Warm Up

Write an equation for the following exponential relationship.

Round the growth factor to the hundredths place.

x	y
0	52
1	84.24
2	136.47
3	221.08

> ×1.62
> ×1.62
> ×1.62

Factor? 1.62

Rate? (% change) 62%

Factor = 1 + Rate (% written as a decimal)

$1.62 = 1 + Rate$
$-1 \quad -1$

$0.62 = Rate$

62% increase

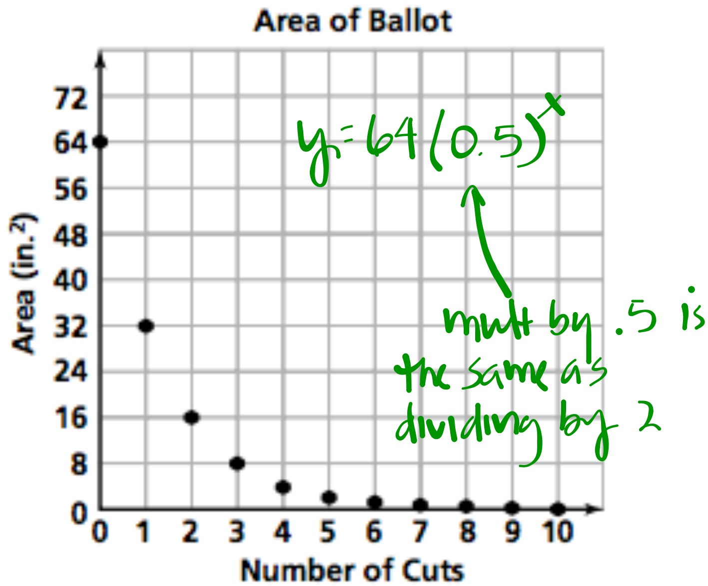
Factor	Rate (% change)
1.21	21%
1.89	89%
2.1	110%
5	400%

Problem 4.1 Recap

A.

Number of Cuts	Area (in.^{2})
0	64
1	32
2	16
3	8
4	4
5	2
6	1
7	0.5
8	0.25
9	0.125
10	0.0625

+1, +1, +1 ; −32, −16, −8



Is this linear?

No, because there is no constant slope $\frac{\Delta y}{\Delta x} = \frac{-32}{1} \neq \frac{-16}{1} \neq \frac{-8}{1}$

Exponential!

Constant factor = 0.5

Homework Questions?

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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

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

$A = 324(0.5)^n$

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?

n	A
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	1

we want to figure out what this is (row 0)

we know this (row 12)

$A = a(0.5)^n$

Area of ballot (A); # of cuts (n)

$1 = a(0.5)^{12}$

initial size of paper (a)

$\frac{1}{0.5^{12}} = \frac{a(0.5)^{12}}{0.5^{12}}$

$4096 = a$

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.

4.2 Fighting Fleas

Representing Exponential Decay

1/3

Exponential patterns like the one in Problem 4.1, in which a quantity decreases at each stage by a constant factor, show **exponential decay.** The factor the quantity is multiplied by at each stage is called the **decay factor.** A decay factor is always greater than 0 and less than 1. In Problem 4.1, the decay factor is $\frac{1}{2}$.

0.5

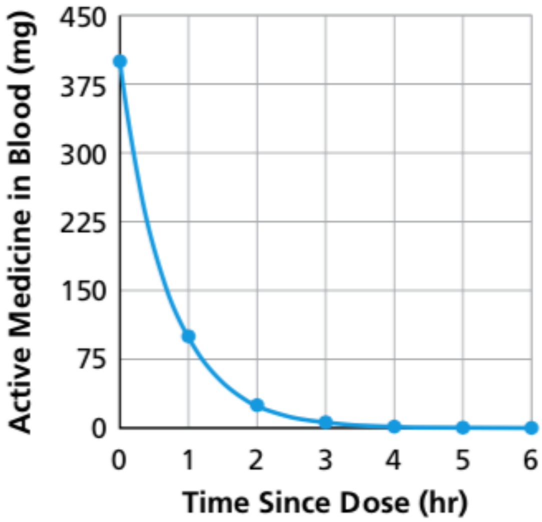
Different from growth factor because < 1

- Are exponential decay patterns also exponential functions? Explain.

