ScienceCube

Specific Heat of Metals

Understanding the concept of specific heat and measuring the specific heat of various metals.

Fundamental Concept

1. **Specific Heat**

   1) Definition: The amount of heat required to raise the temperature of 1 kg (or 1 g) of a substance by 1°C.

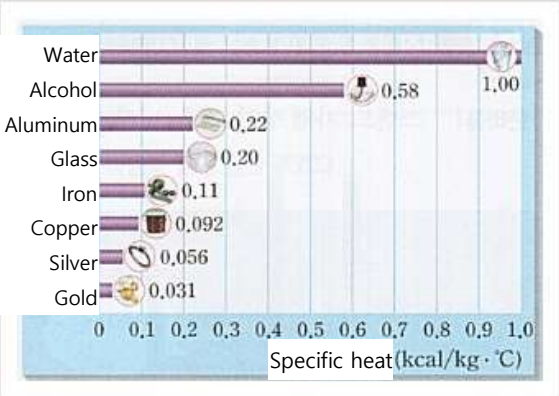
   2) Unit: Kcal/kg·°C

   3) Characteristics:

      ① Specific heat is a property of a substance and varies depending on the type of substance.

      ② The reason for different temperature changes when the same amount of heat is applied to different substances is due to their specific heats.

      ③ Water has a very high specific heat compared to other substances.



< Specific Heat of Various Substances>

2. **Measuring the Specific Heat of Metals**

1) Principle of Measuring Specific Heat

① When a hot object and a cold object come into contact, they reach thermal equilibrium at the same temperature.

② The heat lost by the hot object = The heat gained by the cold object (Law of Conservation of Energy).

2) Measuring the Specific Heat of Metals

By placing a metal sample with mass M_1 and initial temperature t_1 into a calorimeter containing water with mass m_2, specific heat c_2, and initial temperature t_2, and measuring the equilibrium temperature t, the specific heat c_1 of the metal sample can be determined using the equation:

$$M_1c_1(t_1-t)=m_2c_2(t-t_2)$$

Experiment

Materials Needed

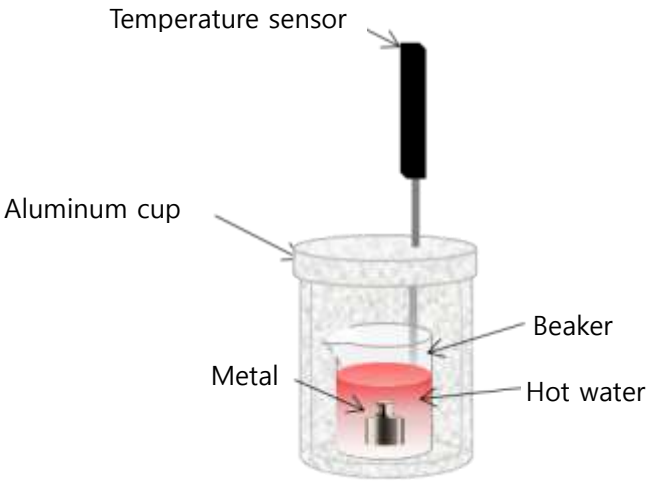
Interface, Science# Program, 2 temperature sensors, 2 Styrofoam cups, two types of metal pieces, metal piece holder, two 100 mL beakers, hot water (about 70°C), room temperature water, stand, electronic scale

Preparation of Experimental Apparatus

1. Measure and record the masses of the two types of metals.

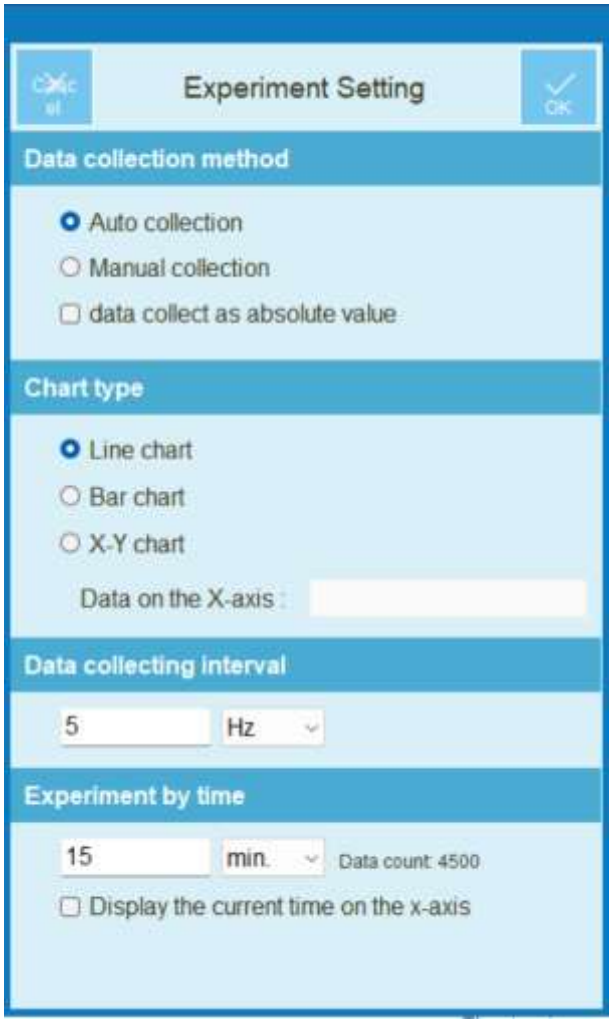
Metal A Metal B

2. Pour 100 mL of hot water and 100 mL of room temperature water into separate beakers.
3. Place each beaker into a Styrofoam cup.
4. Place metal A into the beaker with hot water.
5. Close the Styrofoam cup lid and insert a temperature sensor into the hot water through a hole in the lid.



