Study Prep
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TOPIC: RECTANGULAR COORDINATE SYSTEM

Graphs & the Rectangular Coordinate System

- Graphing in this course usually involves plotting ________ or ___________ on the rectangular coordinate system.

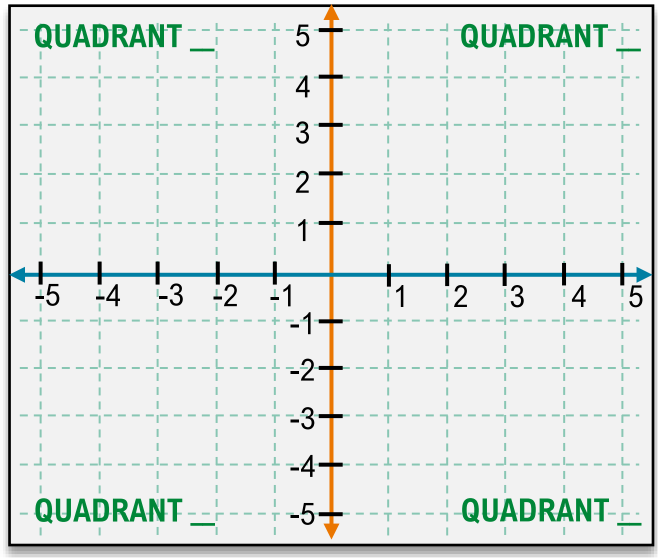
Rectangular Coordinate System ("Cartesian Plane"): 2 perpendicular _________________ form a 2-D plane.

- Horizontal axis is the ___– axis
- Vertical axis is the ___– axis
- **Ordered pairs / points**: Position *always* in form ______
- **Origin**: point (__,__) where x & y axes intersect

  x values are [+ | −] [**RIGHT** | **LEFT**] of origin

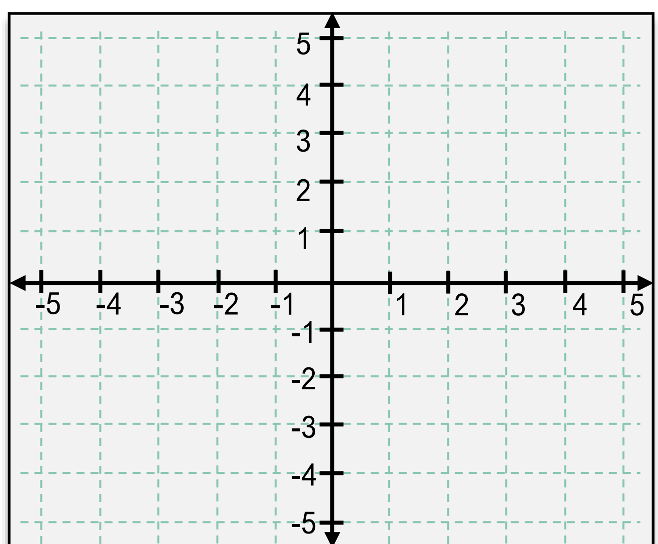
  y values are [+ | −] [**ABOVE** | **BELOW**] origin
- **Quadrants**: x & y axes divide graphs into 4 __________.

  Q1 starts at top-right, #s continue counter-clockwise



EXAMPLE: Plot the points $\boldsymbol{A}\ (4,3), \boldsymbol{B}\ (-3,2), \boldsymbol{C}\ (-2,-3), \boldsymbol{D}\ (5,-4), \boldsymbol{E}\ (0,0), \boldsymbol{F}\ (0,-3)$ on the graph above.

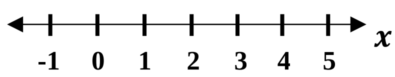
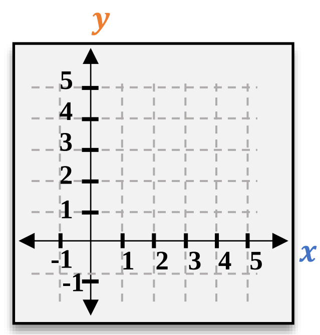
EXAMPLE: Graph the points $\boldsymbol{W}\ (1,-2), \boldsymbol{X}\ (5,2)$, $\boldsymbol{Y}\ (-3,-4), \boldsymbol{Z}\ (-4,3)$. Identify the **quadrant** of each point.



TOPIC: EQUATIONS OF TWO VARIABLES

Solving Two Variable Equations

● Instead of just ONE variable, many equations in this course will involve TWO variables: ___ & ___

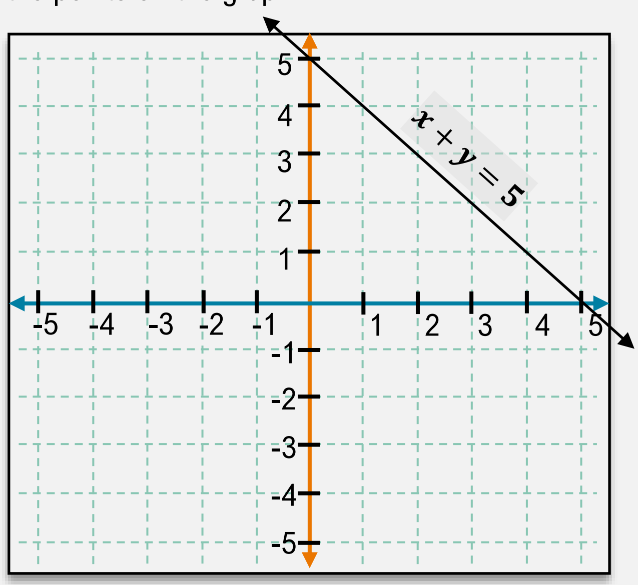
Equations with ONE Variable	Equations with TWO Variables
$x + 2 = 5$ $x = 3$  Solution: _________ **point (x)** on a 1D line	$x + y = 5$ $x = ?$ $y = ?$  Solution(s): ______ **points** _____ on a 2D plane

● If asked to determine if points (x, y) "satisfy" an equation, ___________ x & y values to check if equation is true.

▪ The **graph** of an equation is just a visual representation of all (x, y) which make equation true.

When points **DO** satisfy an equation, they **[ARE | ARE NOT]** on the graph of that equation.
When points **DO NOT** satisfy an equation, they **[ARE | ARE NOT]** on the graph of that equation.

EXAMPLE: The graph of the equation $x + y = 5$ is a line, as shown in the diagram below. **a)** Determine if the points $(3, 2)$, $(4,1)$, $(0,0)$, & $(-1,3)$ satisfy the equation. **b)** Plot each of the points on the graph.



TOPIC: EQUATIONS OF TWO VARIABLES
Graphing Two Variable Equations by Plotting Points

● To graph an equation, calculate & plot ____________________ that make the equation true.

EXAMPLE: Graph the equation $-2x + y = -1$ by creating ordered pairs using $x = -2, -1, 0, 1, 2$.

x		y	Ordered pair (x, y)
-2			
-1			
0			
1			
2			

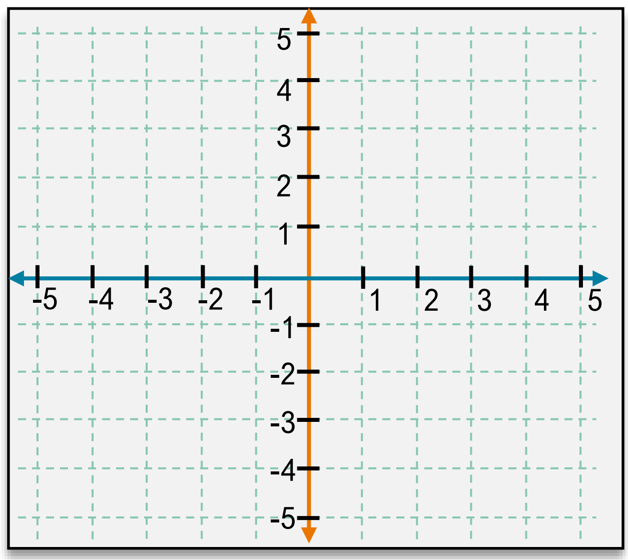
GRAPHING BY PLOTTING POINTS

1) Isolate y to left side: $y = \ldots$

2) Calculate y-values from 3-5 chosen x-values

3) Plot (x, y) points from Step 2

4) Connect points with line/curve



● If you're not *given* x-values to evaluate, choose your own!

TOPIC: EQUATIONS OF TWO VARIABLES

PRACTICE: Graph the equation $\boldsymbol{y - x^2 + 3 = 0}$ by choosing points that satisfy the equation.

$\boldsymbol{x}$		$\boldsymbol{y}$	**Ordered Pair** $(\boldsymbol{x}, \boldsymbol{y})$

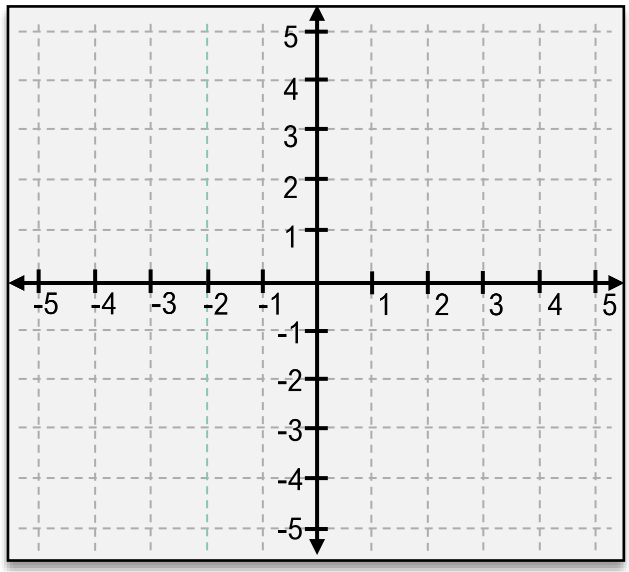
GRAPHING BY PLOTTING POINTS

1) Isolate $\boldsymbol{y}$ to left side: $\boldsymbol{y}$ = …

2) Calculate $\boldsymbol{y}$-values from 3-5 chosen $\boldsymbol{x}$-values

3) Plot (x, y) points from Step 2

4) Connect points with line/curve



TOPIC: EQUATIONS OF TWO VARIABLES

PRACTICE**:** Graph the equation $\boldsymbol{y = \sqrt{x} + 1}$ by choosing points that satisfy the equation. (*Hint: Choose positive numbers only*)

