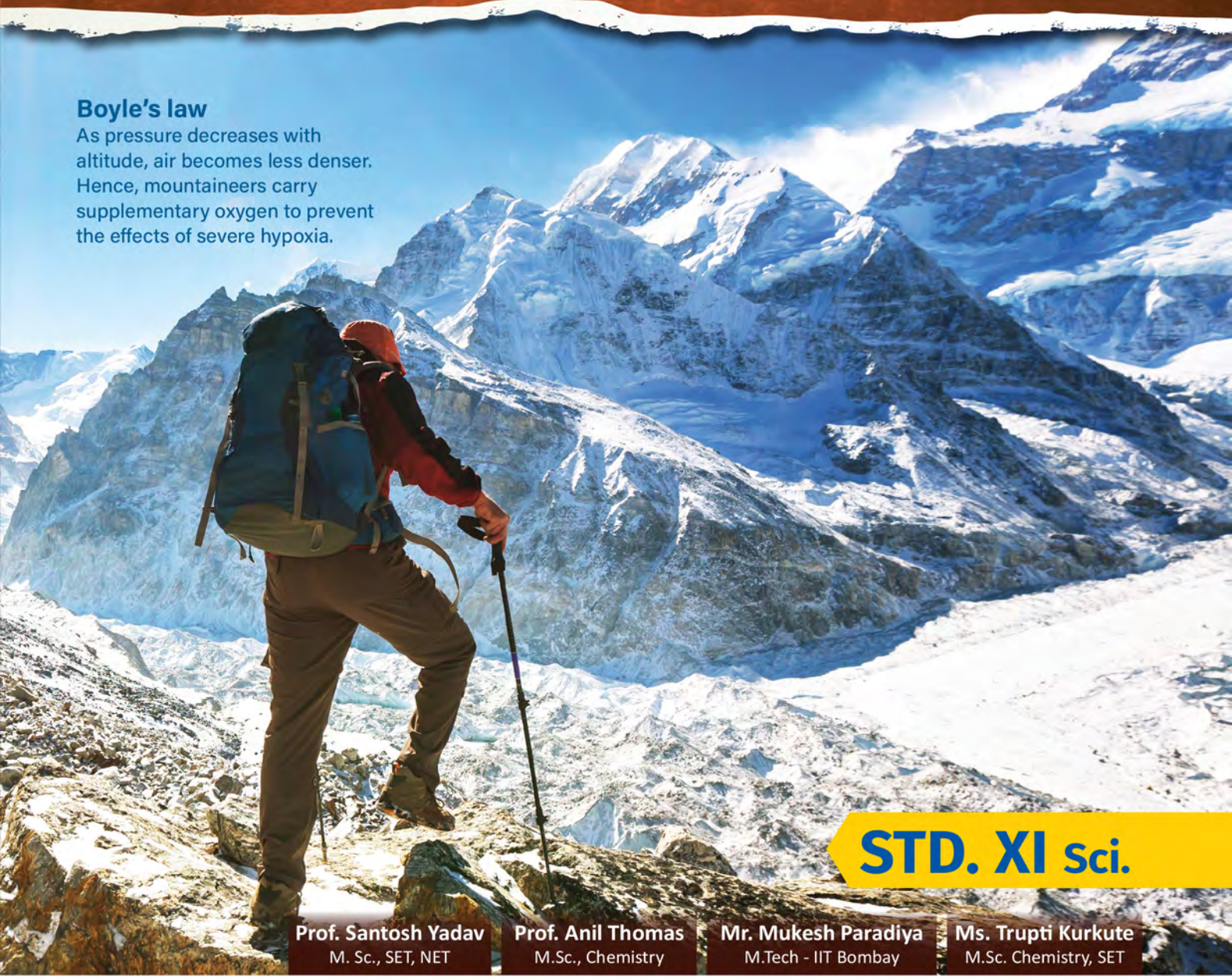
SAMPLE CONTENT

PERFECT

CHEMISTRY

Vol. II



STD. XI Sci.

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PERFECT CHEMISTRY (Vol. II)

Std. XI Sci

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- **Insights**
- **Practice Numericals**

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- Written as per the latest textbook
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  - The Video/pdf links boosting conceptual retention
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PREFACE

"Everything should be made as simple as possible, but not simpler." - Albert Einstein.

Having this vision in mind, we have created **"Perfect Chemistry Vol. II, Std. XI Sci."** as per the latest textbook of the Maharashtra State Board. It focuses on not just preparing students from an examination point of view but also equipping them to understand and appreciate the beauty of the concepts in chemistry.

Every chapter in this book begins with a brief introduction to the chapter. Following with:

- **Insights…** provided at the start captivate readers with intriguing revelations and thought-provoking observations, setting the stage for an engaging exploration of each new chapter.
- The chapter is **segregated subtopic-wise** and encompasses all textual content in the format of Question and Answers. *Textual Exercise questions, Intext questions, 'Can you tell', 'Can you recall', 'Try this'*, and *'Activity'* are placed aptly amongst various additional questions in accordance with the flow of the subtopic.
- **Numerical Zone** covers numericals along with their step-wise solutions using log calculation (wherever necessary) at the end of each topic, followed by **Practice Numericals** (solutions to which they are provided through a QR code), which strengthens the numerical aspect of the students.
- **Important Formulae** are placed after covering the last subtopic of the chapter.
- **Exercise** helps the students gain insight on the various levels of theory and numerical-based questions.
- **Multiple Choice Questions** and **Topic Test** (as per the latest paper pattern) assess the students on their range of preparation and the amount of knowledge of each topic.
- **Quick Review** summarizes the key points in the chapter for last-minute revision.
- The flow chart on the adjacent page will walk you through the **key features** of the book and elucidate how they have been carefully designed to maximize student learning.

Perfect Chemistry Vol. II, Std. XI Sci. adheres to our vision and achieves several goals: building concepts, developing competence to solve numericals, recapitulation, self-study, self-assessment, and student engagement – all while encouraging students toward cognitive thinking.

We hope the book benefits the learner as we have envisioned.

