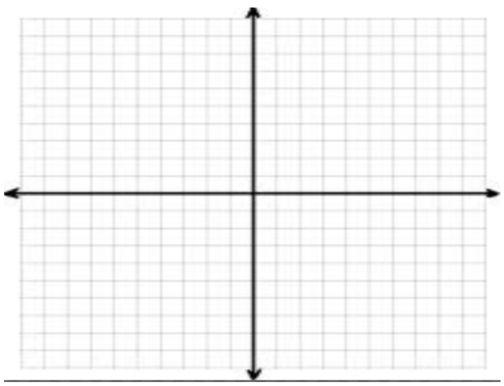
Exponential Growth and Decay

Directions: The purpose of this activity is to give you a feel for the behavior of exponential functions, or functions that take the form **$y=a\cdot b^x$.** Please use complete sentences where appropriate. You might find these definitions handy throughout the activity. For this activity please use **desmos.com**.

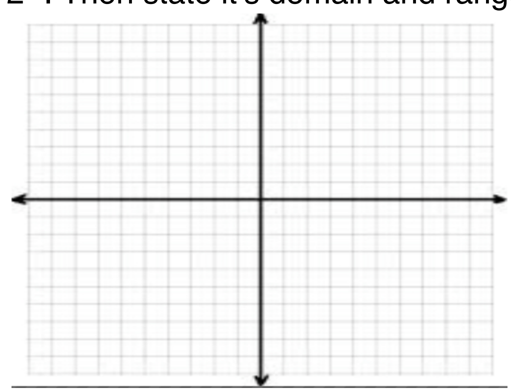
Domain: All **x-values** for which there is a corresponding y-value.
Range: All the output values (**y-values)** that a function takes on.

1. On the graph provided please sketch the function $y=x^2$. Then state it's domain and range.



Domain:_________________
Range:__________________

2. On the graph provided please sketch the function $y=2^x$. Then state it's domain and range.



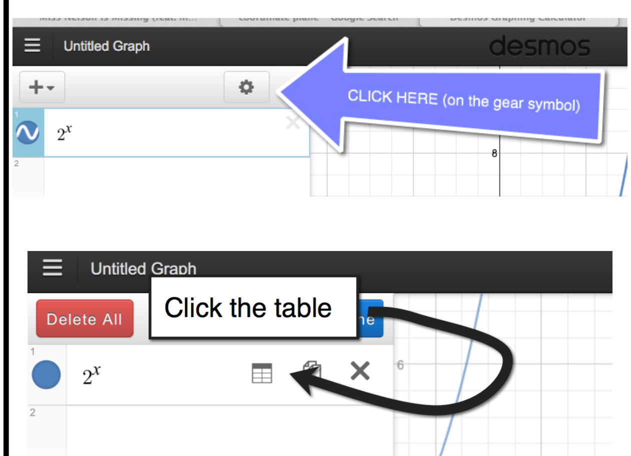
Domain:_________________
Range:__________________

3. For the next part please use the function $y=2^x$. Open up a table in Desmos. Fill in the missing values. As the x values get really big (approach infinity) what happens to the y values? As x gets really negative (approach negative infinity) what happens to the y values?

X values	Y-Values
0	
2	
5	
10	
100	

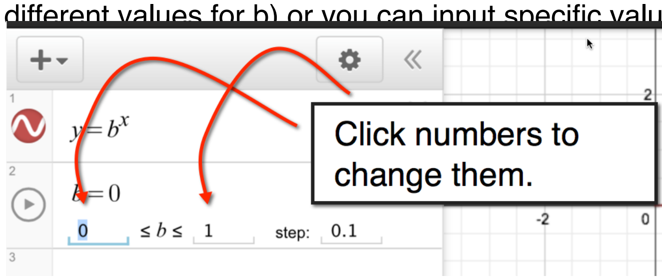
X values	Y-Values
-100	
-10	
-4	
-2	
-1	

Instructions for creating a table in Desmos



4. Please describe the differences in the graphs and explain the differences. (You might find it helpful to create a table for $y=x^2$ also.)

5. Now we are going to create a slider and analyze a **family of functions** called exponential functions (like $y=2^x$ and $y=(1/2)^x$). Type $y=b^x$ into Desmos. When Desmos asks if you'd like to create a slider click the letter "b" and a slider will be created. You can then slide the slider (giving different values for b) or you can input specific values. Let's analyze some values for b.



a. What happens when $b > 1$?

b. What happens when $b < 0$?

c. What happens when $0 < b < 1$? (It might be helpful to make these values the parameters for the sliders; see photo above.)

d. Write a couple sentences describing how changing b affects the graph.

6. Now let's spend some time analyzing the functions from part a above. These are called exponential growth functions. Exponential growth function $y=3\cdot2^x$ s always take the form $y=a\cdot b^{(x-h)}+k$, where $b>1$. Put the general form into Desmos and create sliders for a, b, h, and k. Restrict the values on the b slider to $1 < b < 10$, then set b=2. Start with h=0 and k=0.

a. What happens when "a" is positive? When "a" is negative?

b. What happens when "h" gets bigger? When "h" gets smaller (more negative)?

c. What happens when "k" gets bigger? When "k" gets smaller (more negative)?

d. What is the domain of all the functions you just experimented with?

e. What is the range whenever "a" is positive? What is the range when "a" is negative?

Find the domain and range of the following functions.

f. $y=4^{x-5}$ **g.** $y= 3\cdot4^x - 5$ **h.** $y = -2\cdot3^{x+1} + 2$ **i.** $y= .5\cdot2^x + .7$

j. Is there a difference between $y=3\cdot2^x$ and $y=6^x$? Does it matter if we multiply the 3 and the 2 together first and then graph? Explain.

7. Now let's spend some time analyzing the functions from part 5c above. These are called exponential **decay** functions. Exponential decay function always take the form $y=a \cdot b^{(x-h)}+k$, where $0<b<1$. Put the general form into Desmos and create sliders for a, b, h, and k. Restrict the values on the b slider to $0 < b < 1$, then set b=.5. Start with h=0 and k=0.

a. What happens when "a" is positive? When "a" is negative?

b. What happens when "h" gets bigger? When "h" gets smaller (more negative)?

c. What happens when "k" gets bigger? When "k" gets smaller (more negative)?

d. What is the domain of all the functions you just experimented with?

e. What is the range whenever "a" is positive? What is the range when "a" is negative?

Find the domain and range of the following functions.

f. $y=(.2)^{x-5}$ **g.** $y= 3 \cdot (1/4)^x - 5$ **h.** $y = -2 \cdot (1/2)^{x+1} + 2$ **i.** $y= 5 \cdot (.9)^x + .7$

j. Why do you think these are called decay graphs?

8. Do a Google search for "asymptote". What is an asymptote? Where do they show up in exponential equations?

Find the horizontal asymptotes in the following functions.

a. $y=4^{x-5}$ **b.** $y= 3 \cdot (1/4)^x - 5$ **c.** $y= .5 \cdot 2^x + .7$

9. Please summarize what you've learned from this activity. Consider the meaning of "a", "b", "h", and "k", the domain and range of exponentials, and anything else you've learned.