Dead Dice

INTRODUCTION:

A plague has hit the population of dice. The dice are “dieing”. Their fate is “cast”. You will utilize dice in this activity to imitate survival or decay of many substances in nature as well as animal and plant populations. Radioactive materials decay in a specific way. So does waste in a landfill.

Every month many of the dice succumb to a terrible, fatal disease. During this activity, you will collect data involving “surviving” dice. You will analyze this data through lists and graphs in your TI-83 calculator to develop an equation that could model what is happening to the dice. The model will be an example of exponential decay.

PROCEDURE:

Procedure for using the TI-83 to simulate the rolling of 60 dice:

1. To identify the number that determines which dice are “DEAD” each month use randInt (1,6). To access this function, press • | (PRB menu) · (randInt) À ¢ ¸ ¤ Í . On the TI-82 use round(5*rand+1,0).
2. In the **DATA RECORDING** section, record the result on the calculator screen as the “DEAD” number to be used.
3. Run the program **DICEROLL**.
4. Input the number of dice to be rolled when instructed by the program. Press Í .
5. The screen will lighten slightly while the computer “rolls the dice”.
6. The calculator will output the number of 1’s, 2’s, 3’s, etc. in a list array.
   Example: {4, 7, 5, 9, 2, 8} means that the roll included four 1’s, seven 2’s, five 3’s, etc.
7. Record the number of “dead dice” in the Data Table.
8. Compute the number of remaining “live dice” and record the result in the Data Table.
9. Press Í to start the program over again.
10. Repeat Steps 4-9 until there are no “live dice” remaining.

DATA RECORDING:

The “DEAD” number is ______.

Let **D** represent the initial number of dice. **D** = _____.

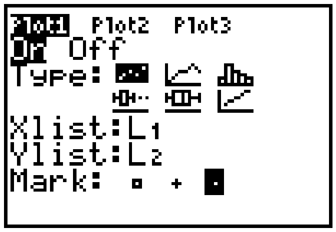
Data Table:

Month	"Dead" Dice this roll	"Live" Dice remaining	Month	"Dead" Dice	"Live" Dice
0	0	60	15		
1			16		
2			17		
3			18		
4			19		
5			20		
6			21		
7			22		
8			23		
9			24		
10			25		
11			26		
12			27		
13			28		
14			29		

Entering the data into the TI-83:

1. Turn on the calculator.
2. Press … .
3. Press **Í** for 1:edit.
4. Use **}** to position cursor on L_1.
5. Press **‘** **Í** to clear out any data in L_1 and L_2.
6. Enter the Month data into L_1. Then press **~** to move to the top of L_2.
7. Enter the "Live" Dice data into L_2. Check that L_1 and L_2 have the same # of elements.
8. After entering all data, press **y** Quit.
9. Set up the **p** to fit the data.
    a. The x-axis will use the Month data.
       Enter an appropriate range for this data.
       Lowest (xmin)__________
       Highest (xmax)_________
       Increments (xscl)_________
    b. The y-axis will contain the "Live" Dice data.
       Enter an appropriate range for this data.
       Lowest (ymin)__________
       Highest (ymax)_________
       Increments (yscl)________
    c. Set (xres) = 1
    d. **y** Quit
10. Set up StatPlot.
    a. Press **y** StatPlot.

b. Press í on Plot1 and turn Plot1 ON.
Enter Plot1 as shown below.



11. Press o and make sure all functions are clear or turned off.
12. Press s .
13. Label axes with quantity and units and sketch results. Show max. and min.

ANALYSIS:

1. a. Identify the independent variable.___________________________________
   b. Identify the dependent variable.____________________________________
   c. Explain why you made these two selections.
   Is this a straight line? Why? Why not? _____________________________________
   ____

2. How would you describe the pattern you see in the graph?

3. Press y • (Draw)
   Select 4: Vertical
   Press í

4. Compare and describe the difference between the appearance of the portion of the graph on the left side versus the portion on the right side of the vertical line.

5. Does the slope differ on the left versus the right side? If so, describe this difference.

6. Looking at the slope of your line, is the number of “Live” Dice decreasing faster at the beginning or end? ______________
   What evidence do you have to support this decision? Consider both your visual graph and your data.

7. Since the number of dice are not decreasing at a constant rate each month, compare the ratio of the die population from one month to the previous month. To do this, refer to the data table and select the 1st eight monthly ratios and record the appropriate values in the chart below. Press **y** [QUIT] and then calculate each ratio as both a decimal and a percent.

	“Live” Dice Ratio	Decimal value	“Live” Dice Percent
$\frac{\text{“Live” Dice Month 1}}{\text{“Live” Dice Month 0}}$			
$\frac{\text{“Live” Dice Month 2}}{\text{“Live” Dice Month 1}}$			
$\frac{\text{“Live” Dice Month 3}}{\text{“Live” Dice Month 2}}$			

8. Are the percents close in value? What value do they approach?

9. More than likely most of the “Live” Dice Ratios (percents) that you chose were close in value. In order to find a mathematical equation to model the data it may be helpful to find the average of the monthly “live” Dice Ratios. To determine this, find the mean of the eight (8) percentages (**P**) you calculated: **P** = _____

10. How can you explain the meaning of the percents in terms of what happened to the dice in the experiment?

Exponential Decay

Your goal is to write an equation to model your data. When data has the general shape of a curve that quickly falls to the right, then levels off as it gets close to zero, the type of model used is Exponential Decay. This model has a standard formula:

$$y = D \cdot P^x$$

where **P** stands for the average monthly decimal value of dice remaining alive
D stands for the initial number of dice.

11. Record your values for **D** = ___________ and **P** = _____________

12. Using your values for **D** and **P**, fill in the following chart:

				Round
Month 1:	**D · P**	= ____ · ____	=	______
Month 2:	**D · P · P**	= ____ · ____ · ____	=	______
Month 3:	**D · P · P · P**	= ____ · ____ · ____ · ____	=	______
Month 4:	**D · P · P · P · P**	= ____ · ____ · ____ · ____ · ____	=	______

13. To what do your calculated values compare in your original data table?

14. Using this pattern, show how you could <u>estimate</u> the number of "live" dice remaining after seven trials. First use variables, then show the calculation.

15. What mathematical operation did we perform? What math shorthand notation can you use to express the formula for Question 14?

16. In this simulation, the exponent represents _________________.

17. Calculate $D \cdot P^{12}$ = _______.

What does this represent in the simulation? ___________________________________

18. Now it's time to write an equation to model all the data and compare the graph to our data. Using $y = D \cdot P^x$, substitute your values for **D** and **P** into the model.

19. Press **o** and enter your formula.

20. Press **s**

21. Sketch the results on the graph below. Label the axes.

22. Does the equation seem to be a good model for your data? ________

Explain why or why not.

23. How can you explain the meaning of the percents in terms of what happened to the dice in the experiment?

24. Could you ever reach zero?

CONCLUSION:

1. In what ways could you change this activity that could affect the results?

2. Briefly describe a few things that occur in nature that could be modeled by an exponential decay equation.