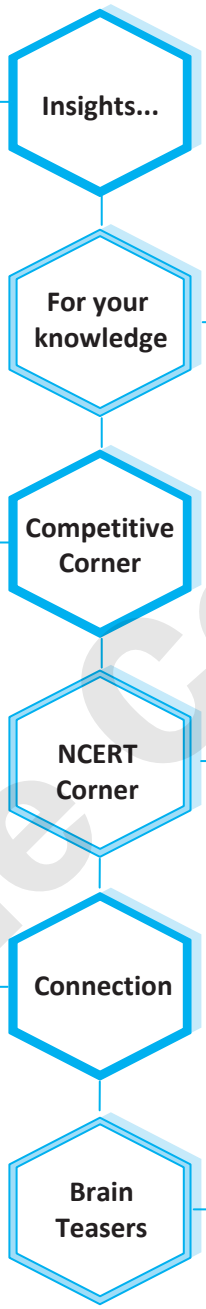
Publisher

Edition: Fifth

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.
Please write to us on: mail@targetpublications.org

KEY FEATURES

'Insights...' *starts each chapter with engaging information and curious facts, sparking your interest right from the beginning.*



For Your Knowledge presents fascinating information about the concept covered.

Competitive Corner includes selective questions from prominent [NEET (UG), JEE (Main) and MHT CET] competitive exams based entirely on the syllabus covered in the chapter.

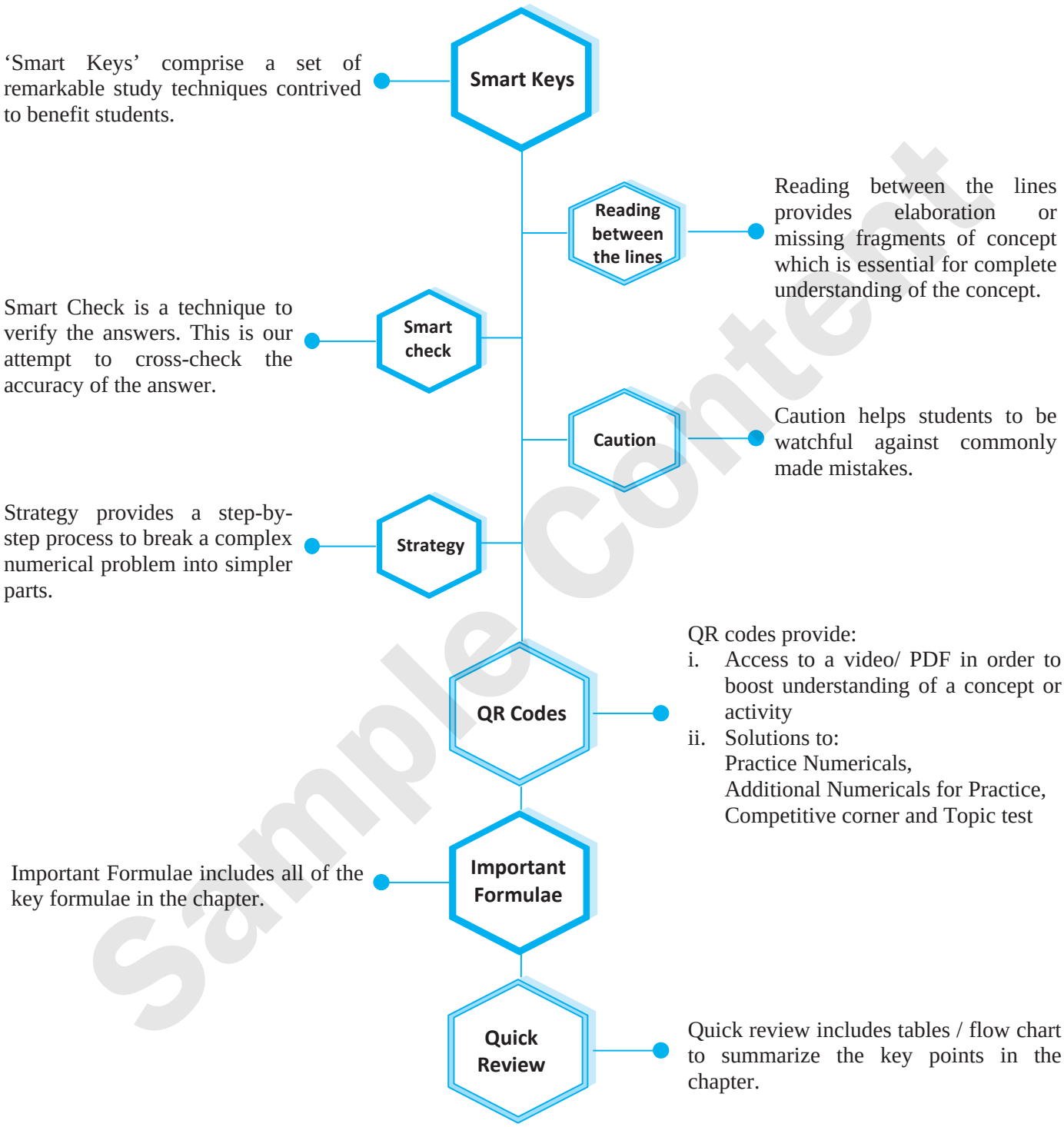
NCERT Corner covers information from NCERT textbook relevant to topic.

Connections enable students to interlink concepts covered in different chapters.

Brain Teasers include challenging questions.

Continued…

KEY FEATURES



CONTENTS

[Reference: Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04**]**

Note:
1. * mark represents Textual Exercise question.
2. # mark represents Intext question.
3. + mark represents Textual examples and Numericals.
4. symbol represents textual questions that need external reference for an answer.
5. Chapters 1 to 9 are a part of Perfect Chemistry Vol. I, Std. XI Sci.