After an animal receives flea medicine, the medicine breaks down in the animal's bloodstream. With each hour, there is less medicine in the blood.

A dog receives a 400-milligram dose of flea medicine. The table and graph show the amount of medicine in the dog's bloodstream each hour for 6 hours after the dose.

Breakdown of Medicine



Time Since Dose (hr)	Active Medicine in Blood (mg)
0	400
1	100
2	25
3	6.25
4	1.5625
5	0.3907
6	0.0977

Problem 4.2

A Study the pattern of change in the graph and the table.

1. How does the amount of active medicine in the dog's blood change from one hour to the next?
2. Write an equation to model the relationship between the number of hours h since the dose is given and the milligrams of active medicine m.
3. How is the graph for this Problem similar to the graph you made in Problem 4.1? How is it different?
4. Does the relationship displayed in the table and graph represent an exponential function? Explain.

B

1. A different flea medicine breaks down at a rate of 20% per hour. This means that as each hour passes, 20% of the active medicine is used. This is the **rate of decay** of the medicine. The initial dose is 60 milligrams. Extend and complete this table to show the amount of active medicine in an animal's blood at the end of each hour for 6 hours.

Breakdown of Medicine

Time Since Dose (hr)	Active Medicine in Blood (mg)
0	60
1	■
2	■
⋮	⋮
6	■

x	y
0	
1	
2	
3	
4	
5	
6	

2. Make a graph using the table you completed in part (1).

3. For the medicine in part (1), Janelle wrote the equation $m = 60(0.8)^h$ to show the amount of active medicine m after h hours. Compare the quantities of active medicine in your table to the quantities given by Janelle's equation. Explain any similarities or differences.

4. Dwayne was confused by the terms *decay rate* (or *rate of decay*) and *decay factor*. He said:

> Because the rate of decay is 20%, the decay factor should be 0.2, and the equation should be $m = 60(0.2)^h$.

Do you agree with him? Explain.

5. Steven recalled that when the growth rate is 80%, the growth factor is 1.8 or 180%. How is the relationship between growth rate and growth factor similar to the relationship between decay rate and decay factor?

Homework

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4. Penicillin decays exponentially in the human body. Suppose you receive a 300-milligram dose of penicillin to combat strep throat. About 180 milligrams will remain active in your blood after 1 day.

a. Assume the amount of penicillin active in your blood decreases exponentially. Make a table showing the amount of active penicillin in your blood for 7 days after a 300-milligram dose.

b. Write an equation for the relationship between the number of days d since you took the penicillin and the amount of the medicine m remaining active in your blood.

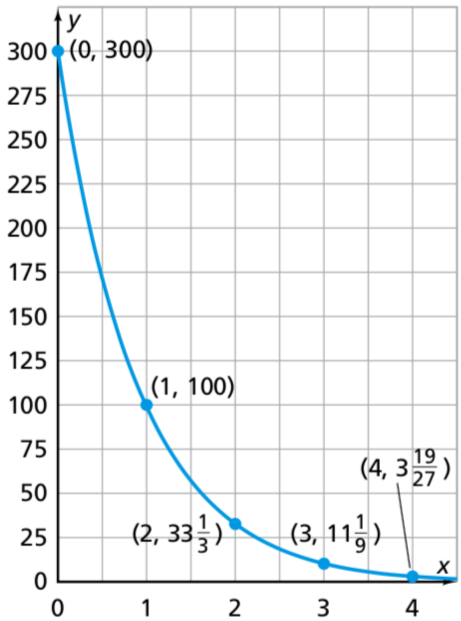
c. What is the equation for a 400-milligram dose?

For Exercises 5 and 6, tell whether the equation represents exponential decay or exponential growth. Explain your reasoning.

5. $y = 0.8(2.1)^x$

6. $y = 20(0.5)^x$

7. The graph below shows an exponential decay relationship.



a. Find the decay factor and the *y*-intercept.

b. What is the equation for the graph?

$$\frac{6.4}{4} \qquad \frac{3.69}{1.23} \qquad \frac{4.2}{3.5}$$

1.6

3

1.2

$4\overline{)6.4}$

$3.5\overline{)4.2}$

$$\frac{6.4}{4} = \frac{3.2}{2} = \frac{1.6}{1}$$

$$\frac{4.2}{3.5} = \frac{0.6}{0.5} = \frac{1.2}{1}$$