$\boldsymbol{x}$		$\boldsymbol{y}$	**Ordered Pair**

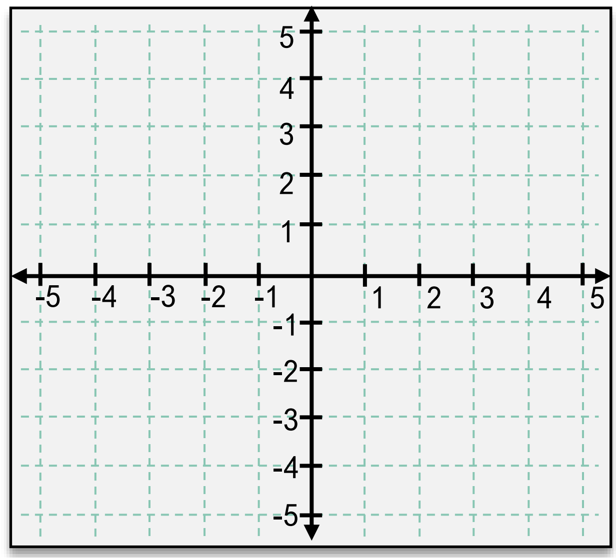
GRAPHING BY PLOTTING POINTS

1) Isolate $\boldsymbol{y}$ to left side**:** $\boldsymbol{y}$ = …

2) Calculate $\boldsymbol{y}$-values from 3-5 chosen $\boldsymbol{x}$-values

3) Plot (x, y) points from Step 2

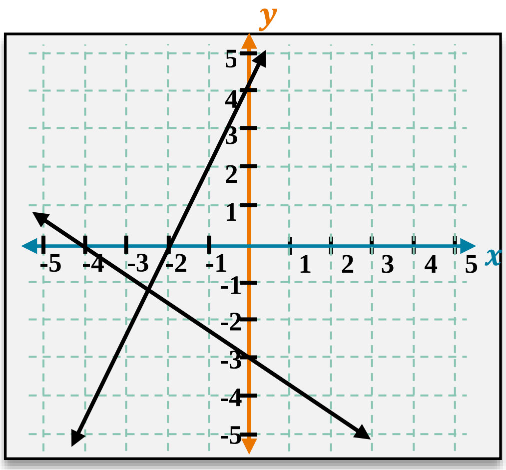
4) Connect points with line/curve



TOPIC: EQUATIONS OF TWO VARIABLES
Graphing Intercepts

INTERCEPTS: Ordered pairs/point(s) where graph crosses x or y axis

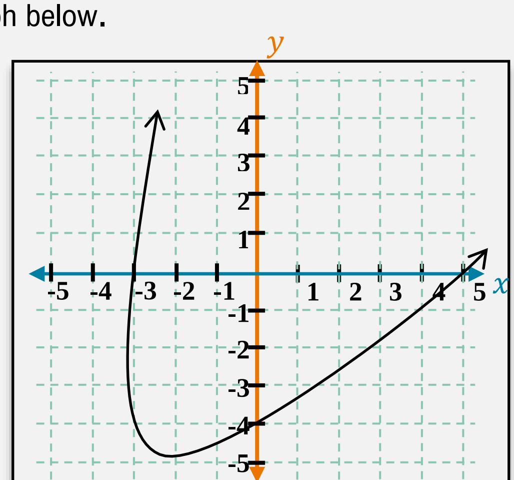
x – intercept



y – intercept

x – Intercept	y – Intercept
x – intercept: x value when graph crosses [x | y] axis [x | y] value is *ALWAYS* zero	y – intercept: y value when graph crosses [x | y] axis [x | y] value is *ALWAYS* zero

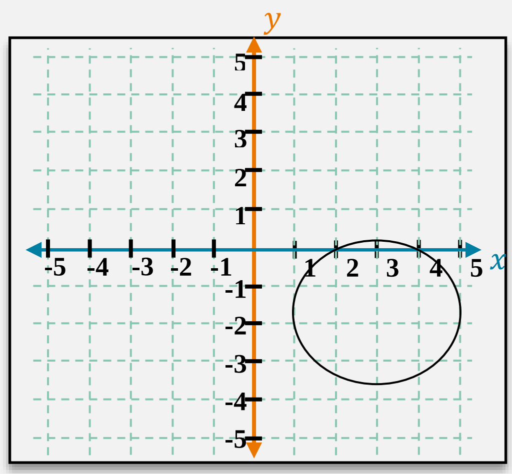
EXAMPLE: Write the x-intercepts & y-intercepts of the graph below.



x – intercept: ________

y – intercept: ________

EXAMPLE: Find the intercepts of the graph below.



Intercepts: ____________

● If asked for "x- or y-intercept", simply write the x or y-value. If asked for just "intercepts", write the ordered pairs.

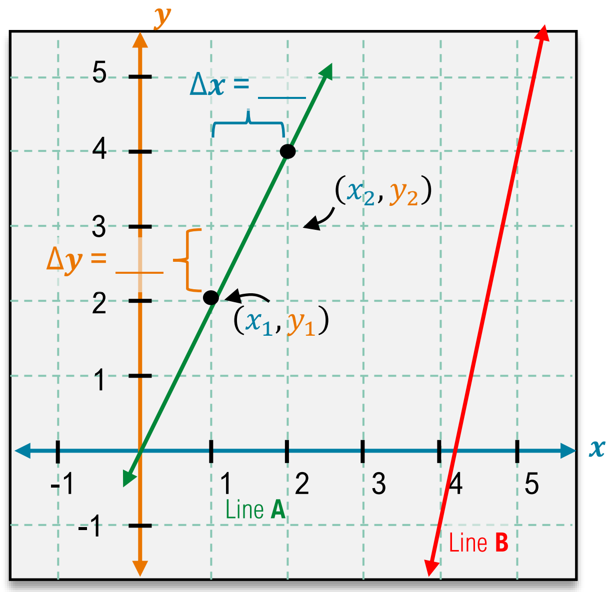
TOPIC: LINES
Slopes of Lines

- **Slope:** A number measuring how ________ a line is; how much ***y changes*** divided by how much ***x changes***.

$m = \frac{\qquad}{\qquad} = \frac{\quad}{\quad}$ "________" over "________"

Δ = "change in"

(x_1, y_1) & (x_2, y_2) are 2 points, may be given or chosen



EXAMPLE: Find the slopes of lines A & B shown in the graph.

Line A

(x_1, y_1) = ________

(x_2, y_2) = ________

Line B

(x_1, y_1) = ________

(x_2, y_2) = ________

Note: Order of points doesn't matter, slope will not change. Generally, set (x_1, y_1) as the ___________ point.

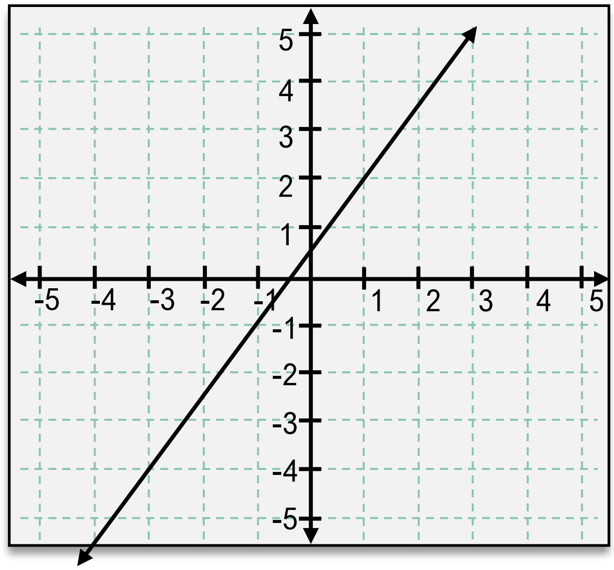
EXAMPLE: Find the slope of **Line B** above using $(x_1, y_1) = (2, 4)$ and $(x_2, y_2) = (1, 2)$ instead.

TOPIC: LINES

PRACTICE: Find the slope of the line shown below.

$$m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

(*Slope*)



PRACTICE: Find the slope of the line containing the points $(-1,1)$ and $(4,3)$.

$$m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

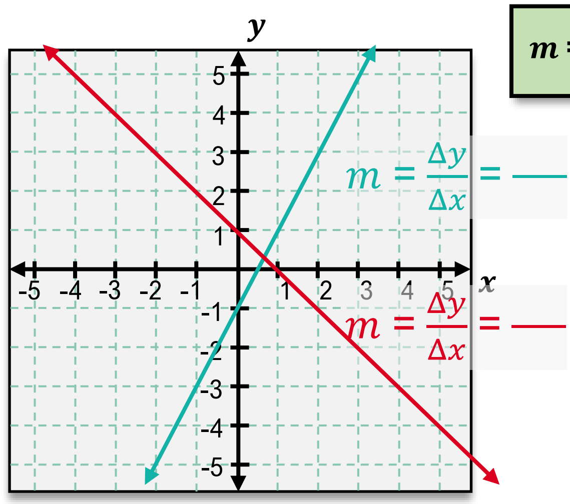
(*Slope*)

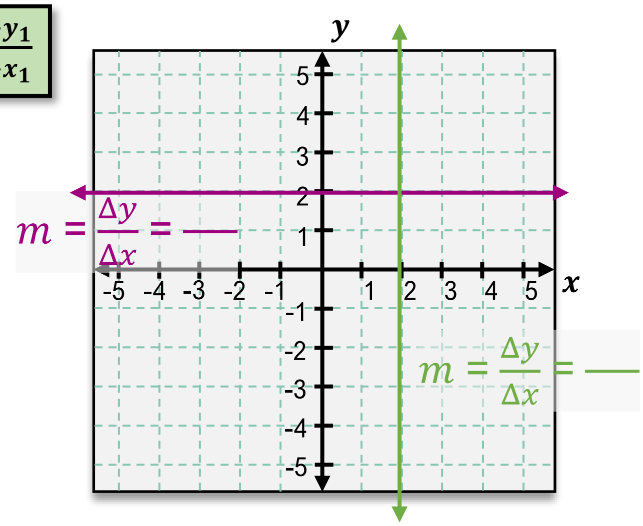
TOPIC: LINES
Types of Slope

● Slope can be **positive**, **negative**, **zero**, or **undefined**.

$$m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

(*Slope*)





If line goes **UP** from left to right, slope is **[+ | −]**

If line goes **DOWN** from left to right, slope is **[+ | −]**

HORIZONTAL line: slope is **[0 | UNDEFINED]** $\boxed{y = \#}$

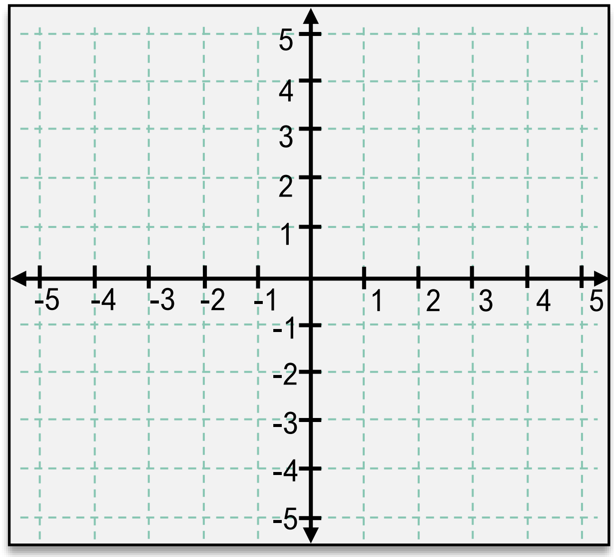
VERTICAL line: slope is **[0 | UNDEFINED]** $\boxed{x = \#}$

TOPIC: LINES

PRACTICE: Graph a line with a slope of 0 that passes through the point $(3, -2)$.

$$m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

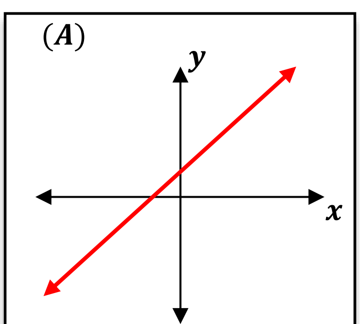
(*Slope*)

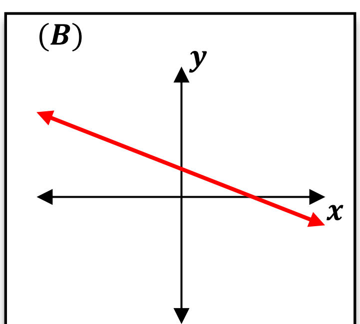


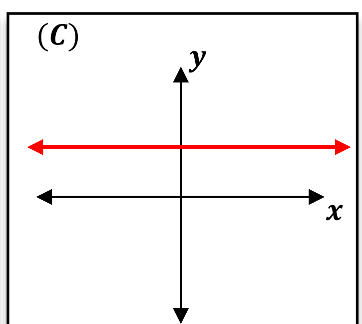
PRACTICE: Which of the following graphs below represents the equation $x = 3$?

