Exponential Growth is where a quantity increases over time where **exponential decay** is where a quantity decreases over time. When we discuss exponential growth and decay, we are going to use a slightly different equation than $y = ab^x$. When you simplify your equation, it will look like $y = ab^x$, but to begin, you will use the following formulas:

Exponential Growth

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

where a>0

y = final amount
a = initial amount
r = growth rate (express as decimal)
t = time

(1 + r) represents the growth factor

Exponential Decay

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

where a>0

y = final amount
a = initial amount
r = decay rate (express as decimal)
t = time

(1 – r) represents the decay factor

Finding Growth and Decay Rates

Example 1: Identify the following equations as growth or decay. Then identify the initial amount, growth/decay factor, and the growth/decay percent.

a. $y = 3.5(1.03)^t$

Growth/Decay: _____

Initial Amount: _____

Growth/Decay Factor: _____

Growth/Decay Percent: _____

b. $f(t) = 10{,}000(0.95)^t$

Growth/Decay: _____

Initial Amount: _____

Growth/Decay Factor: _____

Growth/Decay Percent: _____

c. $g(t) = 400(0.925)^t$

Growth/Decay: _____

Initial Amount: _____

Growth/Decay Factor: _____

Growth/Decay Percent: _____

d. $y = 2{,}500(1.2)^t$

Growth/Decay: _____

Initial Amount: _____

Growth/Decay Factor: _____

Growth/Decay Percent: _____

Growth and Decay Word Problems

Example 2: The original value of a painting is $1400 and the value increases by 9% each year. Write an exponential growth function to model this situation. Then find the value of the painting in 25 years.

Growth or Decay: _____

Starting value (a): _____

Rate (as a decimal): _____

Function: _____

Example 3: The population of a town is decreasing at a rate of 1% per year. In 2000, there were 1300 people. Write an exponential decay function to model this situation. Then find the population in 2008.

Growth or Decay: _____

Starting value (a): _____

Rate (as a decimal): _____

Function: _____

Example 4: The cost of tuition at a college is $12,000 and is increasing at a rate of 6% per year. Find the cost of tuition after 4 years.

Growth or Decay: _____

Starting value (a): _____

Rate (as a decimal): _____

Function: _____

Example 5: The value of a car is $18,000 and is depreciating at a rate of 12% per year. How much will your car be worth after 10 years?

Growth or Decay: _____

Starting value (a): _____

Rate (as a decimal): _____

Function: _____

Applications of Exponential Functions – Compound Interest

As you get older, you will come to learn a great deal about investing your money…savings accounts, stock market, mutual funds, bonds, etc. Today, we are going to learn about compound interest, which is a form of saving and earning money by letting it sit in an account over time. **Compound Interest** is interest earned or paid on both the principal and previously earned interest. In middle school, you learned about **simple interest**, which is interest that is only earned on the principal. It's formula is *I = Prt,* where P represents principal, r represents rate, t represents time, and I represents interest.

Compound Interest

$$A = P(1+\frac{r}{n})^{nt}$$

A = balance after *t* years
P = Principal (original amount)
r = interest rate (as a decimal)
n = number of times interest is compounded per year
t = time (in years)

Example 1: Write a compound interest function that models an investment of $1000 at a rate of 3% compounded quarterly. Then find the balance after 5 years.

P = _____

r = _____

n = _____

t = _____

Example 2: Write a compound interest function that models an investment of $18,000 at a rate of 4.5% compounded annually. Then find the balance after 6 years.

P = _____

r = _____

n = _____

t = _____

Example 3: Write a compound interest function that models an investment of $4,000 at a rate of 2.5% compounded monthly. Then find the balance after 10 years.

P = _____

r = _____

n = _____

t = _____

Summary of Exponential Word Problems

Creating a Growth Function Given a Percentage Rate

The number of chickens in the farm of Sunny House is currently 2,400. The farm grows at an annual rate of 15%. How many chickens will be there in 7 years?

Growth: $y = a(1 + r)^t$
Increase
Grow
Appreciate
Gains

Creating a Decay Function Given a Percentage Rate

A limousine costs $75,000 new but depreciates at a rate of 23% per year. What is the value of the limousine after five years?

Decay: $y = a(1 - r)^t$
Decreases
Decays
Depreciates
Loses

Creating an Exponential Function without Being Given a Percentage Rate

A 5th grade class is raising meal worms for an experiment. They start with 10 meal worms. The population triples every hour. How many meal worms does the class have after 12 hours?

Special Key Words
Doubles (b = 2)
Triples (b = 3)
Half (b = ½)
These values replace (1 ± r)

Creating an Exponential Function Given a Pattern

A population of bees is decreasing. The population in a particular region this year is 1250. After year 1, it is estimated that the population will be 1000. After 2 years, it is estimated that the population will be 800. What will the population be in 6 years?

Without a Given Rate:
$y = a \cdot b^x$
a: starting amount
b: multiplier (constant ratio)

Determine if pattern is growth or decay