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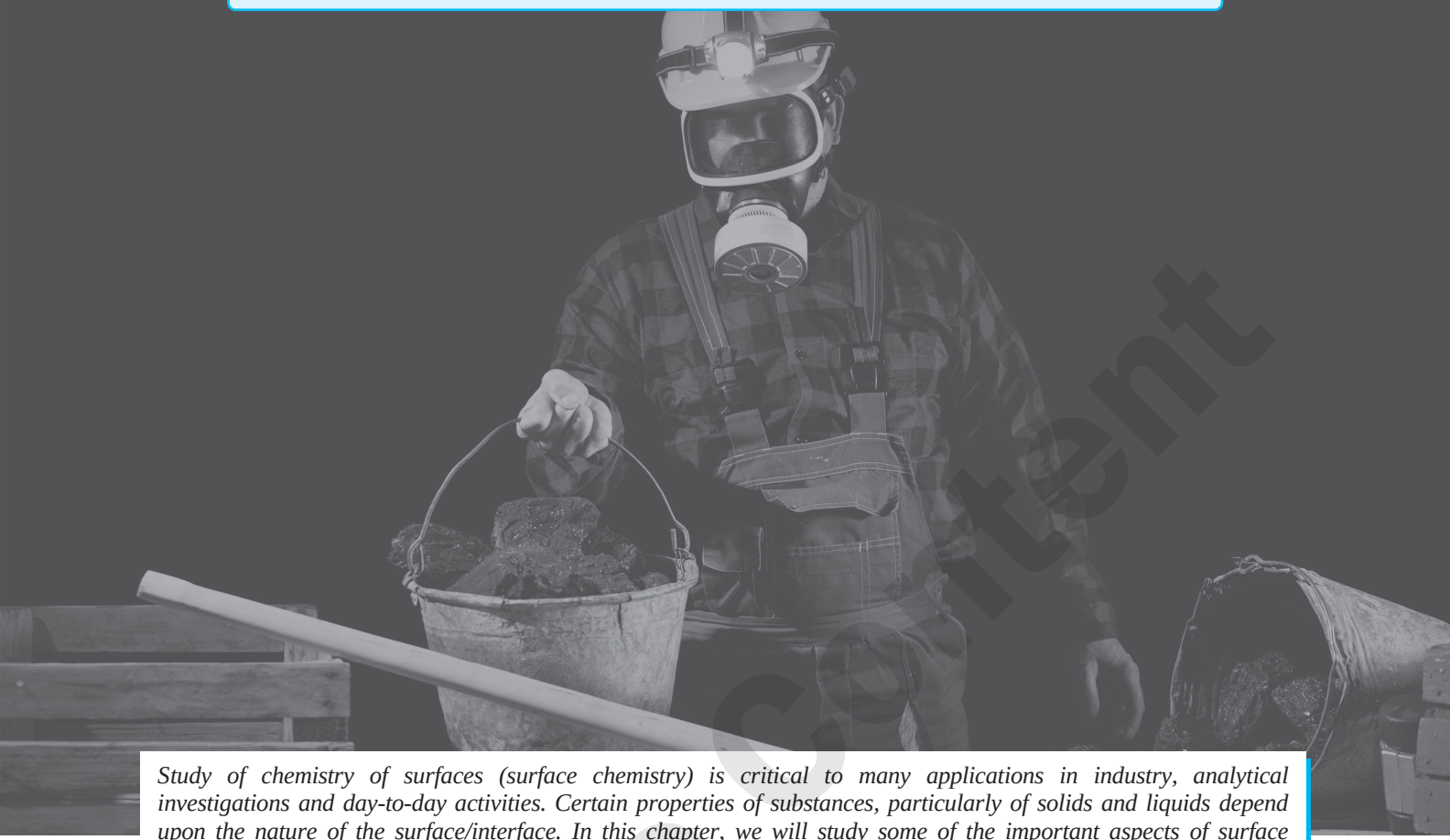
11 Adsorption and Colloids



Study of chemistry of surfaces (surface chemistry) is critical to many applications in industry, analytical investigations and day-to-day activities. Certain properties of substances, particularly of solids and liquids depend upon the nature of the surface/interface. In this chapter, we will study some of the important aspects of surface chemistry such as adsorption, catalysis and colloids.
This chapter is allotted weightage of 4 marks with options and 3 marks without option.

Contents and Concepts

Insights...

1. In the reactions that reduce the amount of ozone in the stratosphere, both homogeneous and heterogeneous catalysts play an important role.
2. Automobile catalytic converters lower the activation energy of NO's breakdown into N_2 and O_2, thereby reducing NO emissions.
3. Enzymes are "nature's catalysts". One molecule of carbonic anhydrase (enzyme) can hydrolyze from 10^4 to 10^6 molecules of CO_2 in 1 second.
4. Dialysis technique is important in the removal of impurities from the blood and is used to clean the blood of people suffering from kidney malfunction.
5. Gold changes its colour to red when the size of its particles is in the range of nanometers.
6. A salad dressing that resembles mayonnaise is a colloid of oil in water, with compounds from egg yolk serving as the emulsifying agent.

Questions and Answers

11.1 Introduction

Q.1. Explain the phenomenon of adsorption with the help of examples. **[2 Marks]**

Ans: Consider the following two examples:

i. **Example 1:** When a metal spoon is dipped in milk and taken out, it is observed that a film of milk particles covers the spoon surface.

ii. **Example 2:** If a cold water bottle is taken out from the refrigerator and kept on a table for a while, water vapour is seen to condense on the outer surface of the bottle, forming droplets or a film.

iii. In the above examples, the milk particles or the water molecules from the air get adsorbed on the surface of the spoon and the bottle, respectively.

iv. Similarly, surfaces of many objects around us are exposed to the atmosphere. Water molecules as well as other gas molecules such as N_2, O_2, from the air form an invisible multimolecular film on these objects. This is known as the phenomenon of adsorption.

11.2 Adsorption

***Q.2. Adsorption is surface phenomenon. Explain.** **[2 Marks]**

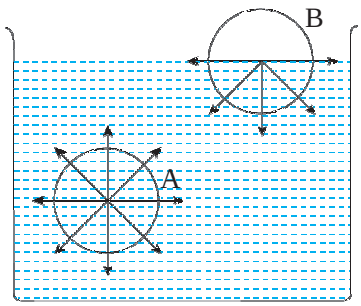
Ans: Consider a surface of a liquid or a solid.

i. The molecular forces at the surface of a liquid are unbalanced or in unsaturation state.

ii. In solids, the ions or molecules at the surface of a crystal do not have their forces satisfied by the close contact with other particles.

iii. Because of the unsaturation, solid and liquid surfaces tend to attract gases or dissolved substances with which they come in close contact. Thus, the substance accumulates on the surface of solid or liquid i.e., the substance gets adsorbed on the surface.

Hence, adsorption is a surface phenomenon.



A - Bulk molecule
B - Surface molecule

READING BETWEEN THE LINES

The attracted species that is in contact with the surface particles is present at much higher concentration than in the bulk. The excess concentration of attracted particles are retained on the surface as they do not penetrate deeper inside the bulk.

