EXPERIMENT-6

To study the solubility of solid substances in water at different temperatures and to plot the solubility curve.

6.1 OBJECTIVES

After performing this experiment, you should be able to :

- *set up the apparatus for studying the solubility of different substances at different temperatures ;*
- *determine the solubility of substances at different temperatures ;*
- *draw a solubility curve and*
- *read solubility values from the curve at different temperatures ;*
- *interpret the variation of the solubility curve of different substances at different temperatures ;*
- *explain the basis of fractional crystallization.*

6.2 WHAT YOU SHOULD KNOW

Solubility of a substance is defined as the amount of the substance dissolved in 100 g of the solvent so as to give a saturated solution at a given temperature. The variation of solubility with temperature is quite different for different substances. For some, salts, for example for NaCl, there is hardly any change in solubility with increase in temperature. For some, such as potassium nitrate, the change in solubility with temperature is very rapid, while for others such as potassium iodide, the change is very slow. This difference in solubility behaviour forms the basis for fractional crystallization of substances. This technique is used for the separation of impurities present in any substance.

It is quite convenient to express the solubility of substances at different temperatures by plotting a graph called solubility curve.

When a solid dissolves in a liquid, the process can be either endothermic or exothermic. For many ionic compounds, this process is endothermic. According to Le Chatelier's principle, the solubility of such salts will increase with increase in temperature. If the process of dissolution is exothermic, for example, for lithium sulphate (Li_2SO_4), the solubility decreases with increase in

temperature. The variation of solubility with temperature of a few salts is depicted in Fig. 6.1.

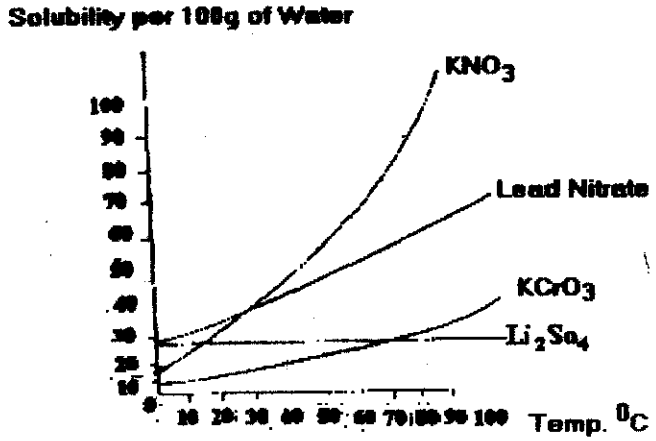

Fig. 6.1 : *Solubility Curves*

6.3 MATERIALS REQUIRED

(1) Apparatus	(2) Chemicals
Boiling tube, Glass rod, Glass water bath (glass beaker 250 mL). Thermometer, wire gauze, Tripod stand, Burner stand with clamp and boss, Spatula, stirrer	Potassium nitrate, Distilled water, Sodium nitrate

6.4 HOW TO PERFORM THE EXPERIMENT

(1) Weigh 10.0 g of powdered sodium nitrate using a physical balance and pour it into the boiling tube.

(2) With the help of a burette, add 7-8 mL of water into boiling tube. Stir it well with the help of stirrer. You will observe that a small amount of salt remains undissolved.

(3) Now from burette, add water in very small volume say 0.1 ml, till all the salt dissolves. Stir well after each addition of water.

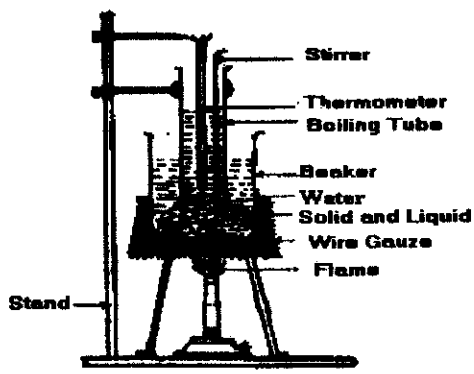

Fig. 6.2 : *Study of Solubility*

Note down the volume of water required for just dissolving the given mass of the salt. Also note down the temperature of solution. This is the solubility of salt at this particular temperature.

(4) Now, add 1 g of sodium nitrate to above boiling tube.

(5) Set up the apparatus as shown in Figure (6.2) Note that the level of water in water bath should be well above the level of solution in boiling tube.

(6) Heat the water bath very slowly with constant stirring of solution. As soon as the salt dissolves, note down the temperature. Let us say, it is temperature, t_1.

(7) Now remove the burner, and let the solution to cool down. As soon as some solid reappears at the bottom of boiling tube, note down the temperature agains. Let us say it is temperature, t_2.

(8) Find out average of temperature t_1 and t_2 as $\left(\frac{t_1 + t_2}{2}\right)$. Add one more gram of sodium nitrate to the boiling tube. And repeat step number 6 and 7 again.

(9) In a similar way find out solubility of sodium nitrate at 5 different temperatures.

(10) Calculate the amount of $NaNO_3$ dissolved in 100 ml of solvent at above recorded temperatures.

(11) Record all your readings in the table 6.1 given below.

6.5 PRECAUTIONS

(1) Powder the substance before use.

(2) Weigh the salt as accurately as possible.

(3) During heating and cooling, stir the solution gently.

(4) Heat the water bath very slowly to control the rise in temperature.

6.6 OBSERVATIONS

Table 6.1: Solubility of $NaNO_3$ at Different Temperatures

S.No.	I Quantity of $NaNO_3$ (mg)	II Volume of Water (u) (ml)	III Amount of $NaNO_3$ per 100 ml of water = solubility= (n/v) x 100g	IV Temp. at which salt dissolves (°C) t_1	V Temp. at which salt reappears t_2(°C)	VI Mean temp. $\left(\frac{(t_1 + t_2)}{2}\right)$ (°C)
1						
2						
3						
4						
5						

Plot a graph of the amount of sodium nitrate dissolved per 100 ml of water versus temperature i.e. solubility as recorded in Column III and temperature as recorded in Column VI, taking solubility along y-axis and temperature along x-axis.

6.7 CONCLUSION

Solubility of sodium nitrate in water changes rapidly / slowly / does not change with temperature.

6.8 CHECK YOUR UNDERSTANDING

1. Define the term solubility.

   .....

2. What is the advantage of solubility curves for separation of substances ?

   .....

3. Why do you heat the water bath slowly ?

   .....

6.9 NOTE FOR THE TEACHER

(1) You can ask the students to perform this experiment with Potassium nitrate (KNO_3) They may compare the curve with that of Sodium nitrate or Ask some students to perform the experience with $NaNa_3$ and others with KNO_3 and compare their graphs.

(2) Ask the students to find out the solubility of the substances at a given temperature from the graphs.

6.10 CHECK YOUR ANSWERS

Ans.1. Solubility of a substance is its amount dissolved in 100g of solvent so as to give a saturated solution at a specified temperature.

Ans.2. Solubility curves indicate the crystallization point at a particular temperature which can be used for separating two substances by the process of crystallization.

Ans.3. Rapid increase in temperature will not allow to read the temperature on the thermometer accurately.