

Exponential Growth and Decay

Exponential Function:

$$y = ab^x \quad \text{OR} \quad y = a(1 \pm r)^t$$

Future Amount \rightarrow y a \leftarrow Start Amount b \leftarrow Multiplier x \leftarrow Time
 Future Amt. \rightarrow y a \leftarrow Start Amt. $(1 \pm r)$ \leftarrow Rate as a decimal t \leftarrow Time

Exponential Growth:

$$b > 1 \quad \text{OR} \quad 1 + r$$

Exponential Decay:

$$0 < b < 1 \quad \text{OR} \quad 1 - r$$

Multiplier:

$$b \quad \text{OR} \quad 1 \pm r$$

Example: Identify if the following is growth or decay.

1. $y = 129(1.63)^x$
 \uparrow
 Growth
2. $y = 3^x$
 $y = 1(3)^x$
 \leftarrow
 Growth
3. $y = 4\left(\frac{5}{6}\right)^x$
 \leftarrow
 Decay

Ex: Find the multiplier for each rate of exponential growth or decay.

1. 9% growth \rightarrow $1 + .09 = 1.09$
2. 8.2% decay \rightarrow $1 - .082 = 0.918$
3. 0.08% growth \rightarrow $1 + .0008 = 1.0008$

Ex: Given $x = 5$, $y = \frac{3}{5}$, and $z = 3.3$, evaluate each expression.

4. 2^{2x}
5. $100(3)^{y-1}$
 $100(3)^{\frac{3}{5}-1}$
 $\boxed{64.44}$
6. $100(0.5)^{3z}$

Predict the population of bacteria for each situation and time period.

7. 55 bacteria double every hour

a. after 3 hours

$$y = 55(2)^3$$

$$y = 1440 \text{ bacteria}$$

8. 225 bacteria triple every hour

a. after 3 hour

$$y = 225(3)^3$$

$$y = 6075 \text{ bacteria}$$

Graphing and Characteristics of Exponential Equations

transformations:

$y = ab^{x-h} + k$

Negative in front reflect over x-axis

Moves Left (+)
Right (-)

Moves up (+)
Down (-)

Domain: $(-\infty, \infty)$
All \mathbb{R} 's

Range: Use k
If a is positive use (k, ∞)
If a is negative use $(-\infty, k)$

Ex: Tell the domain and range for each function.

- | | | |
|------------------------|------------------------|-------------------------|
| 1. $f(x) = -2^x + 4$ | 2. $f(x) = 3(2)^x$ | 3. $f(x) = 4^{x+3} - 1$ |
| D: $(-\infty, \infty)$ | D: $(-\infty, \infty)$ | |
| R: $(-\infty, 4)$ | R: $(0, \infty)$ | |

Asymptote: $y = k$ (Horizontal)

X-Int: $(\#, 0)$

Y-Int: $(0, \#)$

Increasing or Decreasing: Look left to right and follow graph

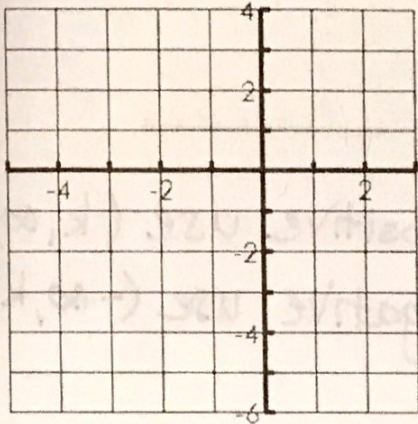
End Behavior:

Right } As $x \rightarrow \infty$, $f(x) \rightarrow$ _____

Left } As $x \rightarrow -\infty$, $f(x) \rightarrow$ _____

} where end of the graph is approaching up or down

1. $y = 2^{x+1}$



Transformations: _____

Domain: _____ Range: _____

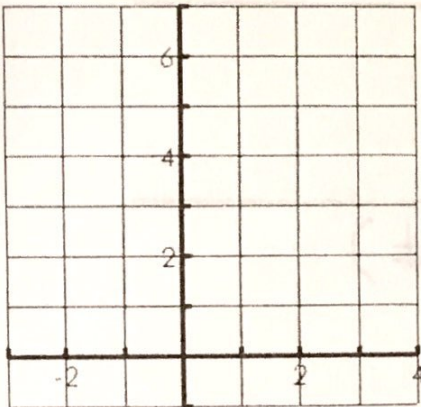
Asymptote: _____

Increasing or Decreasing? _____

X-intercept: _____ Y-intercept: _____

End Behavior: As $x \rightarrow$ _____, $f(x) \rightarrow$ _____
 As $x \rightarrow$ _____, $f(x) \rightarrow$ _____

2. $y = \left(\frac{1}{2}\right)^x + 3$



Transformations: _____

Domain: _____ Range: _____

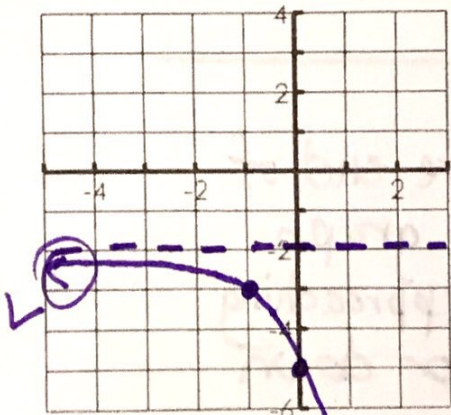
Asymptote: _____

Increasing or Decreasing? _____

X-intercept: _____ Y-intercept: _____

End Behavior: As $x \rightarrow$ _____, $f(x) \rightarrow$ _____
 As $x \rightarrow$ _____, $f(x) \rightarrow$ _____

3. $y = -3^{x+1} - 2$



X	Y
-1	-3
0	-5
1	-11

Transformations: Reflect x-axis, Left 1, Down 2

Domain: $(-\infty, \infty)$ Range: $(-\infty, -2)$

Asymptote: $y = -2$

Increasing or Decreasing? _____

X-intercept: NONE Y-intercept: $(0, -5)$

End Behavior: R As $x \rightarrow \infty$, $f(x) \rightarrow -\infty$
L As $x \rightarrow -\infty$, $f(x) \rightarrow -2$