Q.3. Can you tell? *(Textbook page no. 160)* **[1 Mark]**

What is adsorption?

Ans: ***Adsorption*** *is the phenomenon of accumulation of higher concentration of one substance on the surface of another (in bulk) due to unbalanced/unsatisfied attractive forces on the surface.*

***Q.4. Define adsorption. Why students can read blackboard written by chalks?** **[2 Marks]**

Ans:

i. ***Adsorption*** *is the phenomenon of accumulation of higher concentration of one substance on the surface of another (in bulk) due to unbalanced/unsatisfied attractive forces on the surface.*

ii. When we write on blackboard using chalk, the chalk particles get adsorbed on the surface of the blackboard. Hence, students can read blackboard written by chalks.

Q.5. Why does adsorption occur? **[2 Marks]**

Ans:

i. The adsorption phenomenon is caused by dispersion forces (also known as London dispersion forces or van der Waals forces) which are short range and additive. Adsorption force is the sum of all interactions between all the atoms.

ii. The pulling interactions cause the surface of a liquid to tighten like an elastic film.

iii. A measure of the elastic force at the surface of a liquid is called surface tension.

iv. There is a tendency to have minimum surface tension, i.e., decrease of free energy, which leads to adsorption.

Q.6. Define surface tension. **[1 Mark]**

Ans: *A measure of the elastic force at the surface of a liquid is called* ***surface tension****.*

OR

Surface tension *is the amount of energy required to stretch or increase the surface of a liquid by a unit area.*

GG - GYAN GURU

Water striders…. the gliders!

When the magnitude of the surface tension is greater than the magnitude of downward forces exerted on the surface water molecules by an object, such as 'water strider', the object cannot sink. Surface tension allows water strider to walk on the water without sinking. However, the same strider would sink in oil.

Q.7. Define the following terms. **[1 Mark Each]**

i. Adsorbent **ii. Adsorbate**

Ans:

i. Adsorbent: *The material or substance present in the bulk, on the surface of which adsorption takes place is called* ***adsorbent.***

ii. Adsorbate: *The substance getting adsorbed on the adsorbent is called as* ***adsorbate.***

Q.8. Give some examples of adsorption. **[1 Mark Each]**

Ans: Following are some examples of adsorption:

i. Adsorption of gases like hydrogen and oxygen by finely divided metals, namely, platinum, palladium, copper, nickel, etc.

ii. Adsorption of gases like nitrogen and carbon dioxide by activated charcoal.

iii. Removal of colouring matter like an organic dye, for example, methylene blue. When charcoal is added to methylene blue solution and shaken, it becomes colourless after some time as dye molecules accumulate on the surface of charcoal.

***Q.9. Aqueous solution of raw sugar, when passed over beds of animal charcoal, becomes colourless. Explain.** **[2 Marks]**

Ans:

i. When aqueous solution of raw sugar is passed over beds of animal charcoal, charcoal adsorbs the coloured particles from the raw sugar.

ii. Thus, due to the adsorption of coloured particles, raw sugar becomes colourless when passed over beds of animal charcoal.

Q.10. What is desorption? **[1 Mark]**

Ans: *The process of removal of an adsorbed substance from a surface on which it was adsorbed is called* ***desorption.***

***Q.11. Distinguish between the following:**

Adsorption and absorption. Give one example. **[2 Marks]**

Ans:

	Adsorption	Absorption
i.	Adsorption is a surface phenomenon as adsorbed matter is concentrated only at the surface and does not penetrate through the surface to the bulk of adsorbent.	Absorption is a bulk phenomenon as absorbed matter is uniformly distributed inside as well as at the surface of the bulk of substance.
ii.	Concentration of the adsorbate is high only at the surface of the adsorbent.	Concentration of the absorbate is uniform throughout the bulk of the absorbent.
iii.	It is dependent on temperature and pressure.	It is independent of temperature and pressure.
iv.	It is accompanied by evolution of heat known as heat of adsorption.	It may or may not be accompanied by any evolution or absorption of heat.
v.	It depends on surface area.	It is independent of surface area.
e.g.	Adsorption of a gas or liquid like acetic acid by activated charcoal.	Absorption of water by cotton, absorption of ink by blotting paper.

Q.12. Try this. *(Textbook page no. 161)*

Dip a chalk in ink. What do you observe? **[1 Mark]**

Ans: When a chalk is dipped in ink, it is observed that the ink molecules are adsorbed at the surface of chalk and the surface becomes coloured, while the solvent of the ink goes deeper into the chalk due to absorption.

Q.13. Define sorption. **[1 Mark]**

Ans: *When both adsorption and absorption occur simultaneously, it is known as* ***sorption.***

e.g. When a chalk is dipped in ink, the ink molecules are adsorbed at the surface of the chalk while the solvent of the ink goes deeper into the chalk due to absorption.

11.3 Types of Adsorption

***Q.14. Name the type of adsorption in which van der Waals forces are present.** [1 Mark]

Ans: Physical adsorption or physisorption

***Q.15. Name the type of adsorption in which compound is formed.** [1 Mark]

Ans: Chemical adsorption or chemisorption

Q.16. What is physisorption? State its characteristics. [3 Marks]

Ans: *When the adsorbent such as gas molecules are accumulated at the surface of a solid on account of weak van der Waals forces, the adsorption is termed as* ***physical adsorption or physisorption****.*

Characteristics:

i. The van der Waals forces involved in physical adsorption are similar to forces causing condensation of gas into liquid. Thus, heat is released in physisorption.

ii. The heat released during physisorption is of the same order of magnitude as heat of condensation.

iii. Due to weak nature of van der Waals forces, physisorption is weak in nature.

iv. The adsorbed gas forms several layers of molecules at high pressures.

v. The extent of adsorption is large at low temperatures.

vi. The equilibrium is attained rapidly.

vii. Physisorption is readily reversed by lowering of pressure of gas or by raising temperature.

