**GENERAL INTEGRATED SCIENCE– UNIT 4**

**TASK 7 – Heat Conduction of Cookware Practical**

**NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ WEIGHTING: %**

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Have you ever touched something that became hot enough to burn you only moments after it was cool to the touch? This can happen when you stir a pot of soup on the stove with a metal spoon or roast marshmallows over a fire with a metal rod. So what explains why it’s a better idea to stir your soup with a wooden spoon and roast your marshmallows with a wooden stick? Objects made of metal can quickly **conduct** unwanted heat right up to our hands!

So what is **conduction,**anyway? Conduction is heat moving from one object to another through contact. When heated, molecules in an object begin to shake and move. They also shake and move their neighbours, and the more molecules shaking, the more heat transfer happens. A good example would be roasting a marshmallow on a coat hanger or metal rod. As one end of the rod gains heat from the fire, the rest of the rod gradually heats up as well. Eventually, the whole rod becomes too hot to touch!

Thermal Conductivity is an important material property in industry and daily situations like knowing what to choose in cookware or the proper clothing worn to leave the house. This property is described in units of Watts per meter Kelvin and at steady state can be calculated via a measurement of thermal resistance. Both Thermal Conductivity and Thermal Resistance will affect the amount of heat which passes through a system. In this experiment, a simple set-up will be employed to observe the change in heat flow.

Metals transfer heat via accumulated energy in the free electrons of the metal atoms, these electrons will collide with one another transferring their kinetic energy. This billiard like interaction will propagate throughout the metal until the energy is uniformly spread. Copper is usually considered the best thermal conductor on a thermal conductivity to price ratio. The only metal surpassing Copper is Silver with a thermal conductivity of 429.77 W/m-K.

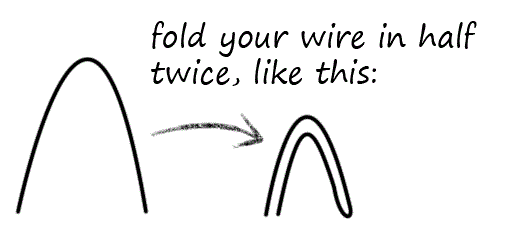
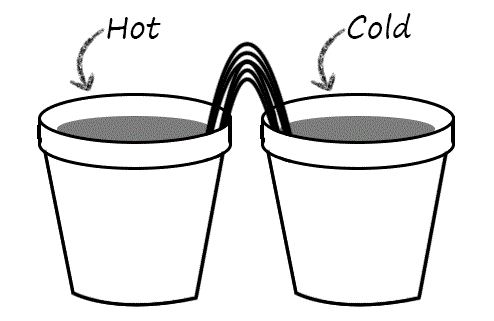
This experiment was designed to compare thermal conductivities thus surface area, length and temperature difference must remain the same in every test. One may use non-metals for this experiment however, may run the risk of lengthy testing time or potential incompletion. It is therefore suggested that metals be used. A listing of common metals may be found in the comparison section.

* Silver
* Copper
* Stainless Steel
* Aluminium
* Silicon

1. Using a device, research the thermal conductivity of each of the above materials. You will use this information to determine your hypothesis.
2. AIM: to determine which metal is the best conductor of thermal energy
3. HYPOTHESIS: The cup attached to the copper wire will experience the most temperature change

**Materials**.

**Procedure:**

1. Fill a jug with 2-litres of cold water, and add 2 cups of ice. Allow this to sit while you prepare the rest of your experiment.
2. Gather the metal strips. Bend each metal strip in half two times to make metal bridges.  ​
3. Place the 12 beakers in pairs, sitting 15cm apart, and add three bridges of the same metal between each cup (i.e., 1 pair with 3 copper bridges, 1 pair with 3 aluminium bridges). One pair of cups will have no bridges. This is the control group.
4. Label one beaker in each pair ‘cold’ and one ‘hot’
5. Place a digital thermometer in each of the beakers that will hold cold water.
6. Draw a table that will allow you to record the different temperatures of the cups over the course of the experiment.
7. Boil a kettle full of water, and add the same amount of hot water to each of the beakers labelled ‘hot’. Be sure the water covers the ends of the bridges.
8. For each pair of cups, pour equal volumes of cold water into the “cold” cup. Be sure the water covers the end of the bridges.
9. Take the initial temperature of the cold water, Record the temperature in your table.
10. Record the temperature of each cold water cup every 5 minutes for a total of 30 minutes.
11. Organize your data with line graphs.

**Record measurements.**

*Table.*

*Graph.*

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On the x-axis, plot time in minutes. On the y-axis, plot temperature difference in degrees. By creating a chart like this, we can see which metal transfers the most heat overall. This also gives us some information about each metal’s conductivity: The steeper the slope, the higher the conductivity.

**Analyse results.**

1. Which cup of cold water experienced the greatest change in temperature from the beginning to the end? Calculate this by subtracting the cup’s starting temperature from its final temperature.
2. Why do you think we should fold the rod in half twice? Would folding it once produce the same results?
3. Why do you think the volumes of water need to be equal?
4. Do you think that all of the heat that’s conducted away from the hot cup goes into the cold cup? Why or why not? Hint: sometimes heat doesn’t always go where we want it to!

**Conclusion** – focus on the thermal conductivity to price ratio

**Teacher Info.**

Copper has the highest heat conductivity value, while steel has the lowest heat conductivity value. Heat conductivity is a really important property of a material—we need to keep it in mind when we’re deciding what we’re going to use the material for! Here’s an example: Because copper is such a great conductor, we use it for things like heating rods and wires. Because steel is a poor conductor and can withstand high temperatures, we use it to build engines in airplanes.

Think back to when we folded our wire bridges in half twice. Why do you think we did this? Remember: conduction happens best when more molecules are in contact with each other. Folding the rod in half twice allows the heat from the hot cup to travel through more molecules, allowing more heat to travel from the hot cup to the cold cup. Folding the metal rods only once will still create a good heat bridge, but we would see a smaller temperature change in the cold cups, making it harder to see which metal is the best conductor!

As for the volumes of water needing to be equal? To get good data from our experiment, each hot water cup needs to hold the same amount of heat, and water has a very specific **heat capacity**. Heat capacity is how much heat energy it takes to change the temperature of a given amount of a substance. Think about it this way: all four of our cups have equal volumes of water at the same temperature, so that means that each hot water cup holds the same amount of heat energy.

So when heat conducts away from the hot cup, does all of that energy go through the metal bridge and into the cold cup? Not at all. Heat is often lost to its surroundings, and in this case, some of the heat from the hot water will be lost to the air. Similarly, the air in the room will lose some of its heat to the cup of cold water. We tried to minimize heat loss by using Styrofoam cups, because Styrofoam is known to be a great **insulator—**a material that’s a poor conductor of heat.