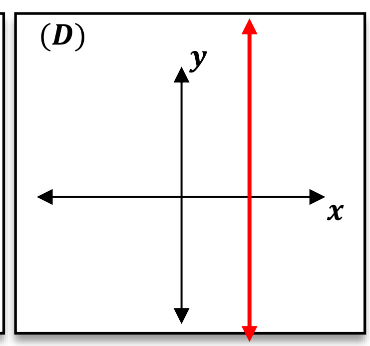
$$m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

(*Slope*)









TOPIC: LINES

Slope – Intercept Form

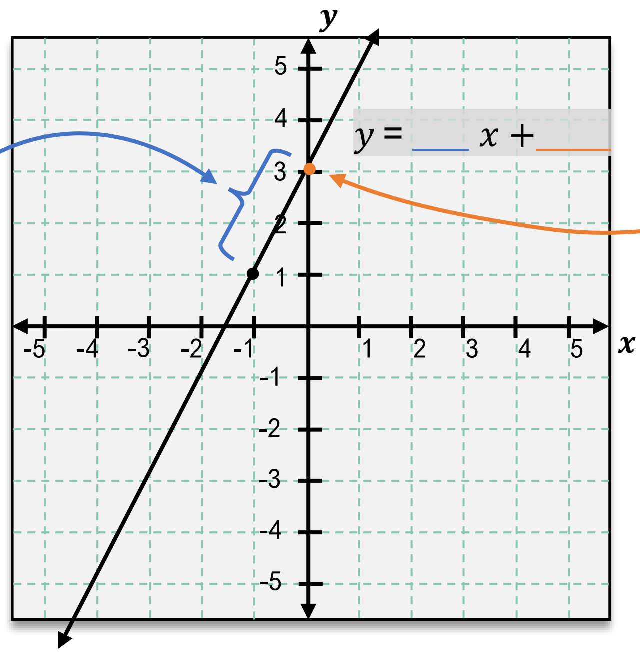
● We can write the equation of a line using its ____________ & _________________.

$$\boxed{y = \_\_x + \_\_}$$

(*Slope – Intercept Form*)

Slope = 2

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\Delta y}{\Delta x}$$



y – Intercept =

y – value where line crosses y – axis

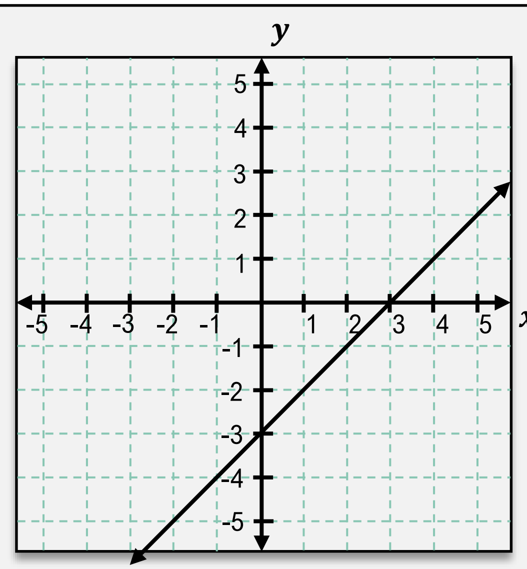
$(x = 0)$

EXAMPLE: In the graph below, identify the y – intercept & slope.

Write the equation in slope-intercept form.

b = _______

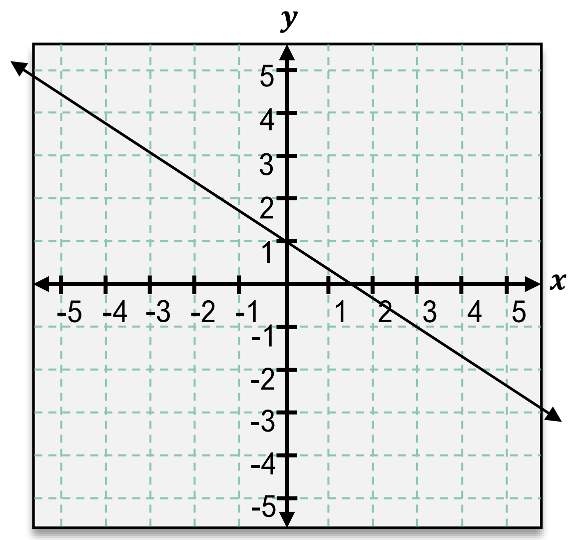
m = _______



TOPIC: LINES

PRACTICE: In the graph shown, identify the y – intercept & slope. Write the equation of this line in Slope-Intercept form.

$$\boldsymbol{y = mx + b}$$



TOPIC: LINES

Graphing Lines from Equations in Slope-Intercept Form

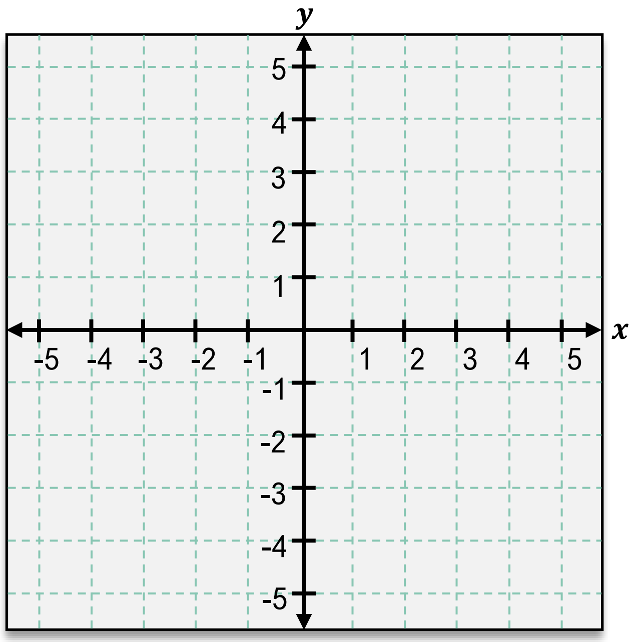
● A line equation in slope-intercept form tells you everything you need to graph it!

$$\boxed{y = mx + b}$$

EXAMPLE: Identify the y – intercept & slope of $y = \frac{2}{3}x + 1$, then graph the equation.

b = ______

m = ______



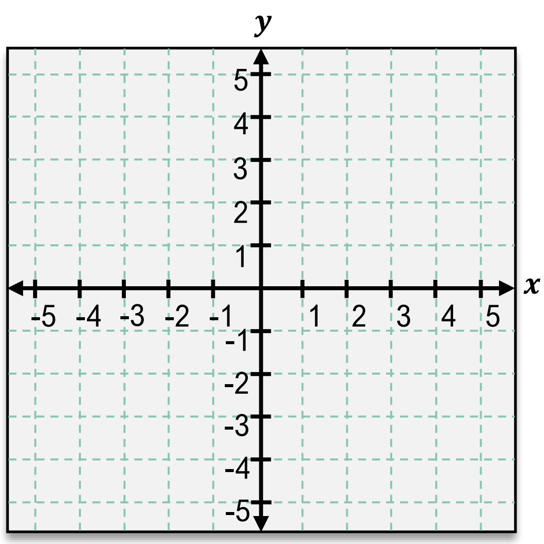
Graphing Lines in Slope-Intercept Form

1) Plot y – intercept $(0, b)$

2) Plot ONE more point using slope $\left(\frac{rise}{run}\right)$:

3) Connect points with a line

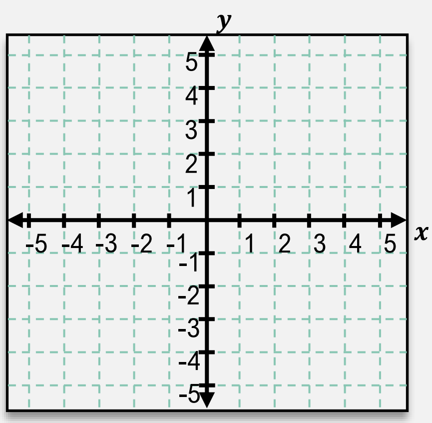
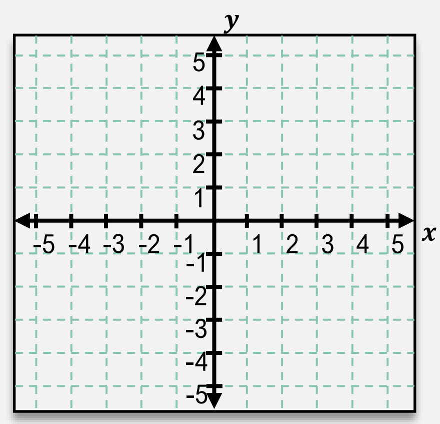
PRACTICE: Identify the y – intercept & slope of $y = -2x - 3$. Then graph the equation.



TOPIC: LINES

Point – Slope Form

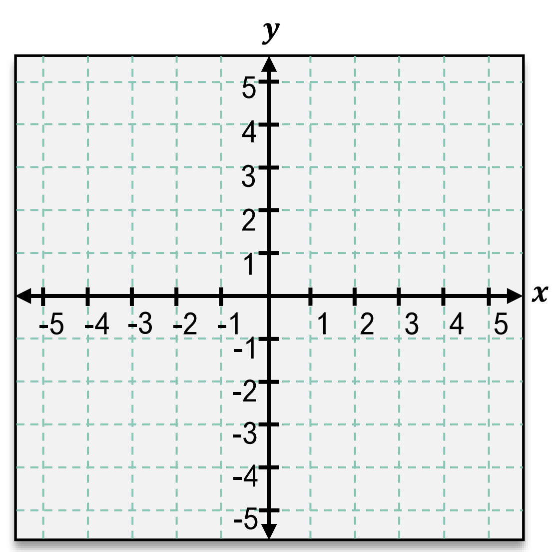
- If asked to write the equation of a line passing through a point that is _____ the y-intercept, use Point-Slope Form.

FORMS OF LINEAR EQUATIONS			
	SLOPE-INTERCEPT	POINT-SLOPE	FORM #3
EQN	$y = mx + b$	$y - y_1 = m(x - x_1)$	
USE IF	Given m & b, asked for graph/EQ Given graph/EQ, asked for m & b	Given m & point (x_1, y_1) **OR** Given 2 points (x_1, y_1) & (x_2, y_2)	
EXAMPLE	Graph the equation $y = \frac{2}{3}x - 1$ 	**a)** Write the equation of a line in point – slope form with slope = $\frac{2}{3}$ which passes through $(3,1)$. **b)** Graph the line **c)** Rewrite your equation from part (a) in Slope-Intercept form 	

PRACTICE: Write the point-slope form of the equation of a line with a slope of $-\frac{2}{5}$ that passes through $(1,3)$. Then graph the equation.

$$y - y_1 = m(x - x_1)$$

(Point-Slope)

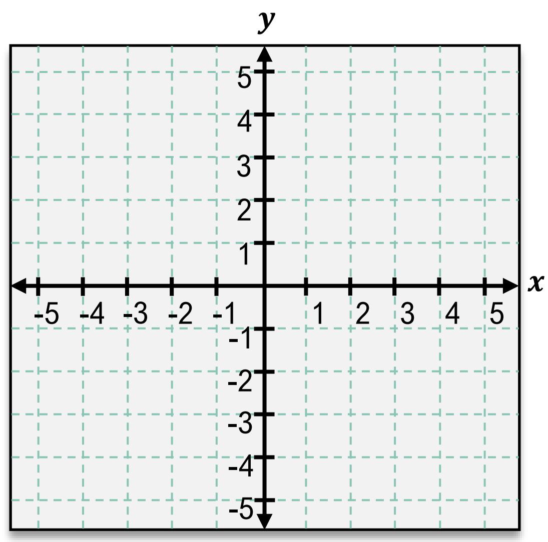


TOPIC: LINES

PRACTICE: Write the point-slope form of the equation of a line with a slope of 0 that passes through $(2, -4)$. Then graph the equation.

$$\boxed{y - y_1 = m(x - x_1)}$$

(*Point-Slope*)



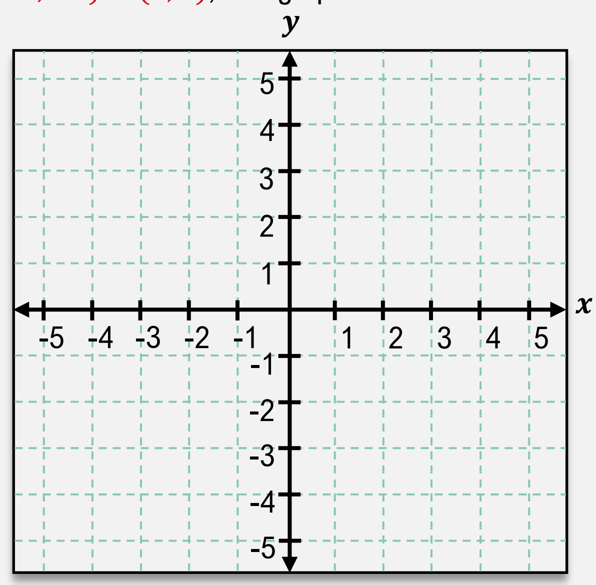
TOPIC: LINES
Finding Equations of a Line Given 2 Points

● Sometimes you will not be given slope, and you'll be asked to write an equation when given TWO points.

