CHAPTER 6
SOLUTIONS

INTRODUCTION

Q.1 Define solution. ***(MTN, DGK, RWP 2016)(K.B)***

Ans:

SOLUTION

Definition:

*"Solutions are **homogeneous mixtures** of two or more components".*

Examples:

- **Salt in water** in an example of solution

Q.2 What are the physical states of solution? **(MTN 2017)*(K.B)***

Ans:

PHYSICAL STATES OF SOLUTION

Generally solutions are found in **three** physical states **depending** upon the **physical state of solvent.**

Examples:

Solid: **Alloy** is a solid solution
Liquid: **Sea water** is a liquid solution
Gas: **Air** is a gaseous solution

Q.3 What are the types of solutions? ***(K.B)***

Ans:

TYPES OF SOLUTION

There are **nine** types of solution ranging from e.g. gas-gas, air we breathe, to solid-solid solution e.g. **dental amalgam** for **filling of tooth**.

MULTIPLE CHOICE QUESTIONS

1. Which one is a gaseous solution? ***(K.B)***

(A) Air (B) Water (C) Matter (D) Soil

2. How many types of solutions are: ***(K.B)***

(A) 9 (B) 8 (C) 11 (D) 10

6.1 SOLUTION

Q.1 Explain the term solution with the help of examples. ***(K.B+A.B)***

Ans:

SOLUTION

*"A **homogeneous mixture of two or more substances** is called solution."*

Solute + Solvent = Solution

Examples:

- Sugar solution
- Sodium chloride solution
- Copper sulphate solution
- Air
- Brass
- Sea water

Physical states of solutions:

The physical states of solutions are as follows:

(i) Solid: e.g. **alloy**
(ii) Liquid: e.g. **sea water**
(iii) Gas: e.g. **air**

Properties of a solutions:

The properties of a solutions are as follows:

(i) A solution has only **one phase**.
(ii) It shows the **properties of** its **components**.
(iii) It has a **uniform composition**.

Homogeneous Mixture:

*"A mixture having **uniform composition throughout** is called homogeneous mixture."*

Boundaries of a solution:

The boundaries of the components **can't be distinguished** i.e. a solution exist as **one phase**.

Examples:

- The **air** we breathe is a solution of several gases.
- **Brass** is a solid solution of **Zn** and **Cu**.
- **Sugar** dissolved **in water**.

Distinction between Solution & Pure Liquid:

The simplest way to distinguish between a solution and a pure liquid is **evaporation**.

The liquid which **evaporates completely**, leaving no residue, is a **pure compound**, while a liquid which **leaves behind a residue** on evaporation is **solution**.

Alloy as a Solution:

An alloy like **brass** or **bronze** is also a homogeneous mixture. Although it **cannot be separated** by **physical means**.

- It **shows** the **properties** of its **components** and
- It has a **variable composition**.

Q.2 Define the terms. ***(U.B+K.B)***

(i) Aqueous solution **(GRW 2017 G-II, FSD 2017 G-I)**

(ii) Universal solvent **(iii) Solute** **(iv) Solvent**

Ans:

(I) AQUEOUS SOLUTION

Definition:

*"The solution which is formed by **dissolving a substance in water** is called an aqueous solution."*

In aqueous solutions **water** is always present in greater amount and termed as **solvent** **Water** is called a **universal solvent** because it **dissolves majority** of **compounds** present in Earth's crust.

Examples:

- Sugar in water.
- Table salt in water.

(II) UNIVERSAL SOLVENT

Definition:

*"Water is called a universal solvent because it **dissolves majority of compounds present in earth's crust**."*

Water can **dissolve ionic** as well as **covalent compounds** in water e.g. **NaCl, Cl_2, HCl**

(III) SOLUTE

Definition:

*"The **component of solution** which is present in **smaller quantity** is called solute".*

Examples:

A **solute is dissolved in a solvent** to make a solution in sugar. In sugar solution, sugar is solute and in sodium chloride solution, sodium chloride is solute.

Number of solutes present in a solution:

In a solution if **more than two substances** are present, **one substance acts as solvent** and **others behave as solutes.**

Example:

In **soft drinks, water** is **solvent** while other substances like **sugar, salts** and **CO_2** are **solutes.**

(IV) SOLVENT

Definition:

*"The **component of a solution** which is present in **larger quantity** is called solvent."*

Example:

In **soft drinks, water** is **solvent** while other substances like **sugar, salts** and **CO_2** are **solutes**.

6.1 SOLUTION

SHORT QUESTIONS

Q.1 Write a note on properties of a solution. *(K.B)*

Ans: *Answer given on pg # 196*

Q.2 Define Homogeneous mixture. Also give examples. *(K.B+A.B)*

Ans: *Answer given on pg # 196*

Q.3 What is an aqueous solution? Also give example. *(K.B+A.B)*

Ans: *Answer given on pg # 197*

Q.4 How can you distinguish between solution and pure liquid? *(U.B)*

Ans: *Answer given on pg # 197*

Q.5 Explain how water is a universal solvent? *(U.B)*

Ans: *Answer given on pg # 197*

Q.6 Define solute and give an example. *(K.B+A.B)*

Ans: *Answer given on pg # 197*

Q.7 Define solvent and give an example. *(K.B+A.B)*

Ans: *Answer given on pg # 197*

6.1 SOLUTION

MULTIPLE CHOICE QUESTIONS

1. **A solution has only ________ phase.** *(K.B)*
   (A) One (B) Three (C) Two (D) Four
2. **Brass is solid solution of Zn and:** *(K.B)*
   (A) Cu (B) Mg (C) Ca (D) Na
3. **The simplest way to distinguish between a solution and a pure liquid is:** *(U.B)*
   (A) Freezing (B) Melting (C) Condensation (D) Evaporation
4. **Which one is called universal solvent?** **(SGD 2017 G-I, FSD 2017 G-II)***(K.B)*
   (A) Alcohol (B) Water (C) Benzene (D) Ether
5. **Brass is an example of:** *(U.B+A.B)*
   (A) Homogenous mixture (B) Heterogeneous mixture
   (C) Pure compound (D) Both A and C
6. **In salt solution which one is solute?** *(K.B)*
   (A) Salt (B) Water (C) Alcohol (D) Benzene
7. **The liquid which evaporates completely leaving no residue is pure compound while liquid which leaves behind residue on evaporation is:** *(U.B)*
   (A) Solution (B) Pure compound (C) Both A and B (D) None of these
8. **In an aqueous solution the solvent is:** *(K.B)*
   (A) Acid (B) Base (C) Alcohol (D) Water
9. **Minimum components of a solution are:** *(K.B)*
   (A) 2 (B) 4 (C) 5 (D) 3

6.2 SATURATED SOLUTION

Q.1 Explain saturated solution with the help of examples.
(Ex-Q.6)(SWL 2016, DGK 2016, BWP 2017, GRW 2017 G-II)*(U.B+K.B+A.B)*

Ans: **SATURATED SOLUTION**

Definition:

*"A solution containing **maximum amount of solute at a given temperature** is called saturated solution".*

Example:

A saturated solution of **sodium thiosulphate ($Na_2S_2O_3$) in water at 20°C** has **20.9 g** of salt **per 100 cm^3 of water**.

$$\textbf{Solute + Solvent} \underset{\text{crystallize}}{\overset{\text{dissolve}}{\rightleftharpoons}} \textbf{Solution}$$

Preparation:

When a small amount of solute is added in a solvent, solute dissolves very easily in solvent. If the addition of solute is kept on, a stage is reached when solvent cannot dissolve more solute. At this stage, further added solute remains un-dissolved and it settles down at the bottom of the container.

Dynamic Equilibrium in Saturated Solution:

On the particle level, a saturated solution is the one, in which **un-dissolved solute** is in **equilibrium with dissolved solute**.

$$\textit{Solute (crystallized)} \rightleftharpoons \textit{Solute (dissolved)}$$

At this stage **dynamic equilibrium** is established. Although dissolution and crystallization continues at a given temperature, but the **net amount of dissolved solute remains constant**.

Q.2 What are supersaturated solution? How can we prepare supersaturated solution?
(GRW 2016, 17)*(U.B+A.B)*

Ans: **SUPERSATURATED SOLUTION**

Definition:

*"The solution that is **more concentrated than a saturated solution** is known as supersaturated solution".*

Example:

A **saturated solution** of **sodium thiosulphate ($Na_2S_2O_3$) in water at 20^{o}C** has **20.9 g** of salt **per 100 cm^3 of water**. **Less than 20.9 g** of salt per 100 cm^3 of water at 20 ^{0}C will be an **unsaturated solution**. A solution having **more** amount **than 20.9 g** of salt per 100 cm^{3}of water at 20^{o}C will be a **supersaturated solution**.

Properties:

(i) When saturated solutions are heated, they develop **further capacity to dissolve more solute**.

(ii) Such solutions contain **greater amount of solute than** is required to form a **saturated solution** and they become **more concentrated**.

(iii) Super saturated solutions are **not stable**.

Preparation of Supersaturated Solution:

Super saturated solutions are not stable. Therefore, an easy way to get a supersaturated solution is to prepare a saturated solution at high temperature. It is then cooled to a temperature where **excess solute crystallizes out** and **leaves behind a saturated solution**.

Q.3 Define unsaturated solution with example. ***(K.B+A.B)***

Ans:

UNSATURATED SOLUTION

Definition:

"A solution which contains ***lesser amount of solute than that which is required to saturate it at a given temperature*** *is called unsaturated solution".*

Such solutions have the **capacity to dissolve more solute** to become a saturated solution.

