Warm Up

Write the equation that represents the data in the table below.

$$0 \quad\quad 4$$

$(?$

x	y
1	10
2	25
3	62.5
4	156.25

$)$ ÷ 2.5

$) \times 2.5$
$) \times 2.5$
$) \times 2.5$

+1(
+1(
+1(

x   y
| 1 | 0 | 4 |

$10 \div 2.5 = 4$

$$y = 4(2.5)^x$$

What Did Dr. Frug's Wife Say When Dr. Frug Said He Needed to Spend More Time Studying Bacteria?

Complete the table and graph. For table cells with letters, write the letter in the corresponding box at the bottom of the page. (Answers are rounded.)

Dr. Frug has three kinds of bacteria in three lab dishes. Each dish contains 100 cells. However, in Dish A, the number is increasing 10% each hour. In Dish B, the number is increasing 30% each hour, and in Dish C, the number is increasing 50% each hour. Complete the table and graph to show the number of cells in each dish for the next 9 hours.
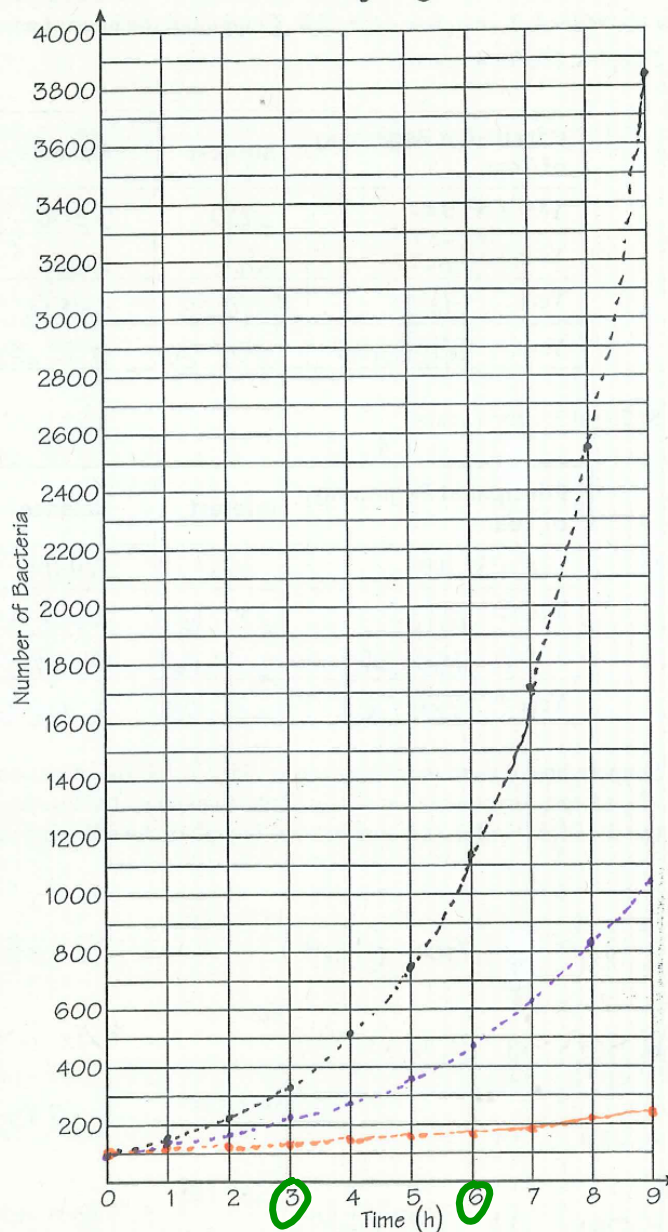
Let t = Time (h)

A = Number of bacteria in lab dish A.

B = Number of bacteria in lab dish B.

C = Number of bacteria in lab dish C.

	1.10	1.30	1.50
t	Ⓐ	Ⓑ	Ⓒ
0	100	100	100
1	110 O	130	150 O
2	121	169 I	225
3	133	220 T	338
4	146 I	286	506 B
5	161	371 L	759
6	177	483	1139 L
7	195 H	627	1709 N
8	214	816 D	2563
9	236 A	1060	3844 C

