Objective: Use the properties of exponents to interpret expressions for exponential functions and to graph exponential functions.

Bellwork: Cellphone/Calculator Assignment

1. Look up your grade on studentview and determine what you need to do to improve your grade.

2. Using a calculator or desmos, find the initial mass of radium and the percentage of the initial mass present after 25 years if the quantity present after t years is given by:

 Y=25(1/2)**t/1599**

 Hint: plug in t=0 to find initial mass.

 Hint: plug in t=25 to find mass after 25 years.

a. initial mass = \_\_\_\_\_\_\_\_\_\_ grams

b. percentage of initial mass left after 25 years = \_\_\_\_\_\_.

**Lesson: Exponential Growth and Decay**

Definitions

Definition: An exponential function f with **base a** is denoted by

y=ax where a>0, a≠1, and x is any real number.

Definition: An exponential growth function (model)

is given by the equation

y=acbx, b>0.

Definition: An exponential decay function (model)

is given by the equation

y=acbx, b<0.

If a>0, then the exponential function(whether growth or decay) is a *positive* exponential function.

If a<0, then the exponential function (whether growth or decay) is a *negative* exponential function.

A table can help here. y=acbx c is the base

|  |  |  |  |
| --- | --- | --- | --- |
| c>1 | c>1 | c<1 | c<1 |
| a>0, b>0 *positive exp growth fn.* | a>0,b<0positive exp decay fn. | a>0, b>0positive exp decay fn. | a>0, b<0positive exp growth fn. |
| a<0, b>0negative exp growth fn. | a<0, b<0negative exp decay fn. | a<0, b>0negative exp decay fn. | a<0, b<0negative exp growth fn. |

Example 1: Label exponential growth or decay



a. exponential growth 5>1 ½>0

b. exponential growth 5/3>1

c. exponential growth 2>1

d. exponential decay (3/8)<1

Example 2: Percent Change

y=acbx c is the base

a. f(x)=4(5)x c=5 b=1 a=4.

Step 1: Make Table and fill in

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | % change |  |
| 0 | 4 |  --- |  |
| 1 | 20 | (20-4)/4 \* 100 | 400 % |
| 2 | 100 | (100-20)/20 | 400 % |

Step 2: Answer=400%

**You can get this from the function through (5-1)\*100%.**

b. f(x)=4(1.05)x

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | % change |  |
| 0 | 4 |  --- |  |
| 1 | 4.2 | (4.2-4)/4 \* 100 | 5 % |
| 2 | 4.41 | (4.41-4.2)/4.2\*100 | 5 % |

You can read growth rate off the function. 5%

c. f(x)=4(.95)x

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | % change |  |
| 0 | 4 |  --- |  |
| 1 | 3.8 | (3.8-4)/4 \* 100 | -5 % |
| 2 | 3.61 | (3.61-3.8)/3.8\*100 | -5 % |

 You can read the **decay rate** off the function. 5%

d. f(x)=4(.05)x

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | % change |  |
| 0 | 4 |  --- |  |
| 1 | .2 | (.2-4)/4 \* 100 | -95 % |
| 2 | .01 | (3.61-3.8)/3.8\*100 | -95 % |

You can read the decay rate off the function: The decay rate is 95%

Example 3 Type of exponential function: positive growth, negative growth, positive decay, negative decay.

f(x)=-6(2/5)x negative exponential decay function

|  |  |
| --- | --- |
| x | f(x) |
| 0 | -6 |
| 1 | -12/5 |
| 2 | -24/25 |



f(x)=-4/5(2)x: negative exponential growth function

|  |  |
| --- | --- |
| x | f(x) |
| 0 | -4/5 |
| 1 | -8/5 |
| 2 | -16/5 |
| 3 | -32/5 |

f(x)=5(1/2)x: positive exponential decay.

|  |  |
| --- | --- |
| x | f(x) |
| 0 | 5 |
| 1 | 5/2 |
| 2 | 5/4 |



**Practice (Guided): Identify the decay/growth rate**

1. f(x)=6(1.06)x

2. f(x)=1000(6)x

3. f(x)=10,000(.94)x

4. f(x)=35(.06)x

5. f(x)=300(.97)x

6. f(x)=2500(3)x

7. f(x)=1500(.03)x

8. f(x)=975(1.03)x

**Closure: Quiz**

**Select the functions that have a growth rate of 5.2% by putting a check in the appropriate box.**

|  |  |  |
| --- | --- | --- |
|  | yes | no |
| f(x)=200(1.052)x |  |  |
| f(x)=500(1.52)x |  |  |
| f(x)=900(1+.052)x |  |  |
| f(x)=800(.052)x |  |  |
| f(x)=700(5.2)x |  |  |
| f(x)=400(1+.52)x |  |  |

**Homework: Complete the following questions.**

**Name Period**

1. The half life of a radioactive material is the amount of time it takes half of the material to decay so that half of the original material remaining. The half life of vanadium-48 is represented by the equation

 A=A0(2)-.0626t

 A0 is the initial amount and t is time in days.

 After 16 days is more or less than ½ of the initial amount of vanadium-48 remaining? Show your work.

2. The population of a city is modeled by the equation

 P=1.5(1.25).25t. Answer the following true/false questions by putting a check in the appropriate box.

|  |  |  |
| --- | --- | --- |
| Statement | True | False |
| Population grows exponentially |  |  |
| Current population is 1.5 m |  |  |
| The population grows by 25% every 25 years |  |  |