Example:

Less than 20.9 g of **sodium thiosulphate** in water **per 100 cm^3 of water** at **20ºC.**

Q.4 Differentiate between dilute and concentrated solution with a common example. **(LHR 2015,16)*(U.B)***

Ans:

DIFFERENTIATION

The differences between dilute and concentrated solution is given below:

Dilute Solution	Concentrated Solution
Definition	
• Dilute solutions are those which contain relatively small amount of dissolved solute in the solution.	• Concentrated solutions are those which contain relatively large amount of dissolved solute in the solution.
Examples	
• Less than 20.9 g of sodium thiosulphate in water per 100 cm^3 of water at 20ºC.	• More than 20.9 g of sodium thiosulphate in water per 100 cm^3 of water at 20ºC.
Type of Solution	
• Unsaturated solution	• Supersaturated solution

6.2 SATURATED SOLUTION

MULTIPLE CHOICE QUESTIONS

1. **Air is an example of solution:** **(LHR 2016)*(A.B)***
(A) Solid in solid (B) Solid in gas
(C) Gas in gas (D) Liquid in gas

2. **The concentrated solution of NaCl is called:** ***(K.B)***
(A) Fluid (B) Brass
(C) Brine (D) Plasma

3. **Addition of more ________ will dilute the solution.** ***(U.B)***
(A) Solution (B) Solvent
(C) Solute (D) Solid

4. **The solutions are classified as dilute and concentrated on the basis of relative amount of _______ present in them.** ***(U.B)***
(A) Solute (B) Solvent
(C) Solution (D) All of these

5. **A solution containing maximum amount of solute at given temperature is called:** ***(U.B)***
(A) Saturated solution (B) Unsaturated solution
(C) Super saturated solution (D) Aqueous solution

6. **A solution having 20.9 g of $Na_2S_2O_3$ per 100cm^3 of water at 20°C is called:** ***(K.B+A.B)***
(A) Saturated solution (B) Unsaturated solution
(C) Supersaturated solution (D) Normal solution

7. **Which one of the solutions is not stable?** ***(U.B)***
(A) Normal solutions (B) Supersaturated solutions
(C) Saturated solutions (D) Unsaturated solutions

6.3 TYPES OF SOLUTIONS

Q.1 Explain different types of solutions with examples. *(DGK 2017)(K.B+A.B)*

Ans:

SOLUTION

Definition:

"*A **homogeneous mixture of two or more substances** is called a solution*"

Examples:

- Sugar solution
- Air

TYPES OF SOLUTIONS

Each solution consists of two components, solute and solvent. The solute as well as solvent may exist as gas, liquid or solid. There are **nine types of solutions depending upon the physical state of solute and solvent**.

Table: Different Types of Solutions with Examples

Sr. No	Solute	Solvent	Example of Solutions
1	Gas	Gas	Air, mixture of H_2 and He in weather balloons, mixture of N_2 and O_2 in cylinders for respiration.
2	Gas	Liquid	Oxygen in water, carbon dioxide in water.
3	Gas	Solid	Hydrogen adsorbed on palladium.
4	Liquid	Gas	Mist, fog, liquid air pollutants.
5	Liquid	Liquid	Alcohol in water, benzene and toluene.
6	Liquid	Solid	Butter, cheese.
7	Solid	Gas	Dust particles or smoke in air.
8	Solid	Liquid	Sugar in water.
9	Solid	Solid	Metal alloys such as brass **(Cu + Zn)**, bronze **(Cu + Sn)**, opals etc

6.3 TYPES OF SOLUTIONS

SHORT QUESTIONS

Q.1 What is solid-solid solution? *(K.B)*

Ans:

SOLID-SOLID SOLUTION

"The solution in which both solute and solvent are in solid state is called solid-solid solution".

Examples:

Metal alloys are solid-solid solutions such as:

- Brass (Cu + Zn)
- Bronze (Cu + Sn)
- Opals

Q.2 What is gas-gas solution? *(K.B)*

Ans:

GAS-GAS SOLUTION

"The solution in which both solute and solvent are in gaseous state is called gas-gas solution"

Examples:

- Air
- Mixture of H_2 and He in weather balloons
- Mixture of N_2 and O_2 in cylinders for respiration

6.3 TYPES OF SOLUTIONS

MULTIPLE CHOICE QUESTIONS

1. Metal alloy in an example of: **(LHR 2014,15)*(A.B)***
(A) Liquid in gas (B) Gas in liquid (C) Solid in gas (D) Solid in solid

2. Example of liquid in liquid solution is: **(GRW 2014)*(A.B)***
(A) Alcohol in water (B) Butter (C) Fog (D) Mist

3. Fog is an example of solution: ***(A.B)***
(A) Gas in liquid (B) Liquid in gas (C) Solid in gas (D) Solid in solid

4. Smoke in an example of solution: **(FSD 2017 G-I)*(A.B)***
(A) Solid in gas (B) Gas in liquid (C) Liquid in solid (D) Liquid in gas

5. Sugar in water is an example of: ***(A.B)***
(A) Solid in solid (B) Solid in liquid (C) Liquid in solid (D) Gas in solid

6. Which one of the following is a liquid in solid solution: **(GRW 2016 G-I)*(A.B)***
(A) Sugar in water (B) Butter (C) Salt in water (D) Smoke

7. Air is an example of solution: **(LHR 2016 G-I)*(A.B)***
(A) Solid in solid (B) Solid in liquid (C) Gas in gas (D) Liquid in gas

6.1 TEST YOURSELF

i. Why is a solution considered mixture? ***(U.B)***

Ans: **SOLUTION CONSIDERED A MIXTURE**

Solution is considered as mixture because the components of solution retain their properties. The can be mixed in any ratio and can be separated by physical means.

ii. Distinguish between the following pairs as compound or solution: ***(U.B+A.B)***
(A) Water and salt solution (B) vinegar and benzene
(C) Carbonated drinks and acetone

Ans: **DISTINCTION BETWEEN COMPOUND OR SOLUTION**

(a) Water is a compound and salt solution is a solution.
(b) Vinegar is solution and benzene is a compound.
(c) Carbonated drink is solution and acetone is a compound.

iii. What is the major difference between a solution and a mixture?
(LHR, GRW, 15, 14, 16)*(U.B)*

Ans: **DIFFERENTIATION**

The differences between a solution and a mixture are as follows:

Solution	Mixture
Definition	
• It is the homogeneous mixture of two or more substances	• It may be homogeneous or heterogeneous.
• Every solution is mixture	• Every mixture is not solution

iv. Why all the alloys are considered solutions? ***(U.B)***

Ans: **ALLOYS AS SOLUTION**

Alloys are considered solutions because they are homogenous mixture of two or more than two metals or non-metals which retain their properties. They have variable composition.

v. Dead sea is so rich with salts that it forms crystals when temperature lowers in the winter. Can you comment why is it named as "Dead Sea"? ***(U.B)***

Ans: **DEAD SEA**

Its water is so salty that no animal or plant can survive in it because high concentration of salts in water causes dehydration of animals and plants and they die. Hence it is called “Dead Sea” means “without life”.

6.4 CONCENTRATION UNITS
6.4.1 PERCENTAGE

Q.1 Write down the types and properties of concentration units for solution.
(DGK. FSD 2016)(K.B)

Ans: **CONCENTRATION UNITS**

Concentration:
"The proportion of a solute in a solution is called concentration".

OR

*It is also a **ratio of the amount of solute to the amount of solution** or **ratio of amount of solute to the amount of the solvent** is called concentration of solution.*

$$\text{Concentration of solution} = \frac{\text{Amount of solute}}{\text{Amount of solution or amount of solvent}}$$

Independence of Concentration:
Concentration does not depend upon the total **volume or total amount of the solution**.

Example:
A **sample** taken from the **bulk solution** will have the **same concentration**.

CONCENTRATION UNITS

There are various types of units used to express concentration of solutions.

(A) Percentage

"*Percentage unit of concentration refers to the **percentage of solute present in a solution***".

The percentage of solute can be expressed by mass or by volume. It can be expressed in terms of **percentage composition** by four different ways.

(i) Percentage-mass/mass (%m/m):
*"It is the **number of grams of solute in 100 grams of solution**."*

Example:
10% m/m sugar solution means that **10g** of **sugar** is dissolved in **90g of water** to make 100g of solution.

Formula:

$$\%m/m = \frac{\text{Mass of solute (g)}}{\text{Mass of solute (g)} + \text{Mass of solvent (g)}} \times 100$$

$$\%m/m = \frac{\text{Mass of solute (g)}}{\text{Mass of solution (g)}} \times 100$$

(ii) Percentage -mass/volume (%m/v):
*"It is the **number of grams of solute dissolved in 100 cm^3 of the solution**".*

Example:
10 % m/v sugar solution contains **10 g** of **sugar** in **100 cm^3** of the **solution**. The exact volume of solvent is not mentioned or it is not known.

Formula:

$$\%m/v = \frac{\text{Mass of solute (g)}}{\text{Volume of solution } (cm^3)} \times 100$$

(iii) Percentage -volume/mass (%v/m)
"*It is the **volume in cm^3 of a solute dissolved in 100 g of the solution***".

Example:

10 % v/m alcohol solution in water means **10 cm^3** of **alcohol** is **dissolved** in **(unknown) volume** of **water** so that the **total mass** of the **solution** is **100 g**. In such solutions the mass of solution is under consideration, total volume of the solution is not considered.

Formula:

$$\% v/m = \frac{\text{Volume of solute } (cm^3)}{\text{Mass of solution } (g)} \times 100$$

(iv) Percentage-volume/volume (% v/v)

*"It is the **volume in cm^3 of a solute dissolved per 100 cm^3 of the solution**".*

Example:

30% v/v alcohol solution means **30 cm^3** of **alcohol dissolved** in sufficient amount of **water**, so that the **total volume** of the **solution** becomes **100 cm^3**.

Formula:

$$(\%v/v) = \frac{\text{Volume of solute}(cm^3)}{\text{Volume of solution}(cm^3)} \times 100$$

Q.2 What is molarity and give its formula to prepare molar solution?

(Ex-Q.4) (SWL 2016, MTN, FSD 2017)*(U.B+K.B)*

Ans: **MOLARITY**

*"**Number of moles of solute dissolved in one dm^3 of solution** is called molarity".*

Representation:

It is represented by **M**.

Significance:

Molarity is the unit mostly **used in chemistry and allied sciences**. It is a concentration unit.

Formula:

The formula used for preparation of molar solution is as follows:

$$\text{Molarity} = \frac{\dfrac{\text{Mass of solute}(g)}{\text{Molar mass of solute } (gmol^{-1})}}{\text{Volume of solution } (dm^3)} = \frac{\text{Number of moles of solute}}{\text{Volume of solution } (dm^3)}$$

$$\text{Molarity (M)} = \frac{\text{Mass of solute } (g)}{(\text{Molar mass of solute } (gmol^{-1})) \times (\text{Volume of solution } (dm^3))}$$

Units of Molarity:

$$\text{Molarity} = \frac{\text{Number of moles of solute}}{\text{Volume of solution in } dm^3}$$

$$M = \frac{mol}{dm^3}$$

$$\mathbf{M = moldm^{-3}}$$

Relationship between Molarity and Solute:

$$\textbf{Molarity} \propto \textbf{solute}$$

As amount of solute is increased, its concentration or molarity also increases. **2M** solution is **more concentrated than 1M solution**.

Q.3 Define molar solution. Describe preparation of molar solution.

(GRW 2016 G-II, LHR 2016 G-I, FSD 2017 G-II)*(U.B+A.B)*

Ans:

MOLAR SOLUTION

*"A solution which **contains 1 mole of solute dissolved per dm^3 of solution** is called molar solution".*

PREPARATION OF MOLAR SOLUTION

One molar solution is prepared by **dissolving 1 mole (molar mass) of** the **solute in** sufficient amount of **water** to make the **total volume** of the **solution** up to **1dm^3** in a measuring flask.

Examples:

1M solution of **NaOH** is prepared by dissolving **40g of NaOH in** sufficient amount of **water** to make the **total volume** of solution **1dm^3**.

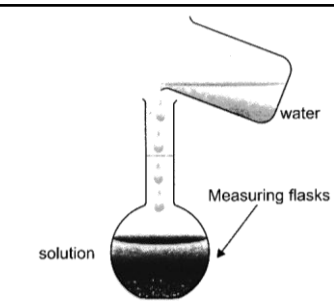


Figure: Dilution of a Solution

Q.4 Explain how dilutes solution are prepared from concentrated. Explain dilution of solution in detail. **(Ex–Q.3) (LHR 2016 G-I)*(U.B+A.B)***

Ans:

DILUTION OF SOLUTION

"*The **process of decreasing concentration of solution by adding more solvent** in it is called dilution of solution".*

Example:

We do have **2M solution of NaCl**. If we **add** more **solvent (water)** to it, the **concentration** of solution **decreases**. This process is called dilution of solution.

PREPARATION OF DILUTE SOLUTION

Dilute molar solution is prepared from a concentrated solution of known molarity.

Example:

Suppose we want to **prepare 100cm^3 of 0.01 M** solution **from given 0.1 M** solution of **potassium permanganate ($KMnO_4$)**.

Method:

It involves following two steps:

(i) Determination of Volume of Concentrated Solution:

First **0.1 M** solution is **prepared by dissolving 15.8 g** of **potassium permanganate** in **1 dm^3 of solution**. Then **0.01 M solution** is **prepared by** the dilution according to following calculations:

By using formula:

Concentrated solution = Dilute solution

$$M_1V_1 = M_2V_2$$

By putting values:

$$V_1 \times 0.1 = 0.01 \times 100$$

$$V_1 \times 0.1 = 0.01 \times 100$$

$$V_1 = 0.01 \times 100 = 10cm^3$$

$$V_1 = 10cm^3$$

Concentrated solution of $KMnO_4$ has dense purple colour.

(ii) <u>Preparation of Solution:</u>

We take **10 cm^3** of this solution with the help of a **graduated pipette** and put in a **measuring flask** of **100 cm^3**. Add water upto the mark, present at the neck of the flask. Now it is 0.01 molar solution of $KMnO_4$.

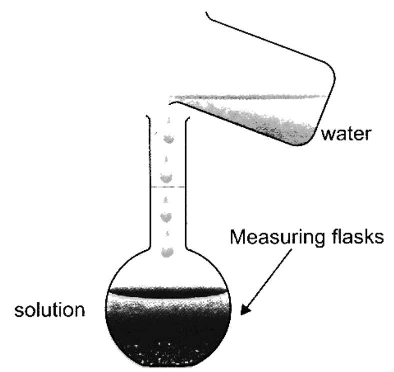


Figure: Dilution of a Solution

6.4 CONCENTRATION UNITS

6.4.1 PERCENTAGE

SHORT QUESTIONS

Q.1 Write a note on mass/mass %? **(BWP, LHR 2016 G-I, 2017, FSD 2016)*(K.B)***

Ans: *Answer given on pg # 203*

Q.2 What do you mean by volume/mass%? **(SGD 2016, GRW 2016,17)*(K.B)***

Ans: *Answer given on pg # 203*

Q.3 Define concentration. **(DGK 2016, FSD 2016, LHR 2015,16, GRW 2016)*(K.B)***

Ans: *Answer given on pg # 203*

Q.4 Define molarity.

(SWL 2016, MTN 2017, FSD 2016, SGD 2016, LHR 2016, GRW 2015, 2016, 17 G-I, II)*(K.B)*

Ans: *Answer given on pg # 204*

NUMERICAL EXAMPLE

NUMERICAL EXAMPLE 6.1

If we add 5cm^3 of acetone in water to prepare 90 cm^3 of aqueous solution, calculate the concentration (v/v) of this solution. ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Volume of acetone = 5 cm^3

Volume of solution = 90 cm^3

To Find:

Concentration of solution (v/v) = ?

Calculations:

$$\text{Conc. of solution } (\%v/v) = \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

$$= \frac{5}{90} \times 100 = 5.5$$

Thus concentration of solution is 5.5 percent by volume.

Result:

Concentration of solution is 5.5 %v/v.

NUMERICAL EXAMPLE 6.2

Calculate the molarity of a solution which is prepared by dissolving 28.4 g of Na_2SO_4 in 400 cm^3 of solution. ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Mass of solute = 28.4 g

Volume of solution = 400 cm^3

Molar Mass of Na_2SO_4 = 142 g/mol

Required Data:

Molarity = ?

Calculations:

$$\text{Number of moles of } Na_2SO_4 = \frac{\text{Mass dissolved (g)}}{\text{Molar mass (g/mol)}}$$

$$= \frac{28.4\,g}{142\,gmol^{-1}} = 0.2\,mol$$

$$\text{Conversation of volume in } dm^3 = 400cm^3 = \frac{400}{1000}dm^3$$

$$= 0.4\,dm^3$$

$$\text{Molarity} = \frac{\text{Number of moles}}{\text{Volume of solution } (dm^3)}$$

$$= \frac{0.2}{0.4}$$

$$= 0.5\text{ mol dm}^{-3}$$

Result:

Molarity of solution is 0.5 mol dm^{-3}.

NUMERICAL EXAMPLE 6.3

How much NaOH is required to prepare its 500 cm^3 of 0.4 M solution? ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Volume of solution = V = 500 cm^3

Molarity = M = 0.4 M

To Find:

Mass of solute = ?

Calculations:

Conversion of mass of solute into moles

Molar mass of NaOH = 40 g mol^{-1}

Conversation of volume in dm^3 = 500 cm^3

$$= \frac{500}{1000} dm^{-3} = 0.5 dm^3$$

Putting the values in formula:

$$M = \frac{\text{Mass of solute (g)}}{\text{Molar mass (g mol}^{-1}) \times \text{volume of solution (dm}^3)}$$

Mass of solute = Molarity × molar × mass × volume

= 0.4 × 40 × 0.5

= 8g

Result:

8g sodium hydroxide is required to prepare 0.4 M solution.

NUMERICAL EXAMPLE 6.4

10 cm^3 of 0.01 molar $KMnO_4$ solution has been diluted to 100 cm^3. Find out the molarity of this solution. ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Molarity of concentrated solution of $KMnO_4$ = M_1 = 0.01

Volume of concentrated solution of $KMnO_4$ = V_1 = 10 cm^3

Volume of dilute solution of $KMnO_4$ = V_2 = 100 cm^3

To Find:

Molarity of dilute solution of $KMnO_4$ = M_2 = ?

Calculations:

Using following formula, molarity required can be calculated as:

Concentrated solution = Dilute solution

$$M_1V_1 = M_2V_2$$

$$M_2 = \frac{M_1V_1}{V_2}$$

By putting the values, we get molarity:

$$M_2 = \frac{0.01 \times 10}{100}$$

$$M_2 = 0.001 \text{ M}$$

Result:

The molarity of dilute (new) solution of $KMnO_4$ is 0.001 M.

6.4 CONCENTRATION UNITS

6.4.1 PERCENTAGE

MULTIPLE CHOICE QUESTIONS

1. **Concentration is ratio of** *(K.B)*
(A) Solvent to solute (B) Solute to solution (C) Solvent to solution (D) Both (A) and (B)

2. **If the solute-solute forces are strong enough than those of solute-solvent forces. The solute:** *(U.B)*
(A) Dissolve readily (B) Does not dissolve
(C) Dissolves slowly (D) Dissolves and precipitates

3. **Which one of the following solution has less water?** **(GRW 2014)***(U.B)*
(A) 0.25M (B) 0.50M (C) 0.60M (D) 2.0M

4. **Concentration is most often expressed as the ratio of the amount of __________ to the amount of solution.** *(U.B)*
(A) Solute (B) Solvent (C) Brine (D) Salt

5. **10g of sugar is dissolved in 90 g of water to make 100 g of solution. This is an example of solution:** *(A.B)*
(A) % m/m (B) % m/v (C) % v/v (D) % v/m

6. **If we add 10cm^3 of acetone in water to prepare 90cm^3 of aqueous solution. What will be the concentration (v/v) of this solution?** *(U.B+A.B)*
(A) 5.5 (B) 11.1 (C) 1.11 (D) 5.6

7. **Number of moles of solute dissolved in 1dm^3 of solution is called:** *(K.B)*
(A) Molarity (B) Molality (C) Solvent (D) Solute

8. **1M solution of NaOH is prepared by dissolving ________ g of NaOH in sufficient water.** *(U.B+A.B)*
(A) 40 (B) 30 (C) 10 (D) 20

9. **2M solution is more concentrated than ________ solution.** *(U.B)*
(A) 1M (B) 2M (C) 3M (D) 5M

10. **Molarity is the number of moles of solute dissolved in:** *(K.B)*
(A) 1kg of solution (B) 100g of solvent (C) 1dm^3 of solvent (D) 1dm^3 of solution

11. **Which one of the following solution contains more water?** *(U.B)*
(A) 2M (B) 1M (C) 0.5M (D) 0.25M

12. **0.1M solution is diluted to ten times its new molarity will be:** *(U.B)*
(A) 0.01M (B) 0.9M (C) 0.2M (D) 0.1M

13. **20g of NaOH has been dissolved in 0.5dm^3 of the solution, its molarity is:** *(U.B+A.B)*
(A) 1M (B) 1.0M (C) 0.5M (D) 1.5M

14. **What mass of NaOH is required to prepare 1M, 500cm^3 of the solution:** *(U.B+A.B)*
(A) 10g (B) 20g (C) 30g (D) 40g

15. **What volume of 2M solution of H_2SO_4 is required to prepare 500cm^3, 0.1M solution:** *(U.B+A.B)*
(A) 10cm^3 (B) 15cm^3 (C) 20cm^3 (D) 25cm^3

6.2 TEST YOURSELF

i. Does the percentage calculations require the chemical formula of the solute? *(U.B)*

Ans: **FORMULA FOR %AGE CALCULATION**

Percentage calculations do not require the chemical formula of the solute because only the mass of solution is considered and molar mass is not required.

ii. Why is the formula of solute necessary for calculation of the molarity of the solution? *(U.B)*

Ans: **NECESSITY OF FORMULA OF SOLUTE**

The formula of solute is necessary for calculation of the molarity of the solution because we have to calculate molar mass of solute. Molar mass of solute can be calculated from its chemical formula.

iii. You are asked to prepare 15 percent (m/m) solution of common salt. How much amount of water will be required to prepare this solution? *(U.B+A.B)*

Ans: **WATER FOR 15% (m/m) SOLUTION**

15% m/m common salt solution means that 15.0g of common salt is dissolved in 85g of water to make 100g of solution.

iv. How much water should be mixed with 18 cm^3 of alcohol so as to obtain 18 % (v/v) alcohol solution? *(U.B+A.B)*

Ans: **WATER FOR 18% (v/v) SOLUTION**

18%v/v alcohol solution in water means that 18cm^3 of alcohol is dissolved in sufficient amount of water so that total volume of the solution becomes 100cm^3.

v. Calculate the concentration % (m/m) of a solution which contains 2.5 g of salt dissolved in 50 g of water. *(U.B+A.B)*

Ans: **NUMERICAL**

Solution:

Give data:

Mass of salt (solute) = 2.5 g

Mass of water (solvent) = 50 g

To Find:

Concentration % m/m of solution = ?

Calculations:

$$\text{Concentration (\%m/m)} = \frac{\text{Mass of solute}(g)}{\text{Mass of solute}_{(g)} + \text{Mass of Solvent}_{(g)}} \times 100$$

$$\% \text{ m/m} = \frac{2.5 \text{ gm}}{2.5 \text{ gm} + 50 \text{ gm}} \times 100$$

$$\% \text{ m/m} = \frac{2.5\text{gm}}{52.5\text{gm}} \times 100 = 4.76\%$$

$$\% \text{ m/m} = 4.76 \%$$

vi. Which one of the following solutions is more concentrated? One molar or three molar: *(U.B)*

Ans: **CONCENTRATION OF SOLUTION**

Concentration depends upon amount of solute. Three molar solutions is more concentrated than one molar solution because it consists of three times the amount of solute.

6.5 SOLUBILITY

6.5.1 SOLUBILITY AND SOLUTE-SOLVENT INTERACTION

Q.1 What is solubility? Write down the factors affecting solubility. **(LHR 2017 G-I)*(U.B+K.B)***

OR

What is general principle of solubility? **(Ex-Q.6)*(U.B+K.B)***
(RWP 2017, MTN 2016, DGK 2016, SGD 2016,17, BWP 2016,17, FSD 2017)

Ans: **<u>SOLUBILITY</u>**

<u>Definition:</u>

"***The number of grams of the solute dissolved in 100 g of solvent to prepare a saturated solution at a particular temperature***".

The **concentration of a saturated solution** is referred to as **solubility of the solute** in a given solvent.

<u>Example:</u>

Solubility of sodium thiosulphate ($Na_2S_2O_3$) in water at 20°C is 20.9g of salt per 100g of water.

<u>Factor Affecting the Solubility:</u>

Following are the factors which affect the solubility of solutes:

(i) Nature of solute and solvent **(like dissolves like)**
(ii) Solute-solvent interactions
(iii) Temperature

<u>LIKE DISSOLVES LIKE (NATURE OF SOLUTE AND SOLVENT)</u>

The general principle of solubility is, **like dissolves like**.

(i) The **polar** substances are **soluble in polar solvents. Ionic solids and polar** covalent compounds are **soluble in water**.

<u>Examples:</u>

KCl, Na_2CO_3, $CuSO_4$, sugar and **alcohol** are all **soluble in water**.

(i) Non-polar substances are **not soluble in polar solvents**.

<u>Examples:</u>

Ether, benzene and **petrol** are **insoluble in water**.

(i) Non-polar covalent substances are **soluble in non-polar solvents** (mostly organic solvents).

<u>Examples:</u>

Grease, paints, naphthalene are **soluble in ether** or **carbon tetrachloride** etc.

Q.2 Write a detailed note on solubility and solute-solvent interaction. **(Ex-Q.5)**
(FSD 2017 G-II, SGD 2017 G-II)*(U.B)*

Ans: **<u>SOLUBILITY AND SOLUTE SOLVENT INTERACTION</u>**

"*The solute-solvent interaction can be explained in terms of creation of attractive forces* ***between the particles of solute and those of solvent***".

<u>Steps to Dissolve Solute in Solvent:</u>

To dissolve one substance (solute) in another substance (solvent) following **three events** must occur:

(i) Solute particles must separate from each other
(ii) Solvent particles must separate to provide space for solute particles.
(iii) Solute and solvent particles must attract and mix up.

<u>Dependence of Solution Formation:</u>

Solution formation depends upon the **relative strength of attractive forces between solute-solute, solvent-solvent and solute-solvent**.

<u>Physical States of Solute:</u>

Generally solutes are **solids**.

Interactions Between Particles:

Ionic solids are arranged in such a regular pattern that the **inter-ionic forces are at a maximum**. If the new forces between solute and solvent particles overcome the solute-solute attractive forces, then solute dissolves and makes a solution.

If **forces between solute particles** are **strong** enough than **solute-solvent forces**, **solute remains insoluble** and solution is not formed. The solvent molecules first pull apart the solute ions and then surround them. In this way solute dissolves and solution forms.

Example (Dissolution of Sodium Chloride):

When NaCl is added in water it dissolves readily because the **attractive interaction between the ions of NaCl and polar molecules of water are strong** enough to overcome the attractive forces between Na^+ and Cl^- ions in solid NaCl crystal. In this process the positive end of the water dipole is oriented towards the Cl^- ions and the negative end of water dipole is oriented towards the Na^+ ions. These **ion-dipole attractions between Na^+ ions and water molecules, Cl^- ions and water molecules are so strong** that they pull these ions from their positions in the crystal and thus NaCl dissolves.

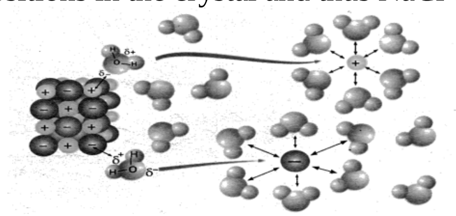


Figure: Inter-action of Solute and Solvent to Form Solution

Q.3 Discuss the effect of temperature on solubility? **(Ex-Q.7)**
(GRW 2016 G-II, LHR 2016 G-II, RWP 2017 G-II)*(U.B)*

Ans:

EFFECT OF TEMPERATURE ON SOLUBILITY

Temperature has major effect on the solubility of most of the substances. Generally it seems that solubility increases with the increase of temperature, but it is not always true.

Possibilities:

When a solution is formed by adding a salt in solvent there are **three** possibilities with reference to effect of temperature on solubility. These possibilities are as follows:

(i) Heat is absorbed
(ii) Heat is given out
(iii) No change in heat

(i) Heat is Absorbed (Endothermic Process)

Solubility usually increases with the increase in temperature for such solutes. When salts like **KNO_3, $NaNO_3$** and **KCl** are added **in water**, the **test tube** becomes **cold**. It means during dissolution of these salts heat is absorbed. Such dissolving process is called **"endothermic"**

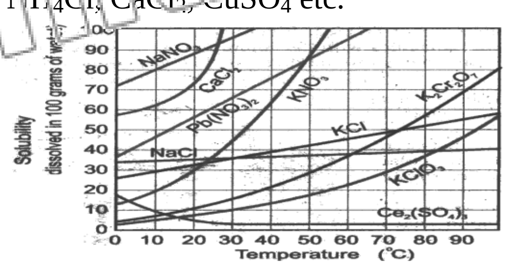
$$\textbf{solvent + solute + heat} \longrightarrow \textbf{solution}$$

Significance of Heat Absorbed:

It means that heat is required **to break the attractive forces between the ions of solute**. This requirement is fulfilled by the surrounding molecules. As a result, their temperature falls down and test tube becomes cold.

Examples:

KNO_3, $NaNO_3$, KCl, NH_4Cl, $CaCl_2$, $CuSO_4$ etc.



(ii) Heat is given out (Exothermic Process)

In such cases, the **solubility of salt decreases with the increase of temperature**

When salts like **Li_2SO_4** and **$Ce_2(SO_4)_3$** are dissolved **in water**, the **test tube** becomes **warm**. i.e. heat is released during this dissolution.

solvent + solute ——→ solution + heat

Why Heat Released?

In such cases **attractive forces among the solute particles** are weaker and solute-solvent interactions are stronger. As a result, there is release of energy.

Examples:

- Li_2CO_3
- $Ca(OH)_2$
- Li_2SO_4
- $CaCrO_4$

(iii) No Change in Heat

In some cases during a dissolution process neither the heat is absorbed nor released.

Example:

When salt like **NaCI** is added **in water**, the solution temperature remains almost the same. In such case **temperature has a minimum effect on solubility**.

6.5 SOLUBILITY

6.5.1 SOLUBILITY AND SOLUTE-SOLVENT INTERACTION

SHORT QUESTIONS

Q.1 What do you mean by "like dissolves like?" Explain with examples. ***(U.B+A.B)***

Ans: *Answer given on pg # 211*

Q.2 Define solubility. ***(K.B)***

Ans: *Answer given on pg # 211*

Q.3 Which factors affect the solubility? ***(U.B)***

Ans: *Answer given on pg # 212*

Q.4 Why test tube becomes warm when lithium sulphate is added in test tube containing water? ***(U.B)***

Ans: *Answer given on pg # 212*

6.5 SOLUBILITY

6.5.1 SOLUBILITY AND SOLUTE-SOLVENT INTERACTION

MULTIPLE CHOICE QUESTIONS

1. Which one of the following will show negligible effect of temperature on its solubility? **(LHR 2014)*(U.B)***

(A) KCl (B) KNO_3 (C) NaCl (D) $NaNO_3$

2. The ionic and polar compounds like NaCl and HCl are more soluble in water than non-polar covalent compounds like: ***(U.B)***

(A) CCl_4 (B) Benzene (C) CS_2 (D) All of these

3. Which one is not soluble in water? **(FSD 2017 G-I)*(K.B)***

(A) C_6H_6 (B) KCl (C) Na_2CO_3 (D) $CuSO_4$

4. Naphthalene is soluble in: ***(K.B)***

(A) Water (B) Ether

(C) Carbon tetrachloride (D) Both B and C

5. Which one of the following salts gives out heat on dissolving in water? ***(U.B+A.B)***

(A) NaCl (B) $Ce_2(SO_4)_3$ (C) KNO_3 (D) KCl

6. Heat is absorbed on dissolving which one of the following salt? ***(U.B+A.B)***

(A) NaCl (B) $Ce_2(SO4)_3$ (C) $NaNO_3$ (D) Li_2SO_4

7. Which one is soluble in water? **(GRW 2017 G-II)*(K.B)***

(A) Benzene (B) Petrol (C) Ether (D) Alcohol

8. Generally solutes are: ***(K.B)***

(A) Liquids (B) Gases (C) Solids (D) Solvents

6.3 TEST YOURSELF

i. What will happen if the solute-solute forces are stronger than those of solute-solvent forces? ***(U.B)***

Ans: **STRONGER SOLUTE-SOLUTE FORCES**

When **solute-solute forces** are **stronger** than those of **solute-solvent forces**, the solute will **not dissolve** and will **not form solution**.

ii. When solute-solute forces are weaker than those of solute-solvent forces. Will solution form? ***(U.B)***

Ans: **WEAKER SOLUTE-SOLUTE FORCES**

It means when **solute-solute forces** are weaker than those of **solute-solvent forces** the solute solvent attractive forces will overcome the **solute forces**, then solute will dissolve and thus **solution will form**.

iii. Why is iodine soluble in CCl_4 and not in water? ***(U.B)***

Ans: **SOLUBILITY OF IODINE IN CCl_4 AND WATER**

The principle of solubility is *"like dissolves like."*

Iodine is soluble in **CCl_4** because both are **non-polar**. Water cannot dissolve iodine because **water** is **polar solvent** and **iodine** is **non-polar**.

iv. Why test tube becomes cold when KNO_3 is dissolved in water? **(SGD 2017 G-I)*(U.B)***

Ans: **SOLUBILITY OF KNO_3**

When KNO_3 is added in water, the test tube becomes cold. It means during dissolution of these salts heat is absorbed from the surrounding to break the forces between ions of solute.

$$\text{Solvent + solute + heat} \longrightarrow \text{solution}$$

6.6 COMPARISON OF SOLUTION, SUSPENSION AND COLLOID

Q.1 Give five characteristics of true solution. **(SWL 2017)*(K.B)***

Ans: **TRUE SOLUTION**

*"A **homogeneous mixture of two or more than two components** is called true solution."*

Examples:

- Solution of **NaCl in water.**
- **Drop of ink** mixed **in water** (simplest example of true solution)
- Solution of **sugar in water**.

Properties:

(i) The **particles** exist in their **simplest form** i.e. as molecules or ions. Their **diameter is 10^{-8} cm**.

(ii) Particles dissolve uniformly throughout and form a **homogeneous mixture**.

(iii) Particles are so small that they **can't be seen with naked eye**.

(iv) Solute **particles** can **pass** easily through a **filter paper**.

(v) Particles are so small that they **cannot scatter** the **rays of light,** thus **do not show Tyndall effect**.

Q.2 Give the five characteristics of colloid solution. **(Ex-Q.8)(GRW 2017 G-I, SGD 2017 G-II)*(K.B)***

OR

Define colloids. Write down characteristics of colloids. **(GRW 2016 G-I)*(K.B)***

Ans: **<u>COLLOIDS OR COLLOIDAL SOLUTIONS</u>**

*"These are **solutions in which the solute particles are larger than those present in the true solutions but not large enough to be seen by naked eye**."*

<u>Examples:</u>

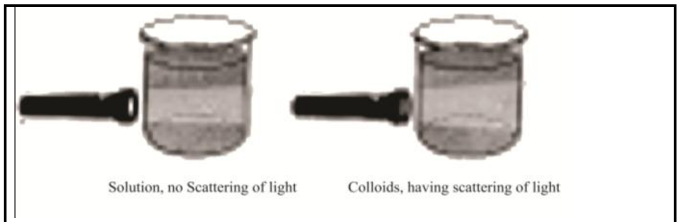
- Starch
- Albumin
- Soap solutions
- Blood
- Milk
- Ink
- Jelly
- Toothpaste

<u>Tyndall Effect and Distinction between Colloid and Solution:</u>

We can see the path of scattered light beam inside the colloidal solution. **Tyndall effect is the main characteristic which distinguishes colloids from solutions**. Hence these solutions are called **false solutions** or **colloidal solutions**.

<u>Tyndall Effect:</u>

*"The **particles of colloids are big enough to scatter the beam of light**. It is called Tyndall effect."*



<u>Figure: Tyndall Effect by Colloids</u>

<u>Properties:</u>

The properties of colloidal solution are as follows:

- The **particles are large** consisting of many atoms, ions or molecules.
- A colloid **appears** to be a **homogeneous** but **actually** it is a **heterogeneous** mixture. Hence, they are **not true solution**. Particles do not settle down for a long time, therefore, colloids are **quite stable**.
- Particles are large but **can't be seen with naked eye**.
- Although particles are big but they **can pass** through a **filter paper**.
- Particles scatter the path of light rays thus emitting the beam of light i.e. **exhibit the Tyndall effect**.

Q.3 What is suspension? Write its characteristics. **(Ex-Q.9) (LHR 2017 G-I, RWP 2017 G-I)*(K.B)***

Ans: **<u>SUSPENSION</u>**

*"**A heterogeneous mixture of undissolved particles in a given medium that settles down after some time is called suspension**."*

<u>Examples:</u>

- Chalk in water (milky suspension)
- Paints
- Milk of magnesia (suspension of magnesium oxide in water)

Properties:

(i) The particles are of largest size. They are larger than **10^{-5}cm in diameter**.

(ii) **Particles remain undissolved** and form a **heterogeneous** mixture. Particles settle down after sometime

(iii) Particles are big enough to be **seen with naked eye**

(iv) Solute particles **cannot pass** through **filter paper**.

(v) Particles are so big that **light is blocked** and difficult to pass.

Q.4 How you can compare solutions, colloid and suspension? *(U.B)*

Ans: **COMPARISON**

Comparison of the characteristics of solution, colloid and suspension are as follows:

Solution	Colloid	Suspension
Size of Particles		
• The particles exist in their simplest form i.e. as molecules or ions. Their **diameter is 10^{-8} cm.**	• The particles are large consisting of many atoms, ions or molecules.	• The particles are of largest size. They are larger than **10^{-5}cm in diameter.**
Solubility of Particles		
• Particles dissolve uniformly throughout and form a **homogeneous mixture.**	• A colloid appears to be a homogeneous but actually it is a heterogeneous mixture. Hence, they are **not true solution.** Particles do not settle down for a long time, therefore, colloids are **quite stable.**	• Particles remain undissolved and Form a **heterogeneous mixture.** Particles settle down after sometime
Observation With Naked Eye		
• Particles are so small that they can't be **seen with naked eye.**	• Particles are large but **can't be seen with naked eye.**	• Particles are big enough to be **seen with naked eye.**
Passing Through Filter Paper		
• Solute particles can **pass** easily through a **filter paper.**	• Although particles are big but they can **pass** through a **filter paper.**	• Solute particles **cannot pass** through **filter paper.**
Tyndall Effect		
• Particles are so small that they cannot scatter the rays of light, thus **do not show Tyndall effect.**	• Particles scatter the path of light rays thus emitting the beam of light i.e. **exhibit the tyndall effect.**	• Particles are so big that **light is blocked** and difficult to pass.

6.6 COMPARISON OF SOLUTION, SUSPENSION AND COLLOID

MULTIPLE CHOICE QUESTIONS

1. In true solution, the particles are of size: ***(K.B)***
(A) 10^{-5} cm (B) 10^{-2} cm (C) 10^{-2} cm (D) 10^{-2} cm

2. Which one produces colloidal solution? ***(K.B)***
(A) Blood (B) Copper sulphate solution
(C) Silver nitrate solution (D) None of these

3. Tyndall effect is shown by: **(LHR 2016, RWP 2017 G-II, SGD 2017 G-II)*(A.B)***
(A) Sugar solution (B) Paint (C) Jelly (D) Chalk solution

4. Which one of the following is heterogeneous mixture? ***(A.B)***
(A) Milk (B) Ink (C) Milk of magnesia (D) Sugar solution

5. Tyndall effect is due to: ***(U.B)***
(A) Blockage of beam of light (B) Non-scattering of beam of light
(C) Scattering of beam of light (D) Passing through beam of light

6. The diameter of particles in solution is: ***(K.B)***
(A) 10^{-6} cm (B) 10^{-4} cm (C) 10^{-8} cm (D) 10^{-5} cm

7. Chalk in water is an example of: ***(A.B)***
(A) Suspension (B) Colloid (C) Solution (D) Solute

8. An example of colloidal solution is: ***(A.B)***
(A) Drop of ink in water (B) Milk of magnesia
(C) Blood (D) Paint

9. Which one is also called false solution? ***(U.B)***
(A) Colloidal solution (B) Suspension (C) Paint (D) Water

6.4 TEST YOURSELF

i. What is difference between colloid and suspension?
(DGK, BWP 2017, FSD, RWP 2016, LHR 2016 G-I)*(U.B)*

Ans: **DIFFERENTIATION**

The differences between colloidal solution and suspension are as follows:

Colloid	Suspension
Composition	
• The particles are large consisting of many atoms, ions or molecules.	• The particles are of largest size. They are larger than 10^{-5}cm in diameter.
Visibility	
• Particles are large but can't be seen with naked eye.	• Particles are big enough to be seen with naked eye
Passing Through Filter Paper	
• Although particles are big but they can pass through a filter paper.	• Solute particles cannot pass through filter paper.
Tyndall Effect	
• Particles scatter the path of light rays thus emitting the beam of light i.e. exhibit the Tyndall effect.	• Particles are so big that light is blocked and difficult to pass.

ii. Can colloids be separated by filtration, if not why? ***(U.B)***

Ans: **SEPARATION OF COLLOIDS**

Colloids cannot be separated by filtration because the particles in colloids are not so big. They can pass through a filter paper.

iii. Why are the colloids quite stable? ***(U.B)***

Ans: **STABILITY OF COLLOID**

The colloids are quite stable because particles do not settle down for a long time. Colloids are quite stable.

iv. Why does the colloid show Tyndall effect? ***(U.B)***

Ans: **TYNDALL EFFECT OF COLLOID**

Colloids show Tyndall effect because in colloids the particle size is suitable to scatter the path of light rays.

v. What is Tyndall effect and on what factors it depends? ***(U.B)***

Ans: **TYNDALL EFFECT AND FACTORS AFFECTING IT**

"The phenomenon of scattering of beam of light by particles of colloids is called Tyndall effect".

Dependence:

It depends upon the size of particles.

vi. Identify as colloids or suspensions from the following: ***(U.B+A.B)***

Milk, milk of magnesia, soap solution and paint.

Ans: **IDENTIFICATION AS COLLOID ARE SUSPENSION**

Colloids: Milk, soap solution

Suspensions: Paints, milk of magnesia

vii. How can you justify that milk is a colloid. ***(U.B)***

Ans. **MILK IS COLLOID**

Justification:

Milk (consists of big particles of carbohydrates, fats, proteins etc.) is a colloid because it shows Tyndall effect.

Milk particles are big but they can pass through a filter paper. Milk particles are larger but cannot be seen with naked eye. Milk particles scatter the path of light rays thus scattering the beam of light i.e. exhibit the Tyndall effect.

ANSWER KEYS

INTRODUCTION

1	A	2	A

6.1 SOLUTION

1	A	2	A	3	D	4	B	5	A	6	B	7	A	8	D	9	A

6.2 SATURATED SOLUTION

1	C	2	C	3	B	4	A	5	A	6	A	7	B

6.3 TYPES OF SOLUTIONS

1	D	2	A	3	B	4	A	5	B	6	B	7	C

6.4 CONCENTRATION UNITS

6.4.1 PERCENTAGE

1	B	2	B	3	D	4	A	5	A	6	B	7	A	8	A
9	A	10	D	11	D	12	A	13	A	14	B	15	D		

6.5 SOLUBILITY

6.5.1 SOLUBILITY AND SOLUTE-SOLVENT INTERACTION

1	C	2	D	3	A	4	D	5	B	6	C	7	D	8	C

6.6 COMPARISON OF SOLUTION, SUSPENSION AND COLLOID

1	A	2	A	3	C	4	C	5	C	6	D	7	A	8	C	9	A

EXERCISE SOLUTION

MULTIPLE CHOICE QUESITONS

1. Mist is an example of solution: **(LHR 2017 G-II, MTN 2016 G-I, BWP 2016 G-I, II)*(A.B)***
(A) Liquid in gas (B) Gas in liquid (C) Solid in gas (D) Gas in solid

2. Which one of the following is a 'liquid in solid' solution?
(RWP 2017 G-I, DGK 2017 G-II, SWL 2017 G-II)*(A.B)*
(A) Sugar in water (B) Butter (C) Opal (D) Fog

3. Concentration is ratio of: **(BWP 2017 G-II)*(K.B)***
(A) Solvent to solute (B) Solute to solution (C) Solvent to solution (D) Both a and b

4. Which one of the following solutions contains more water? **(LHR 2017 G-I,II, RWP 2016 G-I)*(U.B)***
(A) 2M (B) 1M (C) 0.5 M (D) 0.25 M

5. A 5 percent (w/w) sugar solution means that: ***(U.B)***
(A) 5 g of sugar is dissolved in 90 g of water (B) 5 g of sugar is dissolved in 100 g of water
(C) 5 g of sugar is dissolved in 105 g of water (D) 5 g of sugar is dissolved in 95 g of water

6. If the solute-solute forces are strong enough than those of solute-solvent forces. The solute:
(DGK 2017 G-II)*(U.B)*
(A) Dissolves readily (B) Does not dissolve
(C) Dissolves slowly (D) Dissolves and precipitates

7. Which one of the following will show negligible effect of temperature on its solubility?
(MTN 2016 G-II)*(A.B)*
(A) KCl (B) $NaNO_3$ (C) KNO_3 (D) NaCl

8. Which one of the following is heterogeneous mixture?
(BWP 2017 G-I, SGD 2016 G-I, II, FSD 2016 G-I,II)*(A.B)*
(A) Milk (B) Ink (C) Milk of magnesia (D) Sugar solution

9. Tyndall effect is shown by:
(DGK 2016 G-I, GRW 2017 G-I, LHR 2016 G-I, RWP 2017 G-II, SWL 2017 G-II, DGK 2016 G-II)*(A.B)*
(A) Sugar solution (B) Jelly (C) Paints (D) Chalk solution

10. Tyndall effect is due to: **(BWP 2017 G-I, SWL 2017 G-I)*(U.B)***
(A) Blockage of beam of light (B) Non-scattering of beam of light
(C) Scattering of beam of light (D) Passing through beam of light

11. If 10 cm^3 of alcohol is dissolved in 100 g of water, it is called: **(LHR 2017 G-I, SWL 2017 G-I)*(A.B)***
(A) % w/w (B) %w/v (C) % v/w (D) %v/v

12. When a saturated solution is diluted it turns into: **(SGD 2017 G-II)*(U.B)***
(A) Supersaturated solution (B) Saturated solution
(C) A concentrated solution (D) Unsaturated solution

13. Molarity is the number of moles of solute dissolved in: **(GRW 2017 G-II, BWP 2017 G-II)*(K.B)***
(A) 1 kg of solution (B) 100 g of solvent (C) 1 dm^3 of solvent (D) 1 dm^3 of solution

ANSWER KEY

1	A	2	B	3	B	4	D	5	D	6	B	7	D
8	C	9	B	10	C	11	C	12	D	13	D		

EXERCISE SHORT QUESTIONS

1. Why suspensions and solutions do not show Tyndall effect, while colloids do? *(U.B)*

Ans: **SHOWING TYNDALL EFFECT**

Suspensions and Solutions:

Suspensions and solutions do not show Tyndall effect because in suspensions particles are so big that light is blocked and difficult to pass. But in solution particles are so small that they cannot scatter the rays of light, thus do not show Tyndall effect.

Colloids:

Colloids can show Tyndall effect because particles scatter the path of light rays.

2. What is the reason for the difference between solutions, colloids and suspensions? *(U.B)*

Ans: **REASON FOR DIFFERENCE**

The differentiation between solutions, colloids and suspensions is based upon the particle size. In colloidal solutions the particles size is intermediate between true solutions and suspensions.

3. Why does not the suspension form a homogeneous mixture? **(DGK 2016)***(U.B)*

Ans: **SUSPENSION NOT A HOMOGENEOUS MIXTURE**

In suspension particles remain un-dissolved due to their big size. After sometime particles settle down under the action of gravity, therefore suspension does not form a homogeneous mixture.

4. How will you test whether given solution is a colloidal solution or not? *(U.B+A.B)*

Ans: **TESTING OF SOLUTION AS COLLOID**

We will pass light in the solution, if the given solution scattered the light then it is a colloidal solution. It solution does not scatter the light then it is not colloidal solution.

5. Classify the following into true solution and colloidal solution: *(U.B+A.B)*
Blood, starch solution, glucose solution, tooth paste, copper sulphate solution, silver nitrate solution.

Ans: **CLASSIFICATION**

The classification of true solution and colloidal solution are as follows:

True Solutions	Colloidal Solutions
• Glucose solution	• Blood
• Copper sulphate solution	• Tooth paste
• Silver nitrate solution	• Starch solution

6. Why we stir paints thoroughly before using? *(U.B)*

Ans: **STIRRING OF PAINTS BEFORE USE**

Paints are heterogeneous mixture of un-dissolved particles in a given medium. Particles settle down after sometime. So we stir paints to mix thoroughly before using.

7. Which of the following will scatter light and why? Sugar solution, soap solution and milk of magnesia. *(U.B+A.B)*

Ans: **SCATTERING OF LIGHT**

Sugar Solution:

Sugar solution will not scatter the beam light because the particles of sugar solution are so small that they cannot scatter light.

Soap Solution:

Soap solution will scatter light (Tyndall effect) because it is colloidal solution and its particles are large enough to scatter the light.

Milk of Magnesia:

Milk of magnesia cannot scatter the light because it is suspension and its particles are so big that light is blocked.

8. What do you mean by "like dissolves like?" Explain with examples. (MTN 2017, GRW 2015, 16)*(U.B+A.B)*

Ans: **LIKE DISSOLVE LIKE**

"Like dissolves like" means that polar substances are dissolved in polar solvents and non-polar substances are soluble in non-polar solvents.

Examples:

- NaCl (polar) dissolves in water (polar solvent) and does not dissolve in benzene (non-polar).
- Similarly benzene (non-polar) is soluble in petrol (non-polar) but it does not dissolve in water (polar).

9. How does nature of attractive forces of solute-solute and solvent-solvent affect the solubility? **(GRW 2016, LHR 2016, SGD 2016)*(U.B)***

Ans: **EFFECT OF ATTRACTIVE FORCES ON SOLUBILITY**

Solubility depends upon solute solvent attractions.

- If the attractive forces between solute and solvent are stronger than that of solute-solute forces then solubility will take place.
- If the attractive forces between solute particles are stronger than solute solvent forces, solute remains insoluble and solution is not formed.

10. How you can explain the solute-solvent interaction to prepare a NaCl solution? **(LHR, 2016)*(U.B+A.B)***

Ans: **PREPARATION OF NaCl SOLUTION**

When NaCl is added in water it dissolves readily because the attractive forces between the ions of NaCl and polar molecules of water are strong enough to overcome the attractive forces between Na^+ and Cl^- ions in solid NaCl crystal. In this process, positive end of the water dipole is oriented towards the Cl^- ions and the negative end of water dipole is oriented towards the Na^+ ions. These ion-dipole attractions between Na^+ ions and water molecules, Cl^- ions and water molecules are so strong that they pull these ions from their positions in the crystal and thus NaCl dissolves.

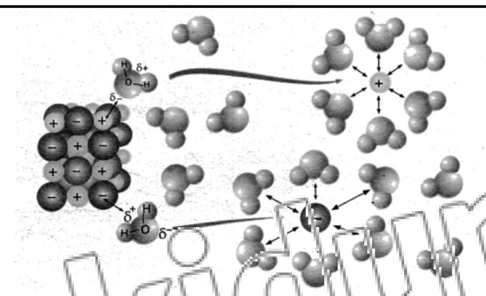


Figure: Interaction of Solute and Solvent to Form Solution

11. Justify with an example that solubility of a salt increases with the increase in temperature.*(U.B+A.B)*

Ans: **INCREASE IN SOLUBILITY WITH TEMPERATURE**

Solubility of some salts which are usually ionic in nature increases with the increase in temperature for such solutes. It means that heat is required to break the attractive forces between the ions of solute. This process is called endothermic.

Example:

Solubility of KNO_3 and KCl can be enhanced by increasing temperature.

12. What do you mean by volume/volume %? **(SGD 2017 G-II)*(K.B)***

Ans: **MEANING OF % VOLUME /VOLUME**

It is the volume in cm^3 of a solute dissolved in 100 g of the solution.

Example:

30% of alcohol solution means 30 cm^3 of alcohol dissolved in sufficient amount of water, so that the total volume of the solution becomes 100 cm^3.

$$\%\,{}^{v}\!/_{v} = \frac{\text{Volume of solute}\left(cm^3\right)}{\text{Volume of solution}\left(cm^3\right)} \times 100$$

EXERCISE LONG QUESTIONS

1. What is saturated solution and how it is prepared?

Ans: *Answer give on pg #* (Topic 6.2)

2. Differentiate between dilute and concentrated solutions with a common example.

Ans: **DIFFERENTIATION**

The differences between dilute and concentrated solutions are as follows:

Dilute Solution	Concentrated Solution
Definition	
• Dilute solutions are those which contain relatively small amount of dissolved solute in the solution.	• Concentrated solutions are those which contain relatively large amount of dissolved solute in the solution.
Examples	
• A solution containing 5g of sodium chloride in 100g water is a dilute solution.	• 0.1M Na_2CO_3 solution is dilute solution as compared to 5M Na_2CO_3 solution.

3. Explain, how dilute solutions are prepared from concentrated solutions?

Ans: *Answer give on pg #* 205 (Topic 6.4.2)

4. What is molarity and give its formula to prepare molar solution?

Ans: *Answer give on pg #* 204 (Topic 6.4.2)

5. Explain the solute-solvent interaction for the preparation of solution.

Ans: *Answer give on pg #* 211 (Topic 6.5)

6. What is general principle of solubility?

Ans: *Answer give on pg #* 211 (Topic 6.5)

7. Discuss the effect of temperature on solubility.

Ans: *Answer give on pg #* 212 (Topic 6.5)

8. Give the five characteristics of colloid.

Ans: *Answer give on pg #* 216 (Topic 6.6)

9. Give at least five characteristics of suspension.

Ans: *Answer give on pg #* 216 (Topic 6.6)

EXERCISE SOLVED NUMERICALS

1. A solution contains 50 g of sugar dissolved in 450 g of water. What is concentration of this solution? ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Mass of sugar (solute) = 50g

Mass of water (solvent) = 450g

To Find:

Concentration of solution (% m/m) = ?

Calculations:

$$\% \text{ m/m} = \frac{\text{Mass of solute}(g)}{\text{Mass of solute}(g) + \text{Mass of solvent}(g)} \times 100$$

$$\% \text{ m/m} = \frac{50g}{50g + 45g} \times 100$$

$$= \frac{50g}{500g} \times 100$$

Thus,

% m/m = 10 m/m

Result:

The concentration of this solution is 10% m/m.

---

2. If 60 cm^3 of alcohol is dissolved in 940 cm^3 of water, what is concentration of this solution? ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Volume of alcohol (solute) = v = 60 cm^3

Volume of water (solvent) = v = 940 cm^3

To Find:

Concentration of solution (% v/v) = ?

Calculations:

$$\%V/V = \frac{\text{Volume of solute}(cm^3)}{\text{Volume of solute}(cm^3) + \text{Volume of solvent}(cm^3)} \times 100$$

$$\% \text{ v/v} = \frac{60cm^3}{60\ cm^3 + 940cm^3} \times 100$$

$$= \frac{60\ cm^3}{1000cm^3} \times 100$$

Thus, % v/v = 6%v/v

Result:

Concentration of this solution = 6%v/v

---

3. How much salt will be required to prepare following solutions (atomic mass: K=39; Na=23; S=32; O=16 and H=I) ***(U.B+A.B)***

(a) 250 cm^3 of KOH solution of 0.5 M

(b) 600 cm^3 of $NaNO_3$ solution of 0.25 M

(c) 800 cm^3 of Na_2SO_4 solution of 1.0 M

Ans:

(a) 250cm^3 of KOH solution of 0.5M

NUMERICAL

Solution:

Given Data:

Molarity of solution = M = 0.5 M

Volume of solution = V = 250 cm^3

$$= \frac{250}{1000} dm^3 = 0.25dm^3$$

Molar mass of KOH = 39+16+1=56gmol^{-1}

To Find:

Amount (mass) of KOH =?

Calculations:

$$M = \frac{\text{Mass of solute}(g)}{\text{Molar mass of solute}(gmol^{-1}) \times \text{Volume of solution}(dm^3)}$$

$$0.5M = \frac{\text{Mass of solute}(g)}{56g\ mol^{-1} \times 0.25dm^3}$$

Mass of solute = 0.5×56×0.25

=7g

Result:

7g salt is required to prepare 250cm^3 solution of KOH. (0.5 M)

(b) $600cm^3$ of $NaNO_3$ solution of 0.25M

NUMERICAL

Solution:

Given Data:

Molarity of $NaNO_3$ solution = M = 0.25M

Volume of solution = V = 600 cm^3

$$= \frac{600}{1000} = 0.6dm^3$$

Molar mass of $NaNO_3$ = 23 + 14 + 3(16)

= $85gmol^{-1}$

To Find:

Amount (mass) of $NaNO_3$ = m =?

