

Name: _____

Date: _____

EXPONENTIAL FUNCTIONS!

So far we have concentrated on **linear functions** which are characterized by having a **constant rate of change**. In the last lesson, we looked at **exponential growth and decay**. In this lesson we will more formally introduce the concept of an **exponential function**.

Do Now: Consider the exponential function $f(x) = 8(2)^x$. Answer the following.

(a) Evaluate each of the following and indicate what point must lie on the graph of $f(x)$ based on each:

✓ (i) $f(2) = 32$

✓ (ii) $f(0) = 8$

✓ (iii) $f(-1) = 4$

coordinate: $(2, 32)$ $\frac{\Delta y}{\Delta x}$ coordinate: $(0, 8)$

coordinate: $(-1, 4)$

(b) Calculate the average rate of change of f over the interval $-1 \leq x \leq 0$.

(c) Calculate the average rate of change over the interval $0 \leq x \leq 2$.

X	Y1
-3	1
-2	2
-1	4
0	8
1	16
2	32
3	64
4	128
5	256
6	512
7	1024

X=-1

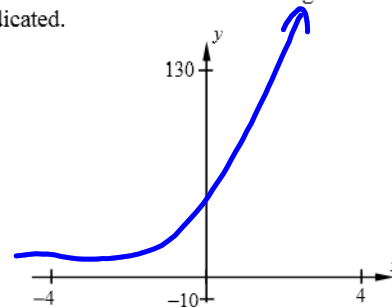
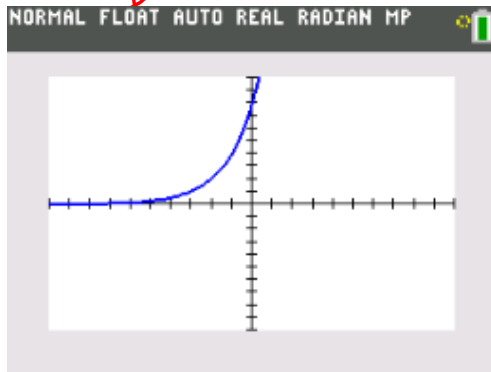
coordinates SLOPE
 $(-1, 4)$
 $(0, 8)$
 $\frac{\Delta y}{\Delta x} = \frac{8-4}{0-(-1)} = \frac{4}{1} = 4$

$(0, 8)$
 $(2, 32)$
 $\frac{\Delta y}{\Delta x} = \frac{32-8}{2-0} = \frac{24}{2} = 12$

(d) What does comparing answers from (b) and (c) tell you about this function? Explain.

This function is getting steeper! It's exponential!

(e) Using your calculator, draw a sketch of this function on the axes below using the window indicated.



Exponential functions are all about **multiplication**. The basic form of an exponential function is given below.

EXPONENTIAL FUNCTIONS

A general exponential function has the form: $y = a(b)^x$, where a is the **y-intercept** and b is the **base** or **multiplying factor**. Sometimes b is known as the growth factor.

initial value
head start

Let's work some more with exponential functions to develop a better sense for them.

Exercise #2: Consider the function $g(x) = 54\left(\frac{1}{3}\right)^x$.

(a) Evaluate $g(0)$. What point does this indicate on the graph of g ?

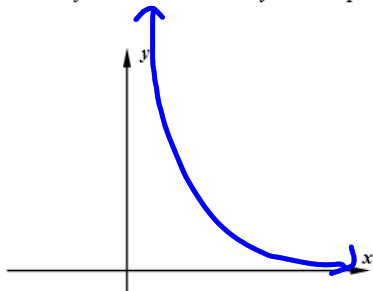
$$54\left(\frac{1}{3}\right)^0 = 54 \cdot 1 = 54$$

(b) Without the use of your calculator, determine the values of $g(1)$ and $g(2)$.

$$54\left(\frac{1}{3}\right)^1 = 18$$

$$54\left(\frac{1}{3}\right)^2 = 6$$

(c) Using your graphing calculator, sketch a graph of this function using the **WINDOW** $-2 \leq x \leq 4$ and $-10 \leq y \leq 100$. Mark the y-intercept.



(d) Why is this exponential function always **decreasing** while the one in Exercise #1 is always increasing?

INCREASING VS. DECREASING EXPONENTIALS

$y = a(b)^x$ will increase if $b > 1$

$y = a(b)^x$ will decrease if b is between 0 and 1

HW

Exercise #3: For each of the following exponential functions, give its y-intercept and tell whether it is increasing or decreasing.

(a) $y = 8\left(\frac{2}{3}\right)^x$

(b) $f(x) = 125(1.5)^x$

(c) $P(t) = 56\left(\frac{3}{2}\right)^t$

Exercise #4: Find the equation of the exponential function, in $y = a(b)^x$ form, for the function given in the table below. Show or explain your thinking.

x	0	1	2	3	4
y	10	30	90	270	810

When given **coordinates (or a table of values)**, you have two strategies for finding an exponential functions:

1.

2.

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**INTRODUCTION TO EXPONENTIAL FUNCTIONS
HOMEWORK**

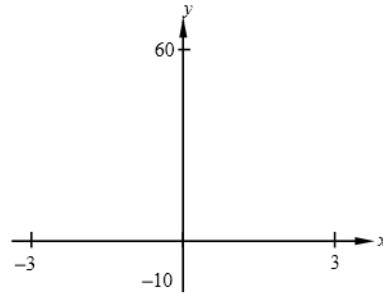
1. Consider the exponential function $f(x) = 10(2)^x$.

(a) Find the value of $f(0)$. What point does this represent on the graph of $y = f(x)$?

(b) Is this an increasing or decreasing exponential function? How can you tell based on its equation?

(c) Is this function's average rate of change over the interval $-1 \leq x \leq 2$ greater or less than that of the linear function $g(x) = 10x + 7$? Justify.

(d) Using your calculator, sketch a graph of this function on the axes shown below. Use the window indicated. Mark the y -intercept.



2. Which of the following is a decreasing exponential function whose y -intercept is 20?

(1) $y = 20\left(\frac{4}{3}\right)^x$

(3) $y = -2x + 20$

(2) $y = 20\left(\frac{1}{2}\right)^x$

(4) $y = \left(\frac{1}{3}\right)^x + 20$

3. Which of the following functions would best describe the data in the table?

(1) $y = 10x + 2$

(3) $y = 5(2)^x$

x	0	1	2	3	4
y	2	10	50	250	1250

(2) $y = 8x + 2$

(4) $y = 2(5)^x$

4. Graphing a basic exponential can be challenging because of how quickly they grow (or decay). In this exercise, we will graph one of the most basic.

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

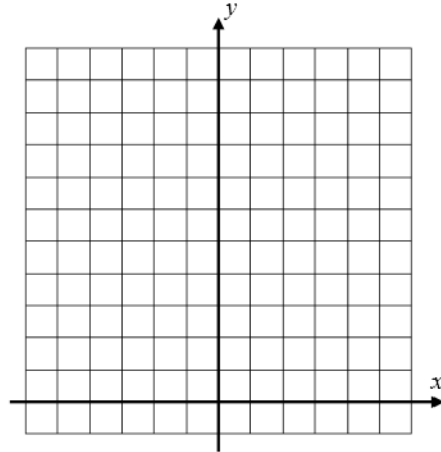
- (a) Evaluate each of the following and state the coordinate point that occurs on the graph of $f(x)$ based on the calculation.

$$f(0) = \qquad f(1) =$$

$$f(2) = \qquad f(3) =$$

- (b) Evaluate each of the following. Remember your facts about negative exponents and give the point on the graph of $f(x)$.

$$f(-1) = \qquad f(-2) = \qquad f(-3) =$$



- (c) Using the points you found in (a) and (b), graph this function for the domain interval $-3 \leq x \leq 3$.

5. Classify each of the following exponential functions as either increasing or decreasing and give the value of their y -intercepts.

(a) $y = 125(1.25)^x$

(b) $y = 22\left(\frac{3}{4}\right)^x$

(c) $y = 256\left(\frac{5}{2}\right)^x$

6. Which of the following could be the equation of the exponential function shown graphed below? Explain your choice.

(1) $y = 15(1.25)^x$

(3) $y = 50(1.04)^x$

(2) $y = 18(0.75)^x$

(4) $y = 40(0.45)^x$

Explanation:

