M&M Exponentials

Teacher Guide

Exponential Function

Activity Overview

In **M&M Exponentials** students will experiment with growth and decay functions. Students will also graph their experimental data and create theoretical equations for exponential growth and decay. In addition, students will use the theoretical equations to solve real-life problems.

Download the M&MExponentials.tns document to your TI-Nspire handheld or desktop software.

As a result of this activity, students will:

- Perform and gather experimental data that will assist them in modeling exponential growth.
- Understand the variables and coefficients of exponential equations and relate these values to the experimental data.
- Understand the process of obtaining the graph of best fit and its meaning.

Inquiry Questions

The following questions will assist teachers to probe for student understanding:

- Based on your experimental data, predict how many M&Ms will appear on the 10^{th} trial?
- Explain what the “a” and “b” values in the equations representing the M&M data are?
- What accounts for the discrepancy between the theoretical and experimental data?

Materials Needed

M&Ms
Graphing Calculator
Graph Paper
Small Paper Cups
Paper Towels
Hand Sanitizer

Exponential Growth

Exponential Functions

Discussion Points and Possible Answers

Problem 1: Experimental steps for exponential growth model.

1.2

Experimental Steps for Students

1. DO NOT EAT THE MANIPULATIVES!

2. Start with a cup of 4 M&Ms.

3. Shake the cup and pour the M&Ms out on the paper towel. Count the number of M&Ms that have the M showing. Add an M&M for each one with an M showing. Record the total number of M&Ms next to t=1.

4. Repeat for 6 trials.

5. Graph trials onto a scatter plot with trials on the x-axis and total M&Ms on the y-axis and predict a 10^{th} trial.

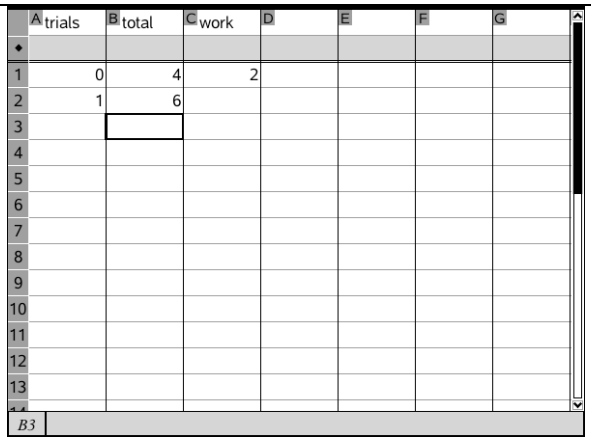
Questions and Possible Answers

1. What type of function is your scatter plot most alike? Linear? Quadratic? Exponential? Or Power? **[It should model exponential functions]**
2. What does the 10^{th} trial produce? **[Answers may vary but should be close to $4(1.5)^{10}$]**
3. What does the input variable represent in terms of the M&M activity? **[The input variable is the number of trials.]**
4. What does the output variable represent in terms of the M&M activity? **[The output variable is the number of M&M's.]**
5. What is the y-intercept and how does it relate to the M&M's? **[You started with only 4 M&M's…it represents the number of M&M's when the number of trials is 0.**

Problem 2: Creating a Spreadsheet of Data

On page 2.2 fill down each column. Labels and formulas have been added. Columns A, B, and C, were labeled "trials," "total," and "work" respectfully. Values were assigned as initial trial =0 and as initial total =4 in your chart. Equations were installed. Be careful not to overwrite these as you fill down (Fill down from A2, B2, and C1)

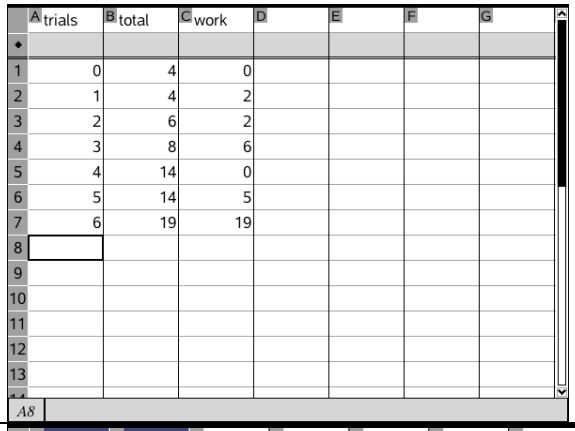
C1=randint(b1,0)
A2=a1+1
B2 =b1 +c1



	trials	total	work	D	E	F	G
1	0	4	2				
2	1	6					
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							

B3

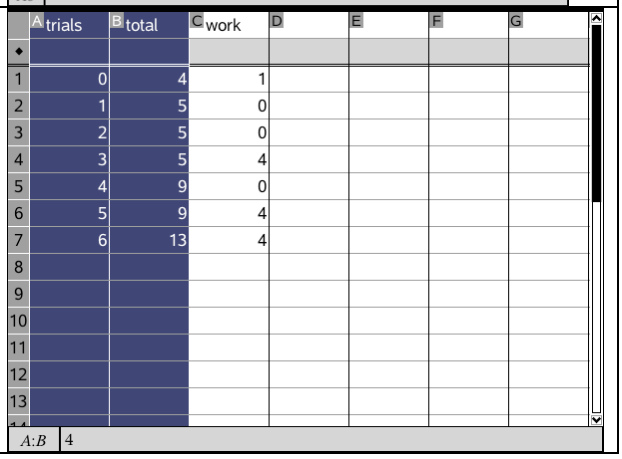
Use Fill Down to automatically fill in columns A, B, and C. While on A2, click (menu), Data, Fill Down, Enter, arrow down to A7 and Enter. Repeat for column B and C.



