# E- CONTENT FORMAT

## PART A SECTION

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| SN | STREAM NAME | SUBJECT NAME | PAPER NAME | TOPIC NAME | YEAR / SEMESTER | NO. OF SLIDE\ PAGES | CONTENT LANGUAGE | CONTENT TYPE:(PDF/ Word /JPG /PPT) | CONTENT KEYWORDS | VIDEO / AUDIO LINK |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Science | Chemistry | Physical Chemistry | Colloids | B.Sc. II$^{nd}$ Sem. | 7 | English | MS Word | Colloids, Dispersed Phase, Dispersion Medium, Sols, Gels, Emulsions | No |

**PART B SECTION: Attached Matter in M.S. Word only.**

**Note:**

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## Colloidal State of Matters

- Thomas Graham (1861) studied the rates of diffusion of solutions of different substances through parchment membrane or animal membrane (semipermeable membrane) and as a result of his experiments, he divided the substances into two classes-
  1) Crystalloids
  2) Colloids

### 1) Crystalloids :-

The substances like common salt, sugar, urea etc. which can be obtained in the crystalline form and in the dissolved state diffusion readily through parchment membrane were termed as crystalloids.

### 2) Colloids:- (Greek : glue – like)

The substances like starch, gum, glue, gelatin, albumin, silicic acid etc. which are non - crystalline in nature and in the dissolved state do not diffuse or diffuse at a very slow rate through the parchment membrane were termed as colloids.

"***Colloidal state of matter is, therefore, a state in which the size of the particles is such (1 to 1000 nm) that they can pass through filter paper but not through animal or parchment membrane ".***

- The size of the colloidal particles is intermediate between that of particles of true solution and suspension. These sizes are such that particles of true solution can pass through parchment membrane as well as filter paper whereas those of colloidal solution cannot pass through parchment membrane but can pass through filter paper and those of suspension can pass neither through parchment membrane nor through filter paper.

**Table-1: Difference between True solutions, Colloidal solutions and Suspensions**

| S. No. | Property | True solutions | Colloidal solutions | Suspensions |
|---|---|---|---|---|
| 1. | **Nature** | Homogeneous | Heterogeneous | Heterogeneous |
| 2. | **Particle size (diameters)** | Less than $10^{-9}$ m or 1nm (i.e. < 10 Å) | Between $10^{-9}$ to $10^{-6}$m or 1nm to 1000nm (i.e. 10 Å to 10000 Å) | More than $10^{-6}$ m or 1000nm (i.e. >10000 Å) |
| 3. | **Filterability** | Pass through ordinary filter paper as well as animal membrane. | Pass through ordinary filter paper but not through animal membrane. | Do not pass-through filter paper and animal membrane. |
| 4. | **Settling** | Do not settle. | Do not settle. | Settle on standing. |
| 5. | **Visibility** | Particles are invisible. | Scattering of light by the particles is observed under ultramicroscope. | Particles are visible to naked eye or under a microscope. |
| 6. | **Diffusion** | Diffuse quickly. | Diffuse slowly | Do not diffuse. |
| 7. | **Appearance** | Clear and transparent | Translucent | Opaque |

## Dispersed Phase and Dispersion Medium:-

- In true solution, the substance dissolve is called the solute and the medium in which it is dissolved is called the solvent, similarly in a colloidal system, the term solute and solvent are replaced by the term dispersed phase and dispersion medium respectively. Thus, dispersed phase means the substance distributed in the dispersion medium in the form of colloidal particles and the dispersion medium means the medium in which the substance is dispersed in the form of colloidal particles.
- A colloidal system is heterogeneous consisting of two phases the dispersed phase and the dispersion medium.

## Classification of colloids:-

Colloids are classified in three different ways as follows:

(A) Based on physical state of dispersed phase and dispersion medium

(B) Based on nature of interaction between dispersed phase and dispersion medium

(C) Based on the type of particles of the dispersed phase

### (A) Based on physical state of dispersed phase and dispersion medium:-

Depending upon whether the dispersed phase and dispersion medium are solids, liquids, or gases, eight types of colloidal systems are possible. A gas mixed with another gas forms a homogenous mixture and not a colloidal system. The examples of the various types of colloidal systems are listed in table.

**Table. 2. Types of colloidal systems (colloidal dispersions)**

| S.No. | Dispersed Phase | Dispersion Medium | Name | Examples |
|---|---|---|---|---|
| 1. | Solid | Solid | Solid sol | Some coloured glasses, gemstones |
| 2. | Solid | Liquid | Sol | Some paints, cell fluids, muddy water |
| 3. | Solid | Gas | Aerosol | Smoke, dust |
| 4. | Liquid | Solid | Gel | Cheese, butter, jellies |
| 5. | Liquid | Liquid | Emulsion | Milk, hair cream |
| 6. | Liquid | Gas | Aerosol | Fog, mist, cloud, insecticides sprays |
| 7. | Gas | Solid | Solid foam | Pumice stone, foam rubber |
| 8. | Gas | Liquid | Foam | Froth, whipped cream, soap lather |

- Out of the various types of colloidal systems, the most common are sols (solids in liquids), gels (liquids in solids) and emulsions (liquids in liquids). Further, it may be mentioned that depending upon the dispersion medium, the sols are given special names as follows:-

| Dispersed Phase | Dispersion Medium | Name of the Sol |
|---|---|---|
| Solid | Water | Aquasol or Hydrosol |
| Solid | Alcohol | Alcosol |
| Solid | Benzene | Benzosol |
| Solid | Gas | Aerosol |

**(B) Based on nature of interaction between dispersed phase and dispersion medium :-**

On this basis, colloidal sols are divided into two categories, namely, **lyophilic** and **lyophobic**. If water is the dispersion medium, the terms used are **hydrophilic** and **hydrophobic**

1. **Lyophilic colloids :-** (lyophilic means liquid-loving)

"*Substances like gum, gelatin, starch, rubber etc which when mixed with a suitable liquid as the dispersion medium directly form the colloidal sol are called lyophilic and the sols thus obtained are called lyophilic sol'*.

