UNIT 9

SOLUTIONS

Learning Objectives

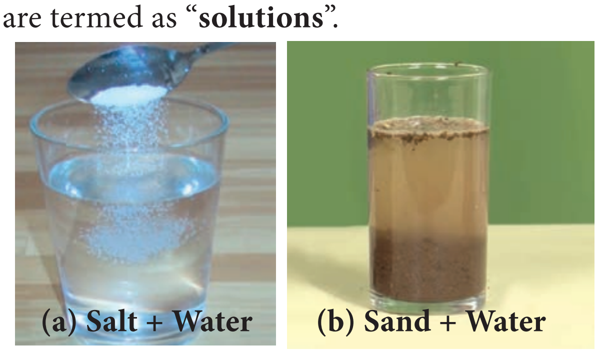
After studying this lesson, students will able to

- define solution.
- recognize the types of solutions.
- analyse the factors influencing solubility.
- explain the various modes of expression of concentration of solution.
- calculate the solubility of solutes in solvents.
- correlate the hydrated salts and anhydrous salts.
- distinguish between deliquescent and hygroscopic substances.

INTRODUCTION

You have learnt about mixtures in your lower classes. Most of the substances that we encounter in our daily life are mixtures of two or more substances. The substances present in a mixture may exist in one or more physical state. For example, when we burn wood, the smoke released is a mixture of solid carbon and gases like CO_2, CO, etc.

In some cases of mixtures, their components can be separated easily whereas in some other cases they cannot be. Consider the two mixtures, one which contains salt and water, and the another which contains sand and water. Water is the one of the components in both the mixtures. In the first case salt disolves in water. In the second case the sand does not disolve in water. Sand in water can be separated by filtration but salt cannot be separated as it dissolves in water to form a homogeneous mixture. This kind of homogenous mixtures are termed as "**solutions**".



(a) Salt + Water (b) Sand + Water

Figure 9.1 a) Homogeneous mixture b)heterogeneous mixture

9.1 SOLUTIONS IN DAY-TO-DAY LIFE

One of the naturally existing solutions is sea water. We cannot imagine life on earth without sea water. It is a mixture of many dissolved salts. The another one is air. It is a mixture of gases like nitrogen, oxygen, carbon dioxide and other gases.

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All the life forms on the earth are associated with solutions. Plants take solutions of nutrients for their growth from the soil. Most of the liquids found in human body including blood, lymph and urine are solutions. Day to day human activities like washing, cooking, cleaning and few other activities involve the formation of solutions with water. Similarly, the drinks what we take, like fruit juice, aerated drinks, tea, coffee etc. are also solutions. Therefore, the ability of water to form solutions is responsible for sustenance of life.

9.2 COMPONENTS OF SOLUTIONS

We know that, a **solution is a homogeneous mixture of two or more substances**. In a solution, the component which is present in lesser amount (by weight), is called **solute** and the component, which is present in a larger amount (by weight) is called **solvent**. The solute gets distributed uniformly throughout the solvent and thus forming the mixture homogeneous. So, the solvent acts as a dissolving medium in a solution. The process of uniform distribution of solute into solvent is called **dissolution**. Figure 9.2 shows the schematic representation of solution.

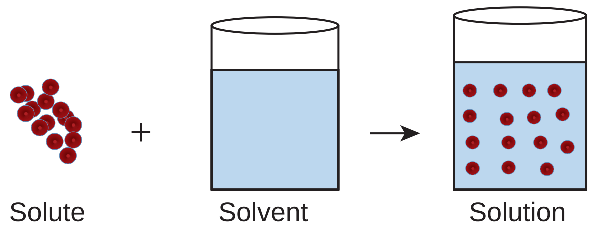
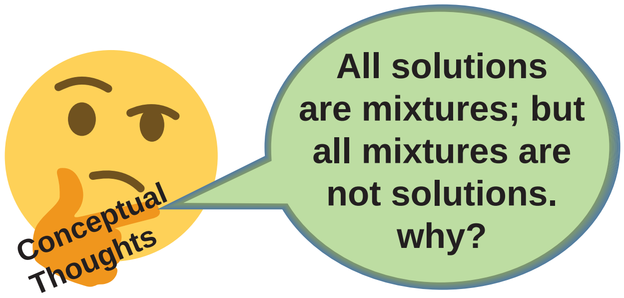


Figure 9.2 Formation of solution



A solution must at least be consisting of two components (a solute and a solvent). Such solutions which are made of one solute and one solvent (two components) are called **binary solutions**. e.g. On adding copper sulphate crystals to water, it dissolves in water forming a solution of copper sulphate as shown in Figure 9.3. It contains two components i.e. one solute- copper sulphate and one solvent-water. So it is a binary solution. Similarly, a solution may contain more than two components. For example if salt and sugar are added to water, both dissolve in water forming a solution. Here two solutes are dissolved in one solvent. Such kind of solutions which contain three components are called **ternary solutions**.

