MiSP Phase Changes Worksheet #2a L3

Name _____ Date _____

Key Question:

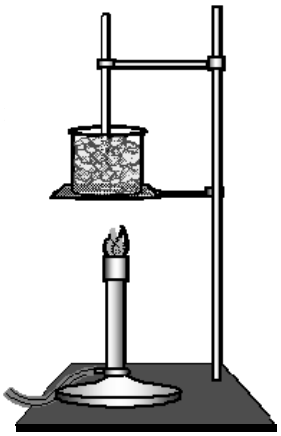
How does the temperature change as water gains heat and boils?

Safety:

- Wear goggles.
- Use caution—the hot plate, Bunsen burner, and heated water will be very hot.

Materials:

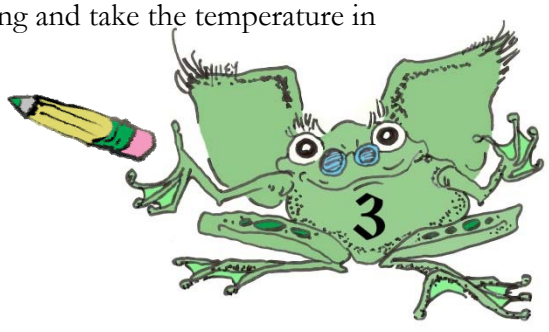
- 250 ml beaker
- Bunsen burner or hot plate (if using a Bunsen burner, you will need:
  - ring stand and
  - iron ring wire gauze)
- thermometer and clamp
- goggles



Procedure:

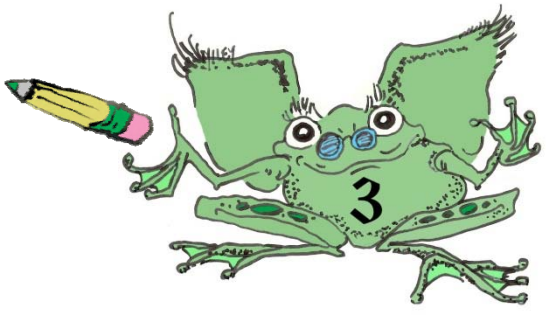
Check off each step as you complete it.

- ☐ 1. Prepare a heating setup: EITHER a Bunsen burner, ring stand, iron ring, and wire gauze OR a hot plate. Your teacher will tell you which setup to prepare and give any special instructions needed. Put on goggles.
- ☐ 2. Put 200 ml of cold tap water into a beaker.
- ☐ 3.Take the temperature of the water immediately and record that reading as the temperature at time 0 (zero) on the data chart.
- ☐ 4.Begin heating the water with the Bunsen burner or hot plate. ONCE YOU START HEATING, DO NOT CHANGE THE SETTING ON THE BUNSEN BURNER OR THE HOT PLATE. THE EXPERIMENT MUST HAVE A CONSTANT AMOUNT OF HEAT BEING ADDED. Take the temperature every 1 minute while you are heating the water. Stir the water with the thermometer before each reading and take the temperature in



the middle of the water in the beaker. Write each reading on the data chart and note when the water begins to boil rapidly (comes to a "rolling" boil).

- 5.After the water begins to boil rapidly, continue taking the temperature at 1-minute intervals for 5 more minutes. Write this data on the data chart.
- 6.At the end of the 5 minutes, shut off your burner. Let the setup cool. Your teacher will tell you how to clean up your lab materials.



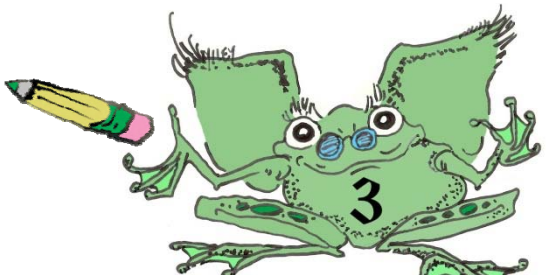
Record your data:

Time (minutes)	Temperature °C	Note: When the water begins to rapidly boil (comes to a rolling boil)

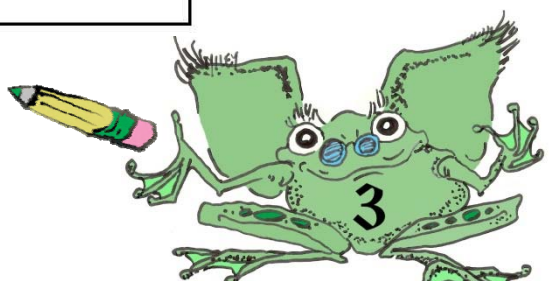
Graph your data:

Graph the data on the next page to show the relationship between time (minutes) and temperature (°C).

- Label the *x*–axis.
- Label the *y*-axis.
- Using your notes on the data chart, circle the data point when the water was first rapidly boiling. Draw a best-fit line between that point and your last data point. Label this line "boiling."
- Draw a best-fit line between the first temperature reading data point and the data point when the water was first rapidly boiling. Label this line "liquid heating."



Discussion Questions:



1. Water has a boiling point (temperature) of 100°C at sea level. According to your thermometer (school thermometers are often inaccurate), what is the boiling point of the water in your experiment? Look at your data chart and graph, too.

