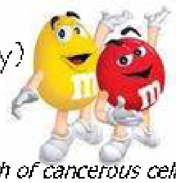
Name_________________________ Partners _______________ _________________

M&M Lab (Exponential Growth and Decay)



Part I: Modeling Exponential Growth M+M Activity

The purpose of this lab is to provide a simple model to illustrate exponential growth of cancerous cells.

In our experiment, an M&M represents a cancerous cell. If the M&M lands "M" up, the cell divides into the "parent" cell and "daughter" cell. The cancerous cells divide like this uncontrollably-without end.

*We will conduct **15 trials** and record the number of "cancerous cells" on the plate.*

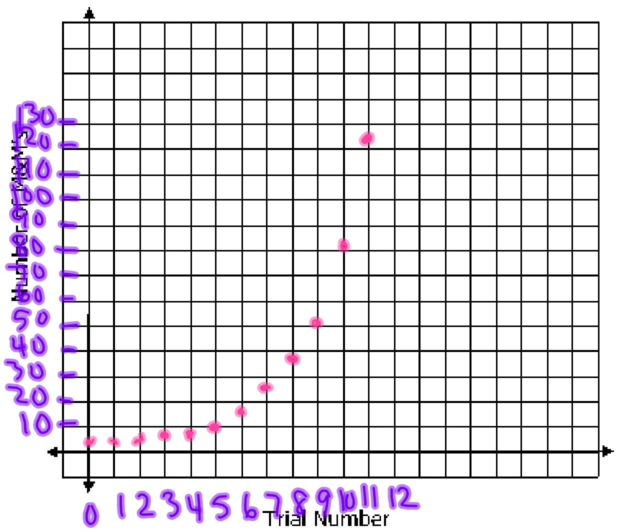
DO NOT EAT THE M&M's UNTIL YOU ARE DONE COLLECTING ALL DATA

Exponential Growth Procedure

1) Place 2 M&M's in a cup/plate. This is trial number 0.
2) Shake the cup and dump out the M&Ms. For every M&M with the "M" showing, add another M&M and then record the new population. (Ex. If 5 M&Ms land face up, then you add 5 more M&Ms)
3) Repeat step number 2 until you are done with 15 trials OR you run out of M&Ms.

Trial #	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
# of M&M's *(# of cells)*	2	3	4	7	7	10	17	28	39	52	84	127				

4) Graph your data (scatterplot) with the trial number on the x-axis and the number of M&M's on the y-axis.



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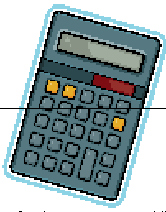


Exponential Growth Discussion

5) Should your graph touch the x-axis? Why or why not?

No, because we never had zero M&Ms

6) After each time you shook the cup, *approximate* the percentage of M&M's that landed with the imprint of "M" face up by looking at your table. .47

To *calculate* the percentage, we will calculate the percent change for *each* trial using the formula below.

$$\frac{\#M\&M\text{'s in Phase1} - \#M\&M\text{'s in Phase0}}{\#M\&M\text{'s in Phase 0}} = \frac{\text{new amount} - \text{old amount}}{\text{old amount}}$$

Complete the table below.

Trial #	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Percent *(write as decimal)*	X	.5	$.\overline{3}$	.75	0	.43	.7	.65	.39	$.\overline{3}$	.62	.51				

Calculate the average of *ALL* the percents: .47

7) We can write an exponential growth function that models the data above using the formula **$y = C(1+r)^t$**

Initial amount of M&M's (# of M&Ms you started with) C = 2

Rate of growth (calculated average from #6) r = .47 (written as a decimal)

Time (this represents a specific phase number) t = # of repetitions Variable

Fill in the variables to write your own exponential growth equation:

$y = 2(1+0.47)^t$

8) We can also use a graphing calculator to write the exponential growth equation.

You will need to enter your data table from page 1 into your graphing calculator.
Click STAT, and under EDIT choose Edit. A blank table should appear. Under L_1 you are going to list the trial number and under L_2 list the Number of M&Ms.
(ONLY IF YOUR ALREADY HAVE DATA IN THE LISTS: To clear the lists before you begin, highlight the list name all the way at the top and press CLEAR—not delete—and ENTER.)
Now you need to find the "curve of best fit". This will make an equation that *best models* your data. Go to your home screen (2nd QUIT), click STAT, scroll right to CALC, select ExpReg, press ENTER.
Write the exponential regression equation to three decimal places.

y = 1.91 (a) * (1.45 (b))^x

9) Use your exponential growth model that you created in #7 to predict the number of "cancerous cells" there would be in:

hand Trial 25 30,476 Trial 50 464,404,835

Now, use your exponential growth model that you created in #8 to predict the number of "cancerous cells" there would be in:

Trial 25 21,803 Trial 50 248,962,293

Explain any differences. The difference due to rounding in our average percentage of change. Just a little difference in the two models makes a HUGE difference in the predictions of exponential growth

Part II: Modeling Exponential Decay

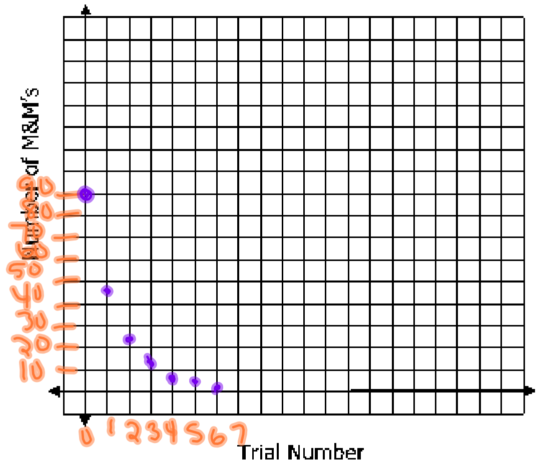
10) Count the total number of M&Ms that you have. Record this number in trial # 0.

11) This time when you shake the cup and dump out the M&Ms, remove the M&Ms with the "M" showing. Record the M&M population.

12) Continue this process and fill in the table. You are done when you have completed 10 phases –OR- when your M&M population gets below 4. **Do NOT record 0 as the population!!!**

Trial #	0	1	2	3	4	5	6	7	8	9	10
M&M Population	90	45	21	11	6	5	4				

13) Sketch the graph representing your data.



Exponential Decay Discussion

14) In the instructions for #14 (in Part II), why do you think you are NOT supposed to reduce the number of M&Ms all the way to zero? Explain.

15) Using your calculator again, write the exponential regression equation to three decimal places (see step #8 in part I)

y = 70.378 * (.586)^x
a b

y=1.91(1.45)^x

16) Use the exponential decay model you found in #16 to determine your M&M population on the 4th Phase? How does this "theoretical" number compare to your actual data for the 4th phase. Are they the same? Are they similar? What are some reasons why your results are different? Explain.

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Part III: Lab Discussion

Look at the exponential regression equations from your calculator ... These questions will help you to determine how well your exponential equation fits your actual data

1. In Part I, what was the "a" value? 1.91 In Part II, what was the "a" value? 70.378

Why were the "a" values different in Parts I and II? They are different because "a" represents the amount of M&Ms we started with

What does the "a" value represent in the equation $y = a * b^x$? BE SPECIFIC. The y-intercept

2. In Part I, what was the "b" value? 1.45 In Part II, what was the "b" value? .586

Why were the "b" values different in Parts I and II? Part I we are adding by a percent and in part II we are subtracting by a percent

What does the "b" value represent in the equation $y = a * b^x$? BE SPECIFIC. It represents the percentage of change

3. In the instructions for Part II (decay) why do you think you are NOT supposed to reduce the number of M&Ms all the way to zero? Explain.