Q.17. Define chemisorption. Write its main features. [3 Marks]

Ans: *When the gas molecules accumulate at the surface of a solid or adsorbate by means of chemical bonds (covalent or ionic), the adsorption is termed as* ***chemical adsorption or chemisorption****.*

Features of chemical adsorption:

i. Chemisorption is specific in nature.

ii. Chemisorption involving the gas-solid as the adsorbate and adsorbent is usually exothermic i.e., heat is released during this process (Exception: The adsorption of hydrogen on glass is endothermic).

iii. The heat evolved in chemisorption per mole of adsorbate is nearly the same order of magnitude as that accompanying chemical bonding.

iv. Chemisorption involves a large energy of activation and hence, it is also referred as activated adsorption.

v. Chemisorption increases with increase in temperature in the beginning, as a greater number of molecules can have activation energy. But after certain temperature chemisorption decreases with increase in temperature as the chemical bonds break.

vi. Sometimes at low temperature, physisorption occurs which passes into chemisorption as the temperature is raised.

vii. Chemisorption is dependent on surface area of the adsorbent.

***[Note:** Chemisorption was first investigated in 1916 by American Chemist, Irving Langmuir (1881-1957).]*

Q.18. Give reasons: [1 Mark Each]

i. Chemisorption also known as activated adsorption.

ii. Adsorption of hydrogen on glass is an endothermic process.

Ans:

i. Chemisorption involves a large energy of activation and hence, it is also referred as activated adsorption.

ii. Adsorption of hydrogen on glass is an endothermic process because heat is absorbed during the process due to dissociation of hydrogen.

***Q.19. Distinguish between the following:**

Physisorption and chemisorption. Give one example. [3 Marks]

Ans:

No.	Physisorption	Chemisorption
i.	The forces operating are weak van der Waals forces.	The forces operating are of chemical nature (covalent or ionic bonds).
ii.	It is not specific in nature as all gases adsorb on all solids. For example, all gases adsorb on charcoal.	It is highly specific and occurs only when chemical bond formation is possible between adsorbent and adsorbate. For example, adsorption of oxygen on tungsten, hydrogen on nickel, etc.
iii.	The heat of adsorption is low and lies in the range 20-40 kJ mol^{-1}.	The heat of adsorption is high and lies in the range 40-200 kJ mol^{-1}.

iv.	It occurs at low temperature and decreases with an increase of temperature.	It is favoured at high temperature, however, the extent of chemical adsorption is lowered at very high temperature due to bond breaking.
v.	It is reversible.	It is irreversible.
vi.	Physisorbed layer may be multimolecular layer of adsorbed particles under high pressure.	Chemisorption forms monomolecular layer of adsorbed particles.
e.g.	At low temperature N_2 gas is physically adsorbed on iron.	N_2 gas chemically adsorbed on iron at high temperature forms a layer of iron nitride, which desorbs at very high temperature.

11.4 Factors Affecting Adsorption of Gases on Solids

***Q.20. Mention factors affecting adsorption of gas on solids.** [2 Marks]

Ans: Adsorption of gases on solids depends up on the following factors:

i. Nature of adsorbate (gas)
ii. Nature of solid adsorbent
iii. Surface area of adsorbent
iv. Temperature of the surface
v. Pressure of the gas

CONNECTIONS

In chapter 10, you studied the concept of critical temperature, liquefaction of gases and their dependence on each other.

***Q.21. Explain how the adsorption of gas on solid varies with**

i. nature of adsorbate and adsorbent [2 Marks] **ii. surface area of adsorbent.** [1 Mark]

Ans:

i. a. Nature of adsorbate:

1. All solids adsorb gases to some extent. It is observed that gases having high critical temperature liquify easily and can be readily adsorbed.
2. The gases such as SO_2, Cl_2, NH_3 which are easily liquefiable are adsorbed to a larger extent as compared to gases such as N_2, O_2, H_2, etc. which are difficult to liquify.
3. Thus, the amount of gas adsorbed by a solid depends on the nature of the adsorbate gas i.e., whether it is easily liquefiable or not.

b. Nature of adsorbent: Substances which provide large surface area for a given mass are effective as adsorbents and adsorb appreciable volumes of gases.

e.g. Silica gel and charcoal are effective adsorbents due to their porous nature.

ii. Surface area of the adsorbent:

a. Adsorption is a surface phenomenon. Hence, the extent of adsorption increases with increase in surface area of the adsorbent.

b. Finely divided substances, rough surfaces, colloidal substances are good adsorbents as they provide larger surface area for a given mass.

Note: Critical temperature of some gases and volume adsorbed. *(Textbook page no. 162)*

Gas	Critical temperature (K)	Volume of gas adsorbed (cm^3) by 1 g of charcoal at 15 °C
Dinitrogen (N_2)	126	08
Hydrogen chloride (HCl)	324	72
Ammonia (NH_3)	406	181
Chlorine (Cl_2)	417	235
Sulphur dioxide (SO_2)	430	380

***Q.22. A finely divided substance is more effective as adsorbent. Explain. OR Explain why finely divided substance is more effective as adsorbent?** [2 Marks]

Ans:

i. Adsorption is a surface phenomenon and hence, the extent of adsorption depends upon surface area of the adsorbent.
ii. Adsorption increases with increase in surface area of the adsorbent.
iii. Finely divided powdered substances provide larger surface area for a given mass.
Hence, finely divided substance is more effective as adsorbent.

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To see complete chapter buy **Target Notes** or **Target E-Notes**

11.9 Colloids

Q.52. State the importance of colloids in day-to-day life. **[2 Marks]**

Ans:

i. Colloid chemistry is the chemistry of everyday life.

ii. A number of substances we use in our day-to-day life are colloids. For example, milk, butter, jelly, whipped cream, mayonnaise.

iii. Knowledge of colloid chemistry is essential for understanding about many useful materials like cement, bricks, pottery, porcelain, glass, enamels, oils, lacquers, rubber, celluloid and other plastics, leather, paper, textiles, filaments, crayons, inks, road construction material, etc.

iv. In many daily processes like cooking, washing, dyeing, painting, ore floatation, water purification, sewage disposal, smoke prevention, photography, pharmacy, use of colloids is important.

Q.53. What are colloids? Explain. **[3 Marks]**

Ans:

i. Colloids are heterogeneous mixtures.

ii. *The component of colloid present in the largest proportion is called* ***dispersion medium*** *and the other components are called* ***dispersed phase****.*

iii. The particles of the dispersed phase are larger than the size of a molecule and smaller than the particles which we can see with naked eye.

e.g.

a. Observe the formation of solution of salt and water. Salt dissolves completely in water and forms homogeneous system.

b. On the other hand, ground coffee or tea leaves with milk form suspension.

c. Between the two extremes of solution and suspension exists a large group of systems called colloidal dispersions or simply colloids.

Q.54. State the differences between colloids and solutions. **[1 Mark]**

Ans:

No.	Colloids	Solutions
i.	Colloids contain particles of dispersed phase with diameters in the range of 2 to 500 nm.	Solutions contain solute particles with diameters in the range of 0.1 to 2 nm.
ii.	They are translucent to light.	They are transparent or may be coloured.
e.g.	Milk, fog, etc.	NaCl solution

Q.55. Explain: Natural phenomena of colloids observed in daily life. **[4 Marks]**

Ans: Following are some examples of colloids observed in daily life.

i. **Blue colour of the sky:** The sky appears blue to us because minute dust particles along with minute water droplets dispersed in air scatter blue light which reaches our eyes.

ii. **Blood:** It is a colloidal dispersion of plasma proteins and antibodies in water and at the same time blood is also a suspension of blood cells and platelets in water.

iii. **Soils:** Fertile soils are colloidal in nature where humus acts as a protective colloid. Soil adsorbs moisture and nourishing materials due to its colloidal nature.

iv. **Fog, mist and rain:**

a. Mist is caused by small droplets of water dispersed in air.

b. Fog is formed whenever there is temperature difference between ground and air.

c. A large portion of air containing dust particles gets cooled below its dew point, the moisture from the air condenses on the surface of these particles which form fine droplets, which are colloidal particles and float in the air as fog or mist.

Q.56. State different ways to classify colloids. **[1 Mark]**

Ans: Colloids can be classified in three different ways:

i. Physical states of dispersed phase and dispersion medium

ii. Interaction or affinity of phases

iii. Molecular size

Q.57. Name the types of colloids based on the physical states of dispersed phase and dispersion medium. Give two examples of each. **[1 Mark Each]**

Ans: There are eight types of colloids based on the physical states of dispersed phase and dispersion medium as given below.

Sr. No.	Type of Colloids	Examples
i.	Solid sol (solid dispersed in solid)	Coloured glasses, gem stones
ii.	Sols and gels (solid in liquid)	Gelatin, muddy water
iii.	Aerosol (solid in gas)	Smoke, dust
iv.	Gel (liquid in solid)	Cheese, jellies
v.	Emulsion (liquid in liquid)	Milk, hair cream
vi.	Aerosol (liquid in gas)	Fog, mist
vii.	Solid sol (gas in solid)	Foam rubber, plaster
viii.	Foam (gas in liquid)	Froth, soap lather

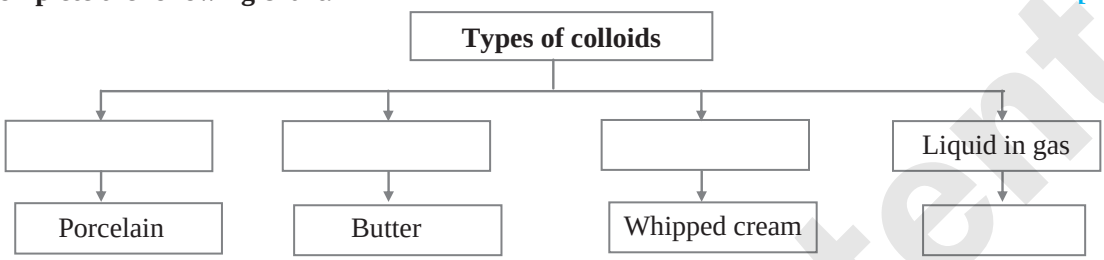
*Q.58. Identify dispersed phase and dispersion medium in the following colloidal dispersions. [1 Mark Each]

i. Milk ii. Blood iii. Printing ink iv. Fog

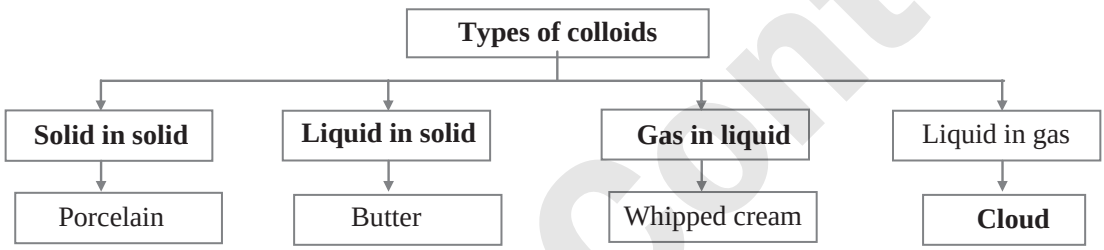
Ans:

Colloidal dispersion	Dispersed phase	Dispersion medium
Milk	Liquid	Liquid
Blood	Solid	Liquid
Printing ink	Solid	Liquid
Fog	Liquid	Gas

Q.59. Complete the following chart. [2 Marks]



Ans:



[Note: Students can write any one example of the given type of colloids.]

Note: Types of colloids based on the physical states of dispersed phase and dispersion medium.

(Textbook page no. 167)

GG - GYAN GURU

Shaving cream is a colloid!!

Shaving and whip creams are all colloids. Shaving cream is a colloid of gas dispersed in a liquid.

Dispersed phase	Dispersion medium	Type of colloid	Examples
Solid	Solid	Solid sol	Coloured glasses, gem stones, porcelain, paper
Solid	Liquid	Sols and gels	Paints, cell fluids, gelatin, muddy water, starch solution
Solid	Gas	Aerosol	Smoke, dust
Liquid	Solid	Gel	Cheese, butter, jellies
Liquid	Liquid	Emulsion	Milk, hair cream
Liquid	Gas	Aerosol	Fog, mist, cloud, hair sprays, insecticide sprays
Gas	Solid	Solid sol	Pumice stone, foam rubber, plaster
Gas	Liquid	Foam	Froth, whipped cream, soap lather

⚠ CAUTION

A gas mixed with another gas forms a homogeneous mixture and hence, it is not a colloidal system.

Q.60. Describe classification of colloids based on the interaction or affinity of phases. **[3 Marks]**

Ans: On the basis of interaction or affinity of phases, a colloidal solution is classified as lyophilic and lyophobic.

i. Lyophilic colloids:

a. *A colloidal solution in which the particles of dispersed phase have a great affinity for the dispersion medium are* ***lyophilic colloids****.*

b. If the lyophilic sol is evaporated, the dispersed phase separates. However, if it is remixed with the medium, the sol can be formed again and hence, such sols are called reversible sols.

c. They are stable and difficult to coagulate.

ii. Lyophobic colloids:

a. *Colloidal solution in which the particles of the dispersed phase have no affinity for the dispersion medium are called* ***lyophobic colloids****.*

b. The common examples are Ag, Au, hydroxides like $Al(OH)_3$, $Fe(OH)_3$, metal sulphides.

c. Once precipitated or coagulated they have little tendency or no tendency to revert back to colloidal state.

[Note: *Lyo means liquid and philic means loving whereas phobic means fearing and hence liquid hating.****]***

⚠ CAUTION

If water is the dispersion medium, the terms hydrophilic and hydrophobic are used.

Q.61. Give reason: Lyophilic sols are called reversible sols. **[2 Marks]**

Ans:

i. When lyophilic sol is evaporated, the dispersed phase separates.

ii. However, if the dispersed phase is remixed with the medium, the sol can be formed again. Hence, lyophilic sols are called reversible sols.

***Q.62. Distinguish between lyophobic and lyophilic sols.** **[2 Marks]**

Ans:

No.	Lyophobic sols (colloids)	Lyophilic sols (colloids)
i.	Lyophobic sols are formed only by special methods.	Lyophilic sols are formed easily by direct mixing.
ii.	They are irreversible.	They are reversible.
iii.	These are unstable and hence, require traces of stabilizers.	These are self-stabilized.
iv.	Addition of small amount of electrolytes causes precipitation or coagulation of lyophobic sols.	Addition of large amount of electrolytes causes precipitation or coagulation of lyophilic sols.
v.	Viscosity of lyophobic sol is nearly the same as the dispersion medium.	Viscosity of lyophilic sol is much higher than that of the dispersion medium.
vi.	Surface tension of lyophobic sol is nearly the same as the dispersion medium.	Surface tension of lyophilic sol is lower than that of dispersion medium.

Q.63. How are colloids classified based on their molecular size? **[3 Marks]**

Ans: Colloids are classified into three types based on their molecular size as described below.

i. Multimolecular colloids:

a. In multimolecular colloids, the individual particles consist of an aggregate of atoms or small molecules with size less than 10^3 pm.

e.g. Gold sol consists of particles of various sizes having several gold atoms.

b. Colloidal solution in which particles are held together with van der Waals force of attraction is called multimolecular colloid.

e.g. S_8 sulphur molecules

ii. Macromolecular colloids: In this type of colloids, the molecules of the dispersed phase are sufficiently large in size (macro) to be of colloidal dimensions.

e.g. Starch, cellulose, proteins, polythene, nylon, plastics.

iii. Associated colloids or micelles:

a. The substances behave as normal electrolytes at low concentration and associated in higher concentration forming a colloidal solution.

b. The associated particles are called micelles.

e.g. Soaps and detergents

***Q.64. Explain micelle formation in soap solution.** **[3 Marks]**

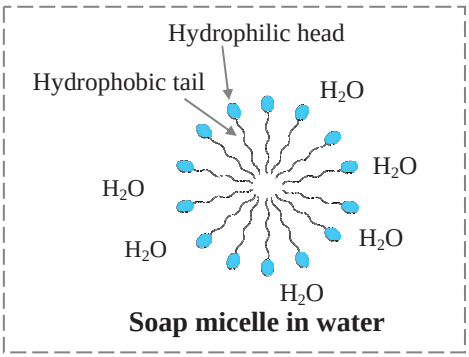
Ans:

i. Soap molecule has a long hydrophobic hydrocarbon chain called tail which is attached to hydrophilic ionic carboxylate group, called head.

ii. In water, the soap molecules arrange themselves to form spherical particles that are called micelles.

iii. In each micelle, the hydrophobic tails of soap molecules point to the centre and the hydrophilic heads lie on the surface of the sphere.

iv. As a result of this, soap dispersion in water is stable.



Soap micelle in water

***Q.65. Draw labelled diagram: Soap micelle** **[1 Mark]**

Ans: *Refer Q.64. (diagram)*

Q.66. How can be colloids prepared by chemical methods? **[2 Marks]**

Ans:

i. Colloidal dispersions can be prepared by chemical reactions leading to formation of molecules by double decomposition, oxidation, reduction or hydrolysis.

ii. Molecules formed in these reactions are water-insoluble and thus, they aggregate leading to the formation of colloids.

e.g.

a. $SO_2 + 2H_2S \xrightarrow{\text{Oxidation}} 3S\downarrow + 2H_2O$

b. $2AuCl_3 + 3HCHO + 3H_2O \xrightarrow{\text{Reduction}} 2Au\downarrow + 3HCOOH + 6HCl$

c. $FeCl_3 + 3H_2O \xrightarrow{\text{Hydrolysis}} Fe(OH)_3\downarrow + 3HCl$

Note: Colloid can be prepared by double decomposition reaction as follows:

$As_2O_3 + 3H_2S \xrightarrow{\text{Double decomposition}} As_2S_3\downarrow + 3H_2O$

***Q.67. Explain Bredig's arc method.** **[3 Marks]**

Ans:

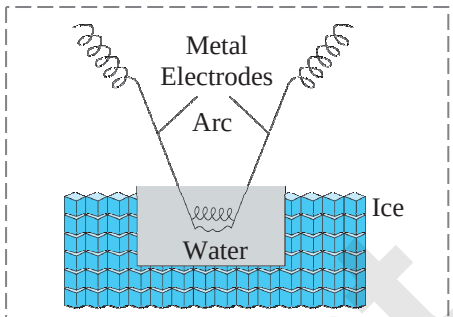
i. Colloidal sols can be prepared by electrical disintegration using Bredig's arc method.

ii. This process involves vaporization as well as condensation.

iii. Colloidal sols of metals such as gold, silver, platinum can be prepared by this method.

iv. In this method, electric arc is struck between electrodes of metal immersed in the dispersion medium.

v. The intense heat produced vapourizes the metal which then condenses to form particles of colloidal sol.



