Exploring more rates of change

Group Work - Thinking Task

- You will randomly get a playing card, numbered 9-Ace
- Silently, go to the station that corresponds to the number on your card
- The task will be presented on the board, with a ten minute timer (I may adjust the timer depending on the pace of the class)

Imagine you posted a video on TikTok and it went viral. You now have 14,000 followers. However, you haven't posted a new video recently since you got locked out of your Tik Tok account.

With each passing day, you lose 30% of your followers.

Estimate how many followers you will have left after 4 days.

How long will it take before you have fewer than 100 followers?

Warm Up

Does the following equation represent exponential growth or decay?

$y = 4(.65)^x$

→ < 1 so it's decay

What is the Factor? 0.65

What is the Rate?

% change 35% decrease

Some practice:

$y = 100(0.47)^x$

Factor = 0.47

Rate = 53% ↓

$y = 100(0.05)^x$

Factor = 0.05

Rate = 95% ↓

$y = 100(0.4)^x$

What is the % decrease?

60%

Homework Questions?

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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?

Factor = 0.6

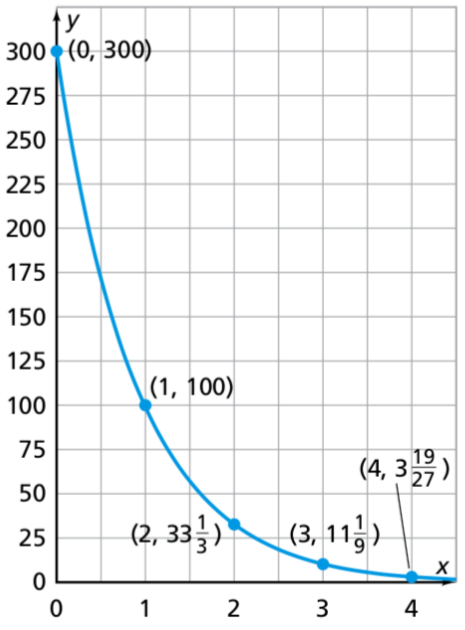
Rate = 40% ↓

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

5. $y = 0.8(2.1)^x$ Growth Rate = 110% ↑

6. $y = 20(0.5)^x$ Decay Rate = 50% ↓

7. The graph below shows an exponential decay relationship.



0	300
1	100
2	$33\frac{1}{3}$

$\times 0.33$

$y = 300(0.33)^x$

What is decay rate?

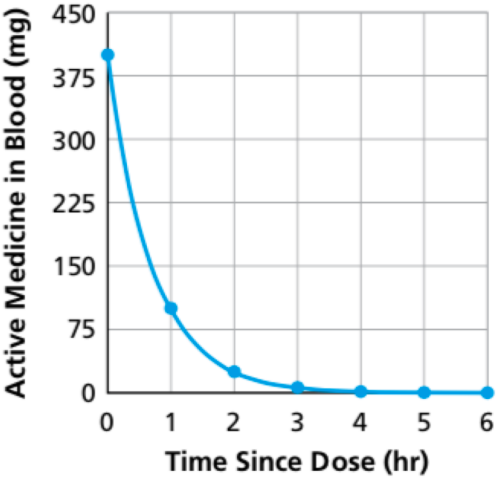
67% ↓

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

b. What is the equation for the graph?

Problem 4.2 Recap

Part A

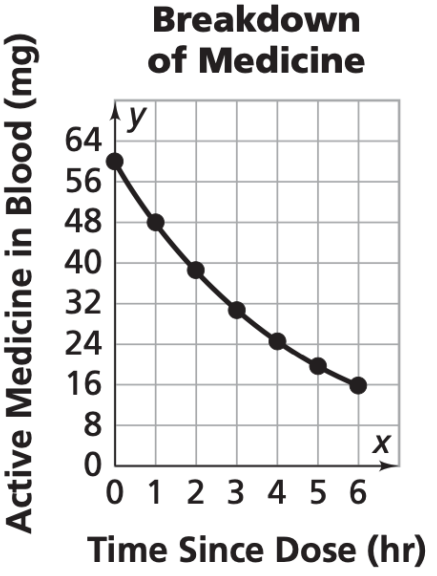


$$m = 400\left(\frac{1}{4}\right)^h$$

Factor = 0.25

Rate = 75% ↓

Part B



$$m = 60(0.8)^h$$

Factor = 0.8

Rate = 20% ↓

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?

4.3 Cooling Water

Modeling Exponential Decay

Sometimes a cup of hot cocoa or tea is too hot to drink at first. So you must wait for it to cool.

- What pattern of change would you expect to find in the temperature of a hot drink as time passes?
- What shape would you expect for a graph of data (*time, drink temperature*)?

This experiment will help you explore these questions.

I have data tables for you to glue/tape into your notebook.

Problem 4.3 - Part A

Time (min)	# of 5 min intervals	Temp °C
0	0	90
5	1	76
10	2	65
15	3	56
20	4	49
25	5	44
30	6	40
35	7	36
40	8	34
45	9	32
50	10	30
55	11	29
60	12	28

Problem 4.3 - Part B

Time (min)	# of 5 min intervals	Temp °C	Air Temp °C	Temp - Air Temp °C
0	0	90	25	65
5	1	76	25	51
10	2	65	25	40
15	3	56	25	31
20	4	49	25	24
25	5	44	25	19
30	6	40	25	15
35	7	36	25	11
40	8	34	25	9
45	9	32	25	7
50	10	30	25	5
55	11	29	25	4
60	12	28	25	3

We will be graphing by 5-minute intervals. With the number of 5-minute intervals as our x-values it will be easier to write an exponential equation.

Problem 4.3

Done for you!

A **1.** Complete the table with data from your experiment.

Hot Water Cooling

Time (min)	Water Temperature	Room Temperature
0		
5		
10		

Start here

→ Make a graph of your (*time, water temperature*) data.

2. Describe the pattern of change in the data. When did the water temperature change most rapidly? When did it change most slowly?

3. Is the relationship between time and water temperature an exponential decay relationship? Explain.

Problem 4.3 - Part A

Time (min)	# of 5 min intervals (x)	Temp °C (y)
0	0	90
5	1	76
10	2	65
15	3	56
20	4	49
25	5	44
30	6	40
35	7	36
40	8	34
45	9	32
50	10	30
55	11	29
60	12	28

Notice that the data you will be graphing is in the columns with the white background.

Done for you!

B

1. Add a column to your table. In this column, record the difference between the water temperature and the air temperature for each time value.
2. Make a graph of the (*time, temperature difference*) data. Compare this graph with the graph you made in Question A.
3. Describe the pattern of change in the data. When did the temperature difference change most rapidly? Most slowly?
4. Estimate the decay factor for the relationship between temperature difference and time in this experiment.
5. Write an equation for the (*time, temperature difference*) data. Your equation should allow you to predict the temperature difference at the end of any 5-minute interval.

Start here

Done for you!

Notice that the data you will be graphing is in the columns with the white background.

Problem 4.3 - Part B

x

y

Time (min)	# of 5 min intervals	Temp °C	Air Temp °C	Temp - Air Temp °C
0	0	90	25	65
5	1	76	25	51
10	2	65	25	40
15	3	56	25	31
20	4	49	25	24
25	5	44	25	19
30	6	40	25	15
35	7	36	25	11
40	8	34	25	9
45	9	32	25	7
50	10	30	25	5
55	11	29	25	4
60	12	28	25	3

C 1. What do you think the graph of the (*time, temperature difference*) data would look like if you had continued the experiment for several more hours?

2. What factors might affect the rate at which a cup of hot liquid cools?

3. What factors might introduce errors in the data you collect?

D Compare the graphs in Questions A and B with the graphs in Problems 4.1 and 4.2. What similarities and differences do you observe?

Homework

Finish classwork