Calculations:

Using the formula:

$$M = \frac{\text{Mass of solute}(g)}{\text{Molar mass of solute}(gmol^{-1}) \times \text{Volume of solution}(dm^3)}$$

$$\text{Molarity} = \frac{\text{Mass of solute}(g)}{85gmol^{-1} \times 0.6dm^3}$$

Mass of solute = 0.25×85×0.6

Mass of solute = 12.75g

Result:

12.75g salt is required to prepare 600 cm^3 solution of $NaNO_3$. (0.25 M)

(c) $800cm^3$ of Na_2SO_4 solution of 1.0M

NUMERICAL

Solution:

Given Data:

Molarity of Na_2SO_4 solution = M = 1 M

Volume of solution = V = 800 cm^3

$$= \frac{800}{1000} = 0.8dm^3$$

Molar mass of Na_2SO_4 = 2(23) + 32 +4(16)

= 46 + 32 + 64

= $142gmol^{-1}$

To Find:

Amount (mass) of Na_2SO_4 =?

Calculations:

Using the formula:

$$M = \frac{\text{Mass of solute}(g)}{\text{Molar mass of solute}(gmol^{-1}) \times \text{Volume of solution}(dm^3)}$$

$$1.0\,M = \frac{\text{Mass of solute}}{142gmol^{-1} \times 0.8dm^3}$$

Mass of solute $= 1.0 \times 142 \times 0.8$

$= 113.6g$

Result:

113.6g salt is required to prepare 800 cm^3 solution of Na_2SO_4. (1.0 M)

---

4. When we dissolve 20 g of NaCl in 400 cm^3 of solution, what will be its molarity? ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Mass of NaCl = 20g

Molar mass of NaCl = 23 + 35.5 = $58.5gmol^{-1}$

Volume of Solution = 400 cm^3

$$= \frac{400}{1000} = 0.4dm^3$$

To Find:

Molarity of solution M = ?

Calculations:

Using the formula:

$$M = \frac{\text{Mass of solute}(g)}{\text{Molar mass of solute}(gmol^{-1}) \times \text{Volume of solution}(dm^3)}$$

$$= \frac{20g}{58.5mol \times 0.4(dm^3)}$$

$$= \frac{20}{23.4} = 0.85M$$

Result:

Molarity of solution will be 0.85 M.

5. We desire to prepare 100 cm^3 0.4 M solution of $MgCl_2$, how much $MgCl_2$ is needed? ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Molarity of solution = M = 0.4 M

Volume of Solution = V = 100cm^3

$$=\frac{100}{1000}dm^3=0.1dm^3$$

Molar Mass of $MgCl_2$ = 24 + 2(35.5)

= 24+71 = 95$gmol^{-1}$

To Find:

Amount (mass) of $MgCl_2$ = ?

Calculations:

Using the formula:

$$M=\frac{\text{Mass of solute}}{\text{Molar mass of solute}\left(gmol^{-1}\right)\times \text{Volume of solutoin}\left(dm^3\right)}$$

$$0.4M=\frac{\text{Mass of solute}(g)}{95g\ mol^{-1}\times 0.1dm^3}$$

Mass of solute = 0.4×95×0.1

= 3.8g

Result:

3.8g of $MgCl_2$ is needed to prepare 100 cm^3 0.4 M solution of $MgCl_2$.

---

6. 12M H_2SO_4 solutions is available in the laboratory. We need only 500cm^3 of 0.1 M solution, how it will be prepared? ***(U.B+A.B)***

NUMERICAL

Solution:

Given Data:

Molarity of Conc. H_2SO_4 solution = M_1 = 12 M

Molarity of dilute H_2SO_4 solution = M_2 = 0.1 M

Volume of dilute H_2SO_4 solution = V_2 = 500cm^3

To Find:

Volume of concentrated H_2SO_4 solution = V_1 = ?

Calculations:

The solution of required concentration will be prepared by the method as follows:

(i) Determination of volume of concentrated solution:

Concentrated solution = Dilute solution

$$M_1 V_1 = M_2 V_2$$

$$12\times V_1 = 0.1\times 500$$

$$V_1 = \frac{0.1M \times 500\ cm^3}{12M}$$

Thus,

Volume of concentrated solution = 4.16 cm^3

(ii) Preparation of Solution:

We take 4.16cm^3 of concentrated 12M H_2SO_4 solution with the help of graduated pipette and put in a measuring flask of 500cm^3. Add water upto the mark, present at the neck of flask. Now it is 0.1 molar solution of H_2SO_4.

ADDITIONAL CONCEPTUAL QUESTIONS

Q.1 Differentiate between solute and solvent. ***(U.B)***

Ans: **DIFFERENTIATION**

The differences between solute and solvent are as follows:

Solute	Solvent
Definition	
The component of solution which is present in smaller quantity is called solute.	The component of a solution which is present in larger quantity is called solvent.
Example	
In sugar solution, sugar is solute.	In sugar solution, water is solvent
Dissolution	
Solute always dissolve in solvent.	Solvent always dissolve solutes.

Q.2 What type of solution of fog and brass are? ***(K.B+A.B)***

Ans: **TYPE OF SOLUTION OF FOG AND BRASS**

(i) Fog: It is an example of liquid in gas solution.

(ii) Brass: Metal alloy of Cu & Zn.

Q.3 How we can prepare solute crystals? ***(U.B+A.B)***

Ans: **FORMATION OF SOLUTE CRYSTALS**

Prepare super-saturated solution of particular solute by preparing saturated solution of that solute at high temperature. It is then cool to a temperature where excess solute crystallize out and leaves behind saturated solution.

Q.4 How we can prepare 2M solution of glucose? ***(U.B+A.B)***

Ans: We can prepare 2M of glucose solution by dissolving ($2\times180g = 360g$) of glucose in $1dm^3$ of a solution.

Q.5 Why concentration of bulk solution and its sample is same? ***(U.B)***

Ans: Because concentration does not depend upon the total volume or total amount of the solution.

Q.6 How the solubility of salt decreases with the increase of temperature? ***(U.B)***

Ans: **DECREASE OF SOLUBILITY WITH TEMPERATURE**

In some salts solubility decrease with the increase of temperature.

Example:

When salts like Li_2SO_4 and $Ce_2(SO_4)_3$ are dissolved in water, the test tube become warm because heat is released during this dissolution.

$$\text{Solvent + solute} \rightarrow \text{solution + heat}$$

TERMS TO KNOW

Terms	Definitions
Solution	"Solutions are **homogeneous mixtures of two or more components**".
Aqueous Solution	"The solution which is formed by **dissolving a substance in water** is called an aqueous solution."
Solute	"The **component of solution** which is present in **smaller quantity** is called solute".
Solvent	"The **component of a solution** which is present in **larger quantity** is called solvent."
Saturated Solution	"A solution containing **maximum amount of solute at a given temperature** is called saturated solution"
Supersaturated Solution	"The solution that is **more concentrated than a saturated solution** is known as supersaturated solution".
Dilute Solution	Dilute solutions are those which contain relatively small amount of dissolved solute in the solution.
Concentrated Solution	Concentrated solutions are those which contain relatively large amount of dissolved solute in the solution.
Concentration	"The **proportion of a solute** in a solution is called concentration".
(%m/m)	"It is the **number of grams of solute in 100 grams of solution**."
(%m/v)	"It is the **number of grams of solute dissolved in 100 cm^3 of the solution**".
(%v/m)	**"**It is the **volume in cm^3 of a solute dissolved in 100 g of the solution**".
(%v/v)	"It is the **volume in cm^3 of a solute dissolved per 100 cm^3 of the solution**".
Molarity	"**Number of moles of solute dissolved in one dm^3 of solution** is called molarity".
Solubility	"The **number of grams of the solute dissolved in 100 g of solvent to prepare a saturated solution at a particular temperature**".
Colloidal Solution (colloid)	"These are **solutions in which the solute particles are larger than those present in the true solutions but not large enough to be seen by naked eye**."
Suspension	"A **heterogeneous mixture of undissolved particles in a given medium that settles down after some time is called suspension**."
True Solution	"A **homogeneous mixture of two or more than two components** is called true solution."
Unsaturated Solution	"A solution which contains **lesser amount of solute than that which is required to saturate it at a given temperature**, is called unsaturated solution".
Dilution of Solution	"The **process of decreasing concentration of solution by adding more solvent** in it is called dilution of solution".
Percentage	"Percentage unit of concentration refers to the **percentage of solute present in a solution**".
Tyndall Effect	"The **particles of colloids are big enough to scatter the beam of light**. It is called Tyndall effect."

SELF TEST

Time: 35 Minutes **Marks: 25**

Q.1 Four possible answers (A), (B), (C) and (D) to each question are given, mark the correct answer. **(6×1=6)**

1. **The example of solid solute in gas solvent is:**
   (A) Butter **(B)** Sugar in water
   (C) Smoke in air **(D)** Opals
2. **The types of solutions on the basis of their physical states are:**
   (A) 3 **(B)** 6
   (C) 9 **(D)** 12
3. **10 gram of sugar is dissolved in 90g of water to make a 100g solution. This solution is:**
   (A) 10% m/m **(B)** 10% m/v
   (C) 10% v/m **(D)** 10% v/v
4. **Which one of the following solution has less water?**
   (A) 0.25M **(B)** 0.5M
   (C) 1.0M **(D)** 2.0M
5. **Solubility of which salt increases on heating?**
   (A) Li_2SO_4 **(B)** $Ce_2(SO_4)_3$
   (C) NaCl **(D)** KCl
6. **Which one of the following shows Tyndall effect?**
   (A) Solution **(B)** Colloid
   (C) Suspension **(D)** True solution

Q.2 Give short answers to the following questions. **(5×2=10)**

(i) Define solution. Give an example.
(ii) Differentiate between saturated and unsaturated solution.
(iii) Define molarity. What is its formula?
(iv) Describe the general principle of solubility "like dissolves like"
(v) Why is iodine soluble in CCl_4 and not in water?

Q.3 Answer the following questions in detail. **(5+4=9)**

(i) Write down five characteristics of colloid. **(5)**
(ii) Define solubility. Explain effect of temperature on solubility of a substance. **(4)**

Note:

Parents or guardians can conduct this test in their supervision in order to check the skill of students.