4. Questions:
   a. Write the exponential equation for this data: ____________
   b. Predict the number of M&M's on Trial #9: ____________
   c. Predict the number of trials needed to have 300 M&M's: ____________
   d. Explain the meaning of $a$ and $b$ in the equation: ____________
   e. Suppose you made the beginning number (4) Trial #0. How would your graph have changed? ____________
   f. How would the equation have changed? ____________

Dec 14-7:17 AM

8. Questions:
   a. Write the exponential equation for this data: ____________
   b. Predict the number of M&M's on Trial #8: ____________
   c. Predict the trial when you would run out of M&M's: ____________
   d. Use the equation to predict the number of M&M's in Trial # -1 (2 times before Trial #1)___: ____________
   g. Use the equation to predict the trial when there would be 900 M&M's (a negative number): ____________
   h. Explain the meaning of $a$ and $b$ in the equation: ____________

Nov 21-9:26 AM

Precalc warmup

Log into Google classroom and join our precalc class with this code:

3rdlxy

Then answer the 3 questions in the transformation and inverse practice

Nov 26-10:31 PM

Precalculus 5.8 Exponential Growth & Decay; Newton's Law; Logistic Growth & Decay

Objective: able to find equations of population growth or decay; use Newton's Law of cooling; use logistic models

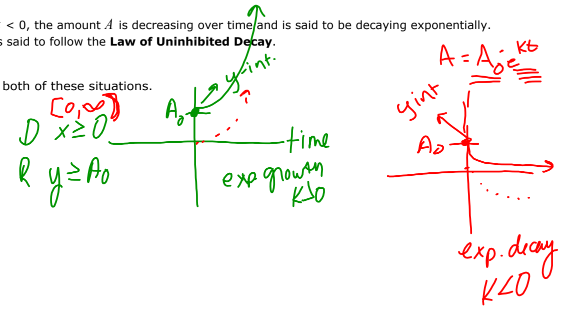
**Exponential Growth and Decay Models** - Many natural phenomena have been found to follow the law that an amount $A$ varies with time $t$ according to

$A(t) = A_0 e^{kt}$, where $A_0$ is the original amount at time $t = 0$, and $k \neq 0$ is a constant.

If $k > 0$, the amount $A$ is increasing over time and is said to be growing exponentially. It is said to follow the **Law of Uninhibited Growth**.

If $k < 0$, the amount $A$ is decreasing over time and is said to be decaying exponentially. It is said to follow the **Law of Uninhibited Decay**.

Graph both of these situations.




Dec 8-7:26 AM

$A = 39\text{ bill}\left(1 + \frac{.032}{2}\right)^{2(20)}$ $P\left(1+\frac{r}{n}\right)^{nt}$

$\approx$ #602 billion

Dec 7-1:02 PM

1. The number $N$ of bacteria present in a culture at time $t$ (in hours) obeys the function

$$N(t) = 1000e^{0.001t}$$

   a. After how many hours will the population equal 1500? 2000?
   b. Graph the relation between $N$ and $t$ and verify your answers in part (a)

(a) $\frac{1500}{1000} = \frac{1000 e^{.001t}}{1000}$

$\frac{3}{2} = e^{.001t}$

$\ln_e \frac{3}{2} = \ln_e e^{.001t}$

$\frac{\ln \frac{3}{2}}{.001} = \frac{.001t(\cancel{\ln e})}{.001}$

$\boxed{t \approx 405.42 \text{ hrs}}$

OR $\log_{10} \frac{3}{2} = \log_{10} e^{.001t}$

OR Answer value ← $\frac{3}{2} = e^{.001t}$ exp, base

$\frac{\ln \frac{3}{2}}{.001} = \frac{.001t}{.001}$

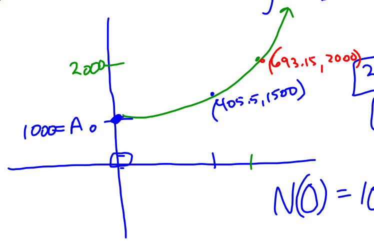
Jan 5-9:51 PM

$2000 = 1000e^{.001t}$

$t \approx 693.15$ mo.

Dec 7-1:29 PM

(b.) $y = 1000e^{.001x}$




2nd trace

Value $\cancel{405.5}$ 693.15

$\approx \cancel{1500}\ 2000$ .0073

$N(0) = 1000$

Dec 7-1:31 PM

2. Iodine 131 is a radioactive material that decays according to the function

$$A(t) = A_0 e^{-0.087t}$$

where $A_0$ is the initial amount present and $A$ is the amount present at time $t$ (in years). What is the half-life of iodine 131?

half life $\quad A(t) = \frac{1}{2}A_0$

$A_0 > 0$

$\frac{\frac{1}{2}A_0}{A_0} = \frac{A_0 e^{-.087t}}{A_0}$

$\frac{1}{2} = e^{-.087t}$

$\frac{\ln\frac{1}{2}}{-.087} = \frac{-.087t}{-.087}$

$t \approx 7.97$ yrs

Jan 5-9:52 PM

**Newton's Law of Cooling** states the temperature of a heated object decreases exponentially over time toward the temperature of the surrounding medium. This can be modeled by the function

$$u(t) = T + (u_0 - T)e^{kt}, k < 0$$

where $T$ is the constant temperature of the surrounding medium, $u_0$ is the initial temperature of the heated object, $t$ is the time in minutes, and $k$ is a negative constant.

3. A thermometer reading $72°F$ is placed in a refrigerator where the the temperature is a constant $38°F$
   a. If the thermometer reads $60°F$ after 2 minutes, what will it read after 7 minutes?
   b. How long will it take before the thermometer reads $39°F$ ?
   c. Graph the relation between temperature and time.

(a) $u_0 = 72°$, $T = 38°$, $t = 2$ min, $u(2) = 60°$

(2, 60) (7, 45.) (0, 72)

$60 = 38 + (\cancel{72-38})e^{k2}$

$60 - 38 = 38 + 34(e^{2k})$

$\frac{22}{34} = \frac{34(e^{2k})}{34}$

$\frac{11}{17} = e^{2k}$

$\ln\left(\frac{11}{17}\right) = \ln e^{2k}$

$\frac{\ln\left(\frac{11}{17}\right)}{2} = \frac{2k(\ln e)}{2}$

$K = \frac{\ln\left(\frac{11}{17}\right)}{2}$

$u(7) = 38 + (72-38)e^{\frac{\ln(11/17)}{2}(7)}$

$\approx 45.41°F$

Jan 5-9:54 PM

b. How long will it take before the thermometer reads $39°F$ ?

$39 = 38 + (\cancel{72-38})e^{\frac{\ln(11/17)}{2}t}$

$\frac{1}{34} = \frac{34\left(e^{\frac{\ln 11/17}{2} \cdot t}\right)}{34}$

$\frac{1}{34} = e^{\frac{\ln 11/17}{2} \cdot t}$

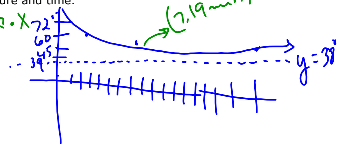
(16.2, 39)

$\frac{\ln\left(\frac{1}{34}\right)}{\frac{\ln(11/17)}{2}} = \frac{\frac{\ln(11/17)}{2} \cdot t}{\frac{\ln(11/17)}{2}}$

$t \approx 16.2$ min.

c. Graph the relation between temperature and time.

$y_1 = 38 + (72-38)e^{\frac{\ln 11/17}{2} \cdot x}$




Jan 7-12:36 PM

d. Determine the time needed to elapse before the temperature reaches $45°F$ using your graph from part (c).

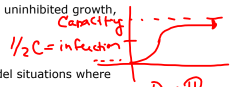
$\approx 7.19$

e. For large values of time, what do you notice about the temperature?

closer to 38° (temp. of medium)

Jan 7-12:37 PM

The exponential growth model $A(t) = A_0 e^{kt}, k > 0$, assumes uninhibited growth, meaning that the value of the function grows without limit.




The logistic growth model is an exponential function that can model situations where the growth of the dependent variable is limited.

**Logistic Growth Model** is given by

$$P(t) = \frac{c}{1 + ae^{-bt}}$$

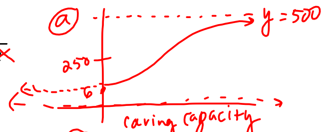
, where $a$, $b$, and $c$ are constants with $b > 0$ and $c > 0$, and time, $t$. The number $c$ is called the carrying capacity because the value $P(t)$ approaches $c$ as $t$ approaches infinity.

$D = \mathbb{R}$
$R \{0 < y < c\}$
no x-int
y int $P(0)$
2 horizontal asymptotes $y = c$, $y = 0$

4. Often, environmentalists will capture an endangered species and transport the species to a controlled environment where the species can produce offspring and regenerate its population. Suppose that six American bald eagles are captured, transported to Montana, and set free. Based on experience, the environmentalists expect the population to grow according to the model

$$P(y) = \frac{500}{1 + 83.33e^{-0.162x}}$$

$P(0) = 6$

ⓐ



ⓑ 500 eagles

Jan 7-12:38 PM

$$P(y) = \frac{500}{1 + 83.33e^{-0.162x}}$$

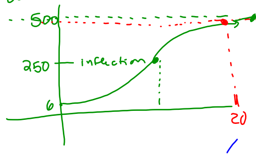
a. Graph $P(t)$.

b. What is the carrying capacity of the environment?

c. What is the predicted population of the American bald eagle in 20 years?

d. When will the population be 300?

$P(20) \approx 117$ eagles
2nd $\boxed{\text{trace}}$ Value $x = 20$

a



$$250 = \frac{500}{1 + 83.33e^{-.162t}}$$

$$\frac{250(1 + 83.33e^{-.162t})}{250} = \frac{500}{250}$$

$$1 + 83.33e^{-.162t} = 2$$

$$\frac{83.33e^{-.162t}}{83.33} = \frac{1}{83.33}$$

$$e^{-.162t} = \frac{1}{83.33}$$

$$\ln e^{-.162t} = \ln \frac{1}{83.33}$$

$$\frac{-.162t(\cancel{\ln e})}{-.162} = \frac{\ln\left(\frac{1}{83.33}\right)}{-.162}$$

$t \approx 27.3$ years

ⓓ

$$300 = \frac{500}{1 + 83.33e^{-.162x}}$$

$x \approx 29.8$ years

Jan 7-1:51 PM

c. What is the predicted population of the American bald eagle in 20 years?

d. When will the population be 300?

Jan 7-1:53 PM

**Rate yourself on how well you understood this lesson.**

| I don't get it at all | I sort of get it | I understand most, but I need more practice | I understand it pretty well | I got it!! |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**What I still need to work on....**

Aug 24-10:50 AM