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Subject: - General Chemistry (2024-2025) lecture (2)

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LIQUID SOLUTION

Liquid solutions involve a mixture of two or more miscible liquids. Examples include: The typical example is water and ethanol. Water and acetone. Ethanol and acetone. Any two oils. An oil and acetone. Benzene and hexane. Diethyl ether and toluene. Any two liquid substances that are soluble in each other, really.

A liquid solution is a homogenous mixture of two or more substances. The substance which is dissolved is called the solute and the substance in which the solute is dissolved is called the solvent. In a liquid solution, the solvent is usually a liquid, but the solute can be a solid, liquid, or gas.

Common examples of solutions are sugar in water and salt in water solutions, soda water, etc. In a solution, all the components appear as a single phase.

Liquid solutions involve a mixture of two or more miscible liquids. Examples include: Vinegar - A solution of water and acetic acid.

Solid solutions generally involve melting two or more solids at high temperatures, mixing, and then letting them cool and solidify. Examples of solid solutions include:

- **Brass - a solid solution (metal alloy) containing copper and zinc**
- **Bronze - a metal alloy, that is a solid solution of tin and copper**
- **Sterling silver - a metal alloy, that is a solid solution of silver and copper**

What are some examples of a liquid-liquid mixture?

1-Oil and Water **2-Vinegar and Olive oil**
3-Toluene and Water **4-Chloroform and Water**
5-Ethanol and Hexane **6-Acetone and Water**

Liquids can flow and assume the shape of their container. ((Blood, Bromine (an element), Coffee, Gasoline, Honey, Mercury (an element) Milk.))

Examples of liquids at room temperature (about 20 degrees Celsius or 68 degrees Fahrenheit) include water, oil, alcohol and mercury.

Characteristics of Solution: -

Solutions have two components, one is solvent and the other is solute.

1. What is a Solvent? The component that dissolves the other component is called the solvent.

2. What is Solute? The component(s) that is/are dissolved in the solvent is/are called solute(s).

3. Solution Examples

The following examples illustrate solvent and solute in some solutions.

- **Air is a homogeneous mixture of gases. Here both the solvent and the solute are gases.**
- **Sugar syrup is a solution where sugar is dissolved in water using heat. Here, water is the solvent and sugar is the solute.**
- **Tincture of iodine, a mixture of iodine in alcohol. Iodine is the solute whereas alcohol is the solvent.**

Properties of Solution:-

Different properties of solutions are as follows:

- **It is a homogeneous mixture.**
- **Its particles are too tiny and have a diameter of less than 1 nm.**
- **The particles are not visible to naked eyes.**
- **Particles don't scatter a beam of light passing through it and hence the path of the light is not visible.**
- **Solutes are inseparable from the mixture and do not sediment. A solution is stable.**
- **The components of a mixture cannot be separated using filtration.**

Types of Solution: -

Liquid solutions, such as sugar in water, are the most common kind, but there are also solutions that are gases or solids. Any state of matter (solid, liquid, or gas) can act both as a solute and as a solvent during the formation of a solution. Therefore, depending on the physical states of solute and solvent, we can classify solutions into nine different types.

S. No	Types of Solution	Solute	Solvent	Examples
1	Solid-solid	solid	solid	Alloys like brass, bronze etc.
2	Solid-liquid	solid	liquid	The solution of sugar, salt etc in water.
3	Solid-gas	solid	gas	Sublimation of substances like iodine, camphor etc into the air.
4	Liquid-solid	liquid	solid	Hydrated salts, mercury in amalgamated zinc, etc.
5	Liquid-liquid	liquid	liquid	Alcohol in water, benzene in toluene
6	Liquid-gas	liquid	gas	Aerosol, water vapour in the air.
7	Gas-solid	gas	solid	Hydrogen absorbed in palladium
8	Gas-liquid	gas	liquid	Aerated drinks
9	Gas-gas	gas	gas	A mixture of gases, etc

A solution is a homogeneous mixture of two or more components. Let's learn more about solutions, their properties, and how to find a concentration of solutions.The Concentration of a Solution

The amount of solute in a given solution is called the concentration of a solution. The proportion of solute and solvent in solutions is not even. Depending upon the proportion of solute, a solution can be:

- *Diluted*
- *Concentrated*
- *Saturated*

The concentration of solution=Amount of solute in Amount of solution
Or
The concentration of solution=Amount of solute in Amount of solvent

Buffer solutions

A solution whose pH is not altered to any great extent by the addition of small quantities of either an acid or base is called buffer solution.

Buffer is also defined as the solution of reserve acidity or alkalinity which resists change of pH upon the addition of a small amount of acid or alkali.

Many chemical reactions are carried out at a constant pH. In nature, there are many systems that use buffering for pH regulation. For example, the bicarbonate buffering system is used to regulate the pH of blood, and bicarbonate also acts as a buffer in the ocean.

Types of buffer solutions:-

(a) Acidic Buffer:

It is formed by the mixture of weak acid and its salt with a strong base.

Examples: (i) $CH_3COOH + CH_3COONa$, (ii) $HCN + NaCN$, (iii) Boric acid + Borax

(b) Basic Buffer:

It is formed by the mixture of a weak base and its salt with strong acid.

Examples: (i) $NH_4OH + NH_4Cl$, (ii) $NH_4OH + NH_4NO_3$, (iii) Glycine + Glycine hydrochloride

(c) Simple Buffer:

It is formed by a mixture of acid salt and normal salt of a polybasic acid,

example $Na_2HPO_4 + Na_3PO_4$

Or a salt of weak acid and a weak base. Example: CH_3COONH_4

Buffer Actions: -

(a) Acidic Buffer: It is the mixture of CH_3COOH and CH_3COONa in aqueous solution.

$CH_3COOH \leftrightharpoons CH_3COO^- + H^+$ (incomplete dissociation)

$CH_3COONa \rightarrow CH_3COO^- + Na^+$ (complete dissociation)

$H_2O \leftrightharpoons H^+ + OH^-$ (incomplete dissociation)

Action of acid: when a drop of strong acid (HCl) is added in the above buffer solution H+ ions combine with CH3COO- ions to form feebly ionized CH3COOH. Whose ionization is further suppressed due to common ion effect. So pH of the solution unaltered.

Action of base: when a drop of strong base (NaOH) is added to the above buffer solution it reacts with free acid to form un dissociated water molecules. So pH of the solution unaltered.

$CH_3COOH + OH^- \leftrightharpoons CH_3COO^- + H_2O$

(b) Basic Buffer: It is the mixture of NH_4OH and NH_4Cl in aqueous solution.

$NH_4OH \leftrightharpoons NH_4^+ + OH^-$ (incomplete dissociation)

$NH_4Cl \rightarrow NH_4^+ + Cl^-$ (complete dissociation)

$H_2O \leftrightharpoons H^+ + OH^-$ (incomplete dissociation)

Action of acid: when a drop of HCl is added, the added H+ ions combine with NH_4OH to form un dissociated water molecules. So the pH of buffer is unaffected.

$NH_4OH + OH^- \leftrightharpoons NH_4^+ + H_2O$

Action of base: when a drop of NaOH is added, the added OH^- ions combine with NH_4^+ ions to form feebly ionized NH_4OH. It is further suppressed due to common ion effect. So the pH of buffer is unaffected.

Hendersion's Equation (pH of buffer)

(a) Acidic Buffer:

It is a mixture of CH_3COOH and CH_3COONa

$CH_3COOH \leftrightharpoons CH_3COO^- + H^+$

$CH_3COONa \rightarrow CH_3COO^- + Na^+$

By the law of chemical equilibrium, $K_a = \{[CH_3COO^-] [H^+]\} / [CH_3COOH]$

$\therefore [H^+] = \{K_a [CH_3COOH]\} / [CH_3COO^-]$

Taking negative log both sides, we obtain that

$-\log[H^+] = -\log K_a - \log \{[CH_3COOH]/[CH_3COO^-]\}$

$pH = pK_a + \log \{[CH_3COO^-]/[CH_3COOH]\}$

$pH = pK_a + \log \{[salt] / [acid]\}$

This equation is known as Henderson's Equation

Where, K_a = dissociation constant

$[CH_3COO^-]$ = initial concentration of salt
$[CH_3COOH]$ = initial concentration of acid

(b) Basic Buffer:

It is a mixture of NH_4OH and NH_4Cl

$NH_4OH \rightleftharpoons NH_4^+ + OH^-$

$NH_4Cl \rightarrow NH_4^+ + Cl^-$

By the law of chemical equilibrium, $Kb = \{[NH_4^+] [OH^-]\} / [NH_4OH]$

$\therefore [OH^-] = \{K_b [NH_4OH]\} / [NH_4^+]$

Taking negative log both sides, we obtain that

$-\log [OH^-] = -\log K_b - \log \{[NH_4OH] / [NH_4^+]\}$

$pOH = pK_b + \log \{ [NH_4^+] / [NH_4OH]\}$

$pOH = pK_b + \log \{[salt] / [base]\}$

This equation is known as Henderson's Equation

Where, K_b = dissociation constant

$[NH_4^+]$ = initial concentration of salt
$[NH_4OH]$ = initial concentration of base
$pH + pOH = 14$

Applications of Buffer in chemistry

(i) Buffers are used in industrial processes such as manufacture of paper, dyes, inks, paints, drugs, etc.(ii) Buffers are also employed in agriculture, dairy products and preservation of various types of foods and fruits. (iii) It is used to determine the pH with the help of indicators.

(iv) Blood is the natural buffer, it maintenance of pH is essential to sustain life because enzyme catalysis is pH sensitive process. The normal pH of blood plasma is 7.4.(v) For the removal of phosphate ion in the qualitative inorganic analysis after the second group using $CH_3COOH + CH_3COONa$ buffer.

Some Questions of solution

Q1/ What determines properties of solutions?

It can be represented in a number of ways. Colligative characteristics of a solution rely on the total number of dissolved particulates in solution, not on their chemical identity. Vapor pressure, boiling point, freezing point, and osmotic pressure are all colligative qualities.

Q2/ What are the 3 types of solutions?

Solid solution, Liquid solution, Gaseous solution.

Q3/Which component in a solution that has the largest quantity?
A solution is a mixture of two or more components that is homogenous. The solvent is the material that is present in the maximum amount, whereas the solute is the substance that is present in the least amount.

Q4/What are the two classification of solutions?

There are two types of solutions based on if the solvent is water or not. Aqueous solutions are those where the solvent is water. Sugar in water, carbon dioxide in water, etc. are examples. Non-Aqueous Solutions do not use water as a solvent.

Q5 / Why concentrated solution should not be heated for a long time?

The concentrated solution is more powerful than regular solutions. If they've been heated for a long period, there's a potential they'll become more powerful and concentrated, making them more difficult to handle.

Some Questions four buffer solution

Q1/ Is milk alkaline or acid?

The pH of milk is 6.7 to 6.9, making it slightly below neutral and therefore acid-forming. The exception is raw milk, which may be more alkalizing than pasteurized milk.

Q2/What are the properties of buffers? The properties of buffet are (i) pH of buffer solution are reserved. (ii) Its pH does not change on standing for long periods of time. (iii) Its pH does not change on dilution.

Q3/What is pH stand for? The abbreviation pH stands for potential hydrogen. It is a scale used to specify the acidity or basicity of an aqueous solution. pH is the negative of the base 10 logarithm of the activity of the H^+ ion. Mathematically pH = – log $[H^+]$

Q4/What is the pH of blood?Blood has a normal pH range of 7.35 to 7.45. This means that blood is naturally slightly alkaline or basic.