Warm-up: Identify the parent function. Identify all transformations and write the transformed parent table. Finally, rewrite the expression.

$$g(x) = 8(4)^{3-x} - 6$$

Writing Exponential Equations

MGSE9-12.A.CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from ~~linear, quadratic, simple rational,~~ and exponential functions (integer inputs only).

MGSE9-12.A.CED.2 Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (The phrase "in two or more variables" refers to formulas like the compound interest formula, in which A = P(1 + r/n)nt has multiple variables.)

What am I learning today?

How to write the equation for an exponential function

How will I show that I learned it?

Recognize an exponential scenario and write an equation to model it

An exponential function is created by MULTIPLYING BY THE SAME NUMBER.

It takes the general form of

$$f(x) = a(b)^{nx} + k$$

where a is the initial value, b is the multiplier, x is the time, n is the frequency of change and k is a constant.

Steps for writing exponential equations:

Step 1: Find the value you are starting with. Label this "a".

Step 2: Find your ratio of increase. If it is a %, change it to a decimal and add it to 1 if the problem is increasing or subtract it from 1 for decreasing. Label this "b".

Step 3: Plug into the formula $y = A(B)^{nx}$

Step 4: When solving, pay attention to the rate of change. Divide your time by your rate to find the proper value of x.

Ex. A There are 10 mushrooms in your yard. The mushrooms double every 2 days.

a) Write an equation for this if x=# of days.

$a = 10$

$b = 2$ (double)

$n = \frac{1}{2}$

$f(x) = 10(2)^{\frac{x}{2}}$

b) How many mushrooms will there be in 15 days?

$f(15) = 10(2)^{\frac{15}{2}}$

176(4)~~8~~

$= 1810.19$

≈ 1810 mushrooms

Ex. B A hand sanitizer kills 1/2 of the germs after each use. You have 5,000,000 germs on your hands now.

a) Write an equation for this if x=# of uses.

$a = 5,000,000$ $f(x) = 5000000\left(\frac{1}{2}\right)^x$

$b = 1 - \frac{1}{2} = \frac{1}{2}$

$n = 1$

b) How many germs will you have after 5 uses?

$f(5) = 5000000\left(\frac{1}{2}\right)^5$

$= 156,250$ germs

If there is a % change, the base is (1 + r) for growth and (1 - r) for decay.

What's going to be the base of your exponential in the following cases?

1. 20% increase

$1 + 0.20 = 1.2^x$

2. 4% decrease

$1 - .04 = .96^x$

3. 12.5% increase

$1 + .125 = 1.125^x$

4. 3.5% decrease

$1 - .035 = .965^x$

Ex. A The population of Atlanta was 420,000 in 2010 and expected to grow at a rate of 8% per decade. Predict the population, to the nearest ten thousand, for the year 2035.

$a = 420{,}000$
$b = 1.08$
$n = \frac{1}{10}$

$P(t) = 420000(1.08)^{\frac{t}{10}}$

$t = 2035 - 2010 = 25$

$P(25) = 420000(1.08)^{\frac{25}{10}}$

$= 509106.54$

$\approx 510{,}000$ people

Ex. B Caffeine is eliminated from the bloodstream at a rate of 15% per half hour. There are initially 500 mg of caffeine. Predict the amount of caffeine in the bloodstream after 1 hour and 4 hours.

$a = 500$
$b = 1 - .15 = .85$
$n = 2$ (hours)

$C(t) = 500(.85)^{2t}$

$C(1) = 500(.85)^{2(1)}$

$= 361.25$ mg

$C(4) = 500(.85)^{2(4)}$

$= 136.25$ mg

$n = \frac{1}{30}$ (minutes)

$C(t) = 500(.85)^{\frac{t}{30}}$

$C(60) =$

$C(240)$

Steps for Writing Exponential Equations from a Table:

Step 1: Find the y-intercept. Label this "a".

Step 2: Find your ratio of change by dividing the 2nd # by the 1st #. Check it by dividing the 3rd # by the 2nd #. Label this "b".

Step 3: Plug into the formula $y = A(B)^x$

Your credit card debt is growing according to the following table.

Month	Debt
0	-$50.00
1	-$52.00
2	-$54.08
3	-$56.24
4	-$58.49

Write an equation to represent how much you owe based on how many months you haven't paid off the debt.

4% per month

$a = -50$

$b = \frac{-52}{-50} = 1.04$

$f(x) = -50(1.04)^x$

$(1.04)^{12} = 1.60 \rightarrow 60\%$ annual interest

Your credit card debt is growing according to the following table.

Month	Debt
0	-$50.00
1	-$52.00
2	-$54.08
3	-$56.24
4	-$58.49

If you wait 1 year to pay off the debt, how much will you owe? How much additional money are you paying in interest?

$f(12) = -50(1.04)^{12}$

$= -\$80.05$

Interest $= 80.05 - 50$

$= \$30.05$

Your credit card debt is growing according to the following table.

Month	Debt
0	-$50.00
1	-$52.00
2	-$54.08
3	-$56.24
4	-$58.49

B/t month 10-12

rate = slope

When is your debt growing more quickly? Between months 1 and 3 or months 10 and 12?

$RoC_{1-3} = \frac{-56.24-(-52)}{3-1}$

$= -\$2.12$ /month

(10, -74.01) (12, -80.05)

$RoC_{10-12} = \frac{-80.05-(-74.01)}{12-10}$

$= -\$3.02$/month

Compound Interest Formula

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

$P\left(1+\frac{r}{n}\right)^{t\cdot n}$

A = final amount of money

P = Principal Investment (initial amount of money)

r = % change as a decimal

n = number of times compounded per year

t = number of years

annually	$n=1$
semi-annually	$n=2$
quarterly	$n=4$
monthly	$n=12$
daily	$n=365$

If you have $5000 compounded quarterly at a rate of 6%, how much will you have after 5 years? P $n=4$ t $r=.06$

$A=5000\left(1+\frac{.06}{4}\right)^{4\cdot 5} = \$6734.28$

If you have $5000 compounded monthly at a rate of 6%, how much will you have after 5 years?

$A=5000\left(1+\frac{.06}{12}\right)^{12\cdot 5} = \$6744.25$

If you have $5000 compounded monthly at a rate of 8%, how much will you have after 5 years?

$A=5000\left(1+\frac{.08}{12}\right)^{12\cdot 5} = \$7449.23$

If you have $5000 compounded monthly at a rate of 8%, how much will you have after 10 years?

$A=5000\left(1+\frac{.08}{12}\right)^{12\cdot 10} = \$11,098.20$

The number e

- Considered the "natural base" or the "Euler Number"
- Created by $\lim_{n\to\infty}\left(1+\frac{1}{n}\right)^n$
- ≈ 2.72 (expanded: 2.718281828459...)

Continuously Compounded

$$A = Pe^{rt}$$

A = final amount of money
P = Principal Investment (initial amount of money)
r = % change as a decimal
t = number of years

If you have \$5000 compounded continuously at a rate of 6%, how much will you have after 5 years?

$A = 5000 \cdot e^{.06 \cdot 5} = \$6749.29$

If you have \$5000 compounded continuously at a rate of 6%, how much will you have after 8 years?

$A = 5000 \cdot e^{.06 \cdot 8} = \$8080.37$