- Use ___________ of the two points as (x_1, y_1)

FORMS OF LINEAR EQUATIONS			
	SLOPE-INTERCEPT	POINT-SLOPE	FORM #3
EQN	$y = mx + b$	$y - y_1 = m(x - x_1)$	
USE IF	Given m & b, asked for graph/EQ Given graph/EQ, asked for m & b	Given m & point (x_1, y_1) **OR** Given 2 points (x_1, y_1) & (x_2, y_2)	

EXAMPLE: Write the equation of the line passing through the points $(-1, -5)$ & $(2, 4)$, and graph it.



$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

(Slope)

$$y - y_1 = m(x - x_1)$$

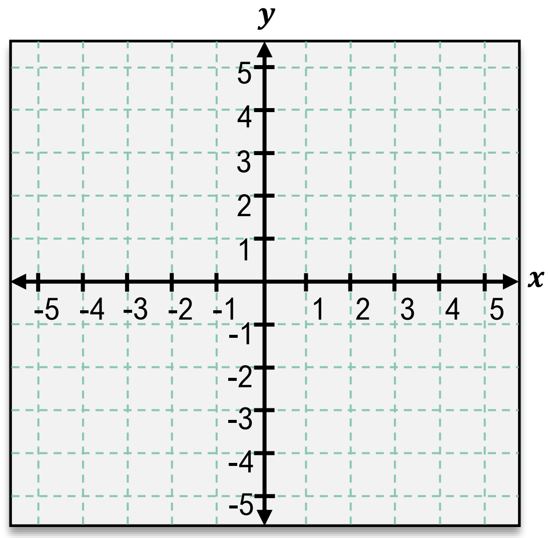
(Point – Slope Form)

TOPIC: LINES

PRACTICE: Write the point-slope form of the equation of a line that passes through the points $(2,1)$ and $(-4,3)$. Then graph the equation.

$$\boxed{y - y_1 = m(x - x_1)}$$

(*Point-Slope*)



TOPIC: LINES
Standard Form of a Line

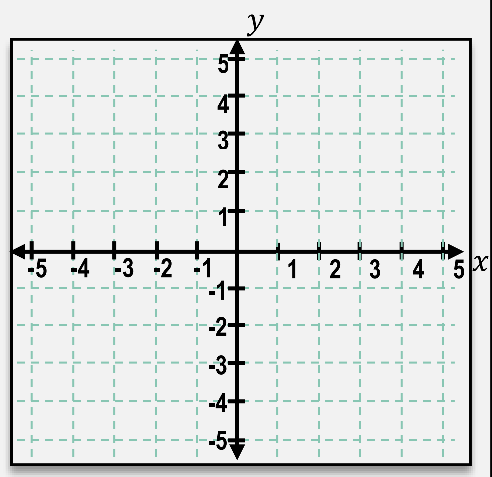
- When problems give a line in **Standard** Form and ask for Slope or Intercept, you'll have to ____________ it.
  - To do this, __________ y to left side of equation.

FORMS OF LINEAR EQUATIONS			
	SLOPE-INTERCEPT	POINT-SLOPE	STANDARD or "GENERAL"
EQN	$\boxed{y = mx + b}$ $y = 2x + 3$	$\boxed{y - y_1 = m(x - x_1)}$	$\boxed{Ax + By + C = 0}$ $-4x + 2y - 6 = 0$
USE IF	Given/asked for b	Given (x_1, y_1) & m or (x_2, y_2)	**1)** Asked to rewrite in other form **OR** **2)** Finding x & y ___________

EXAMPLE: Find the slope & y-intercept of the equation $-9x + 3y - 12 = 0$.

- To graph a line in Standard Form, you can find the x & y intercepts quickly *without* rewriting in Slope-Intercept.
  - For x-intercept, set $y = 0$ & solve for x. For y-intercept, set $x = 0$ and solve for y.

EXAMPLE: Graph the equation $3x + 2y - 6 = 0$ by finding the intercepts without using Slope-Intercept form.

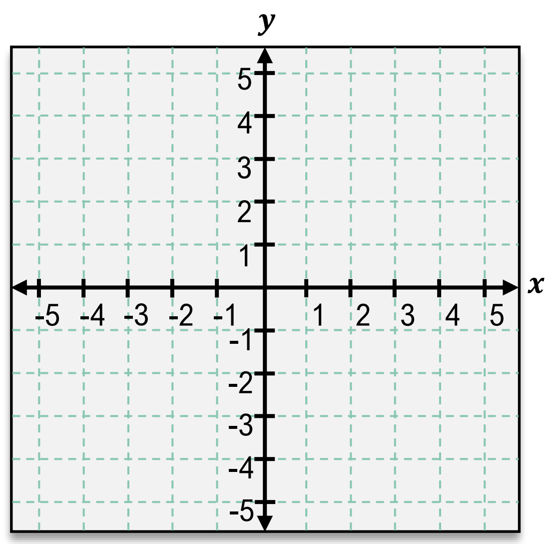


TOPIC: LINES

PRACTICE: Find the slope & y-intercept of the line given by the equation $3x + 2y - 6 = 0$.

FORMS OF LINEAR EQUATIONS		
SLOPE-INTERCEPT	POINT-SLOPE	STANDARD
$y = mx + b$	$y - y_1 = m(x - x_1)$	$Ax + By + C = 0$

PRACTICE: Graph the equation $9x + 6y + 18 = 0$ by finding the intercepts.



TOPIC: LINES

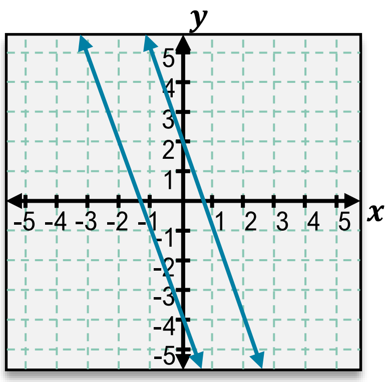
Parallel and Perpendicular Lines

● Parallel & perpendicular lines are related by ___________.

FORMS OF LINEAR EQUATIONS		
SLOPE-INTERCEPT	POINT-SLOPE	STANDARD
$y = mx + b$	$y - y_1 = m(x - x_1)$	$Ax + By + C = 0$

Parallel Lines

$y = -3x + 2$ $\qquad$ $y = -3x - 4$



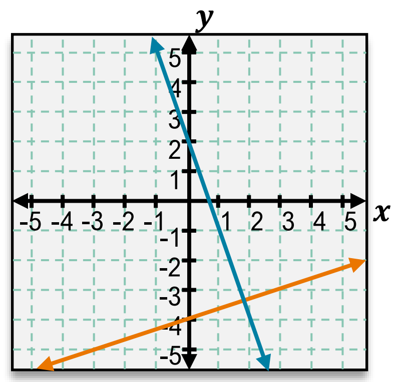
$m_1 = m_2$

Slopes are _______; y-intercepts are __________

Lines *never* intersect

Perpendicular Lines

$y = -3x + 2$ $\qquad$ $y = \frac{1}{3}x - 4$

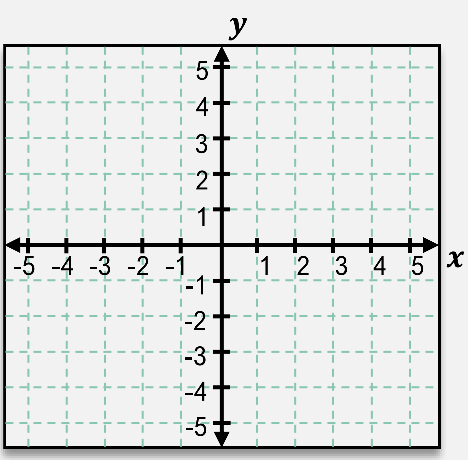


$m_1 = -\frac{1}{m_2}$

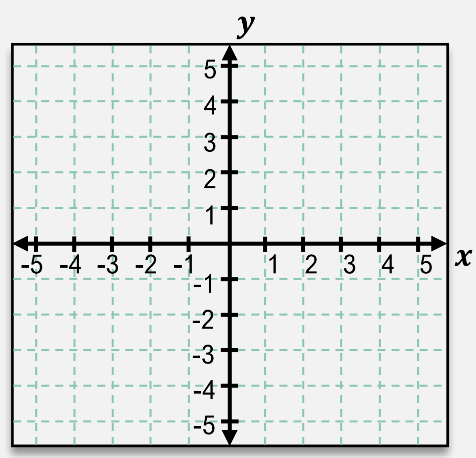
Slopes have ___________ signs and are __________

Lines intersect at ***right*** angles (90°)

EXAMPLE: Write the equation of a line passing through $(-1, 4)$ that is parallel to $y = 2x - 6$.



EXAMPLE: Write the equation of a line perpendicular to $x + 4y - 8 = 0$ that has a y-intercept of 3.



TOPIC: LINES

PRACTICE**:** Write an equation of a line that passes through the point $(3, -4)$ and is parallel to the line $x + 2y + 18 = 0$.

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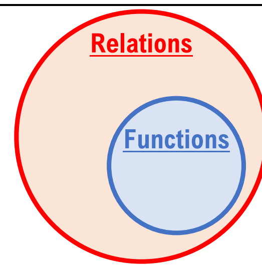
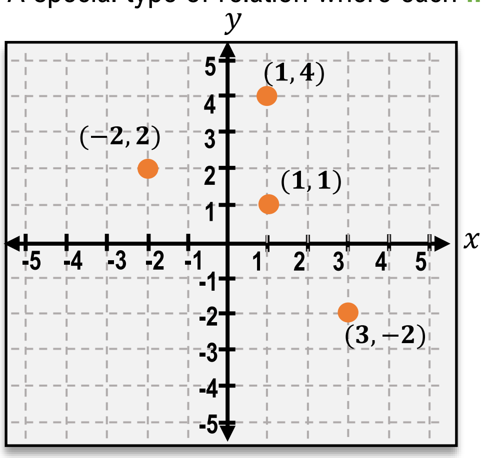
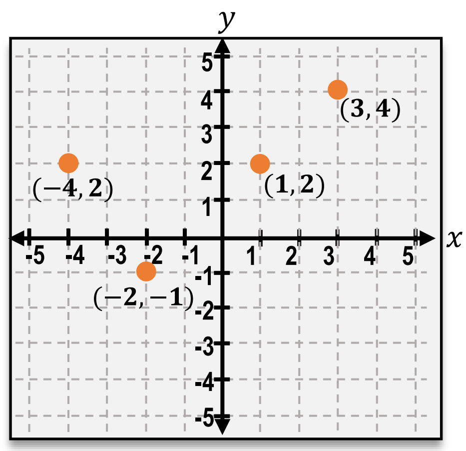


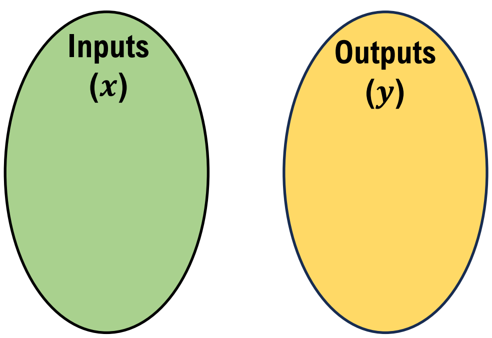
TOPIC: INTRO TO FUNCTIONS & THEIR GRAPHS

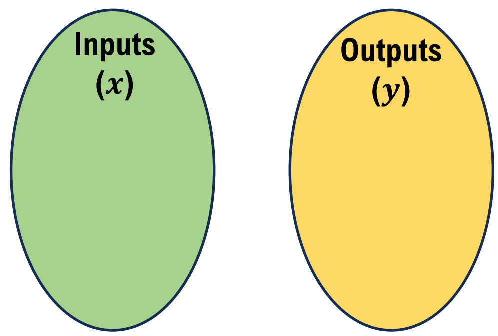
Relations and Functions

- **Relation:** A connection between ______ & ______ values.
  - Graphically, they are represented as ___________ pairs (x, y)
- **Function:** A special type of relation where each input has at most ______ output.