	trials	total	work	D	E	F	G
1	0	4	0				
2	1	4	2				
3	2	6	2				
4	3	8	6				
5	4	14	0				
6	5	14	5				
7	6	19	19				
8							
9							
10							
11							
12							
13							

A8

Graph trials onto a scatter plot with the trial numbers on the horizontal axis and the total number of M&M's on the vertical axis and highlight Columns A and B. To do this, first select column A by arrowing up to the top of column A then press caps, (tab) Right to select column B.



	trials	total	work	D	E	F	G
1	0	4	1				
2	1	5	0				
3	2	5	0				
4	3	5	4				
5	4	9	0				
6	5	9	4				
7	6	13	4				
8							
9							
10							
11							
12							
13							

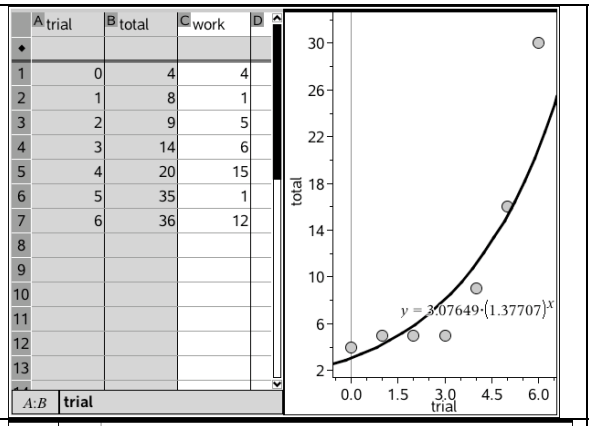
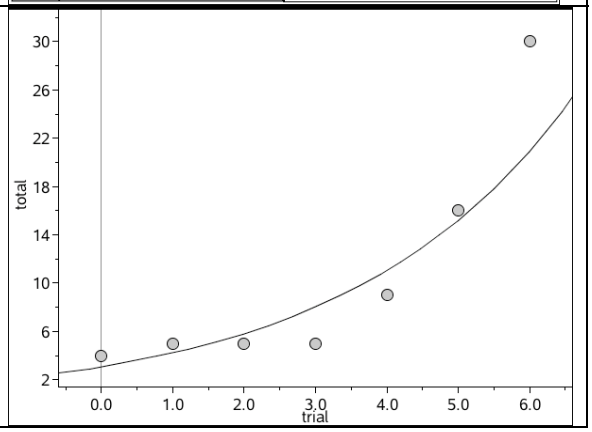
A:B 4

Questions and Possible Answers

1. Explain the meaning of each of the formulas. **[Answer: The first adds one more to identify trials, the second formula adds the new amount of M&M's to the previous one, and the third formula generates a**

random number of M&Ms with M's on them (note: the random number must be between the total number of M&M's and the number 0).]

Problem 2.3 Analyzing the Exponential Equations

Click on Menu, Data, Quick Graph. **Menu, Analyze, Regression, Show Exponential**	
Each student writes a model for a best-fit curve. **Ctrl K, ctrl C, Ctrl I, ESC, Ctrl V gives full screen.**	

Possible Questions and Answers:

What does each of the numbers in the regression equation represent? Why is the equation not: $y=4\ (1.5)^x$? Are your numbers close to the theoretical answer? **[Answer: The first coefficient represents the original number of M&M's and the base represents the rate of increase; Although the numbers in the exponential regression equation are not exact, they should be similar].**

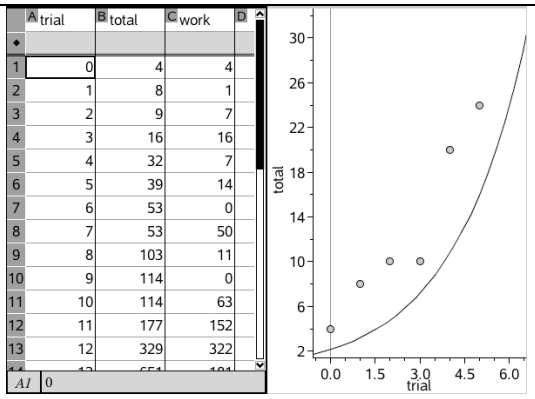
Problem 2.5: Increasing the Number of Cases

Repeat fill down steps to fill in the table to at least row 101 with column A and B. Notice on column C there will be a point around 80 that will be too large and error out with a domain error.

Delete all of these error rows.

Arrow up and highlight Column A and B. Quick Graph, Regression and now compare the new equations.

Write new experimental models to compare with previous models.



	A trial	B total	C work	D
1	0	4	4	
2	1	8	1	
3	2	9	7	
4	3	16	16	
5	4	32	7	
6	5	39	14	
7	6	53	0	
8	7	53	50	
9	8	103	11	
10	9	114	0	
11	10	114	63	
12	11	177	152	
13	12	329	322	

Questions and Possible Answers

How does the regression equation found from the 100 cases differ from that of the regression equation of only 7 cases? **[Answer: The more cases, the closer the theoretical equation is to the experimental.]**