TOPIC: INTRODUCTION TO EXPONENTIAL FUNCTIONS

Exponential Functions

◆ **Polynomial** functions have a variable base with a number exponent; **exponential** functions have the opposite!

- Exponential functions have a:
  - **Base** that is _____, _____, & ___ 1.
  - **Exponent** (power) that contains a _____.

Recall — Polynomial Function

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

New — Exponential Function

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

Power: x

Base: 2

EXAMPLE Determine if each function is an exponential function.

(A) $f(x) = \left(\frac{2}{3}\right)^x$

Exponential function? ☐

Power: _____

Base: _____

(B) $f(y) = 1^y$

Exponential function? ☐

Power: _____

Base: _____

(C) $f(x) = 10^{x+1}$

Exponential function? ☐

Power: _____

Base: _____

◆ You will be asked to evaluate exponential functions for specified values of x.

- For exponents that cannot easily be done by hand, type (BASE) ^ (POWER) into a calculator.

EXAMPLE Evaluate the exponential function $f(x) = 2^x$ for each given value of x.

(A) $x = 4$

(B) $x = -3$

(C) $x = 3.14$

(D) $x = 12$

TOPIC: INTRODUCTION TO EXPONENTIAL FUNCTIONS

PRACTICE Determine if each function is an exponential function. If so, identify the power & base, then evaluate for $x = 4$.

(***A***)

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

Exponential function? ☐

Power: _____

Base: _____

$f(4) =$_____

(***B***)

$f(x) = 3(1.5)^x$

Exponential function? ☐

Power: _____

Base: _____

$f(4) =$_____

(***C***)

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

Exponential function? ☐

Power: _____

Base: _____

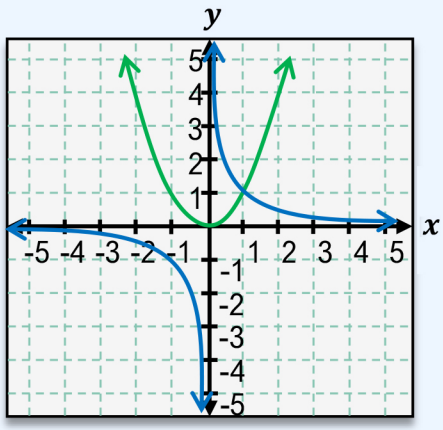
$f(4) =$_____

TOPIC: GRAPHING EXPONENTIAL FUNCTIONS

Graphs of Exponential Functions

◆ Graphs of exponential functions are _____ and _____. *(no breaks, no two x's result in same y)*

Recall — Polynomial & Rational Functions



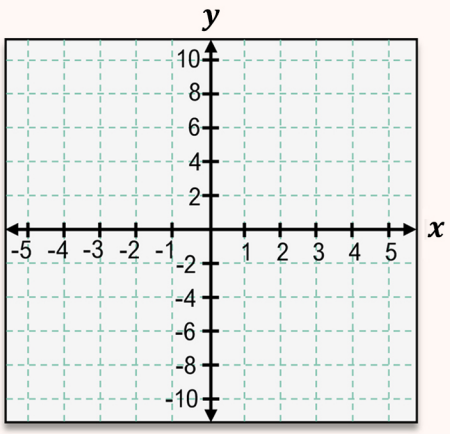
As $x \to \infty$, $f(x) \to \infty$

As $x \to -\infty$, $f(x) \to \infty$

As $x \to \infty$, $f(x) \to 0$

As $x \to -\infty$, $f(x) \to 0$

New — Exponential Functions



x	$f(x) = 2^x$
-3	⅛
-2	¼
-1	
0	
1	
2	
3	
...	
10	1024

As $x \to \infty$, $f(x) \to$ _____

As $x \to -\infty$, $f(x) \to$ _____

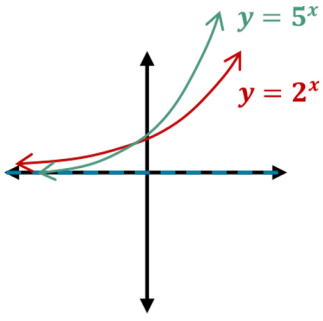
_____ at $y =$ ___

Domain: *always* _____

Range: depends on _____; _____

◆ The direction & steepness of the graph of an exponential function $f(x) = b^x$ depends on the value of ____.

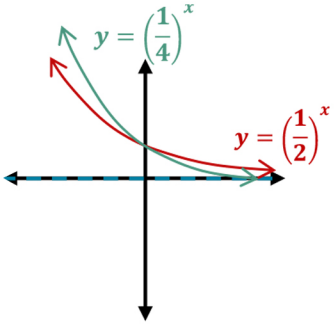
$b > 1$



◆ Graph **[INCREASES | DECREASES]**

◆ Graph gets steeper for **[LARGER | SMALLER]** b

$0 < b < 1$

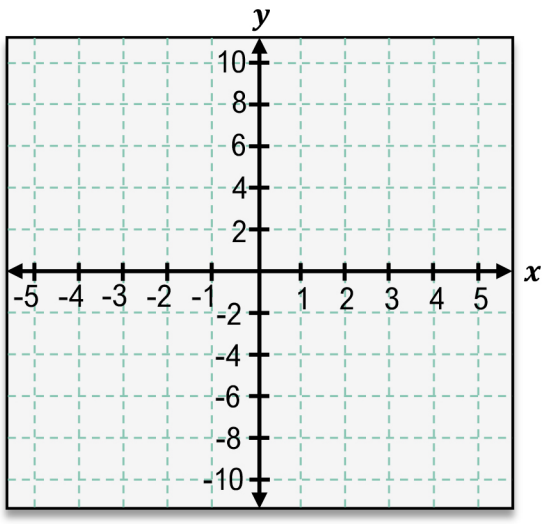


◆ Graph **[INCREASES | DECREASES]**

◆ Graph gets steeper for **[LARGER | SMALLER]** b

TOPIC: GRAPHING EXPONENTIAL FUNCTIONS

EXAMPLE: Sketch the graph of $f(x) = \left(\frac{1}{2}\right)^x$. Identify any asymptotes and determine the domain and range.



x	$f(x) = \left(\frac{1}{2}\right)^x$
-3	
-2	
-1	
0	
1	
2	
3	

Asymptote: _____

Domain: _____

Range: _____

TOPIC: THE NUMBER e

The Number e

- You will have to evaluate exponential expressions & graph exponential functions with a base of e:
  - e, like π (3.14…), is ***NOT*** a variable, but a ***number***.

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

$$e = 2.718281828459\ldots$$

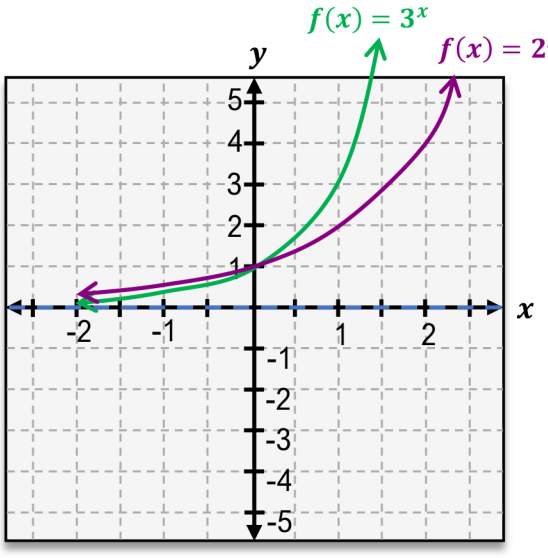
- A calculator should be used to evaluate an exponential function of base e: 2nd LN (POWER)

EXAMPLE Evaluate the exponential function $f(x) = e^x$ for each given value of x.

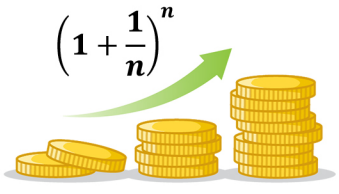
(***A***) $x = 2$

(***B***) $x = -3$

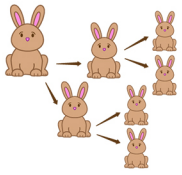
- The graph of $f(x) = e^x$ is _____ the graphs of $f(x) = 2^x$ and $f(x) = 3^x$ because $2 <$ ___ < 3.
  - Just like ***any*** exponential function, exponential functions of base e can be graphed using _____.

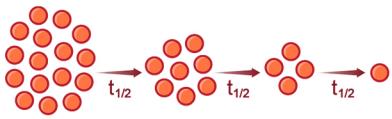


- e comes from the idea of compounding interest, but is useful in many different contexts.



Compounding Interest


Population Growth



Radioactive Decay

TOPIC: THE NUMBER e

PRACTICE: Graph the given function.

$g(x) = e^{x+3} - 1$

TO GRAPH

0) Identify & graph parent function, $f(x) = b^x$
   a. Plot: $(-1, \underset{1/b}{\_\_\_}), (0,1), (1, \underset{b}{\_\_})$, connect
   b. HA at: $y = 0$

1) Shift HA to $y = k$: $y =$ _____

2) a. Reflect? □ → test points over $[x \mid y]$
   b. Shift test points by $(\underset{h}{\_\_\_\_}, \underset{k}{\_\_\_\_})$

3) Sketch curve approaching asymptote

FROM GRAPH

Domain: *always* _____

Range: If ABOVE asymp.: $(\underset{k}{\_\_\_\_}, \infty)$

If BELOW asymp.: $(-\infty, k)$