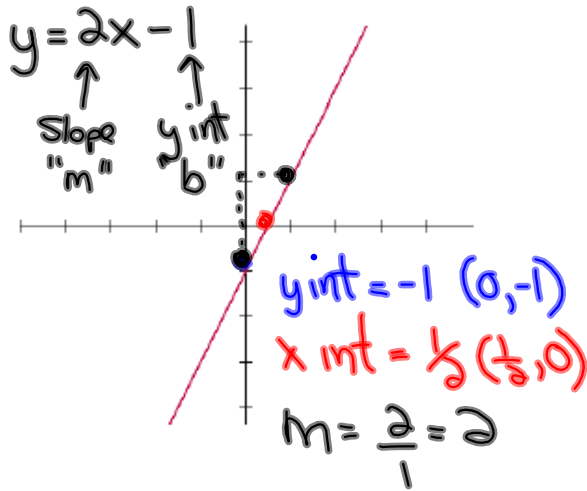


# Catalog of Essential Functions

## 1. Linear



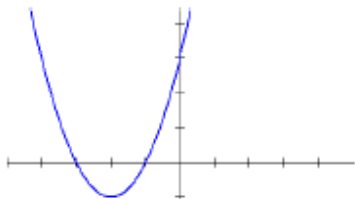
Straight Line

Equation will be degree one

Should be able to identify the **slope, intercepts, and equation** from the graph

$$y = x$$

## 2. Quadratic



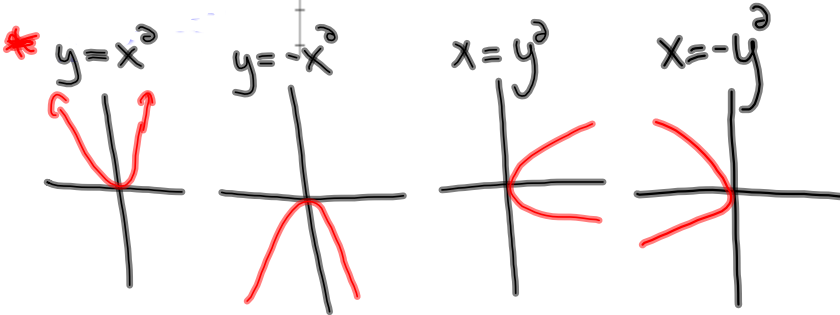
Parabola (U-Shaped)

Either y or x will be squared (not both!)

\*

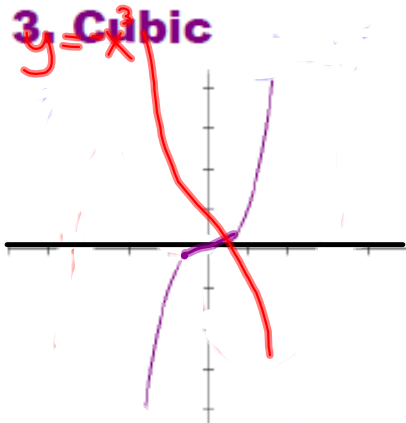
Should know the 4 basic quadratic functions

Should be able to apply transformations to the basic quadratic functions



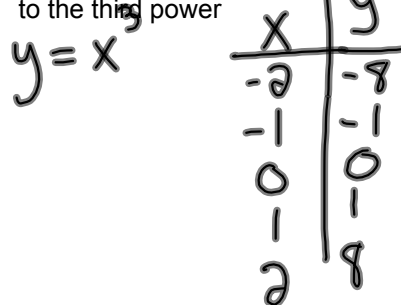
$y = x^2$	
x	y
-2	4
-1	1
0	0
1	1
2	4

## 3. Cubic



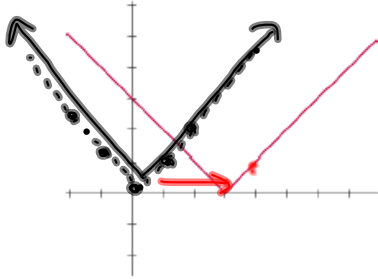
S-Shaped

We will work with functions that are raised to the third power



# Catalog of Essential Functions

## 4. Absolute Value



V-Shaped

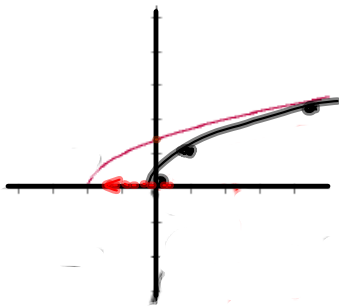
Equation will have a variable within the absolute value bars

Should be able to apply transformations to the basic absolute value function

$y = |x|$

x	y
-2	2
-1	1
0	0
1	1
2	2

## 5. Square Root



Half Parabola

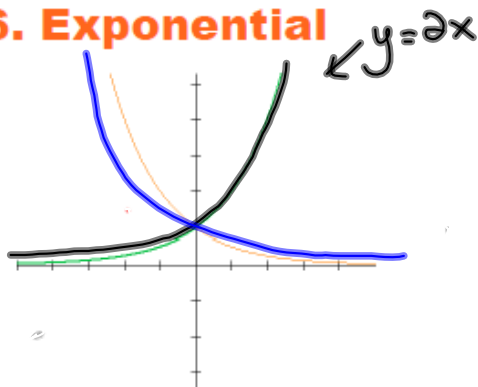
Equation will have a variable under the square root sign

Should be able to apply transformations to the basic square root function

$y = \sqrt{x}$

x	y
0	0
4	2
9	3

## 6. Exponential



Steadily increasing or decreasing

Base will be a number and variable will appear in the exponent ex:  $y = 2^x$

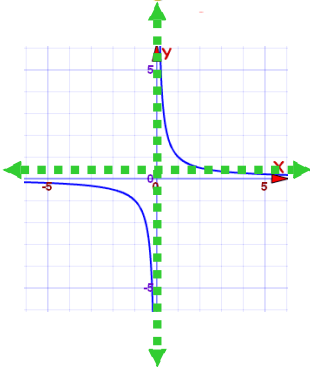
Should be able to identify the **horizontal asymptote**

$y = 2^x$

x	y
-2	1/4
-1	1/2
0	1
1	2
2	4

# Catalog of Essential Functions

## 7. Reciprocal



Will have two branches

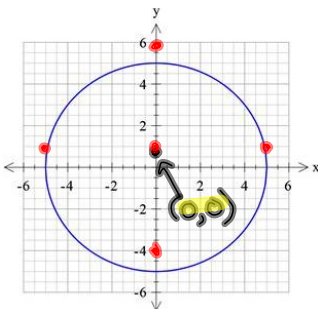
Equation will have a variable within the denominator of a rational expression

Should be able to identify the vertical and horizontal asymptotes

$$y = \frac{1}{x}$$

x	y
-2	-1/2
-1	-1
0	undefined
1	1
2	1/2

## 8. Circle



• General form:  $(x - h)^2 + (y - k)^2 = r^2$

\* center:  $(h, k)$   $(0, 0)$   
 \* radius =  $r$   $5$

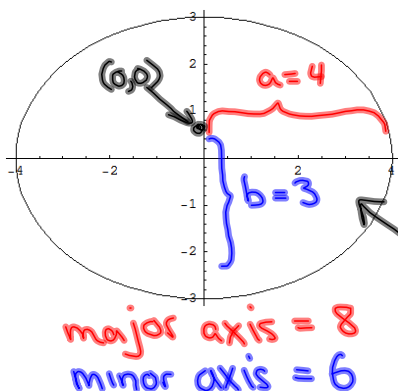
• Be able to identify the function that would describe either just the top or bottom of the circle.

$$x^2 + y^2 = r^2$$

$$x^2 + y^2 = 5^2$$

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

## 9. Ellipse



• General form:  $\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1$

Where ...

- Center:  $(h, k)$
- $a > b$
- If  $a$  is the denominator of the "y" term the ellipse will have a vertical major axis.

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

$$\frac{x^2}{16} + \frac{y^2}{9} = 1$$

# Transformations:

## New Functions From Old Functions

- ① ✓ Translations (Slide transformations)
- ② Stretches
- ③ Reflections

# Translations

\*  $h$  = horizontal translation (shift left or right)  
 Focus on...  $k$  = vertical translation (shift up or down)

- determining the effects of  $h$  and  $k$  in  $y - k = f(x - h)$  on the graph of  $y = f(x)$  or  $y = f(x - h) + k$
- sketching the graph of  $y - k = f(x - h)$  for given values of  $h$  and  $k$ , given the graph of  $y = f(x)$
- writing the equation of a function whose graph is a vertical and/or horizontal translation of the graph of  $y = f(x)$

base:  $y = x^2$

Ex: ①  $y = (x - 3)^2 + 2$   
 $h = 3$  right 3  
 $k = 2$  up 2

base:  $y = |x|$

②  $y - 4 = |x + 3|$   
 $y = |x + 3| + 4$   
 $h = -3$  left 3  
 $k = 4$  up 4

function notation:

③  $g(x) = f(x + 2) - 1$   
 $h = -2$  left 2  
 $k = -1$  down 1

## Translation

- To *translate* or *shift* a graph is to move it up, down, left, or right without changing its shape.
- Translation is summarized by the following table and illustration:

