Warm Up

All cards are pairs. Find your match!

If you have a rate, find the factor.

If you have a factor, find the rate.

Find a place to sit with your "match."

4.3 Recap

Problem 4.3

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.

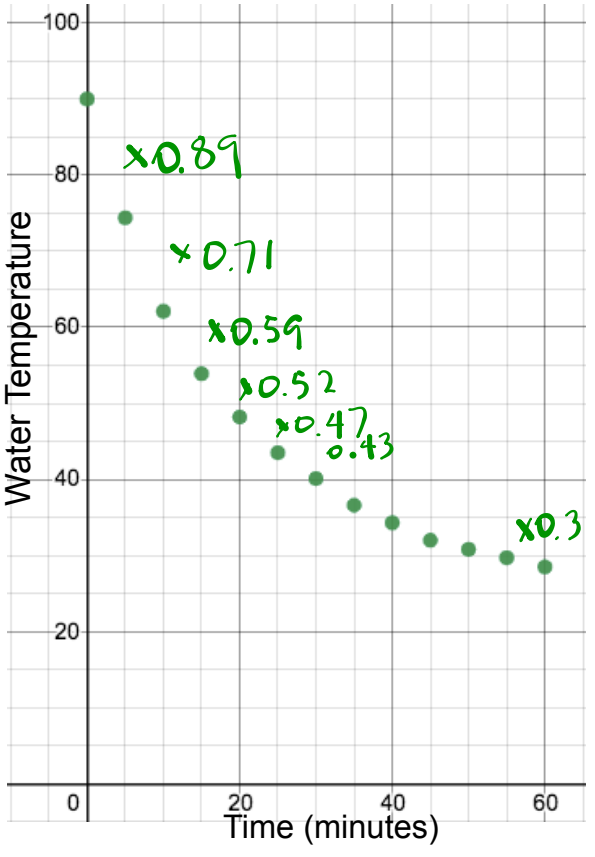
2. Describe the pattern of change in the data. When did the water temperature change most rapidly? When did it change most slowly?

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

# of intervals

	Time (min)	Water Temp. (°C)	Room Temp. (°C
0	0	89	27
1	5	71	27
2	10	59	27
3	15	52	27
4	20	47	27
5	25	43	27
6	30	40	27
7	35	37	27
8	40	35	27
9	45	33	27
10	50	32	27
11	55	31	27
12	60	30	27

Problem 4.3 Recap



Not exponential

No constant factor

Curved doesn't always mean exponential!

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.

Start here

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.

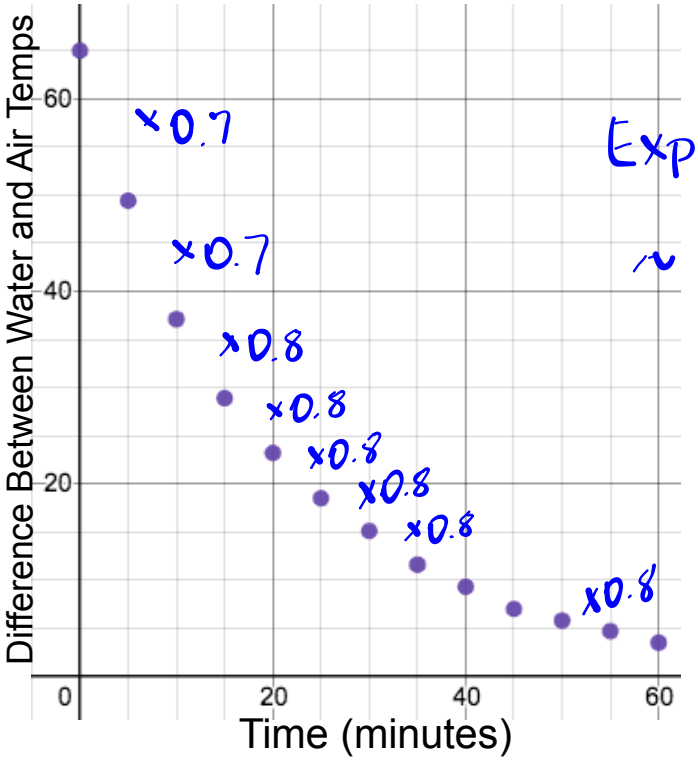
5. Write an equation for the (*time, temperature difference*) data. Your equation should allow you to predict the temperature difference at the end of any 5-minute interval.

