Warm-Up:

Write each expression as a single natural logarithm.

1. $4 \ln 3$ $\quad \ln 3^4$

2. $\ln 18 - \ln 10$ $\quad \ln \frac{18}{10} = \ln \frac{9}{5}$

3. $\ln 3 + \ln 4$ $\quad \boxed{\ln 12}$

4. $-2 \ln 2$ $\quad \ln 2^{-2}$

Solve each equation.

5. $\cancel{\ln}\, 5x = e^4$ $\quad = \frac{5x}{5} = \frac{54.6}{5}$ $\quad \boxed{x = 10.9}$

6. $\cancel{\ln}\,(x - 7) = e^2$

$x - 7 = 7.4$

$\boxed{x = 14.4}$

7. $\frac{2 \ln x}{2} = \frac{4}{2}$

$\cancel{\ln}\, x = e^2$

$\boxed{x = 7.4}$

8. $\cancel{\ln}\,(2 - x) = e^1$

$$\begin{array}{r} 2 - x = 2.7 \\ -2 \qquad -2 \\ \hline -x = .7 \end{array}$$

$\boxed{x = -.7}$

Objective: Model exponential situations

Agenda:
- Warm-Up
- Modeling Exponential Situations Notes
- Exponential Growth And Decay Notes
- M&M Lab
- Closure

Today's HW:
Sleep

Graphing Exponential Functions

**Make a table of values
**Draw these points on the graph
**Connect point to make a smooth curve
**Determine the domain and range based on the x-values and y-values you see on the graph

Exponential Growth: base of an exponential growth function is greater than 1

$x>1$

Exponential Decay: base of an exponential decay function is $0<x<1$

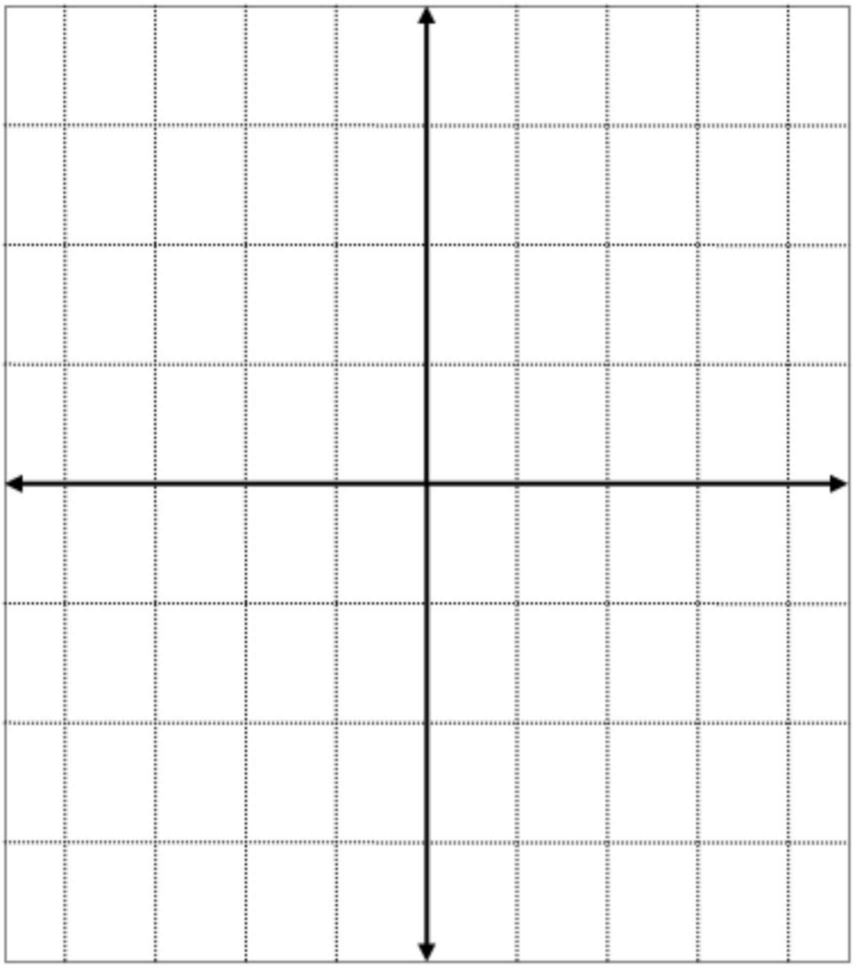
in between 0 and 1

x	**$y = 4^x$**

Domain: always

Range: either

or



Are these functions examples of exponential growth or decay?

Example 1: $y = (0.7)^x$

decay

Example 2: $y = \frac{1}{2}(3)^x$

growth

Example 3: $y = 10(\frac{4}{3})^x$

growth

Find the corresponding growth or decay factor for each annual rate of change.

Growth: 1 + r (in decimal form)

Decay: 1- r (in decimal form)

Example 4: -55% **Example 5**: -0.1%

Example 6: +500% **Example 7**: +100%

eliminated

Exponential Decay: $y = a(1-r)^t$

depreciated

y = final amount

a = initial amount

decreases

r = rate (change from a percent to decimal)

t= time

10% = .1

2.5% = .025

Example 8: A cup of coffee contains 130 milligrams of caffeine. If caffeine is eliminated from the body at a rate of 11% per hour, how long will it take for half of this caffeine to be eliminated from a person's body?

$y = a(1-r)^t$

$a = 130$

$y = \frac{130}{2} = 65$

$r = 11\% = .11$

$t = ?$

$65 = 130(1-.11)^t$

$\frac{65}{130} = \frac{\cancel{130}(.89)^t}{\cancel{130}}$

$\frac{1}{2} = .89^t$

$.5 = .89^t$

$\log .5 = t \log .89$

$\frac{\log .5}{\log .89} = \frac{t \cdot \cancel{\log .89}}{\cancel{\log .89}}$

$\boxed{5.9 \text{ hours} = t}$

Example 9: A computer system depreciates at an average rate of 4% per month. If the value of the computer system was originally \$12,000, in how many months is it worth \$7,350?

$$y = a(1-r)^t$$

$a = 12,000$

$y = 7,350$

$r = 4\% = .04$

$t =$

$$7350 = 12000(1-.04)^t$$

$$\frac{7350}{12000} = \frac{\cancel{12000}(.96)^t}{\cancel{12000}}$$

$$.6125 = .96^t$$

$$\log .6125 = \log .96^t$$

$$\frac{\log .6125}{\log .96} = \frac{t \cancel{\log .96}}{\cancel{\log .96}}$$

$$\boxed{t = 12 \text{ months}}$$

increases
grows

Exponential Growth: $y = a(1+r)^t$

y = final amount

a = initial amount

r = rate (change from a percent to decimal)

t= time

Example 10: The population of a city of one million is increasing at a rate of 3% per year. If the population continues to grow at this rate, in how many years will the population have doubled?

$y = a(1+r)^t$

$y = 2{,}000{,}000$

$a = 1{,}000{,}000$

$r = .03$

$t = ?$

$$\frac{2000\,000}{1000\,000} = \frac{\cancel{1000\,000}(1+.03)^t}{\cancel{1000\,000}}$$

$$2 = 1.03^t$$

$$\log 2 = \log 1.03^t$$

$$\frac{\log 2}{\log 1.03} = \frac{t \cdot \cancel{\log 1.03}}{\cancel{\log 1.03}}$$

$$\boxed{t = 23.4 \text{ years}}$$

Example 11: In 1910, the population of a city was 120,000. Since then, the population has increased by exactly 1.5% per year. If the population continues to grow at this rate, what will the population be in 2010?

$y = a(1+r)^t$

pemdas

$a = 120{,}000$

$r = .015$

$y = ?$

$t = 100$

$y = 120{,}000(1.015)^{100} = 120{,}000 \cdot 4.4$

$y = 531{,}845.48$

Exponential Regression Models

Use all of the same steps for Quadratic Regression and Linear Regression, but choose **0: ExpReg** instead!

Example 12: The table shows the number of squirrels in a particular forest *t* years after a forest fire.

Number of Squirrels

Years	Squirrels
0	30
1	60
2	120
3	240
4	480
5	960

$y = 30(2)^x$

Find the exponential model of best fit for this data.

Predict the number of squirrels after 8 years.

<u>Exponential Regression Models</u>

Use all of the same steps for Quadratic Regression and Linear Regression, but choose **0: ExpReg** instead!

Example 13: The table shows the number of bacteria cells present after x hours.

Time in Hours, x	0	1	2	3	4	5
Number of Cells, N	50	71	100	141	200	283

Find the exponential model of best fit for this data.

Predict the number of cells after 7 hours.

M&M Growth And Decay Lab

Closure