MiSP Thermal Conduction Worksheet #2 L3

Name ____________________________ Date ____________

HEAT CONDUCTION IN DIFFERENT MATERIALS

Introduction

Some materials are good conductors of heat. Some are poor conductors of heat. Those that are poor conductors are called insulators.

Good heat conductors will absorb heat quickly and their temperature will increase quickly. Good heat conductors will also release heat quickly and their temperature will drop fast.

Materials that are good conductors are used to allow heat to move from one place to another. Insulators are used to prevent the movement of heat from one place to another.

Problems

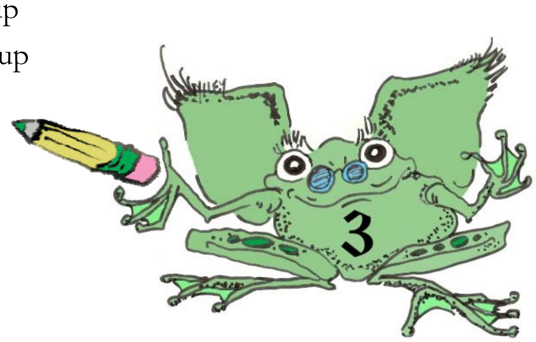
- Which materials are the best conductors of heat?
- Which materials are insulators?

Hypotheses

1. If a material is a good heat conductor and is placed in hot water, then its temperature will increase **quickly**/**slowly** (*circle one*).
2. If a material is a poor heat conductor (an insulator) and is placed in hot water, then its temperature will increase **quickly**/**slowly** (*circle one*).

Materials:

- goggles
- 3 materials: tubes/pipes/rods or strips made of aluminum, copper, plastic (PVC), glass, and/or wood; your teacher will tell you which you will use. (Note: Each material sample will have a stick-on thermometer attached at an equal distance from the bottom of the tube or strip.)
- Hot water (approximately 50ºC) — enough for one setup per group
- Cool water (approximately 10ºC) — enough for one setup per group



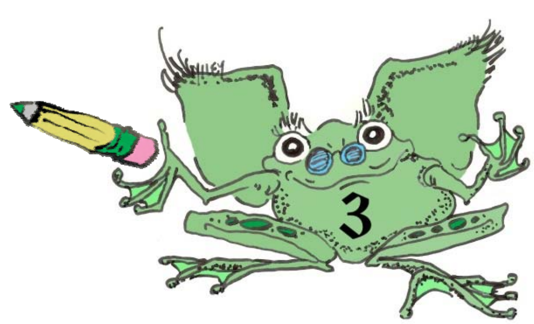
- 2 large beakers (or similar containers)
- timer
- color pencils

Safety:

- Wear goggles.
- Use caution when handling the hot water.

Procedure: Check off each step as you complete it.

- ☐ Fill one large beaker (or other container) with hot water (about 50^{o}C) to a depth so that the water level is approximately 4 cm below the thermometer. Fill the second large beaker (or other container) with cool water (about 10^{o}C) to the same depth. Set the cool water beaker aside.
- ☐ Write on the data table the materials that your tubes or strips are made from.
- ☐ Record the initial temperature of each tube or strip in the data table (time 0).
- ☐ Place the three tubes or strips carefully in the beaker with hot water. **Immediately start timing.**
- ☐ Record the temperature of each bar every 15 seconds (.25 minute) in the table for three minutes or until one of the samples reaches the maximum temperature.
- ☐ After 3 minutes or when one of the samples reaches the maximum temperature, move the tubes or strips to the cool water beaker.
- ☐ Note on your data table when the samples were moved to cool water.
- ☐ Continue to record the temperature of each sample for another 3 minutes or until one of the samples reaches the minimum temperature.
- ☐ Convert the data in the seconds column to minutes by dividing by 60 seconds/minute.



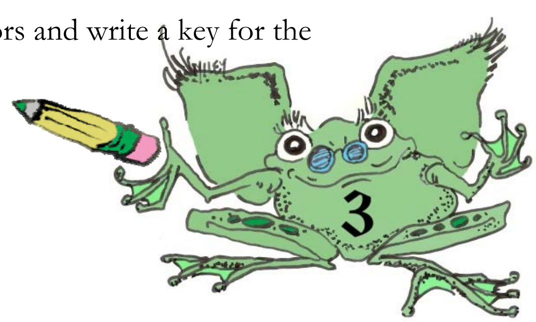
Record your data here:

Time (seconds)	Time Minutes Seconds (first column)/ 60 seconds per minute	Temperature ºC — Material: ___________	Temperature ºC — Material: ___________	Temperature ºC — Material: ___________
0	0			
15	.25			

Graph your data:

Graph the data on the next page to show the relationship between time (minutes) and the temperature (ºC) of each material.

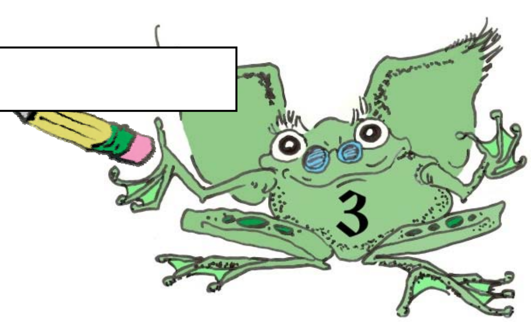
- Label the *x*–axis.
- Label the *y*–axis.
- Connect the data points for each material. Use three different colors and write a key for the graph.



