

Name _____ Partners _____

LESSON 12 - 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 up to 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



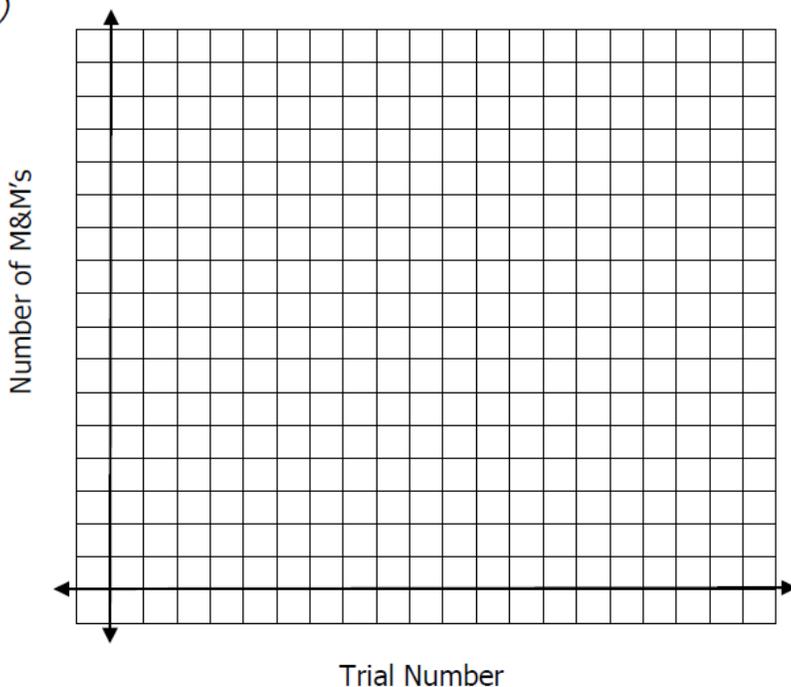
Exponential Growth Procedure

- 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															

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

5)



Exponential Growth Discussion

- 5) 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. _____

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

$$\text{percent} = \frac{\# \text{ of MMs in Trial 1} - \# \text{ of MMs in Trial 0}}{\# \text{ of MMs in Trial 0}} = \frac{\text{new amount} - \text{old amount}}{\text{old amount}}$$

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															

Calculate the average of ALL the percents: _____

- 6) 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 = _____

Rate of growth (calculated average from #5) r = _____ (written as a decimal)

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

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

- 7) Use your exponential growth model that you created in #6 to predict the number of "cancerous cells" there would be in:

Trial 25 _____ Trial 50 _____

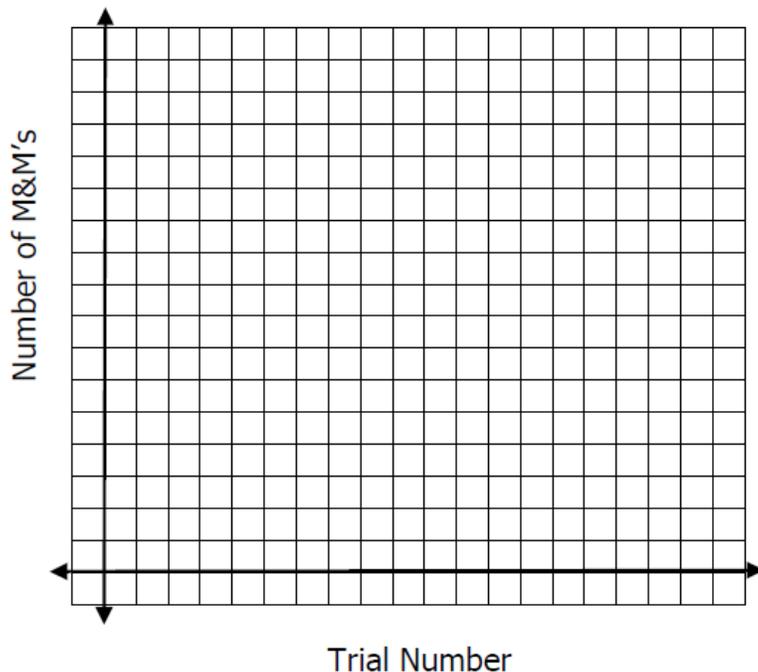


Part II: Modeling Exponential Decay

- 8) Count the total number of M&Ms that you have. Record this number in trial # 0.
- 9) 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.
- 10) 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											

11) Sketch the graph representing your data.



Exponential Decay Discussion

12) 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. _____

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

$$\text{percent} = \frac{\# \text{ of MMs in Trial 1} - \# \text{ of MMs in Trial 0}}{\# \text{ of MMs in Trial 0}} = \frac{\text{new amount} - \text{old amount}}{\text{old amount}}$$

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															

Calculate the average of ALL the percents: _____

13) We can write an exponential decay 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) $C =$ _____

Rate of decay (calculated average from #6) $r =$ _____ (written as a decimal)

Trial # (this represents a specific phase number) $t =$ # of repetitions

Fill in the variables to write your own exponential decay equation: _____.

14) Use the exponential decay model you found in #13 to determine your M&M population on the 4th trial? How does this "theoretical" number compare to your actual data for the 4th trial. Are they the same? Are they similar? What are some reasons why your results are different? Explain.

Part III: Lab Discussion

Look at the exponential equations from your analysis ... 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? _____ In Part II, what was the "a" value? _____ Why were the "a" values different in Parts I and II?

What does the "a" value represent in the equation $y = ab^x$? BE SPECIFIC.

2. In Part I, what was the "b" value? _____ In Part II, what was the "b" value? _____ Why were the "b" values different in Parts I and II?

What does the "b" value represent in the equation $y = ab^x$? BE SPECIFIC.

Part IV: Alternate Data Analysis: Using Common Ratios

GROWTH EXAMPLE:

To calculate the common ratio, we will divide the numbers of M&Ms from one trial by the number of M&Ms from the preceding trial using the formula below.

$$ratio = \frac{\# \text{ of MMs in Trial 1}}{\# \text{ of MMs in Trial 0}} = \frac{\# \text{ of MMs in Trial 2}}{\# \text{ of MMs in Trial 1}} = \frac{\# \text{ of MMs in Trial 3}}{\# \text{ of MMs in Trial 2}} \quad \text{etc...}$$

Complete the table below.

Trial #	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ratio	X															

Calculate the average of ALL the ratios: _____

We can write an exponential growth function that models the data above using the formula $y = C(a)^t$

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

C = _____

Ratio (calculated average from #5)

a = _____ (written as a decimal)

Time (this represents a specific phase number)

t = # of repetitions

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

3. Alternate Data Analysis: Using Common Ratios

DECAY EXAMPLE:

To calculate the common ratio, we will divide the numbers of M&Ms from one trial by the number of M&Ms from the preceding trial using the formula below.

$$ratio = \frac{\# \text{ of MMs in Trial 1}}{\# \text{ of MMs in Trial 0}} = \frac{\# \text{ of MMs in Trial 2}}{\# \text{ of MMs in Trial 1}} = \frac{\# \text{ of MMs in Trial 3}}{\# \text{ of MMs in Trial 2}} \quad \text{etc...}$$

Complete the table below.

Trial #	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ratio	X															

Calculate the average of ALL the ratios: _____

We can write an exponential decay function that models the data above using the formula $y = C(a)^t$

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

$C =$ _____

Ratio (calculated average from #5)

$a =$ _____ (written as a decimal)

Time (this represents a specific phase number)

$t =$ # of repetitions

Fill in the variables to write your own exponential decay equation: _____.