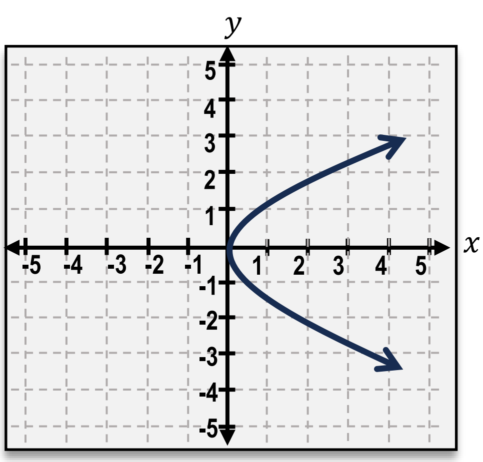


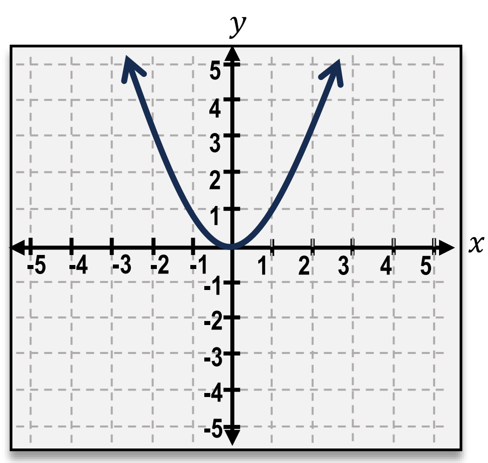


[FUNCTION | NOT A FUNCTION]

[FUNCTION | NOT A FUNCTION]

- A way to quickly determine if a graph is a function or not is the **Vertical Line Test:**
  - If you can draw ***any*** vertical line that passes through more than 1 point, the graph ________ a function.



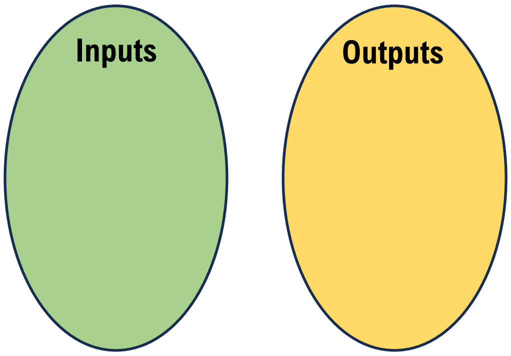


[FUNCTION | NOT A FUNCTION]

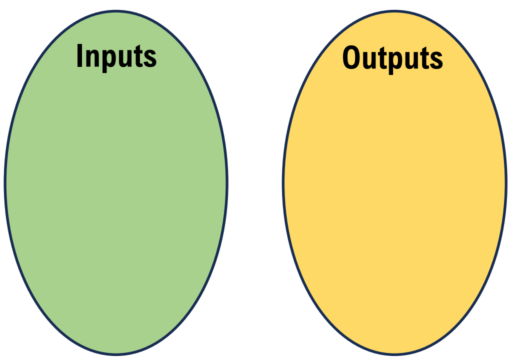
[FUNCTION | NOT A FUNCTION]

TOPIC: INTRO TO FUNCTIONS & THEIR GRAPHS

PRACTICE: State the inputs and outputs of the following relation. Is it a function? $\{(-3,5),(0,2),(3,5)\}$

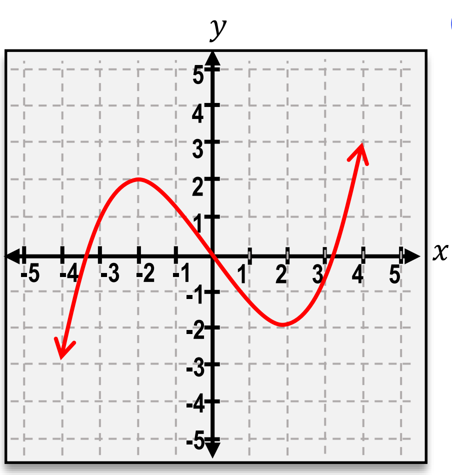


PRACTICE: State the inputs and outputs of the following relation. Is it a function? $\{(2,5),(0,2),(2,9)\}$

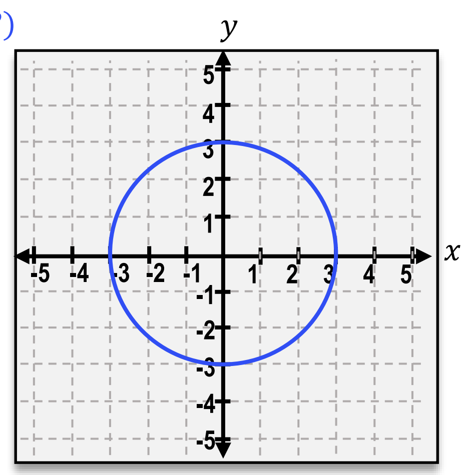


PROBLEM: Determine below which of the graphs are functions (select all that apply).

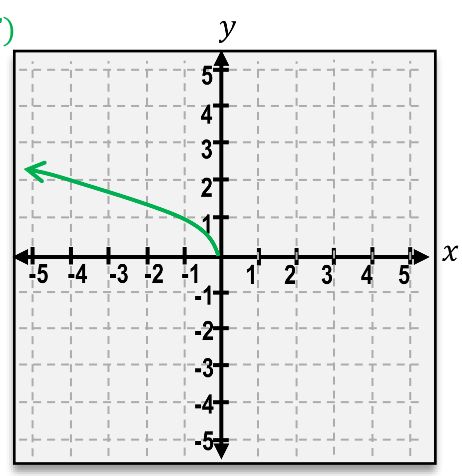
(A)



(B)



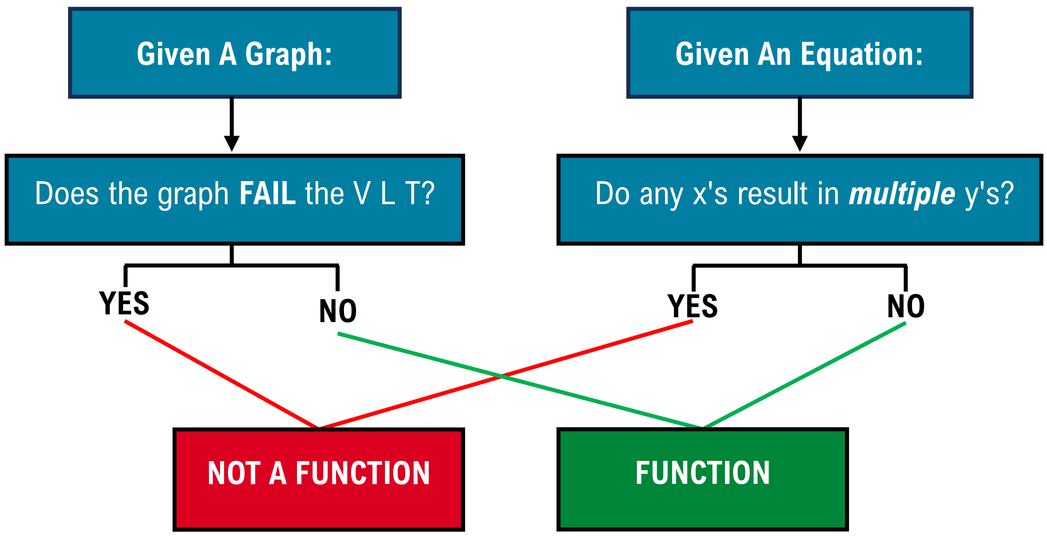
(C)



Study Prep
Available on Pearson+

TOPIC: INTRO TO FUNCTIONS & THEIR GRAPHS
Verifying if Equations are Functions

● To verify if an **equation** is a function, you should __________ for _____ as a first step.



EXAMPLE: Determine if each of the equations below is **a function**, or **not a function**.

(A)

$$y + 4 = 3x$$

x		y
-1		
0		
1		
2		

If equation is a _______, then it is a

[**FUNCTION \| NOT A FUNCTION**].

(B)

$$x^2 + y^2 = 25$$

x		y
-1		
0		
1		
2		

If equation has an _______ power of y, then it is a

[**FUNCTION \| NOT A FUNCTION**].

● If an equation is a function, we can write it using function ___________ (replace ____ with ______).

- We can write $y = 3x - 4$ as ____ $= 3x - 4$

TOPIC: INTRO TO FUNCTIONS & THEIR GRAPHS

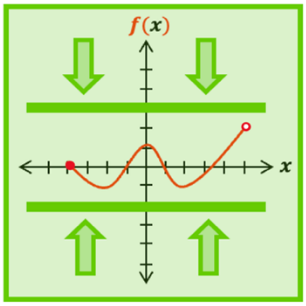
PRACTICE: Is the equation $y = -2x + 10$ a function? If so, rewrite it in function notation and evaluate at $f(3)$.

PRACTICE: Is the equation $y^2 + 2x = 10$ a function? If so, rewrite it in function notation and evaluate at $f(-1)$.

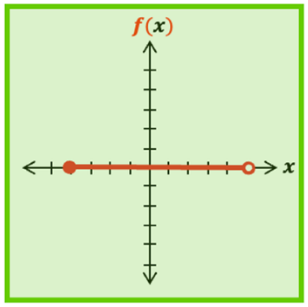
TOPIC: INTRO TO FUNCTIONS & THEIR GRAPHS
Finding The Domain And Range Of A Graph

- The **domain** of a graph is the allowed ___-values, and the **range** of a graph is the allowed ___-values.
  - To find the **domain** of a graph, "***squish***" to the ___-axis. To find the **range**, "***squish***" to the ___-axis.