Title:________________________

Key ________________: ________________: ________________:

Color:



Discussion:

1. Which material increased in temperature the quickest? the slowest? Which materials cooled the fastest? the slowest? Complete the chart below:

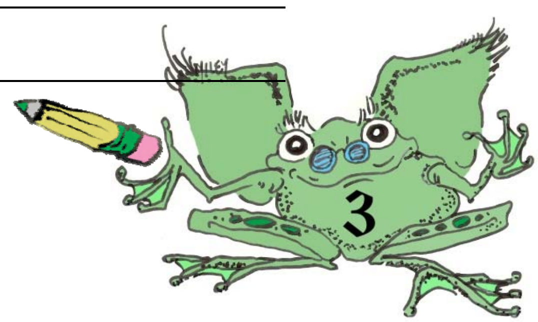
Heating — Change in temperature	Material	Cooling — Change in temperature	Material
Fastest increase		Fastest decrease	
Medium		Medium	
Slowest increase		Slowest decrease	

2. Which material in your experiment is the best conductor? Explain. Refer to the graph in your explanation.

3. Which material in your experiment is the worst conductor / the best insulator? Explain. Refer to the graph in your explanation.

4. If the materials were supplied with a constant (even) source of heat and were NOT moved to the cool beaker, predict what the temperature would be in each material after 6 minutes (360 seconds).

Material:	Predicted temperature after 6 minutes:



5. Explain why the heat transfer in the experiment is *conduction* and not *convection* or *radiation*.

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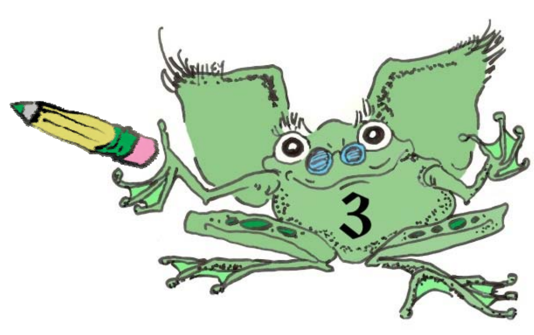

6. Look at the graph you made. Notice that as time passed, the temperature of each material changed. You will compare the temperature changes when each material was in the hot water by calculating the unit rate of change (slope) of each line. Use the information from the graph to calculate the unit rates of change (slopes) for each material's data on the graph. If your data all lie on a line, determine the unit rates of change (slopes) of the lines. If your data points do not produce lines, determine the unit rates of change (slopes) of best-fit lines. *(If you use best-fit lines, the ordered pairs to determine unit rates of change [slopes] must be from the best-fit line, not from your data chart.)*

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

Material in Hot Water	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)** $\Delta y/\Delta x$

7. Are the calculated unit rates of change (slopes) positive/+ or negative/-? What does that tell you about the changes in temperature as time passed?

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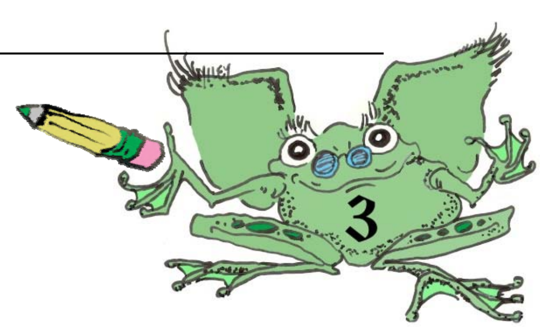

8. In #2 you identified the best conductor and in #3 you identified the worst conductor (best insulator). Compare those two materials' unit rates of change (slopes). Discuss both the numerical value and the sign (positive/+ or negative/-).

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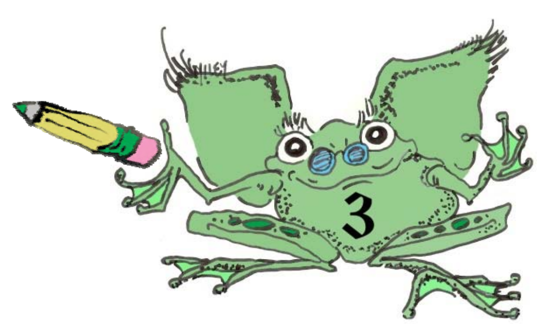
9. Select the material that is the best conductor: _________________________ Find the y-intercept for its line on the graph. Use the equation for a line to calculate the y-intercept. Use the line or best-fit line you used in #6. The equation for a line is

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

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



10. Based on the unit rate of change (slope) that you calculated above and the *y*-intercept, write an equation for the line or best-fit line for the material that was the best conductor. 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 — Best Conductor:

11. Using the equation above, calculate the predicted temperature of the material after 12 minutes if there was a constant supply of heat. Show your work.