MiSP Phase Changes Worksheet #1a L3

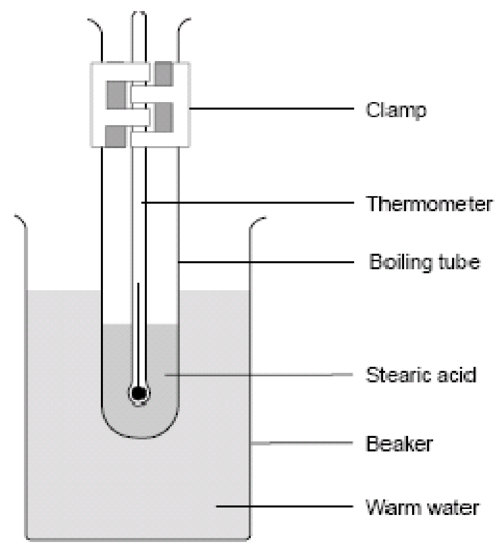
Name ______________________________ Date _____________

Key Question:

How does the temperature change as a liquid loses heat and becomes a solid?

Introduction:

In this experiment your teacher will melt a solid called stearic acid and then cool it to determine its freezing point.

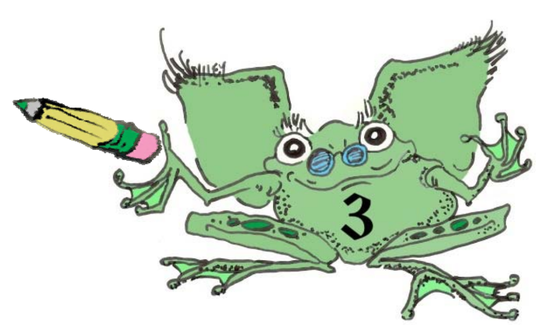


The demonstration:

1. The apparatus is shown on the right.

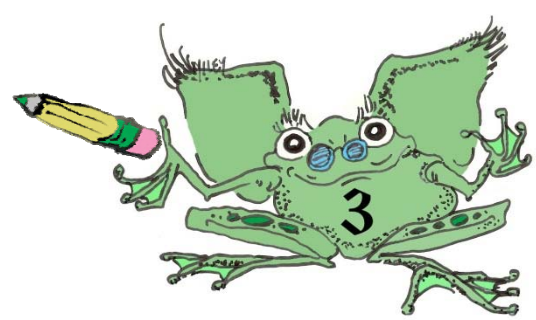
2. The setup will be heated until the stearic acid is completely melted and the temperature is between 75ºC and 80ºC.

3. The tube will be removed from the hot water. On the chart below, record the temperature every 0.5 (½) minute as the stearic acid cools. <u>Note on the chart when solid is first observed and when the liquid has all become solid.</u>



Record your data:

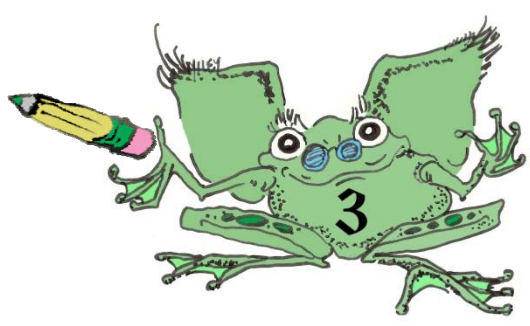
Time (minutes)	Temperature °C	Note: When solid is first observed When the liquid has all become solid

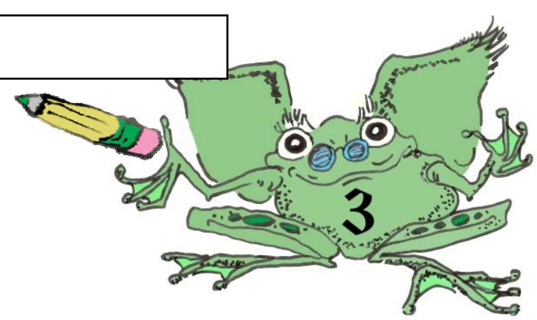


Graph your data:

Graph the data on the next page to show the relationship between time (minutes) and temperature (^{o}C).

- Label the *x*-axis.
- Label the *y*-axis.
- Using your notes on the data chart, circle the data points when solid stearic acid was first observed and when the liquid was totally solidified. Draw a best-fit line between those two points. Label this line "solidifying."
- Draw a best-fit line between the first temperature reading data point and the data point when solid stearic acid was first observed. [Note: It may be necessary to ignore the first one or two data points because the cooling of the liquid may not have started due to leftover heat in the glass of the tube.] Label this line "liquid cooling."