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2. Which line on the graph (liquid heating OR boiling) has the steepest slope (the greatest angle)?

_____

3. In which part of the graph (liquid heating OR boiling) did the temperature change (increase) the most?

_____

4. The temperature of your Bunsen burner or hot plate was 200°C or more. Yet once the water was boiling, the temperature changed little, if at all. So, at the boiling temperature, what is the heat that is still being added to the water doing?

_____

_____

5a. Your teacher will give you Phase Changes Worksheet #2b. It has a labeled ideal graph that shows the heating curve (from solid to gas) of any substance. How does your graph compare to the liquid heating (warming) to boiling part of the ideal graph?

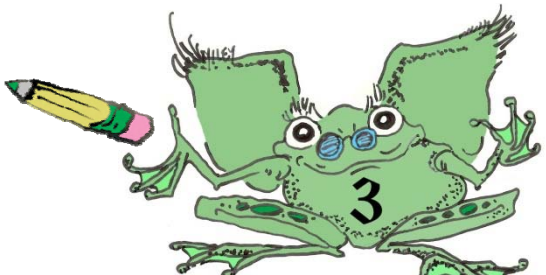
_____

_____

5b. From the labeled graph on Worksheet #2b, what happens to the temperature of a substance when it is gaining heat and changing from a

solid to a liquid (melting)? _____

liquid to a gas (boiling)? _____



5c. According to the labeled ideal graph on Worksheet #2b, what happens to the temperature of a substance when it is gaining heat in the

solid state (phase)? _____

liquid state (phase)? _____

gas state (phase)? _____

6. Look at the graph you drew. Notice that as time passed and heat was added to the water, the temperature changed. You will compare the changes in temperature in the two regions of the graph (liquid heating AND boiling) by calculating the unit rates of change (slopes). Use the best-fit lines. *(When using best-fit lines, the ordered pairs to determine unit rates of change (slopes) must be from the best-fit lines, not from your data chart.)*

Unit Rate of Change = $\frac{\Delta \text{ Temperature } ^{o}C}{\Delta \text{ Time (minutes)}} = \frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)}$

Section of graph Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Temperature ^{o}C Δy	Δ Time (minutes) Δx	**Unit Rate of Change (slope)** $\Delta y / \Delta x$
Liquid Heating			
Boiling			

7a. How do the unit rates of change (slopes) for the two sections of the graph compare? Discuss numerical values and signs (positive/+ or negative/-).

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_____

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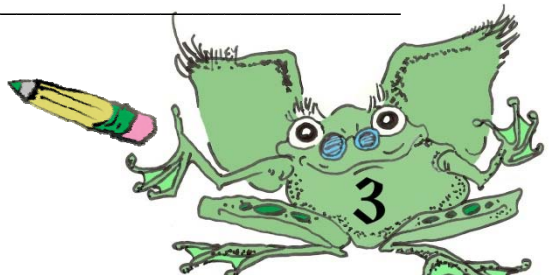


7b. According to the unit rates of change, in which section of the graph was the temperature changing most rapidly?

_____

_____

7c. Look at the ideal graph on Worksheet #2b. What is the unit rate of change (slope) when a substance melts (changes from a solid to a liquid) and boils (changes from a liquid to a gas)?

_____

_____

7d. Look at the ideal graph on Worksheet #2b. When heating a pure solid, liquid, or gas, is the slope positive (+) or negative (-)? Explain your answer.

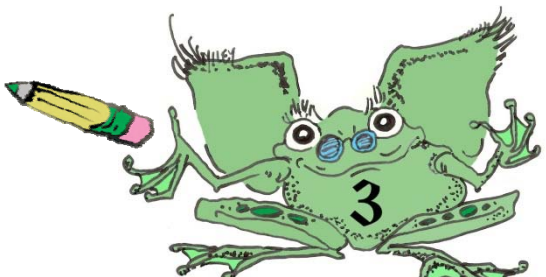
_____

_____

8. If both sections (best-fit lines) of the graph (liquid heating AND boiling) were extended, each would intersect the *y*-axis. Determine the *y*-intercept for the best-fit lines for both sections of the water heating graph. Use the equation for a line to calculate the *y*-intercept. Use the best-fit lines you used in #6. The equation for a line is

$y = mx + b$
where m is the unit rate of change (slope) and
b is the *y*-intercept

Y-Intercept — Liquid Heating	*Y*-Intercept — Boiling
m =	m =
Ordered pair (x, y) = (___ , ___)	Ordered pair (x, y) = (___ , ___)
$y = mx + b$ Solve for b:	$y = mx + b$ Solve for b:



9. Based on the unit rates of change that you calculated above and the *y*-intercepts, write equations for the best-fit lines for both sections of the graph.
Remember that the equation for a line is $\boldsymbol{y = mx + b}$ and *m* is the unit rate of change (slope) and *b* is the *y*-intercept.

Equation — Liquid Heating	Equation — Boiling

10a. Using one or both of the equations above (based on your data, graph, and two best-fit lines), if the experiment continued for two more minutes (your last time entered on the chart plus 2 minutes), what would be the temperature?

_____

10b. Which formula did you use and why?

_____

_____