Figure 9.3 Formation of Copper sulphate solution

9.3 Types of Solutions

9.3.1 Based on the physical state of the solute and the solvent

We know that substances normally exist in three physical states (phases) i.e., solid, liquid and gas. In binary solutions, both the solvent and solute may exist in any of these physical states. But the solvent constitutes the major part of the solution. Its physical state is the primary factor which determine the characteristics of the solution. Therefore, there are different types of binary solutions as listed in Table 9.1.

Table 9.1 Types of binary solutions

Solute	Solvent	Example
Solid solution		
Solid	Solid	Copper dissolved in gold (Alloys)
Liquid	Solid	Mercury with sodium (amalgam)
Liquid solution		
Solid	Liquid	Sodium chloride dissolved in water
Liquid	Liquid	Ethyl alcohol dissolved in water
Gas	Liquid	carbon-di-oxide dissolved in water (Soda water)
Gaseous solution		
Liquid	Gas	Water vapour in air (cloud)
Gas	Gas	Mixture of Helium-Oxygen gases,

9.3.2 Based on the type of solvent

Most of the substances are soluble in water. That is why, water is called as 'Universal solvent". However some substances do not dissolve in water. Therefore, other solvents such as ethers, benzene, alcohols etc., are used to prepare a solution. On the basis of type of solvent, solutions are classified into two types. They are aqueous solutions and non-aqueous solutions.

a) Aqueous solution:

The solution in which water acts as a solvent is called aqueous solution. E.g. Common salt in water, Sugar in water, Copper sulphate in water etc.

b) Non – Aqueous solution:

The solution in which any liquid, other than water, acts as a solvent is called non-aqueous solution. Solvent other than water is referred to as non-aqueous solvent. Generally, alcohols, benzene, ethers, carbon disulphide, acetone, etc., are used as non-aqueous solvents. Examples for non-aqueous solutions: Sulphur dissolved in carbon disulphide, Iodine dissolved in carbon tetrachloride.

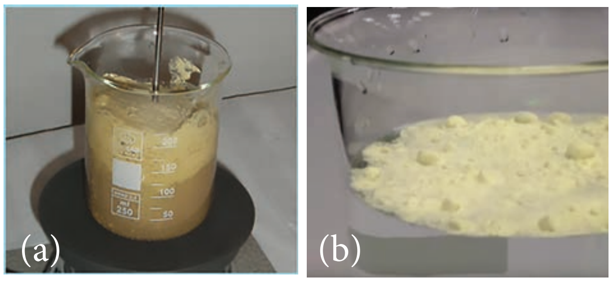


Figure 9.4 a) Sulphur is soluble in CS_2
b) Sulphur is insoluble in water

9.3.3 Based on the amount of solute

The amount of the solute that can be dissolved in the given amount of solvent is limited under any given conditions. Based on the amount of solute, in the given amount of solvent, solutions are classified into the following types:

(i) Saturated solution

(ii) Unsaturated solution

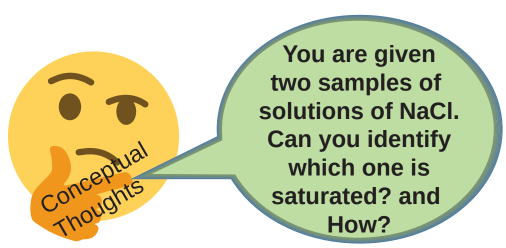
(iii) Super saturated solution

(i) Saturated solution: A solution in which no more solute can be dissolved in a definite amount of the solvent at a given temperature is called saturated solution. e.g. 36 g of sodium chloride in 100 g of water at 25°C forms saturated solution.

Further addition of sodium chloride, leave it undissolved.

(ii) Unsaturated solution: Unsaturated solution is one that contains less solute than that of the saturated solution at a given temperature. e.g. 10 g or 20 g or 30 g of Sodium chloride in 100 g of water at 25°C forms an unsaturated solution.

(iii) Super saturated solution: Supersaturated solution is one that contains more solute than the saturated solution at a given temperature. e.g. 40 g of sodium chloride in 100 g of water at 25°C forms super saturated solution. This state can be achieved by altering any other conditions liken temperature, pressure. Super saturated solutions are unstable, and the solute is reappearing as crystals when the solution is disturbed.



