Specific Heat Capacity of Metals
PHYS section 11

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November 16, 2015

Date Performed:	November 11, 2015
Partners:	Whole class
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1 Objective

The objective of this experiment is to measure the specific heat capacity of three different samples of metal and to compare those with the accepted values, in order to identify them.

2 Definitions

Heat Heat is the measure of the internal kinetic energy of a substance.

Temperature Temperature is a measure of the kinetic energy of a particle. It is the degree or intensity of heat in a substance. Celcius is a unit of temperature. One degree Celcius represents the temperature change of one gram of water when 2.39×10^{-5}Joules of heat is added to it.

Specific Heat Capacity The specific heat capacity is the energy transferred to one kilogram of substance causing its temperature to increase by one degree Celcius.**?**

Thermal Equilibrium Thermal equilibrium is a condition where two substances in physical contact with each other exchange no net heat energy. Substances in thermal equilibrium are at the same temperature.

3 Theory

The change in the internal energy of an object or substance is equal to the product of the mass and the specific heat capacity and the change in temperature.

$$\Delta U = mC_p\Delta T$$

When water and the metal samples are in thermal equilibrium the change in heat of the water is equal in magnitude to the change in heat of the metal.

$$\Delta U_{metal} = \Delta U_{water}$$

From this relationship we may derive a formula for the specific heat capacity of the metal sample given the mass of metal, mass of water, change in temperature of the water, change in temperature of the metal and the specific heat capacity of water.

$$m_{metal}C_{metal}\Delta T_{metal} = m_{water}C_{water}\Delta T_{water}$$

$$C_{metal} = \frac{m_{water}}{m_{metal}}\frac{\Delta T_{water}}{\Delta T_{metal}}C_{water}$$

4 Materials

- Kettle
- 3 different types of metals, cube, long cylinder, short cylinder
- styrofoam cups
- graduated cylinder
- scale
- thermometer
- tongs
- flask of water

5 Method

a. Weigh the samples and record

b. Measure 350 ml of water (300ml of water for cube) in graduated cylinder and transfer to styrofoam cup

c. Measure the initial temperature of the water

d. Boil water and add metal samples to kettle

e. Use tongs to transfer a sample to the cup with water

f. Place thermometer in cup, cover it, stir and record equilibrium temperature

g. Repeat steps b-f for each sample

6 Data

Metal	Mass Metal	water valume	Temp Water Initial	Temp Final
Cube	90.6 g	350ml	20.5 Celcius	24.5 Celcius
long cylinder	203.0 g	350ml	20.8 Celcius	24.8 Celcius
Short cylinder	64.1 g	300ml	20.9 Celcius	22.5 Celcius

Table 1: Experimental data

Material	Specific Heat Capacity
Water	4180 $^{J}/_{kg \cdot ^\circ C}$
Aluminum	900 $^{J}/_{kg \cdot ^\circ C}$
Zinc	380 $^{J}/_{kg \cdot ^\circ C}$
Copper	387 $^{J}/_{kg \cdot ^\circ C}$
Iron	452 $^{J}/_{kg \cdot ^\circ C}$
steal	452 $^{J}/_{kg \cdot ^\circ C}$
Lead	128 $^{J}/_{kg \cdot ^\circ C}$
silver	230 $^{J}/_{kg \cdot ^\circ C}$

Table 2: Known specific heat capacities

7 Example Calculations

This is the calculation for the specific heat capacity of copper.

$$C_{metal} = \frac{m_{water}}{m_{metal}} \frac{\Delta T_{water}}{\Delta T_{metal}} C_{water}$$

$$\Delta T_{water} = 24.5 - 20.5 = 4\text{Celcius}$$

$$\Delta T_{metal} = 100 - 24.5 = 75.5\text{Celcius}$$

$$C_{metal} = \frac{0.350\text{kg}}{0.0906\text{kg}} \frac{4\text{Celcius}}{75.5\text{Celcius}} 4180 \text{ J/kg}\cdot^\circ\text{C} = 856 \text{ J/kg}\cdot^\circ\text{C}$$

The percent error is calculated as follows.

$$Error = \frac{900 - 856}{900} = 4.9\%$$

8 Results

Material	Measured C_p	Percent Error
Aluminum	856 J/kg·°C	4.9%
Zinc	383 J/kg·°C	0.8%
Copper	404 J/kg·°C	4.4%

Table 3: Calculated specific heat capacities

9 Discussion of Error

There could be Error contain in the experiment since we are doing this experiment under limited time. First of all, although the Styrofoam cups is very insulated from heat, it might because we use it too quickly experiment after experiment and not wait till the cup to fully cool down, it had effected our result. Secondly, before the cylinder/cube reaches from the hot kettle to the Styrofoam cups, it contact with room temperature air which might effected the result because the metal didn't put in experiment cups quickly.

10 Conclusions

After comparing to the result of our own experiement, we have found out that the three unknow metal are Aluminum, Zinc, and copper. The result is very reliable since the Percentage error is only less than 5%, this means the experiment is very succesful from the result we collect.