: Parent Graph:			
Parent Graph:			
YOU Try: Parent Graph: