## Algebra II

Lesson 8-2.B: Graphs of Exponential Functions

## Mrs. Snow, Instructor

The exponential equation general form is: $\boldsymbol{y}=\boldsymbol{a} \boldsymbol{b}^{\boldsymbol{x}}$

## GROWTH FUNTION

- Base >1
- graph rises as x-values get larger Graph $y=\mathbf{2}^{\boldsymbol{x}}$

| $x$ | $2^{x}=y$ |
| :---: | :---: |
| -3 | $2^{-3}=8^{-1}=\frac{1}{8}$ |
| -2 |  |
| -1 |  |
| 0 |  |
| 1 |  |
| 2 |  |
| 3 |  |



Domain:
Range:

## DECAY FUNCTION

- $0<b a s e<1$
- graph falls as x-values get larger

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

| $x$ | $\left(\frac{1}{2}\right)^{x}=y$ |
| :---: | :---: |
| -3 | $\left(\frac{1}{2}\right)^{-3}=2^{3}=8$ |
| -2 |  |
| -1 |  |
| 0 |  |
| 1 |  |
| 2 |  |
| 3 |  |



Domain:
Range:

Notice that the graphs of both types of exponentials get infinitely close to but do not touch or cross the $x$-axis.

Asymptote - a line that a graph approaches as x or y increases in absolute value. It is like an invisible boundary that a graph cannot cross or touch.

Let's take a look at how the coefficients affect the parent function $y=b^{x}$ :

Graph the following
How does the coefficient change the look of the parent function?
$y=2^{x}$
$y=(.3) 2^{x}$
little coefficient it shrinks
$y=(3) 2^{x}$
big coefficient gets it stretchs
$y=(-1) 2^{x}$
negative flips it across $x$-axis
**remember you are expected to make a " $T$ " table with $x$ and $y$ values on it along with usage of calculator for solving these problems.


Graph, what are the horizontal asymptotes?
$y=3^{x}$
Asymptote $\mathrm{y}=0$
$y=(3)^{x+1}$
shifts left 1 unit ( $x$ lies, see + go left)
asymptote $\mathrm{y}=0$
$y=(3)^{x}-2$
down 2 units ( $y$ is honest, see - 2 go down) Asymptote $\mathrm{y}=-2$
$y=(3)^{x-2}+3$
right 2 and up 3
asymptote $\mathrm{y}=3$


Summary:
Combined translation form of the Exponential Function:

$$
y=a b^{x-h}+k
$$

## The number $\boldsymbol{e}$

Like $\pi$, e is a widely used constant, and both numbers are irrational numbers.

$$
\pi \approx 3.14159 \ldots . \quad \mathrm{e} \approx 2.71828 \ldots
$$

The constant $\pi$ is used in applications involving circles, while e is found in applications involving growth and decay. Why do we call this value " e "? It is in honor of its discoverer, Leonard Euler (1701-1783), a Swiss mathematician. Euler noticed that living things and many mathematical quantities grew or decayed at a constant rate of 2.718. Thus the word "natural" was attached to this type of exponent. The number 2.718 is found when we graph the exponential function $=\left(1+\frac{1}{x}\right)^{x}$.
$y=\left(1+\frac{1}{x}\right)^{x}$.
What is the asymptote?
Looking at the table or extending the graph out we will find that the horizontal asymptote is $\mathrm{y}=2.71828$


We can evaluate $\mathrm{e}^{\mathrm{x}}$ just as we evaluate any other exponential function. To evaluate $\mathrm{e}^{6}$, to 4 decimal places: hit $\mathbf{2}^{\text {nd }} \mathrm{e}^{\mathrm{x}}$, type 6 ENTER ANS $=403.4288$

Graph:


Domain:
Range:


Domain:
Range:


Note: With a table of values, we can enter the data into the calculator STAT program, following the directions given in the fall. Once the data is entered via STAT-EDIT, you can go into the STAT-CALCULATE and scroll down until you find the item " $A$ " ExpReg. This will generate the values for the exponential coefficient and base. Using VARS, the equation may be sent to the $y$-plot.