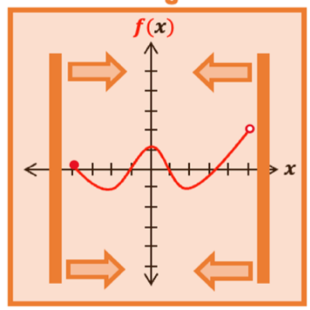
Domain:



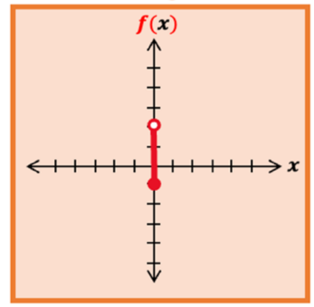
Domain:



Range:



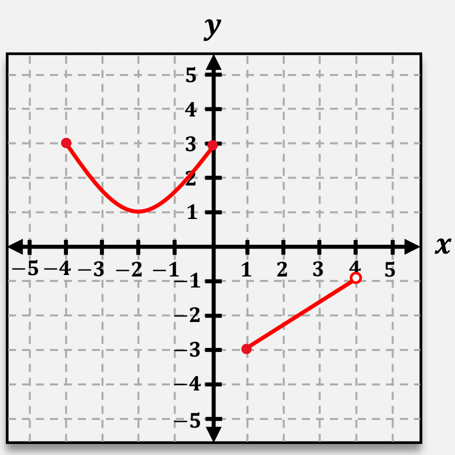
Range:

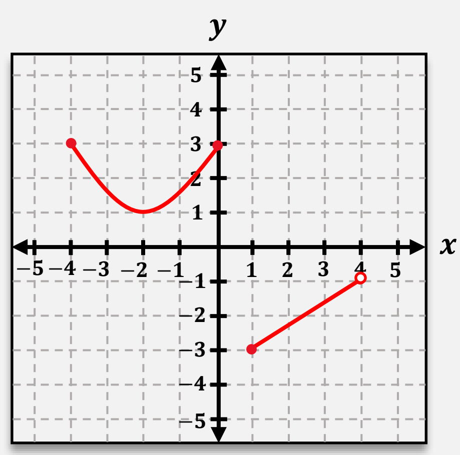


Interval Notation:	Set Builder Notation:
$Domain = [-4, 5)$	$Domain = \{x \mid -4 \leq x < 5\}$
$Range = [-1, 2)$	$Range = \{y \mid -1 \leq x < 2\}$

- The **[,], ≤, ≥** symbols mean we **[INCLUDE | DON'T INCLUDE]** the value.
- The **(,), <, >** symbols mean we **[INCLUDE | DON'T INCLUDE]** the value.

EXAMPLE: Determine the **domain** & **range** of the following graph below. Express the answer using interval notation.

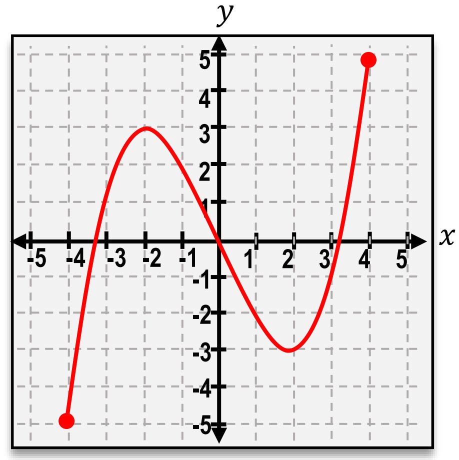




- When we have multiple intervals or "jumps" in the graph, use the union symbol (___).

TOPIC: INTRO TO FUNCTIONS & THEIR GRAPHS

PRACTICE: Find the domain and range of the following graph (write your answer using interval notation).



TOPIC: INTRO TO FUNCTIONS & THEIR GRAPHS
Finding the Domain of an Equation

- You may need to find the **domain** (allowed x-values) of a function when given an equation instead of a graph.
  - First determine ***restrictions*** by identifying values that ________ the function. Two common situations:

1) x inside of a Square Root

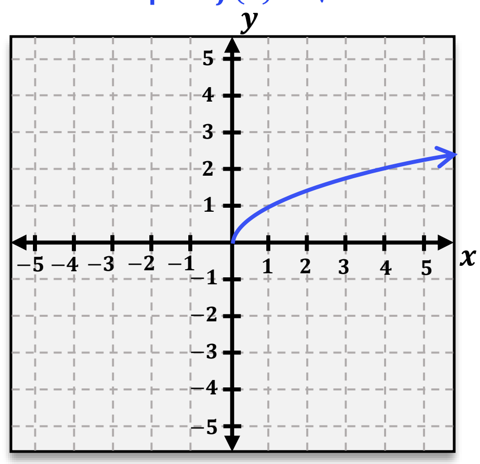
Domain: x-values that don't make the inside of the square root ___________.

EXAMPLE: Find the domain of the function $f(x) = \sqrt{x}$ without graphing. Express using interval notation.

Restriction: x-values that make $\sqrt{\ }$ negative: ______, therefore

Domain:

Graph of $f(x) = \sqrt{x}$:



2) x in the Denominator of a Fraction

Domain: x-values that don't make the denominator _________.

EXAMPLE: Find the domain of the function $f(x) = \frac{2}{x-5}$ using interval notation.

Restriction: x-values that make denominator 0: _______, therefore

Domain:

TOPIC: INTRO TO FUNCTIONS & THEIR GRAPHS

PRACTICE: Find the domain of $f(x) = \sqrt{x+4}$. Express your answer using interval notation.

PRACTICE: Find the domain of $f(x) = \frac{1}{x^2-5x+6}$. Express your answer using interval notation.

TOPIC: COMMON FUNCTIONS

Graphs of Common Functions

● There are several graphs that may ___________ show up in this course.

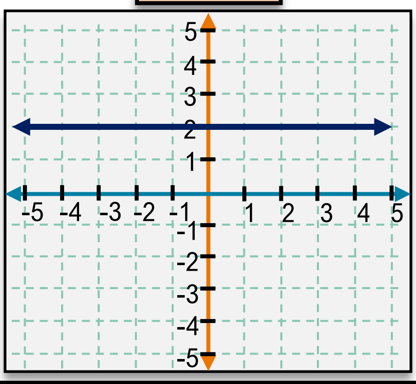
Graphs of Common Functions

Constant Function
(y = same value, does NOT depend on x)

$\boxed{f(x) = c}$

Domain: _________

Range: _________

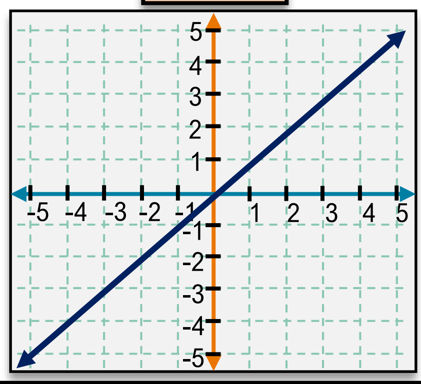


Identity Function

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

Domain: _________

Range: _________



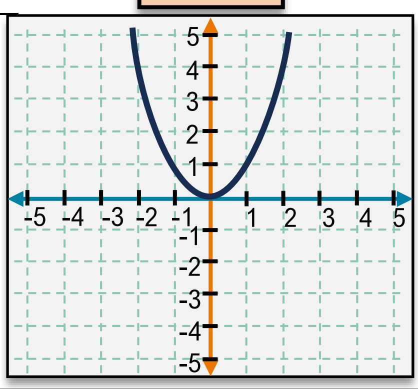
Square Function
(Output = square of input)

$\boxed{f(x) = x^2}$

● **Shape is a** ___________

Domain: _________

Range: _________

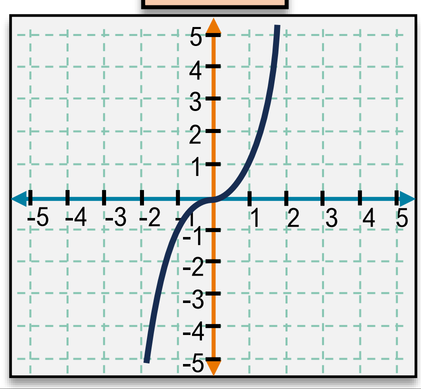


Cube Function
(Output = cube of input)

$\boxed{f(x) = x^3}$

Domain: _________

Range: _________



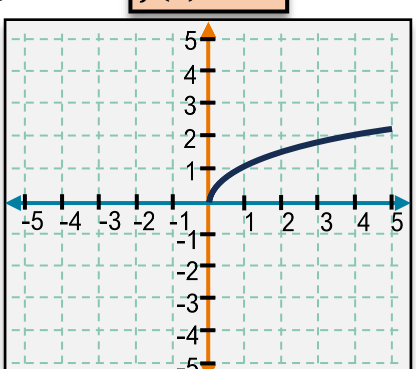
Square Root Function
(Output is the square root of input)

● x **[CAN | CANT]** be negative

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

Domain: _________

Range: _________



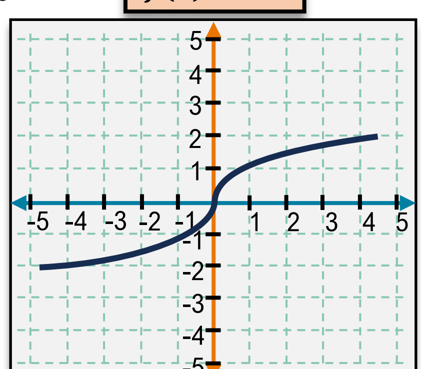
Cube Root Function
(Output is the cube of input)

● x **[CAN | CANT]** be negative

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

Domain: _________

Range: _________

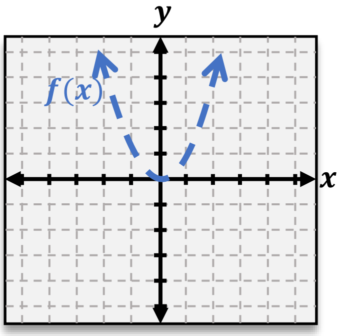
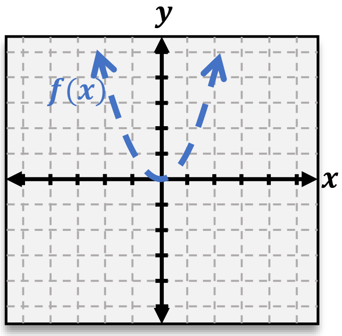
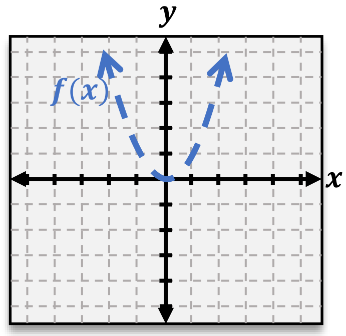


TOPIC: TRANSFORMATIONS

Intro to Transformations

- Transformations occur when a function is ______________ and changes position and/or shape.

Transformations of Functions

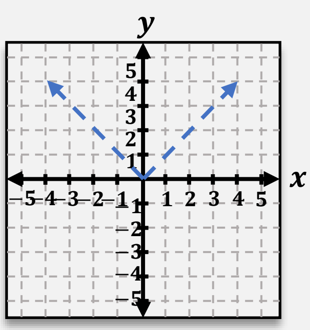
1) Reflection (*FOLDING a function*)	**2) Shift** (*MOVING a function*)	**3) Stretch** (*SQUEEZING a function*)
		
$-f(x)$	$f(x-h)+k$	$c \cdot f(x)$

EXAMPLE: The graph of the $f(x) = |x|$ is shown below. Match the following functions $p(x)$, $q(x)$, & $r(x)$ to their corresponding graphs.

(A) $p(x) = |x-3| + 2$

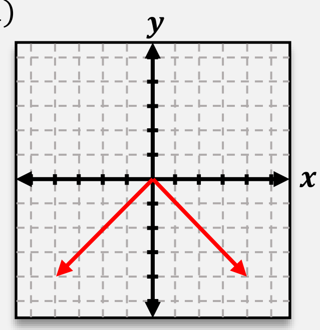
(B) $q(x) = -|x|$

(C) $r(x) = -4|x|$

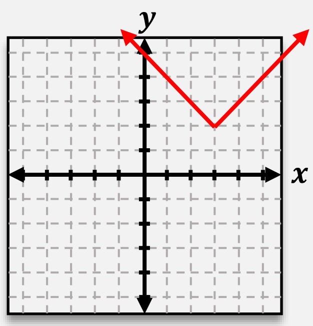


Reflection	Shift	Stretch
$-f(x)$	$f(x-h)+k$	$c \cdot f(x)$

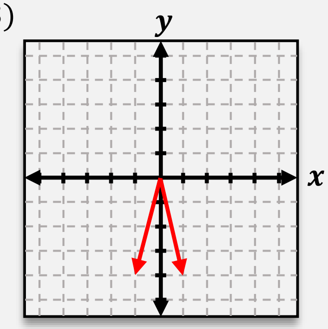
(1)



(2)



(3)



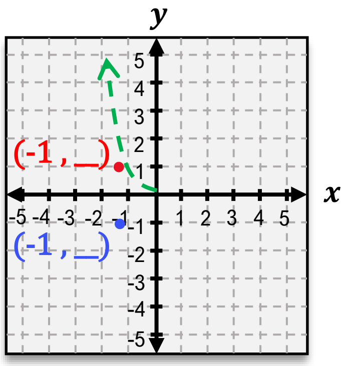
Transformations of Functions		
Reflection	Shift	Stretch

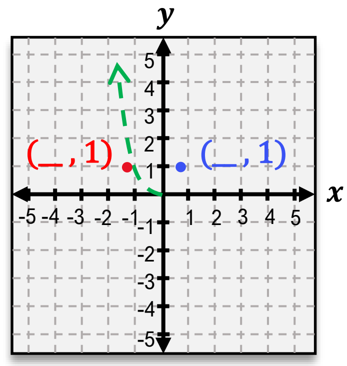
TOPIC: TRANSFORMATIONS

Reflections

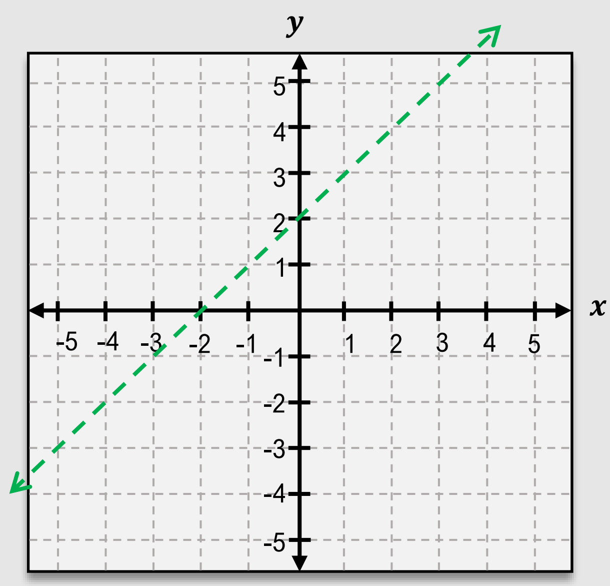
- A reflection is a transformation where the function appears to be "__________" over the ___ -axis, or the ___ -axis.

REFLECTION OVER [X-AXIS | Y-AXIS]	REFLECTION OVER [X-AXIS | Y-AXIS]
[x's | y's] change signs $f(x) \to -f(x)$	[x's | y's] change signs $f(x) \to f(-x)$





EXAMPLE: Given $f(x) = x + 2$, let $h(x)$ be the function $f(x)$ with a ***reflection*** over the x**-axis**. Sketch the graph of $h(x)$, and determine which of the functions below matches the new function $h(x)$.



(A) $h(x) = x - 2$

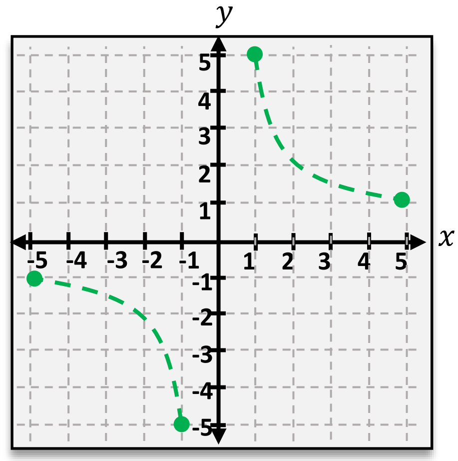
(B) $h(x) = -x + 2$

(C) $h(x) = -x - 2$

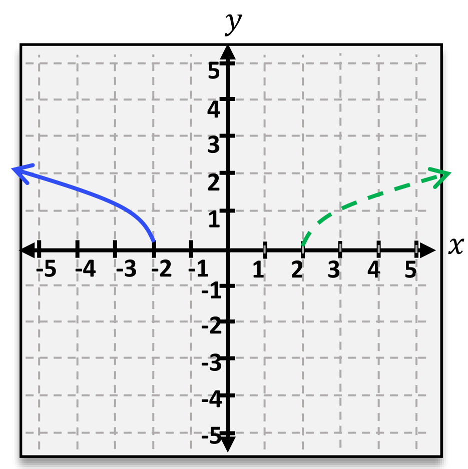
(D) $h(x) = x + 2$

TOPIC: TRANSFORMATIONS

PROBLEM: Written below is a graph of the function $f(x)$. Sketch a graph of the function $g(x)$, where $g(x)$ is the function $f(x)$ after it has been reflected over the ***x-axis***.



PRACTICE: Written below is a graph of the function $f(x) = \sqrt{x-2}$. If $g(x)$ is a reflection of $f(x)$ about the ***y-axis*** what is the equation for $g(x)$?



Transformations of Functions		
Reflection	Shift	Stretch

TOPIC: TRANSFORMATIONS
Shifting A Function

- A shift occurs when a function is moved ______________ and/or ______________ from its original position.

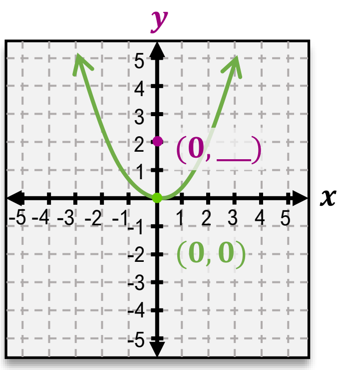
SHIFTS

General Form: $f(x) \rightarrow f(x-h)+k$

VERTICAL SHIFT $(h=0)$

Vertical shifts change the [x's | y's]

$f(x) \rightarrow f(x-h)+k$



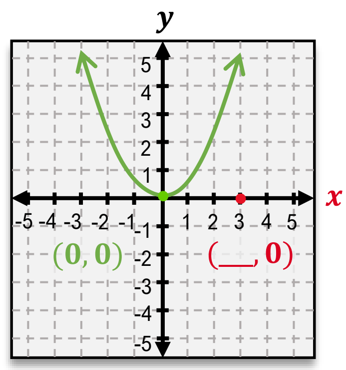
For $f(x)+k$, graph shifts [UP | DOWN]

For $f(x)-k$, graph shifts [UP | DOWN]

HORIZONTAL SHIFT $(k=0)$

Horizontal shifts change the [x's | y's]

$f(x) \rightarrow f(x-h)+k$



For $f(x+h)$, graph shifts [RIGHT | LEFT]

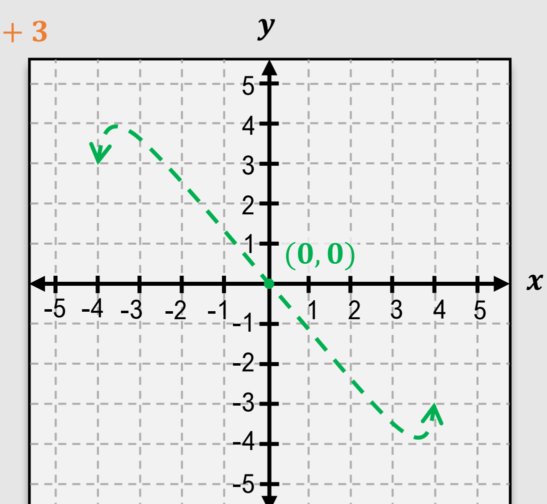
For $f(x-h)$, graph shifts [RIGHT | LEFT]

EXAMPLE: Given the function $f(x)$, sketch the transformation: $f(x-2)+3$

$f(x) \rightarrow f(x-h)+k$

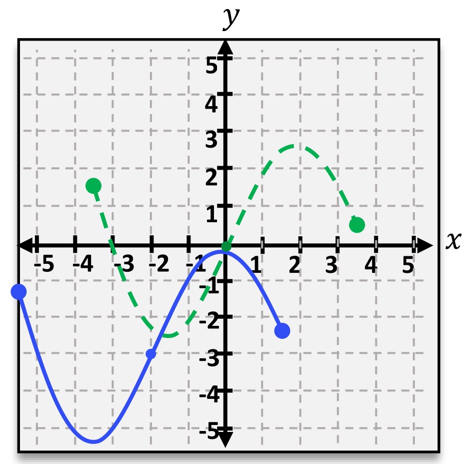
$h =$ _____

$k =$ _____



TOPIC: TRANSFORMATIONS

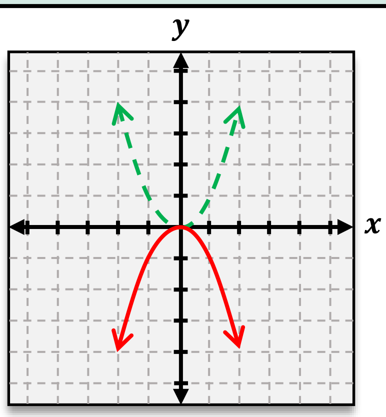
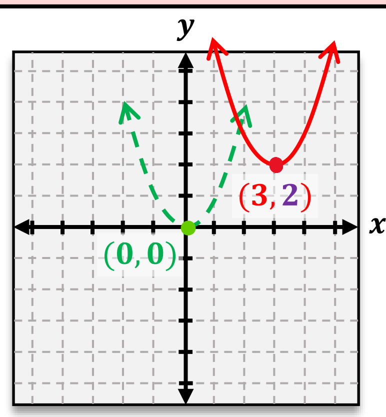
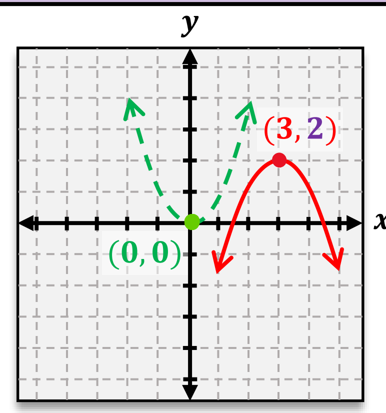
PRACTICE: The green dotted line in the graph below represents the function $f(x)$. The blue solid line represents the function $g(x)$, which is the function $f(x)$ after it has gone through a shift transformation. Find the equation for $g(x)$.



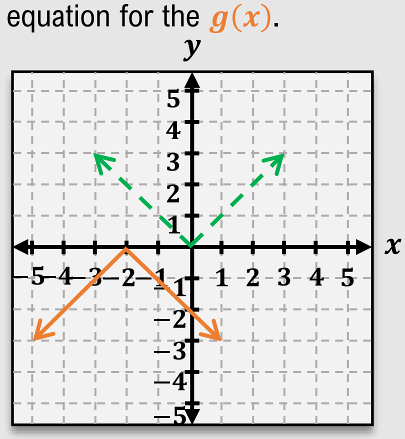
Transformations of Functions		
Reflection	Shift	Stretch

TOPIC: TRANSFORMATIONS
Graphs Of Shifted & Reflected Functions

- It is possible to see a ____________ of transformations to a single function.

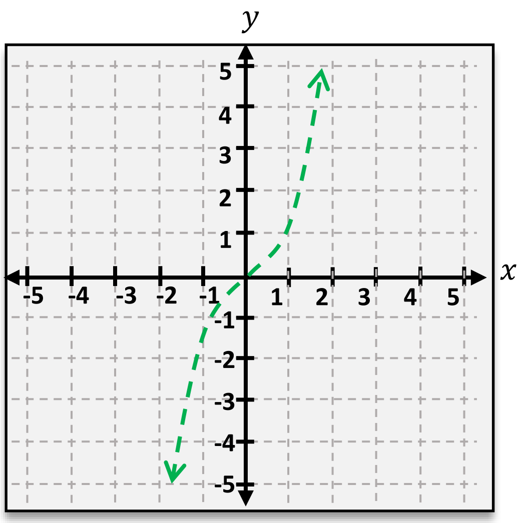
REFLECTION	SHIFTS	REFLECTIONS & SHIFTS
		
$f(x) \to -f(x)$	$f(x) \to f(x-3)+2$	$f(x) \to -f(x-3)+2$

EXAMPLE: If $g(x)$ is a transformation of the function $f(x) = |x|$, write the equation for the $g(x)$.



TOPIC: TRANSFORMATIONS

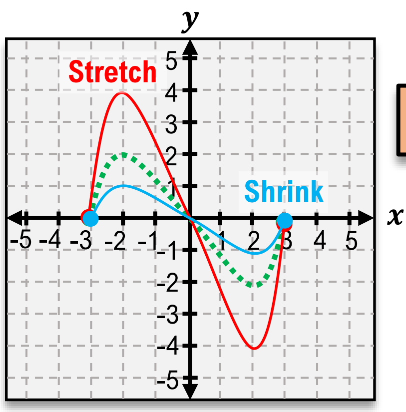
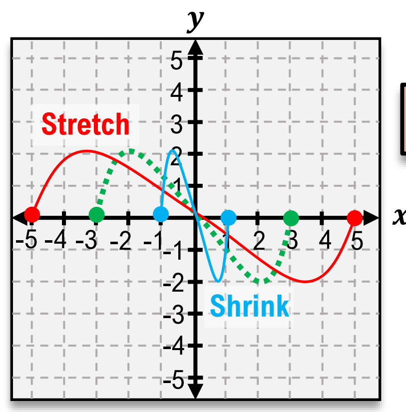
PROBLEM: If $h(x)$ is a transformation of $f(x) = x^3$ where $f(x)$ is reflected over the ***x-axis***, then shifted down 2 units. (A) write the equation for $h(x)$. (B) Sketch a graph of $h(x)$.



TOPIC: TRANSFORMATIONS
Stretches And Shrinks

Transformations of Functions		
Reflection	Shift	Stretch

- Stretches/Shrinks occur when a ___________ (c) is multiplied inside or outside the function.

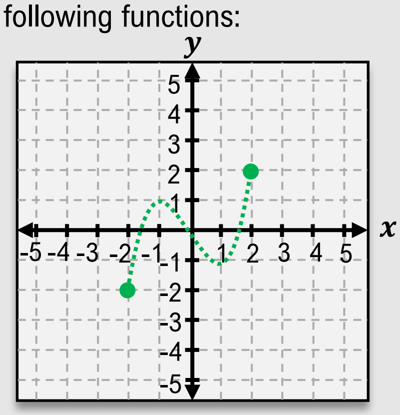
Vertical Stretch/Compress	Horizontal Stretch/Compress
 $f(x) \rightarrow c \cdot f(x)$	 $f(x) \rightarrow f(c \cdot x)$
● When ____< c < ____ the graph vertically [**STRETCHES | SHRINKS**]	● When ____< c < ____ the graph horizontally [**STRETCHES | SHRINKS**]
● When c > ____ the graph vertically [**STRETCHES | SHRINKS**]	● When c > ____ the graph horizontally [**STRETCHES | SHRINKS**]

EXAMPLE: Graphed below is the function $f(x)$. Sketch the graphs of the following functions:

(A) $2 \cdot f(x)$

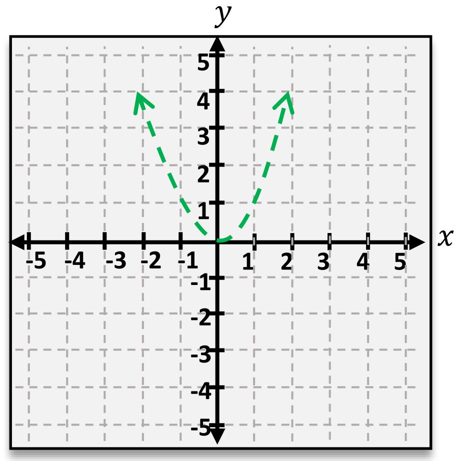
(B) $\frac{1}{2} \cdot f(x)$

(C) $f(\frac{1}{2} \cdot x)$



TOPIC: TRANSFORMATIONS

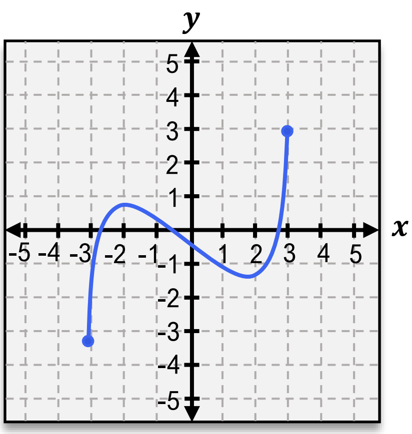
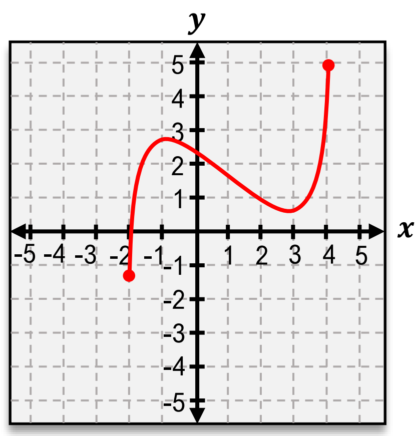
PROBLEM: Given that $f(x) = (c \cdot x)^2$, graph $f(x)$ when $(A)\ c = 2$, $(B)\ c = \frac{1}{2}$



TOPIC: TRANSFORMATIONS

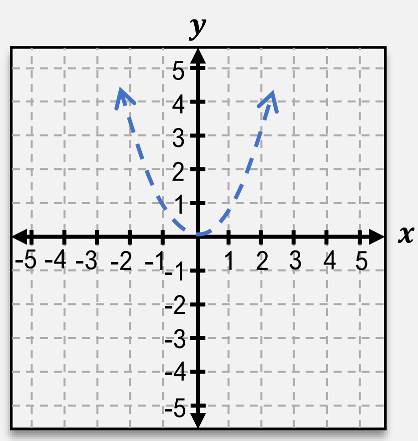
Domain & Range of Transformed Functions

- A transformation can ____________ the domain and range of a function.
  - We can find the domain & range of a transformed function by _________________ the new graph.

Function: $f(x)$	Function: $f(x-1)+2$
	
Domain → D: $[-3,3]$ Range → R: $[-3,3]$	Domain → D: [____, ____] Range → R: [_____, _____]

EXAMPLE: Given the function $f(x) = x^2$, sketch a graph of the function $g(x) = (x-3)^2 + 2$ and determine its domain and range.

$$\boxed{f(x) \to f(x-h)+k}$$



Domain Of $f(x)$: $(-\infty, \infty)$

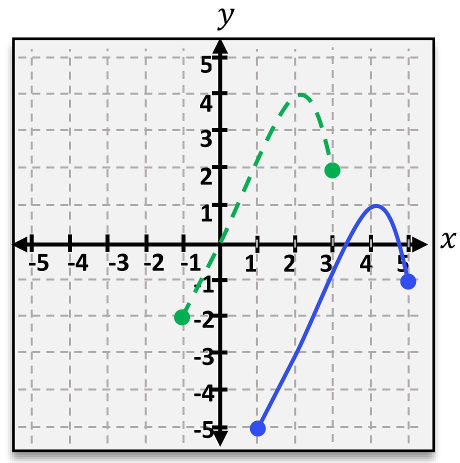
Range Of $f(x)$: $[0, \infty)$

Domain Of $g(x)$:

Range Of $g(x)$:

TOPIC: TRANSFORMATIONS

PRACTICE: The green dotted curve below is a graph of the function $f(x)$. Find the domain and range of $g(x)$ (the blue solid curve), which is a transformation of $f(x)$.



Domain of $f(x) = [-1, 3]$

Range of $f(x) = [-2, 4]$

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TOPIC: FUNCTION COMPOSITION
Function Composition

- Function composition is like evaluating, but you replace the inside variable of a function with ***ANOTHER*** __________.

EVALUATING a Function	COMPOSING a Function
$f(x) = x^2 + 3x - 10$ $f(7) = (\quad)^2 + 3(\quad) - 10$ $=$ Result is a **[NUMBER | FUNCTION]**	$f(x) = x^2 + 3x - 10$ $g(x) = x - 2$ $f(g(x)) = (\qquad)^2 + 3(\qquad) - 10$ $=$ Result is a **[NUMBER | FUNCTION]**

Note: $f(g(x))$ is often written as ____________. First letter = outside function, second letter = inside function

EXAMPLE: Given the functions $f(x) = x + 4$ and $g(x) = x^2 - 3$, find the following composite functions (fully simplify your answer).

(A) $f(g(x)) =$

(B) $g(f(x)) =$

TOPIC: FUNCTION COMPOSITION

PRACTICE: Given the functions $\boldsymbol{f(x) = \sqrt{x+4}}$ and $\boldsymbol{g(x) = (x-2)^2 - 4}$, $(\boldsymbol{A})$ find $(\boldsymbol{f \circ g})(\boldsymbol{x})$ and $(\boldsymbol{B})$ $(g \circ f)(x)$.

PRACTICE: Given the functions $\boldsymbol{f(x) = \frac{1}{x^2-2}}$ and $\boldsymbol{g(x) = \sqrt{x+2}}$, $(\boldsymbol{A})$ find $(\boldsymbol{f \circ g})(\boldsymbol{x})$ and $(\boldsymbol{B})$ $(g \circ f)(x)$.

TOPIC: FUNCTION COMPOSITION
Evaluating Composed Functions

● You may have to compose functions and ***then*** ___________ at a specific value, $f(g(\#))$. Two common methods:

Method 1: Compose → Evaluate *Use when first asked to find $f(g(x))$*	**Method 2: Evaluate inside → Evaluate outside**
$f(x)$ $g(x)$ $\searrow$ $\swarrow$ $f(g(x))$ $\downarrow$ $f(g(\#))$	$f(x)$ $g(x)$ $\downarrow$ $g(\#)$ $\searrow$ $\swarrow$ $f(g(\#))$
EXAMPLE: For $f(x) = x^2$ and $g(x) = x - 1$, find $f(g(x))$ and then evaluate $f(g(3))$	EXAMPLE: For $f(x) = x^2$ and $g(x) = x - 1$, evaluate $f(g(3))$

PRACTICE: Given the functions $f(x) = x + 3$ and $g(x) = x^2$, (A) find $(f \circ g)(2)$ and (B) $(g \circ f)(2)$.

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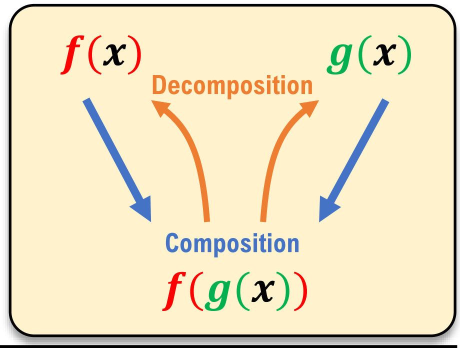
TOPIC: FUNCTION COMPOSITION
Domain Of Composite Functions

- To find the **domain** of a composite function, follow these steps to exclude x-values from $f \circ g(x)$:
  - **1)** Find any x-values not defined for ______
  - **2)** Find any x-values that make $g(x)$ not defined for ______

EXAMPLE: Given the functions $f(x) = \frac{1}{x-2}$ and $g(x) = \sqrt{x}$, determine $f \circ g(x)$ and its domain.

PRACTICE: Given the functions $f(x) = x^2$ and $g(x) = \sqrt{x-8}$ find $(f \circ g)(x)$ and determine its domain.

TOPIC: FUNCTION COMPOSITION
Decomposing Functions



- Function decomposition is the __________ of function composition.
  - There are many correct answers when decomposing functions.

EXAMPLE: Express the function $h(x) = \sqrt{x-2}$ as a composition of two functions f & g so that $h(x) = (f \circ g)(x)$.

PROBLEM: Express the function $h(x) = \frac{1}{x^2+3x-10}$ as a composition of two functions f & g so that $h(x) = (f \circ g)(x)$.