9.3.4 Concentrated and dilute solutions

It is another kind of classification of unsaturated solutions. It expresses the relative concentration of two solutions with respect to their solutes present in the given amount of the solvent. For example, you are given two cups of tea. When you taste them, you feel that one is sweeter than the other. What do you infer from it? The tea which sweet more contains higher amount of sugar than the other. How can you express your observation? You can say that the tea is stronger. But a chemist would say that it is 'concentrated'.

When we compare two solutions having same solute and solvent, the one which contains higher amount of solute per the given amount of solvent is said to be '**concentrated solution**' and the another is said to be '**dilute solution**'. They are schematically represented by Figure 9.5.

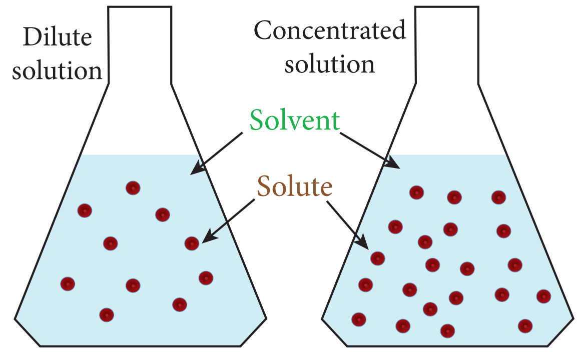


Figure 9.5 Dilute and Concentrated Solution

Differentiating solutions as dilute and concentrated is a qualitative representation. It does not imply the quantity of the solute. This difference is observed by means of some physical characteristics such as colour, density, etc.

Activity 1

Look at the following pictures. Label them as dilute and concentrated solution and justify your answer.

Tea

Copper sulphate

9.4 Solubility

Usually, there is a limit to the amount of solute that can be dissolved in a given amount of solvent at a given temperature. When this limit is reached, we have a saturated solution and any excess solute that is added, simply settle down at the bottom of the solution. The extent of dissolution of a solute in a solvent can be better explained by its solubility. Solubility is a measure of how much of a solute can be dissolved in a specified amount of a solvent.

Solubility is defined as the number of grams of a solute that can be dissolved in 100 g of a solvent to form its saturated solution at a given temperature and pressure. For example, 36 g of sodium chloride need to be dissolved in 100 g of water to form its saturated solution at 25°C. Thus the solubility of NaCl in water is 36 g at 25°C. The solubility is mathematically expressed as

$$\text{Solubility} = \frac{\text{Mass of the solute}}{\text{Mass of the solvent}} \times 100$$

Table 9.2 Solubility's of some common substances in water at 25°C

Name of the solute	Formula of the solute	Solubility g/100 g water
Calcium carbonate	$CaCO_3(s)$	0.0013
Sodium chloride	NaCl (s)	36
Ammonia	$NH_3(g)$	48
Sodium hydroxide	NaOH(s)	80
Glucose	$C_6H_{12}O_6(s)$	91
Sodium bromide	NaBr(s)	95
Sodium iodide	NaI(s)	184

9.4.1 Factors affecting solubility

There are three main factors which govern the solubility of a solute. They are:

(i) Nature of the solute and solvent

(ii) Temperature

(iii) Pressure

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(i) Nature of the solute and solvent

The nature of the solute and solvent plays an important role in solubility. Although water dissolves an enormous variety of substances, both ionic and covalent, it does not dissolve everything. The phrase that scientists often use when predicting solubility is "like dissolves like." This expression means that dissolving occurs when similarities exist between the solvent and the solute. For example: Common salt is a polar compound and dissolves readily in polar solvent like water.

Non-polar compounds are soluble in non-polar solvents. For example, Fat dissolved in ether. But non-polar compounds, do not dissolve in polar solvents; polar compounds do not dissolve in non-polar solvents.

(ii) Effect of Temperature

Solubility of Solids in Liquid:

Generally, solubility of a solid solute in a liquid solvent increases with increase in temperature. For example, a greater amount of sugar will dissolve in warm water than in cold water.

In endothermic process, solubility increases with increase in temperature.

In exothermic process, solubility decreases with increase in temperature.

Solubility of Gases in liquid

Do you know why is it bubbling when water is boiled? Solubility of gases in liquid decrease with increase in temperature. Generally, water contains dissolved oxygen. When water is heated, the solubility of oxygen in water decreases, so oxygen escapes in the form of bubbles.

Aquatic animals live more in cold regions because, more amount of dissolved oxygen is present in the water of cold regions. This shows that the solubility of oxygen in water is more at low temperatures.

(iii) Effect of Pressure

Effect of pressure is observed only in the case of solubility of a gas in a liquid. When the pressure is increased, the solubility of a gas in liquid increases.

The common examples for solubility of gases in liquids are carbonated beverages, i.e. soft drinks, household cleaners containing aqueous solution of ammonia, formalin-aqueous solution of formaldehyde, etc.

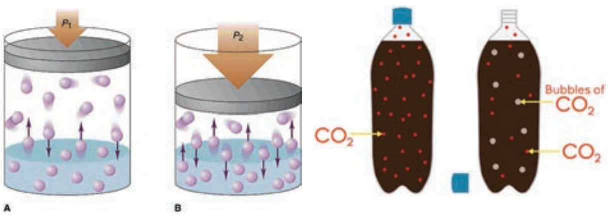

Figure 9.6 Effect of pressure on solubility

More to know

The effect of pressure on the solubility of a gas in liquid is given by **Henry's law**. It states that, the solubility of a gas in a liquid is directly proportional to the pressure of the gas over the solution at a definite temperature.

9.5 Concentration of a Solution

So far, we discussed what is a solution? what does it consist of and its types. Most of the chemical reactions take place in solutions form. So it is essential to quantify the solute in solvent to study the reactions. To quantify the solute in a solution, we can use the term "**concentration**".

Concentration of a solution may be defined as the amount of solute present in a given amount of solution or solvent.

Quantitatively, concentration of a solution may be expressed in different methods. But here, we shall discuss percentage by mass (% mass) and percentage by volume (% volume).

9.5.1 Mass percentage

Mass percentage of a solution is defined as the percentage by mass of the solute present in the solution. It is mostly used when solute is solid and solvent is liquid.

$$\text{Mass Percentage} = \frac{\text{Mass of the solute}}{\text{Mass of the solution}} \times 100$$

$$\text{Mass Percentage} = \frac{\text{Mass of the solute}}{\text{Mass of the solute + Mass of the solvent}} \times 100$$

For example: 5% sugar solution (by mass) means 5 g of sugar in 95 g of water. Hence it is made 100g of solution.

Usually, mass percentage is expressed as w/w (weight / weight); mass percentage is independent of temperature.

9.5.2 Volume percentage

Volume percentage is defined as the percentage by volume of solute (in ml) present in the given volume of the solution.

$$\text{Volume Percentage} = \frac{\text{Volume of the solute}}{\text{Volume of the solution}} \times 100$$

$$\text{Volume Percentage} = \frac{\text{Volume of the solute}}{\text{Volume of the solute + volume of the solvent}} \times 100$$

For example, 10% by volume of the solution of ethanol in water, means 10 ml of ethanol in 100 ml of solution (or 90 ml of water)

Usually volume percentage is expressed as v/v (volume / volume). It is used when both the solute and solvent are liquids. Volume percentage decreases with increases in temperature, because of expansion of liquid.

You can notice that in the commercial products that we come across in our daily life such as a solution of syrups, mouth wash, antiseptic solution, household disinfectants etc., the concentration of the ingredients is expressed as v/v. Similarly, in ointments, antacid, soaps, etc., the concentration of solutions are expressed as w/w.

Ointment

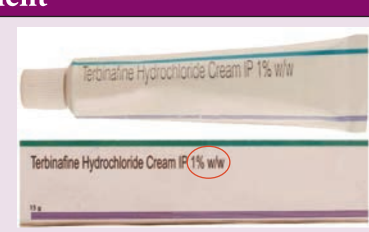

Figure 9.7 Ointment (w/w percent)

9.6 Hydrated salts and Water of Crystallization

When ionic substances are dissolved in water to make their saturated aqueous solution, their ions attract water molecules which then attached chemically in certain ratio. This process is called hydration. These ionic substances crystallize out from their saturated aqueous solution with a definite number of molecules of water. The number of water molecules found in the crystalline substance is called **water of crystallization**. Such salts are called hydrated salts.

Figure 9.8 a) Crystalline hydrated salt
b) Amorphous anhydrous salt

On heating these hydrated crystalline salts, they lose their water of crystallization and become amorphous or lose their colour (if they are coloured). Table 9.3 shows some common hydrated salts:

Table 9.3 Hydrated salts

Common Name	IUPAC Name	Molecular Formula
Blue Vitriol	Copper (II) sulphate pentahydrate	$CuSO_4 \cdot 5H_2O$
Epsom Salt	Magnesium sulphate heptahydrate	$MgSO_4 \cdot 7H_2O$
Gypsum	Calcium sulphate dihydrate	$CaSO_4 \cdot 2H_2O$
Green Vitriol	Iron (II) sulphate heptahydrate	$FeSO_4 \cdot 7H_2O$
White Vitriol	Zinc sulphate heptahydrate	$ZnSO_4 \cdot 7H_2O$

9.6.1 Copper sulphate pentahydrate $CuSO_4 \cdot 5H_2O$ (Blue vitriol)

The number of water molecules in blue vitriol is five. So its water of crystallization is 5. When blue coloured copper sulphate crystals are gently heated, it loses its five water molecules and becomes colourless anhydrous copper sulphate.

$$CuSO_4 \cdot 5H_2O \underset{\text{Cooling}}{\overset{\text{Heating}}{\rightleftharpoons}} CuSO_4 + 5H_2O$$

(Copper sulphate pentahydrate) Blue colour — (Anhydrous copper sulphate) colourless

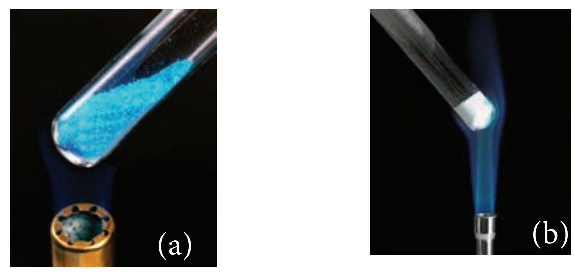

Figure 9.9 a) Copper sulphate before heating
b) Copper sulphate after heating

If you add few drops of water or allow it to cool, the colourless anhydrous salt again turns back into blue coloured hydrated salt.

Figure 9.10 Anhydrous copper sulphate turns to blue when water is added

9.6.2 Magnesium sulphate heptahydrate $MgSO_4 \cdot 7H_2O$ (Epsom salt)

Its water of crystallization is 7. When magnesium sulphate heptahydrate crystals are gently heated, it loses seven water molecules, and becomes anhydrous magnesium sulphate.

$$MgSO_4{\cdot}7H_2O \underset{\text{Cooling}}{\overset{\text{Heating}}{\rightleftharpoons}} MgSO_4 + 7H_2O$$

(Magnesium sulphate heptahydrate) (Anhydrous Magnesium sulphate)

If you add few drops of water or allow it to cool, the colourless anhydrous salt again turns back into hydrated salt.

9.7 Hygroscopy

Certain substances, when exposed to the atmospheric air at ordinary temperature, absorb moisture without changing their physical state. Such substances are called **hygroscopic substances** and this property is called hygroscopy.

Hygroscopic substances are used as drying agents.

Example: 1. Conc.Sulphuric acid (H_2SO_4).
2. Phosphorus Pentoxide (P_2O_5).
3. Quick lime (CaO).
4. Silica gel (SiO_2).

9.8 Deliquescence

Certain substances which are so hygroscopic, when exposed to the atmospheric air at ordinary temperatures, absorb enough water and get completely dissolved. Such substances are called **deliquescent substances** and this property is called **deliquescence**.

Deliquescent substances lose their crystalline shape and ultimately dissolve in the absorbed water forming a saturated solution.

Deliquescence is maximum when:

1) The temperature is low
2) The atmosphere is humid

Examples: Caustic soda (NaOH), Caustic potash (KOH) and Ferric chloride ($FeCl_3$).

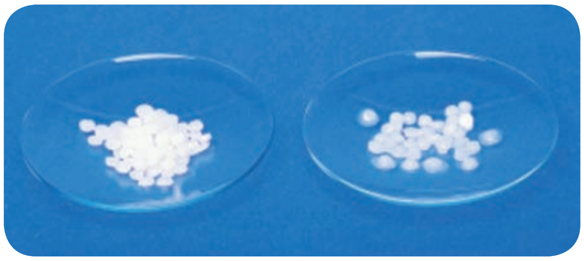

Figure 9.11 Deliquescence in Sodium hydroxide

9.9 Problems Based on Solubility and Percentage by Mass and Volume

I. Problems based on solubility

1) 1.5 g of solute is dissolved in 15 g of water to form a saturated solution at 298K. Find out the solubility of the solute at the temperature.

Table 9.3 Difference between hygroscopic substances and deliquescence.

Hygroscopic substances	Deliquescence substances
When exposed to the atmosphere at ordinary temperature, they absorb moisture and do not dissolve.	When exposed to the atmospheric air at ordinary temperature, they absorb moisture and dissolve.
Hygroscopic substances do not change its physical state on exposure to air.	Deliquescent substances change its physical state on exposure to air.
Hygroscopic substances may be amorphous solids or liquids.	Deliquescent substances are crystalline solids.

Mass of the solute = 1.5 g

Mass of the solvent = 15 g

$$\text{Solubility of the solute} = \frac{\text{Mass of the solute}}{\text{Mass of the solvent}} \times 100$$

$$\text{Solubility of the solute} = \frac{1.5}{15} \times 100$$

$$= 10 \text{ g}$$

2) Find the mass of potassium chloride would be needed to form a saturated solution in 60 g of water at 303 K? Given that solubility of the KCl is 37/100 g at this temperature.

Mass of potassium chloride in 100 g of water in saturated solution = 37 g

$$\text{Mass of potassium chloride in 60 g of water in saturated solution} = \frac{37}{100} \times 60$$

$$= 22.2 \text{ g}$$

3) What is the mass of sodium chloride that would be needed to form a saturated solution in 50 g of water at 30°C. Solubility of sodium chloride is 36 g at 30°C?

At 30°C, 36 g of sodium chloride is dissolved in 100 g of water.

∴ Mass of sodium chloride that would be need for 100 g of water = 36 g

$$\therefore \text{Mass of sodium chloride dissolved in 50 g of water} = \frac{36 \times 50}{100}$$

$$= 18 \text{ g}$$

4) The solubility of sodium nitrate at 50°C and 30°C is 114 g and 96 g respectively. Find the amount of salt that will be thrown out when a saturated solution of sodium nitrate containing 50 g of water is cooled from 50°C to 30°C?

Amount of sodium nitrate dissolved in 100 g of water at 50°C is 114 g

$$\therefore \text{Amount of sodium nitrate dissolving in 50 g of water at 50°C is} = \frac{114 \times 50}{100}$$

$$= 57 \text{ g}$$

$$\text{Similarly amount of sodium nitrate dissolving in 50g of water at 30°C is} = \frac{96 \times 50}{100}$$

$$= 48\text{g}$$

Amount of sodium nitrate thrown when 50g of water is cooled from 50°C to 30°C is

$$57 - 48 = 9 \text{ g}$$

II. Problem based on mass percentage

1) A solution was prepared by dissolving 25 g of sugar in 100 g of water. Calculate the mass percentage of solute.

Mass of the solute = 25 g

Mass of the solvent = 100 g

$$\text{Mass Percentage} = \frac{\text{Mass of the solute}}{\text{Mass of the solution}} \times 100$$

$$\text{Mass Percentage} = \frac{\text{Mass of the solute}}{\text{Mass of the solute + Mass of the solvent}} \times 100$$

$$= \frac{25}{25+100} \times 100$$

$$= \frac{25}{125} \times 100$$

$$= 20\%$$

2) 16 grams of NaOH is dissolved in 100 grams of water at 25°C to form a saturated solution. Find the mass percentage of solute and solvent.

Mass of the solute (NaOH) = 16 g

Mass of the solvent H_2O = 100 g

(i) **Mass percentage of the solute**

$$\text{Mass percentage of solute} = \frac{\text{Mass of the solute}}{\text{Mass of the solute + Mass of the solvent}} \times 100$$

$$= \frac{16 \times 100}{16 + 100}$$

$$= \frac{1600}{116}$$

Mass percentage of the solute = 13.79 %

(ii) Mass percentage of solvent = 100 – (Mass percentage of the solute)

= 100 – 13.79

= 86.21%

3) Find the amount of urea which is to be dissolved in water to get 500 g of 10% w/w aqueous solution?

$$\text{Mass percentage (w/w)} = \frac{\text{Mass of the solute}}{\text{Mass of the solution}} \times 100$$

$$10 = \frac{\text{Mass of the urea}}{500} \times 100$$

Mass of urea = 50g

(iii) **Problem based on volume – volume percentage.**

1) A solution is made from 35 ml of Methanol and 65 ml of water. Calculate the volume percentage.

Volume of the ethanol = 35 ml

Volume of the water = 65 ml

$$\text{Volume percentage} = \frac{\text{Volume of the solute}}{\text{Volume of the solution}} \times 100$$

$$\text{Volume percentage} = \frac{\text{Volume of the solute}}{\text{Volume of the solute + Volume of the solvent}} \times 100$$

$$\text{Volume percentage} = \frac{35}{35+65} \times 100$$

$$\text{Volume percentage} = \frac{35}{100} \times 100$$

= 35%

2) Calculate the volume of ethanol in 200 ml solution of 20% v/v aqueous solution of ethanol.

Volume of aqueous solution = 200 ml

Volume percentage = 20%

$$\text{Volume percentage} = \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

$$20 = \frac{\text{Volume of ethanol}}{200} \times 100$$

$$\text{Volume of ethanol} = \frac{20 \times 200}{100} = 40 \text{ ml}$$

Points to Remember

- A solution is a homogeneous mixture of two or more substances.
- An aqueous solution is a solution in which the solvent is water.
- A non-aqueous solution is a solution in which the solvent is a liquid, other than water
- A solution in which no more solute can be dissolved in a definite amount of the solvent at a given temperature is called saturated solution.
- An unsaturated solution is one that contains less solute than the saturated solution at a given temperature.
- A supersaturated solution is one that contains more solute than the saturated solution at a given temperature.
- Polar compounds are soluble in polar solvents.
- Non-polar compounds are soluble in non-polar solvents.
- In endothermic process, solubility of solid solute increases with increase in temperature.
- In exothermic process, solubility of solid solute decreases with increase in temperature.

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TEXTBOOK EVALUATION

I. Choose the correct answer.

1. A solution is a __________ mixture.
   a. homogeneous b. heterogeneous
   c. homogeneous and heterogeneous
   d. non homogeneous

2. The number of components in a binary solution is __________
   a. 2 b. 3
   c. 4 d. 5

3. Which of the following is the universal solvent?
   a. Acetone b. Benzene
   c. Water d. Alcohol

4. A solution in which no more solute can be dissolved in a definite amount of solvent at a given temperature is called _______
   a. Saturated solution
   b. Un saturated solution
   c. Super saturated solution
   d. Dilute solution

5. Identify the non aqueous solution.
   a. sodium chloride in water
   b. glucose in water
   c. copper sulphate in water
   d. sulphur in carbon-di-sulphide

6. When pressure is increased at constant temperature the solubility of gases in liquid __________.
   a. No change b. increases
   c. decreases d. no reaction

7. Solubility of NaCl in 100 ml water is 36 g. If 25 g of salt is dissolved in 100 ml of water how much more salt is required for saturation ____________.
   a. 12g b. 11g c. 16g d. 20g

8. A 25% alcohol solution means
   a. 25 ml alcohol in 100 ml of water
   b. 25 ml alcohol in 25 ml of water
   c. 25 ml alcohol in 75 ml of water
   d. 75 ml alcohol in 25 ml of water

9. Deliquescence is due to __________
   a. Strong affinity to water
   b. Less affinity to water
   c. Strong hatred to water
   d. Inertness to water

10. Which of the following is hygroscopic in nature?
    a. ferric chloride
    b. copper sulphate penta hydrate
    c. silica gel
    d. none of the above

II. Fill in the blanks

1. The component present in lesser amount, in a solution is called _______
2. Example for liquid in solid type solution is _____
3. Solubility is the amount of solute dissolved in _____ g of solvent.
4. Polar compounds are soluble in _____ solvents
5. Volume persentage decreases with increases in temperature because _____

III. Match the following

1. Blue vitriol	– $CaSO_4 \cdot 2H_2O$
2. Gypsum	– CaO
3. Deliquescence	– $CuSO_4 \cdot 5H_2O$
4. Hygroscopic	– NaOH

IV. True or False: (If false give the correct statement)

1. Solutions which contain three components are called binary solution.
2. In a solution the component which is present in lesser amount is called solvent.
3. Sodium chloride dissolved in water forms a non-aqueous solution.
4. The molecular formula of green vitriol is $MgSO_4 \cdot 7H_2O$
5. When Silica gel is kept open, it absorbs moisture from the air, because it is hygroscopic in nature

V. Short answer

1. Define the term: Solution
2. What is mean by binary solution
3. Give an example each i) gas in liquid ii) solid in liquid iii) solid in solid iv) gas in gas
4. What is aqueous and non-aqueous solution? Give an example.
5. Define Volume percentage
6. The aquatic animals live more in cold region Why?
7. Define Hydrated salt.
8. A hot saturated solution of copper sulphate forms crystals as it cools. Why?
9. Classify the following substances into deliquescent, hygroscopic.

   Conc. Sulphuric acid, Copper sulphate penta hydrate, Silica gel, Calcium chloride, and Gypsum salt.

VI. Long answer:

1. Write notes on i) saturated solution ii) unsaturated solution
2. Write notes on various factors affecting solubility.
3. a) What happens when $MgSO_4 \cdot 7H_2O$ is heated? Write the appropriate equation

   b) Define solubility
4. In what way hygroscopic substances differ from deliquescent substances.
5. A solution is prepared by dissolving 45 g of sugar in 180 g of water. Calculate the mass percentage of solute.
6. 3.5 litres of ethanol is present in 15 litres of aqueous solution of ethanol. Calculate volume percent of ethanol solution.

