Determine the Calorimeter Constant (W) Of Calorimeter (Polythene Bottle)

Theory

In order to determine the calorimeter constant, a known volume of hot water at a known temperature is added to a known volume of water taken in the calorimeter at room temperature. Since energy is conserved, the heat gained by the calorimeter and the cold water must be equal to the heat lost by hot water. If t_1, t_2 and t_3 are the temperatures of cold water, hot water and mixture respectively and m_1, m_2 and m_3 are the masses of calorimeter, cold water and hot water respectively, then we can write

$$m_1C_1(t_3 - t_1) + m_2C(t_3 - t_1) = m_3C(t_2 - t_3)$$

Here C_1 is the heat capacity of calorimeter and C is the heat capacity of water. The quantity m_1C_1 is the calorimeter constant, W

$$W(t_3 - t_1) + m_2C(t_3 - t_1) = m_3C(t_2 - t_3)$$

$$W(t_3 - t_1) = m_3C(t_2 - t_3) - m_2C(t_3 - t_1)$$

$$W = \frac{C[m_3(t_2 - t_3) - m_2(t_3 - t_1)]}{(t_3 - t_1)}$$

The heat capacity of water, C is 4.184 J/K or J/°C.

Knowing all the parameters on RHS, the value of W can be calculated.

It may be noted that $t_2 > t_3 > t_1$.

Procedure

1. Put 100 ml of distilled water in polythene bottle with a thermometer and stirrer Fig.

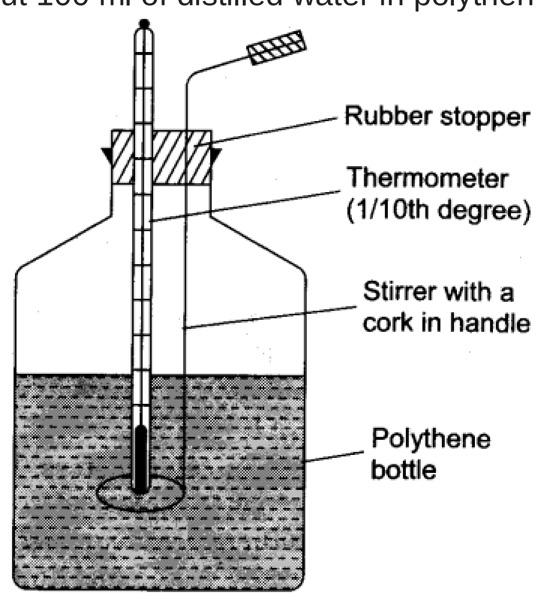

Fig. Polythene bottle calorimeter.

2. Note the temperature (t_1°C).
3. Heat some water in a beaker to a temperature 20-30°C higher than that of room temperature.
4. Put 100 ml of this warm water in another beaker.
5. Note the temperature of this water. Let it be t_2°C.
6. Add warm water from the beaker into the polythene bottle without any loss of time.
7. Stir the contents.
8. Read the temperature attained after mixing. Let it be t_3°C.

Observations

Volume of water taken in bottle = 100 ml
Temperature of water = t_1°C
Volume of warm water added = 100 ml
Temperature of warm water = t_2°C
Temperature after mixing = t_3°C

Calculations

Heat given out by hot water = Heat taken by bottle and cold water.

$$-100 \times 4.184 \times (t_3 - t_2) = \mathrm{W} \times (t_3 - t_1) + 100 \times 4.184 \times (t_3 - t_1)$$

$$\mathrm{W} = \frac{100 \times 4.184 \times (t_2 - t_3) - 100 \times 4.184 \times (t_3 - t_1)}{(t_3 - t_1)}$$

$$\mathrm{W} = 4.184 \left[100 \frac{(t_2 - t_3)}{(t_3 - t_1)} - 100 \right] \mathrm{J/°C}$$

From the above expression the calorimeter constant, W can be calculated.