**Vertical and Horizontal Shifts** Suppose  $c > 0$ . To obtain the graph of

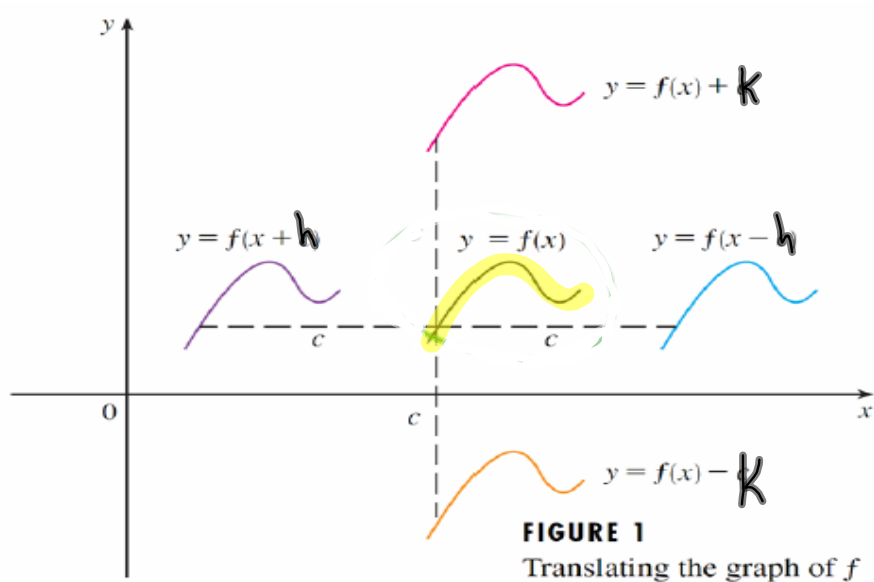
$y = f(x) + k$  shift the graph of  $y = f(x)$  a distance  $k$  units upward

$y = f(x) - k$  shift the graph of  $y = f(x)$  a distance  $k$  units downward

$y = f(x - h)$ , shift the graph of  $y = f(x)$  a distance  $h$  units to the right

$y = f(x + h)$ , shift the graph of  $y = f(x)$  a distance  $h$  units to the left

## Translations illustrated...



## Using Mapping Notation to Describe Transformations:

\*Think of this as a set of instructions to follow to transform a graph.

base:  $y = x^2$

x	$y = x^2$
-3	9
-2	4
-1	1
0	0
1	1
2	4
3	9

$k=2 \rightarrow$  up 2

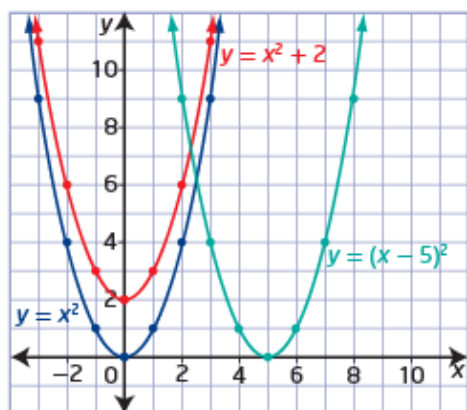
x	$y = x^2 + 2$
-3	11
-2	6
-1	3
0	2
1	3
2	6
3	11

$h=5 \rightarrow$  right 5

x	$y = (x - 5)^2$
2	9
3	4
4	1
5	0
6	1
7	4
8	9

$$(x, y) \rightarrow (x, y + k)$$

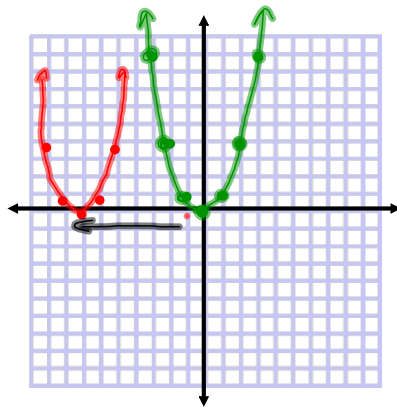
$$(x, y) \rightarrow (x + h, y)$$

Graph Translations of the Form  $y - k = f(x)$  and  $y = f(x - h)$ 



Identify the translations for each of the following and sketch the transformation

Translate 7 units left



base:

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

x	f(x)
-2	4
-1	1
0	0
1	1
2	4

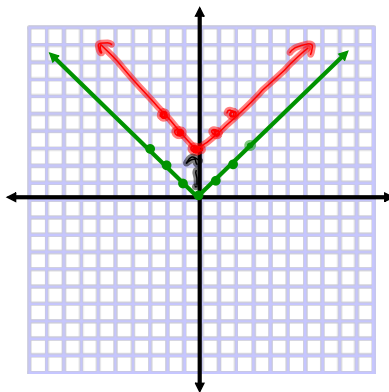
$h = -7$

$$f(x) = (x+7)^2$$

x	f(x)
-9	4
-8	1
-7	0
-6	1
-5	4

$$(x, y) \longrightarrow (x-7, y)$$

Translate 3 units up



base:

$$f(x) = |x|$$

x	f(x)
-2	2
-1	1
0	0
1	1
2	2

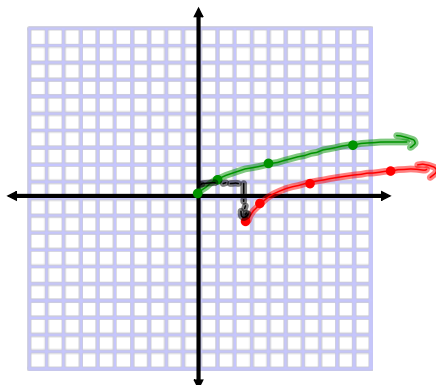
$k = 3$

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

x	f(x)
-2	5
-1	4
0	3
1	4
2	5

$$(x, y) \longrightarrow (x, y+3)$$

Translate 3 units right and 2 units down.



base:

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

x	f(x)
0	0
1	1
4	2
9	3

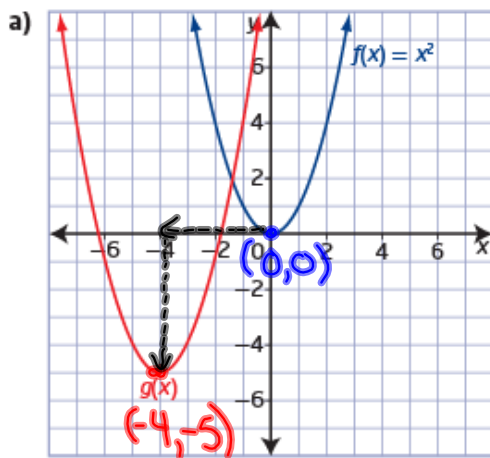
$h = 3$   
 $k = -2$

$$f(x) = \sqrt{x-3} - 2$$

x	f(x)
3	-2
4	-1
7	0
10	1

$$(x, y) \longrightarrow (x+3, y-2)$$

Determine the Equation of a Translated Function:

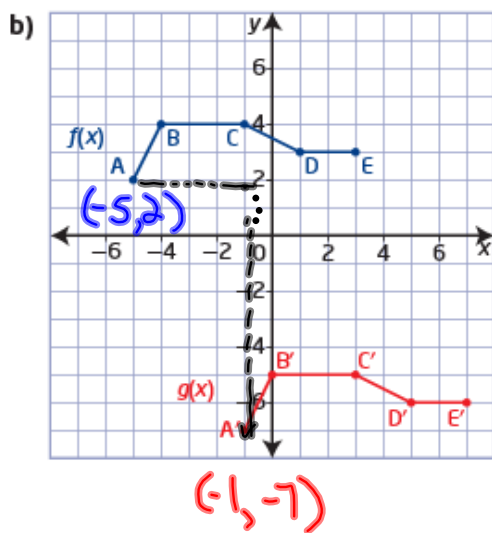


Translate 4 units Left  
and 5 units down

$$h = -4 \quad k = -5$$

$$g(x) = (x+4)^2 - 5$$

$$\text{or } g(x) = f(x+4) - 5$$

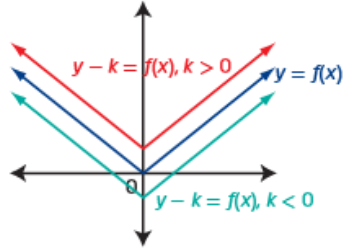
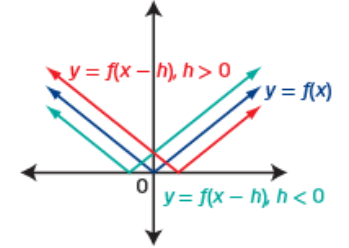


Translated 4 units right  
and 9 units down

$$h = 4 \quad k = -9$$

$$g(x) = f(x-4) - 9$$

- Translations are transformations that shift all points on the graph of a function up, down, left, and right without changing the shape or orientation of the graph.
- The table summarizes translations of the function  $y = f(x)$ .

Function	Transformation from $y = f(x)$	Mapping	Example
$y - k = f(x)$ or $y = f(x) + k$	A vertical translation If $k > 0$ , the translation is up. If $k < 0$ , the translation is down.	$(x, y) \rightarrow (x, y + k)$	
$y = f(x - h)$	A horizontal translation If $h > 0$ , the translation is to the right. If $h < 0$ , the translation is to the left.	$(x, y) \rightarrow (x + h, y)$	

- A sketch of the graph of  $y - k = f(x - h)$ , or  $y = f(x - h) + k$ , can be created by translating key points on the graph of the base function  $y = f(x)$ .

## Homework

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