Time (min)	Water Temp. (°C)	Room Temp. (°C)
0	89	27
5	71	27
10	59	27
15	52	27
20	47	27
25	43	27
30	40	27
35	37	27
40	35	27
45	33	27
50	32	27
55	31	27
60	30	27

Δ

62

Problem 4.3 Recap



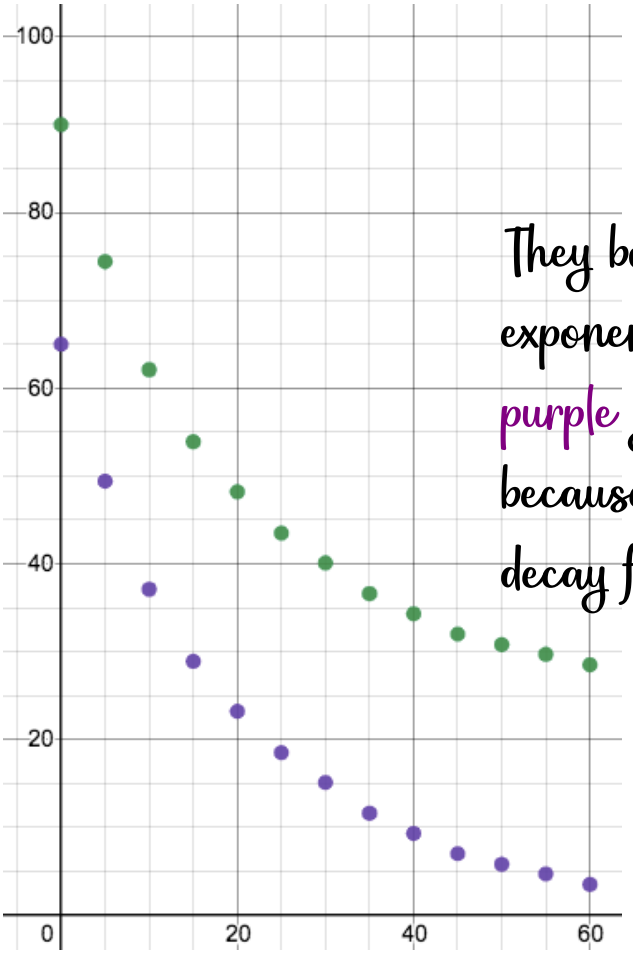
Exponential

~ constant decay factor

~ 0.8

Equation?

Curved doesn't always mean exponential!



They both look like they are exponential, but only the purple graph is exponential because it has a constant decay factor.

Equation:

$y = 62(0.8)^x$

20 min:

$y = 62(0.8)^{20}$

$y = 0.71$

4 · 5 min intervals

$y = 62(0.8)^4$

$= 25.4$

Big Take Away:

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? It will be room temp → 27°C
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?

Bead Activity

1. Go to Google Classroom and open the link to the spreadsheet

"Bead Activity Class Data Table."

2. Once opened, put your iPad face down on your desk.

Whoever has the **"Factor"** card will get the supplies when I say we are ready.

Name _____ Period _____ Date _____

Exponential Decay Bead Activity

1. Gathering data: **Cup # _____**

   a. Start with a cup full of 100 beads. Shake the cup and pour the beads onto a piece of paper.

   b. Remove all the beads that have the hole face up. Count the number of beads remaining and record that number in the table for trial #1. Return the remaining beads to the cup. Shake the cup and pour the beads onto the paper.

   c. Repeat step b until the table is filled in or until you run out of beads. Add this same data to the Class Data Table shared with you in Drive.

Trial Number	Number of beads remaining	Decay Factor
0	100	>
1		>
2		>
3		>
4		>
5		>
6		>
7		>
8		>
9		>
10		>
11		>
12		>
13		>
14		>
15		

Calculate decay factors for each of your trials and add them into the table above.