VII. HOTS

1. Vinu dissolves 50 g of sugar in 250 ml of hot water, Sarath dissolves 50 g of same sugar in 250 ml of cold water. Who will get faster dissolution of sugar? and Why?
2. 'A' is a blue coloured crystaline salt. On heating it loses blue colour and to give 'B'. When water is added, 'B' gives back to 'A'. Identify A and B, write the equation.
3. Will the cool drinks give more fizz at top of the hills or at the foot? Explain

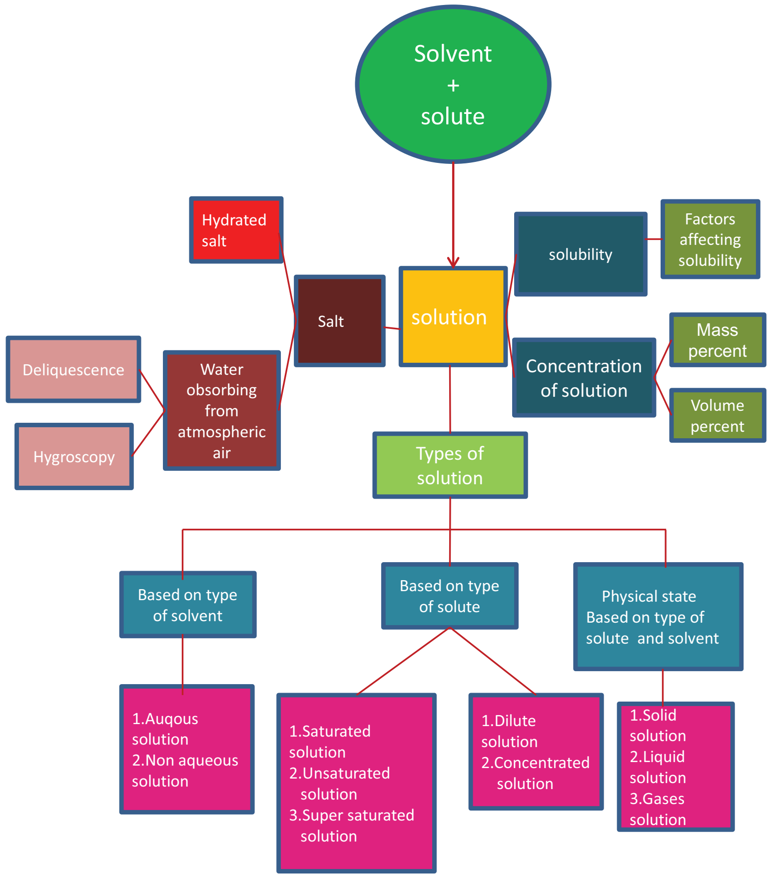
REFERENCE BOOKS

1. Properties Liquids Solutions John Murrell 2nd Edition.
2. Fundamental Interrelationships Between Certain Soluble Salts and Soil Colloids (Classic Reprint) Hardcover, by Leslie Theodore Sharp

INTERNET RESOURCES

1. https://www.cwcboe.org/cms/lib/NJ01001185/Centricity/Domain/203/Solutions%20Suspensions%20and%20Colloids.pdf

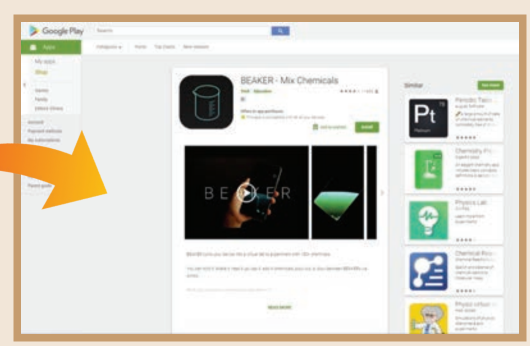
Concept Map



ICT CORNER

Solutions

BEAKER application enable the students to use their mobile as virtual chemistry laboratory and also to do various experiments on their own.



Steps

- Access the application "BEAKER – Mix Chemicals" with help of the URL or QR code, Install it in the mobile. You can see that the screen will act like a beaker after opening the application.
- If you click the round button, you can see many elements and compounds.
- If you click any elements and compounds, it will be added to the beaker in the home screen.
- By clicking Menu at the left side, You can see lid, match stick, burner and chemist. Use those whenever necessary.

URL: https://play.google.com/store/apps/details?id=air.thix.sciencesense.beaker

or Scan the QR Code.

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