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Discussion Questions:

1. Water has a freezing/melting point (temperature) of $0^{\circ}C$. Based on your observations of the stearic acid, what is its freezing point?

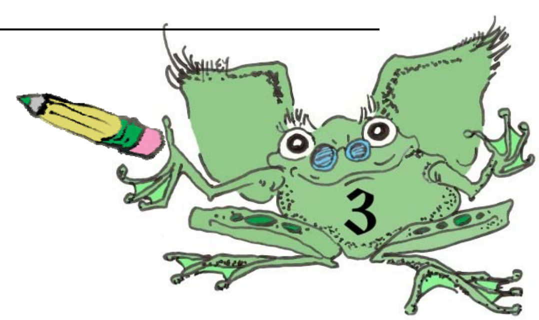
2. Which line on the graph (liquid cooling OR solidifying) has the steepest slope (the greatest angle)?

3. In which part of the graph (liquid cooling OR solidifying) did the temperature change (decrease) the most?

4. Your classroom temperature is approximately $20^{\circ}C$. So, during the whole time the tube was removed from the beaker, the stearic acid was losing heat surrounding, cooler environment. Why did the temperature not continue to decrease at the same rate after the stearic acid started to solidify?

5a. Your teacher will give you Phase Changes Worksheet# 1b, which has a graph of stearic acid cooling made in a professional laboratory. How is your graph like the one on Worksheet #1b? How is it different?

5b. From the labeled graph on Worksheet #1b, what happens to the temperature of a substance when it is losing heat and changing from a liquid to a solid?



6. Look at the graph you drew. Notice that as time passed and heat was lost by the stearic acid, the temperature changed. You will compare the changes in temperature in the two regions of the graph (liquid cooling AND solidifying) by calculating the unit rate of change (slope). Use the best-fit lines. *(When using best-fit lines, the ordered pairs to determine unit rate of change [slope] must be from the best-fit line, not from your data chart.)*

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

Section of Graph Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Temperature °C Δy	Δ Time (minutes) Δx	**Unit Rate of Change (slope)** $\frac{\Delta y}{\Delta x}$
Liquid Cooling			
Solidifying			

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

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

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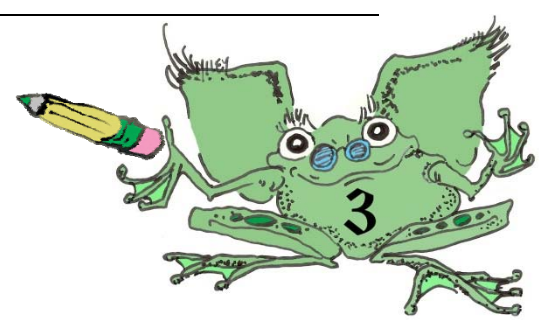

7c. Look at the ideal data on Worksheet #1b. What is the unit rate of change (slope) when the stearic acid was changing from a liquid to a solid on that graph?

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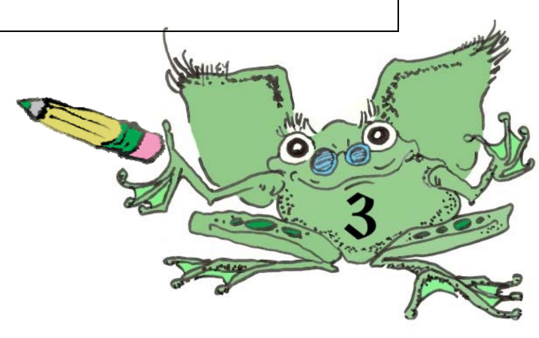
8. If both sections of the graph (liquid cooling AND solidifying) were extended, they would intersect the y-axis. Determine the y-intercept for both sections (BEST-FIT LINES) of the cooling graph. Use the equation for a line to calculate the y-intercept. Use the best-fit lines you used in #6. The equation 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 Cooling	*Y*-Intercept — Solidifying
$m =$ Ordered pair $(x, y) =$ (____ , ____) $y = mx + b$ Solve for b:	$m =$ Ordered pair $(x, y) =$ (____ , ____) $y = mx + b$ 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 Cooling	Equation — Solidifying



10. The line formulas are useful for working with this data but only up to a point. For example, we could predict when the temperature of the stearic acid would be 10^{o}C using the formula, but that prediction would not hold true in the classroom because it is (hopefully) not that cool in the school. What are other ways that using the line formulas to predict times or temperatures on a cooling graph would not produce correct information?