Interface Setup

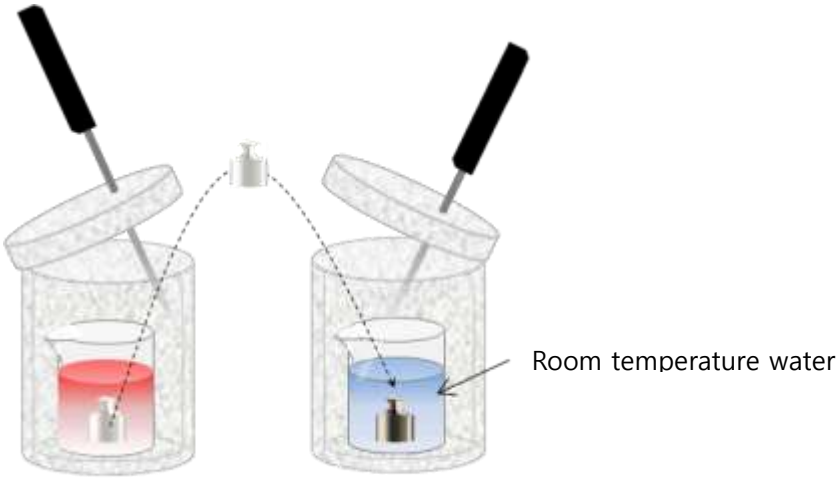
1. Run the Science# program.
2. Connect the temperature sensors to the interface..
3. Click to set up the experimental environment as shown below or click to automatically set up.



 automatically set up

Data Collection

1. Click  to start collecting data.
2. After 6 minutes, quickly transfer the metal to the beaker with room temperature water



3. Stir the water gently for about 5 minutes with the temperature sensor to ensure the water is evenly heated by the hot metal.

4. When the temperature stabilizes, stop collecting data.
5. Repeat the experiment with metal B using the same procedure.

Data Analysis

Recording Data

1. Plot the temperature change of water over time for metal A.

2. Complete the following table based on the results of the experiment with metal A.

Substance	Mass	Temperature Before Equilibrium	Temperature After Equilibrium	Temperature Difference (ΔT)
Room Temperature Water				
Metal A				

3. Plot the temperature change of water over time for metal B.

4. Complete the following table based on the results of the experiment with metal B..

Substance	Mass	Temperature Before Equilibrium	Temperature After Equilibrium	Temperature Difference (ΔT)
Room Temperature Water				
Metal B				

Data Application and Extended Activities

The following formula uses the heat gained by water and the heat lost by the metal to calculate the specific heat of the metal. Using this formula, calculate the specific heat of each metal.

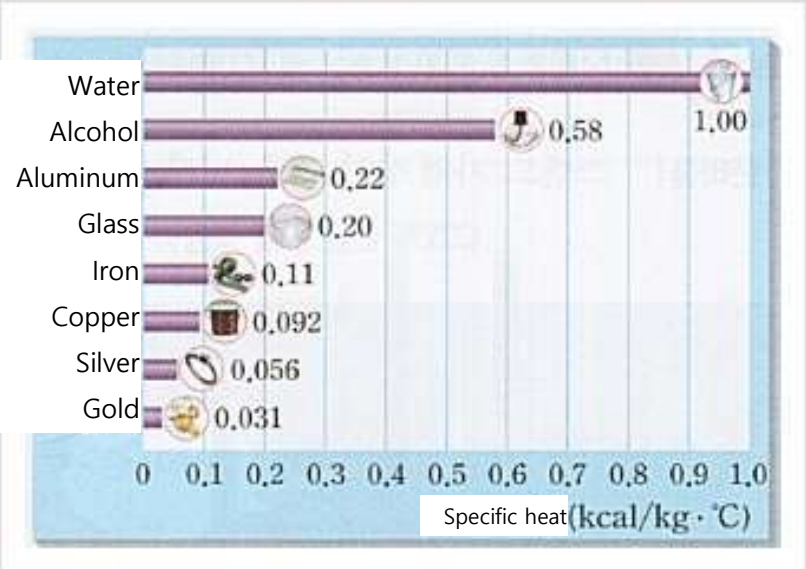
(Assume the specific heat of water is 1 cal/g·°C.)

$$M_{water}\, c_{water}\, (\Delta T_{water}) = m_{metal} c_{metal}\, (\Delta T_{metal})$$

(M,m: Mass, c: Specific Heat, ΔT: Temperature Difference)

	Metal A	Metal B
Specific Heat (cal/g·°C)		

1. Refer to the following specific heat table to identify the types of metal A and metal B.



	Metal A	Metal B
Type of Metal		

2. It takes 1000 cal of heat to raise the temperature of 1 kg of water by 1°C, and 560 cal of heat to raise the temperature of 1 kg of soybean oil by 1°C. Explain why there is a difference in the amount of heat required to raise the temperature of the two substances by the same amount.

3. Which metal, when placed in water, would cause a greater change in the water's temperature: a metal with a high specific heat or a metal with a low specific heat? Explain the reason as well.