- ❖ As they form the colloidal sol directly, they are also called intrinsic colloids.

2. **Lyophobic colloids:-** (lyophobic means liquid - hating)
   **"***Substances like metals, their sulphides etc. when simply mixed with the dispersion medium do not form the colloidal sol. Their colloidal sols can be prepared only by special methods. Such substances are called lyophobic and the sols formed by them are called lyophobic sols".*

- ❖ As their colloidal sols have to be prepared by indirect methods, they are also called extrinsic colloids.
- ❖ The greater stability of the lyophilic colloidal sols then the lyophobic colloidal sols is due to the fact that the former are highly hydrated in the solution.
- ❖ The essential points of difference between the lyophilic sols and lyophobic sols are given in table.

**Table-3: Points of difference between lyophilic sols and lyophobic sols**

| S.No. | Property | Lyophilic sols | Lyophobic sols |
|---|---|---|---|
| 1. | Ease of preparation | Prepared easily by directly mixing with the liquid dispersion medium. | Cannot be prepared directly, prepared by special methods only. |
| 2. | Stability | They are quite stable and are not easily precipitated or coagulated. | They are easily precipitated by addition of a small amount of a suitable electrolyte. |
| 3. | Hydration | They are highly hydrated. | They are not much hydrated. |
| 4. | Reversible and irreversible nature | They are reversible in nature i.e., once precipitated can reform the colloidal sol by simply remixing with the dispersion medium. | They are irreversible in nature i.e., once precipitated cannot form the colloidal sol by simple addition of the dispersion medium. |
| 5. | Nature of substances | These sols are usually formed by the organic substances like starch, gum, proteins etc. | These sols are usually formed by the inorganic substances like metals, their sulphides etc. |
| 6. | Viscosity | Their viscosity is much higher than that of the medium. | Their viscosity is almost the same as that of the medium. |
| 7. | Surface tension | Their surface tension is usually lower than that of the dispersion medium. | Their surface tension is nearly same as that of the dispersion medium. |

### (C) Based on the type of particles of the dispersed phase:-

Depending upon how the different substances may have size in the range of the colloids, the various types of colloids or colloidal dispersions may be divided into the following three categories:

(1). Multimolecular colloids

(2). Macromolecular colloids

(3). Associated colloids

### (1). Multimolecular colloids:-

*"When on Dispersion of a substance in the dispersion medium, a large number of atoms or smaller molecules of the substances (with diameters less than 1 nm) aggregate together to form species having size in the colloidal range, the species thus formed are called multimolecular colloids".*

For Example, a gold sol may contain particles of various sizes having several atoms. Sulphur sol consists of particles containing a thousand or so of $S_8$ sulphur molecules. These are held together by Van der Waals forces.

### (2). Macromolecular colloids:-

"*When certain substances having big size molecules, called macromolecules, having large molecular masses are dissolved in a suitable liquid, they form a solution in which the molecule of the substances, i.e., the dispersed particles have size in the colloidal range, such substances are called macromolecular colloids*".

These macromolecular substances are usually Polymers with very high molecular masses.

- Examples of naturally occurring macromolecules are starch, cellulose, protein, enzymes and gelatin.
- Examples of man-made macromolecules are polyethylene, nylon, polystyrene, synthetic rubber etc.

### (3). Associated colloids:-

"*The substances which when dissolved in a medium at low concentration behave as normal, strong electrolytes but at higher concentration exhibit colloidal state properties due to the formation of aggregated particles are called associated colloids".*

The aggregate particles thus formed are called micelles. The formation of micelles take place only above of particular temperature called kraft temperature ($T_k$) and above a particular concentration called critical micelle concentration (CMC). Examples: soaps and synthetic detergent.

**Table-4: Comparison of some important characteristic of multimolecular, macromolecular and associated colloids.**

| S.No. | Multimolecular colloids | Macromolecular colloids | Associated colloids |
|---|---|---|---|
| 1. | They are formed by the aggregation of a large number of atoms or molecules which generally have diameters less than 1 nm e.g., sols of gold, sulphur etc. | They are molecules of large size, e.g., Polymers, like rubber, nylon, starch, protein etc. | They are found by the aggregation of a large number of ions in concentrated solution, e.g., soap sol, detergent |
| 2. | Their molecular masses are not very high. | They have high molecular masses. | Their molecular masses are generally high. |
| 3. | Their atoms or molecules are held Together by weak Van der Walls forces. | Due to long chain, the Van der Walls forces holding them are comparatively stronger. | Higher is the concentration, greater are the Van der Walls forces. |