Exponential Decay Activity

Each group needs:

- 1 cup
- 1 bag of beads
- A piece of graph paper

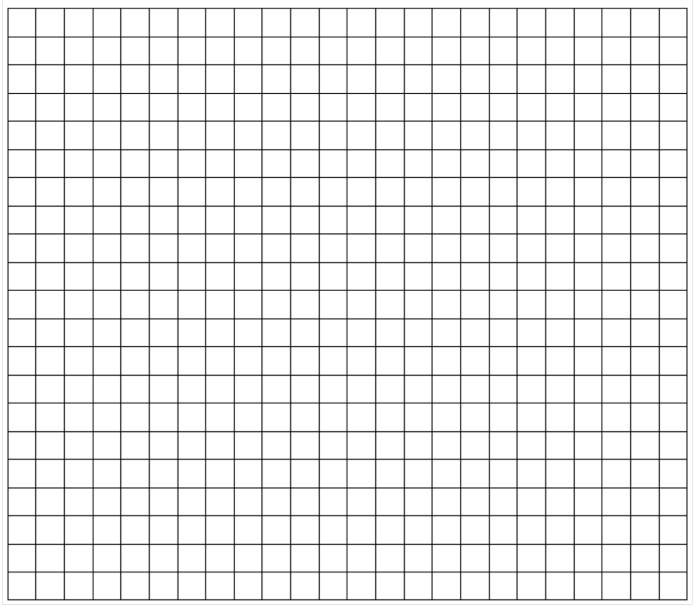
Count your beads to make sure you have 100, and put them in the cup.

2. Using your data, what is the calculated decay factor? Show below how you calculated this.
   Note: As the experimenter, you can decide which data points you want to include in your calculations as long as you have valid reasoning.

3. What is the decay rate?

4. Write an equation you can use to calculate the number of beads remaining after "x" number of trials.

5. Graph your data: Create a graph of Trials (x) and Total Beads Remaining (y).



6. Thinking about what we know about probability we could have predicted this decay factor. Explain what the probability would be for one of the beads to fall hole side up?

   Based on this probability, what should the **decay factor** be?

7. Compare the number of remaining beads we would expect based on probability to the number of beads the class actually had in the experiment.

   a. In the left-hand column fill in the total number of beads the class had after each trial. (Class totals are in the spreadsheet shared in Drive)

   b. In the right-hand column fill in the number of beads you would expect to remain after each trial based on your **predicted decay factor from #6**.

Trial Number	**ACTUAL Number** of Remaining Beads (class totals)	**EXPECTED Number** of Beads Remaining based on **decay factor from #6**
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

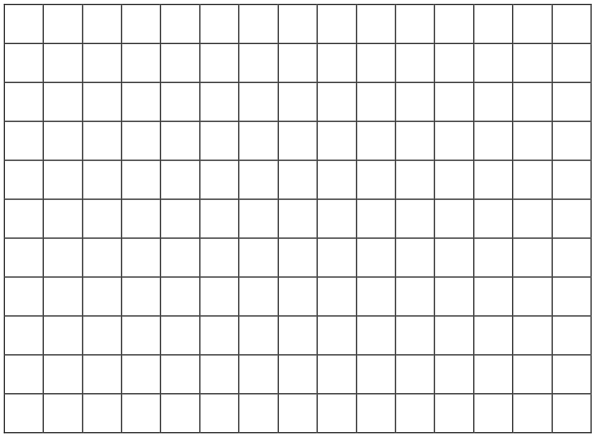
8. How does the **actual** number of beads remaining calculated above compare to your **expected** amount? Why might there be a difference?

9. Assuming the same decay factor that you calculated for the class data, if there are 43 beads remaining after 10 trials, how many beads were there initially?

10. If we had used Skittles instead of beads and had removed the Skittles with the "S" side up at each trial, what would the **decay rate** have been? (Skittles only have an "S" on one side.)

11. What would the equation be if we started with 100 Skittles?

12. Using two different colors draw below (on the same plot) the expected graphs for the exponential decay relationship if we started with 100 beads, compared to that with 100 Skittles. Explain how the graphs are the same, and how they are different.



Same:

Different: