Name_________________________ Partners ________________ _________________

LESSON 4.3 - 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

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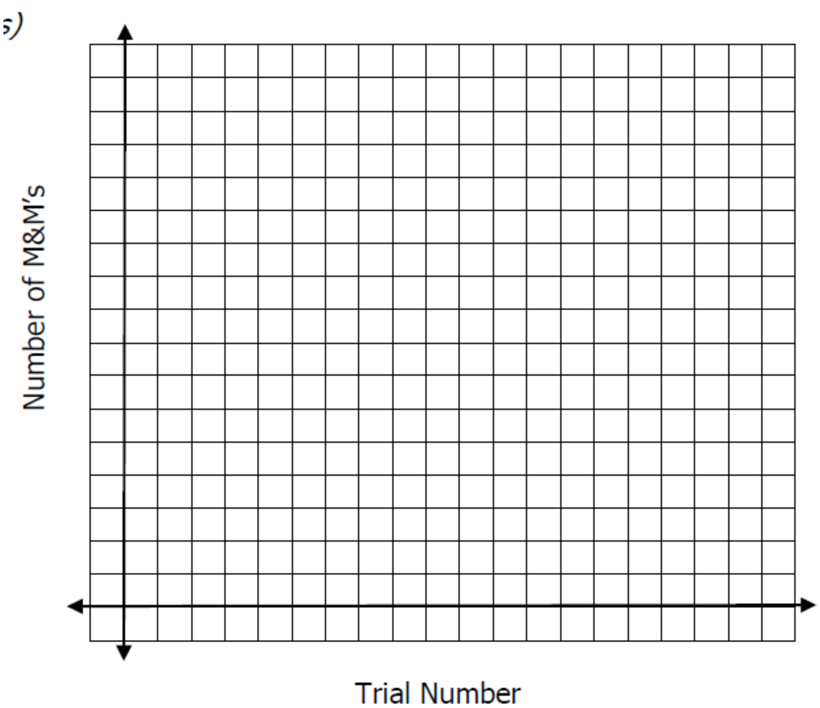
1) Place 2 M&M's in a cup/plate. This is trial number 0.
2) Shake the cup and dump out the M&Ms. For every M&M with the "M" showing, add another M&M and then record the new population. (Ex. If 5 M&Ms land face up, then you add 5 more M&Ms)
3) Repeat step number 2 until you are done with 15 trials OR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

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

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) **a** = ____________ (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: ____________________________________.

6) Use your exponential growth model that you created in #5 to predict the number of "cancerous cells" there would be in:

Trial 8 _____________________ Trial 25 ___________________ Trial 50 ______________________

7) 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. ____________________

8) To PRESENT AN ALTERNATIVE DATA ANALYSIS, we will calculate the percent change for each trial using the formula below.

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

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: ________________

9) 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 above) **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: ____________________________________.

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

Trial 20 ____________________ Trial 40 _______________________

11) Use the exponential growth model you found in #9 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 II: Modeling Exponential Decay

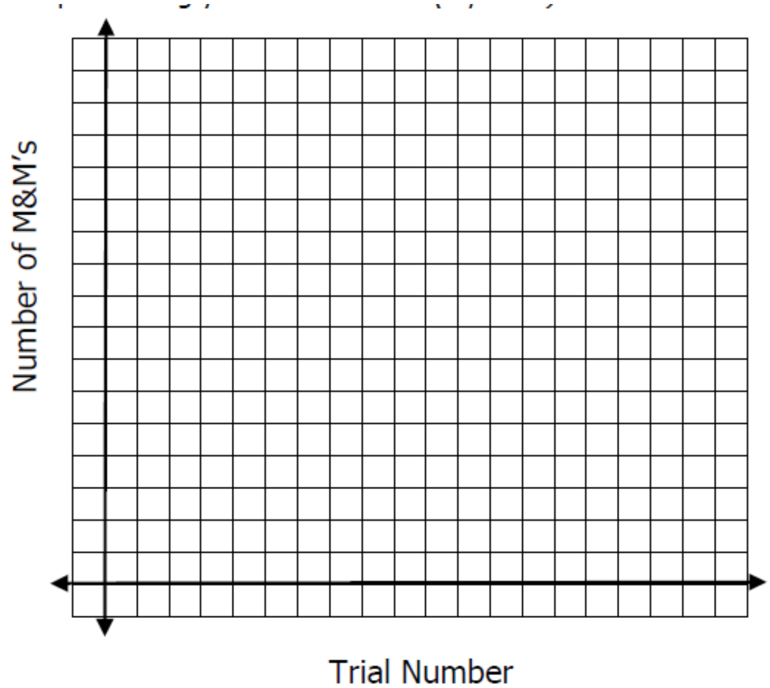
1) Count the total number of M&Ms that you have. Record this number in trial # 0.

2) 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.

3) 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											

4) Sketch the graph representing your data.



Exponential Decay Data Analysis – Option 1

5) 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.

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

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 above) **a** = _____________ (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: ______________________________________.

Exponential Decay Data Analysis – Option 2

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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. _____________________

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

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

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: ___________________

8) 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 above) **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: ______________________________________.

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 "C" value? ____________ In Part II, what was the "C" value? _____________

2. Why were the "C" values different in Parts I and II?

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3. What does the "C" value represent in the equation $y = Ca^t$? BE SPECIFIC.

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4. In Part I, what was the "a" value? ____________ In Part II, what was the "a" value? ____________

5. Why were the "a" values different in Parts I and II?

____

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6. What does the "a" value represent in the equation $y = Ca^t$? BE SPECIFIC.

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7. What does the "r" value represent in the equation $y = C(1+r)^t$? BE SPECIFIC.

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8. Write down your 2 equations for the exponential growth experiment.

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9. Input both these equations on your graphing calculator and display them on the same graph. What do you notice? Why is this true?