Determine the Enthalpy Of Dissolution Of Given Solid Copper Sulphate ($CuS0_4.5H_2o$) In Water At Room Temperature

Theory

In this experiment, the enthalpy of dissolution is measured by the use of calorimetric techniques. A known volume of the water is taken in a polythene bottle as shown in Fig. Its temperature is noted and then known weight of the solute is added to it. The solution is stirred gently and change in temperature is recorded. From the change in temperature, heat absorbed or evolved can be calculated. In this experiment one mole of solute is dissolved per 400 moles of water. For maintaining this ratio 7.0 g of $CuS0_4.5H_20$ is dissolved in 200 mL of water.

Requirements

(a) Apparatus. 250 ml or 500 ml polythene bottle fitted with a rubber cork with two holes, one for thermometer (1/10 th degree) and other for stirrer, two beakers, stirrer, measuring cylinder, etc.
(b) Chemicals. Hydrated copper sulphate, distilled water.

Procedure

A. Determination of Calorimeter Constant

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

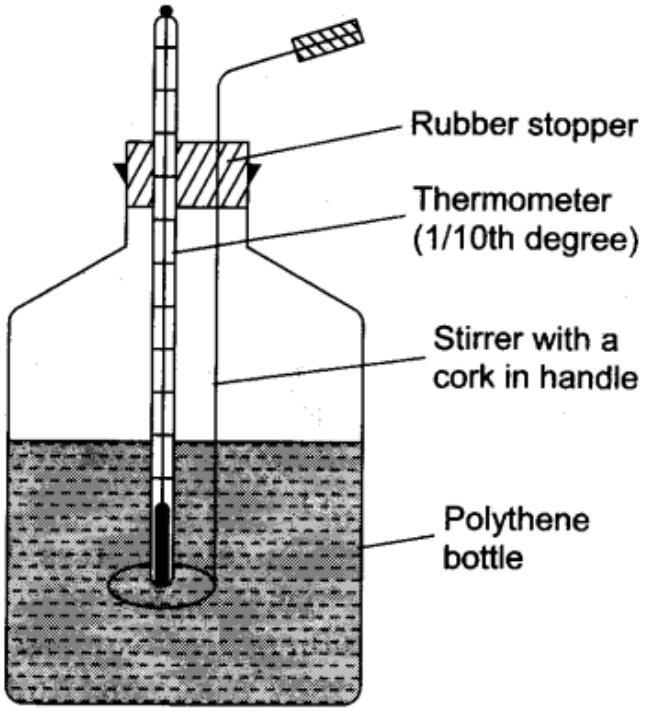

Fig. Polythene bottle calorimeter.

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.

B. Determination of Enthalpy of Dissolution

1. Put 200 ml of distilled water into the polythene bottle.
2. Now fit a cork with two holes into the mouth of the polythene bottle. Insert a thermometer into one hole with its bulb about 1 cm above the bottom of the bottle. Put the stirrer into the second hole.
3. Note down the temperature (t_1).
4. Take a known weight of finely powdered substance.
5. Transfer the known weight (say w g) of finely powdered hydrated copper sulphate quickly by removing the rubber cork and putting it back into its position without any loss of time.
6. Stir it with the help of a stirrer till hydrated copper sulphate is dissolved. However, the rate of stirring should he kept as low as efficiency permits to minimise the energy introduced by stirring (vigorous stirring does cause some increase in temperature).
7. Note down the temperature (t_2) when the substance just dissolves.

Observations

Weight of the hydrated copper sulphate dissolved =w g
Volume of water taken into the bottle = 200 ml
= 200 g (assuming density = 1 g/ml)
Temperature of water =t_1°C
Temperature of water after dissolving hydrated copper sulphate = t_2°C
Calorimeter constant of the polythene bottle = W J/°C

Calculations

Assuming density and specific heat of the solution to be same as that of water, heat

evolved or absorbed for dissolution of w g of the solute

$$Q = W(t_2 - t_1) + (200 + w)(t_2 - t_1) \times 4.184 \text{ J}$$

Heat liberated on dissolution of 1 g of copper sulphate

$$= \frac{W(t_2 - t_1) + (200 + w)(t_2 - t_1) \times 4.184 \text{ J}}{w}$$

Heat liberated on dissolution of 1 mol (249.5 g) of copper sulphate

$$= \frac{W(t_2 - t_1) + (200 + w)(t_2 - t_1) \times 4.184}{w} \times 249.5 \text{ J}$$

$$\therefore \quad \Delta_{Sol} H \text{ of copper sulphate} = - \frac{W(t_2 - t_1) + (200 + w)(t_2 - t_1) \times 4.184}{w} \times 249.5 \text{ J/mol}$$

Result

Enthalpy of dissolution of copper sulphate is…… J/mol.

Note: If $t_2 > t_1$ heat is evolved during dissolution and Δ_{sol} H has negative sign.

Similarly we can find out the enthalpy of dissolution of potassium nitrate. For that dissolve 5.5 g of KNO_3 in 200 mL of water. Here, the mole ratio of solute and solvent is 1: 200.