233	150	195	915	816	110	1709	220	1911	506	236	3844	146	371	1139	169	480
	O	H		D	O	N	T		B	A	C	I	L	L	I	

Exponents and Exponential Functions:
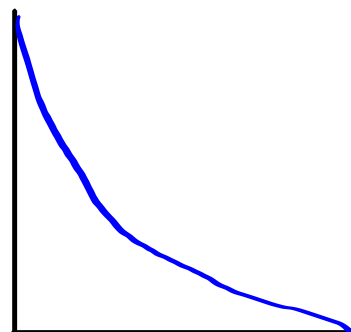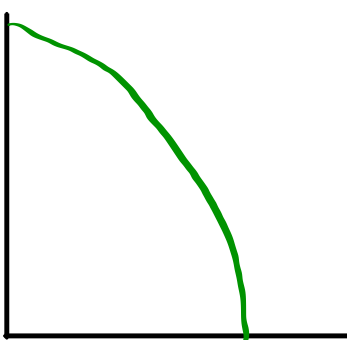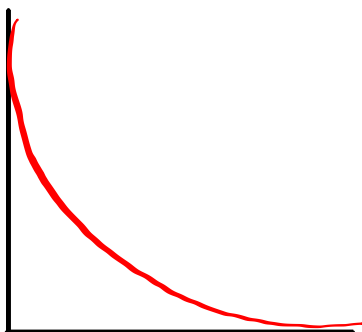Tables and Graphs for Exponential Functions

11.14

Investigation 4

Exponential Decay

The exponential functions you have studied so far have all involved quantities that increase. In this Investigation, you will explore quantities that decrease, or decay, exponentially as time passes.

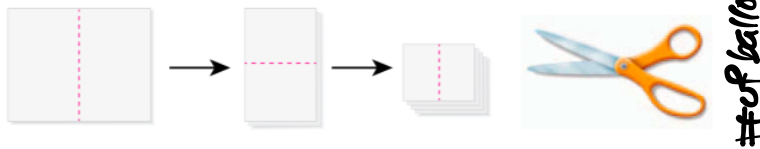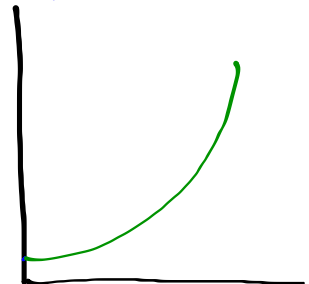## What do you think a graph of exponential decay will look like?

Let's check it out!

4.1 Making Smaller Ballots
Introducing Exponential Decay

In Problem 1.1, you read about the ballots Chen is making. Chen cuts a sheet of paper in half. He stacks the two pieces and cuts them in half. Chen then stacks the resulting four pieces and cuts them in half, and so on.

Problem 1.1

(handwritten graph with y-axis labeled "# of ballots" and x-axis labeled "# of cuts", showing an upward exponential curve)

You investigated the pattern in the number of ballots each cut made. In this Problem, you will look at the pattern in the areas of the ballots.

Problem 4.1

A The paper Chen starts with has an area of 64 square inches. Copy and complete the table to show the area of a ballot after each of the first 10 cuts.

Areas of Ballots

Number of Cuts	Area (in.^{2})
0	64
1	32
2	16
3	8
4	4
5	2
6	1
7	
8	
9	
10	

B How does the area of a ballot change with each cut?

C Write an equation for the area A of a ballot after any cut n.

D Make a graph of the data.

E 1. How is the pattern of change in the area different from the exponential growth patterns you studied? How is it similar?

   2. How is the pattern of change in the area different from linear patterns you studied? How is it similar?

Remember, the factor is the number we repeatedly **multiply** by.

Homework

Page 66, #'s 1, 3, 19-22

1. Chen, from Problem 4.1, finds that his ballots are very small after only a few cuts. He decides to start with a larger sheet of paper. The new paper has an area of 324 in.^{2}. Copy and complete this table to show the area of each ballot after each of the first 10 cuts.

Areas of Ballots

Number of Cuts	Area (in.^{2})
0	324
1	162
2	81
3	■
4	■
5	■
6	■
7	■
8	■
9	■
10	■

a. Write an equation for the area A of a ballot after any cut n.

b. With the smaller sheet of paper, the area of a ballot is 1 in.^{2} after 6 cuts. Start with the larger sheet. How many cuts does it take to get ballots this small?

c. Chen wants to be able to make 12 cuts before getting ballots with an area of 1 in.^{2}. How large does his starting piece of paper need to be?

3. Latisha has a 24-inch string of licorice (LIK uh rish) to share with her friends. As each friend asks her for a piece, Latisha gives him or her half of what she has left. She doesn't eat any of the licorice herself.

   a. Make a table showing the length of licorice Latisha has left each time she gives a piece away.

   b. Make a graph of the data from part (a).

   c. Suppose that, instead of half the licorice that is left each time, Latisha gives each friend 4 inches of licorice. Make a table and a graph for this situation.

   d. Compare the tables and the graphs for the two situations. Explain the similarities and the differences.

For Exercises 19–22, write each number in scientific notation.

19. There are about 33,400,000,000,000,000,000,000 molecules in 1 gram of water.

20. There are about 25,000,000,000,000 red blood cells in the human body.

21. Earth is about 93,000,000 miles (150,000,000 km) from the sun.

22. The Milky Way galaxy is approximately 100,000 light years in diameter. It contains about 300,000,000,000 stars.