Bredig's arc method

***Q.68. Draw labelled diagram: Bredig's arc method** **[2 Marks]**

Ans: *Refer Q.67. (diagram)*

Q.69. Describe the process involved in peptization? **[2 Marks]**

Ans:

i. During peptization a precipitate is converted into colloidal sol by shaking with dispersion medium in the presence of a small amount of an electrolyte. The electrolyte used is known as peptizing agent.

ii. During the process, the precipitate adsorbs one of the ions of the electrolyte on its surface and as a result, positive or negative charge is developed on the precipitate which finally breaks up into small particles of colloidal size.

***[Note:** This method is generally applied to convert a freshly prepared precipitate into a colloidal sol.]*

Q.70. Why is it necessary to purify colloidal solutions? **[2 Marks]**

Ans:

i. Colloidal solution generally contains excessive amount of electrolytes and some other soluble impurities.

ii. A small quantity of an electrolyte is necessary for the stability of colloidal solution, however, a large quantity of electrolyte may result in coagulation.

iii. It is also necessary to reduce soluble impurities.

Hence, it is necessary to purify colloidal solutions.

Q.71. i. What is purification of colloidal solution?

ii. How can a colloidal solution be purified using the method of dialysis? **[3 Marks]**

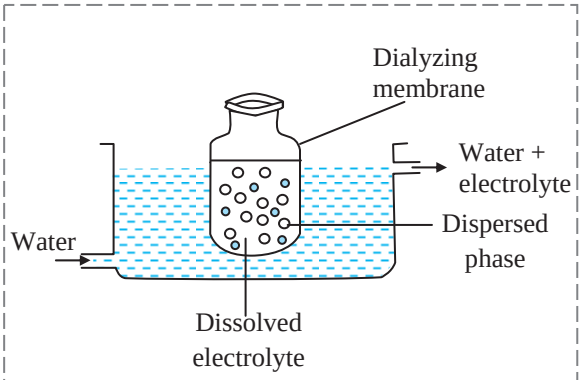
Ans:

i. The process used for reducing the amount of impurities to a requisite minimum is known as purification of colloidal solution.

ii. a. ***Dialysis*** *is a process of removing a dissolved substance from a colloidal solution by diffusion through a suitable membrane.*

b. Purification of colloidal solution can be carried out using dialysis by the following method.

1. The apparatus used is dialyser.
2. A bag of suitable membrane containing the colloidal solution is suspended in a vessel through which fresh water is continuously flowing.
3. The molecules and ions diffuse through membrane into the outer water and pure colloidal solution is left behind.



Dialysis

***Q.72. Draw labelled diagram: Dialysis [2 Marks]**

Ans: *Refer Q.71. (diagram)*

Q.73. What are the general properties exhibited by colloidal dispersions? [2 Marks]

Ans: General properties exhibited by colloidal dispersions:

i. Colloidal system is heterogeneous and consists of two phases, dispersed phase and dispersion medium.

ii. The dispersed phase particles pass slowly through parchment paper or animal membrane, but readily pass through ordinary filter paper.

iii. Colloidal particles are usually not detectable by powerful microscope.

***Q.74. Write note on: Tyndall effect [4 Marks]**

Ans:

i. Tyndall observed that when light passes through true solution, the path of light through it cannot be detected.

ii. However, if the light passes through a colloidal dispersion, the particles scatter some light in all directions and the path of the light through colloidal dispersion becomes visible to observer standing at right angles to its path.

iii. *The phenomenon of scattering of light by colloidal particles and making path of light visible through the dispersion is referred as* ***Tyndall effect*** *and the bright cone of the light is called* ***Tyndall cone****.*

iv. Tyndall effect is observed only when the following conditions are satisfied.

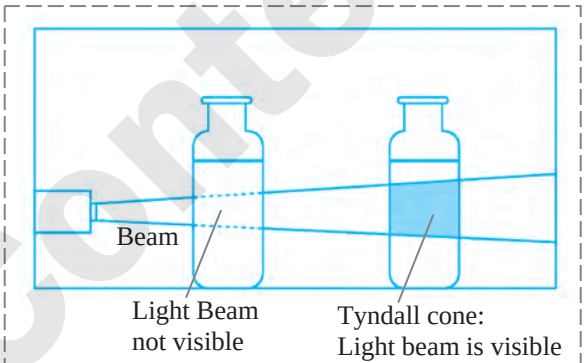
a. The diameter of the dispersed particles is not much smaller than the wavelength of light used.

b. The refractive indices of dispersed phase and dispersion medium differ largely.

v. Significance of Tyndall effect:

a. It is useful in determining number of particles in colloidal system and their particle size.

b. It is used to distinguish between colloidal dispersion and true solution.



Tyndall effect

FOR YOUR KNOWLEDGE

Examples of Tyndall effect observed in everyday life:

i. Scattering of automobile headlight by fog and mist.

ii. The light beam from the movie projector becomes visible (appears bright) in the darkened cinema hall due to the scattering of light by the dust particles.

iii. When the sun beam enters the darkened room through the hole in the window, it appears bright due to the scattering of light by dust particles.

***Q.75. What happens when a beam of light is passed through a colloidal sol. [2 Marks]**

Ans:

i. When a beam of light is passed through colloidal sol, it is observed that the colloidal particles scatter some of the incident light in all directions.

ii. Because of this scattering of light, the path of light through the colloidal dispersion becomes visible to observer standing at right angles to its path and the phenomenon is known as Tyndall effect.

iii. *Refer Q.74. (diagram)*

***Q.76. Draw labelled diagram: Tyndall effect** **[2 Marks]**

Ans: *Refer Q.74. (diagram)*

Q.77. Discuss the factors that influence the colour of colloidal solutions. **[2 Marks]**

Ans:

i. Colour of colloidal solution depends on the wavelength of light scattered by dispersed particles.

ii. The colour of colloidal dispersion also changes with the manner in which the observer receives the light.

e.g. Mixture of a few drops of milk and large amount of water appears blue when viewed by the scattered light and red when viewed by transmitted light.

iii. It also depends on size of colloidal particles.

e.g. Finest gold sol is red in colour whereas with increase in size it appears purple.

***Q.78. Write note on: Brownian motion** **[2 Marks]**

Ans:

i. *The colloidal or microscopic particles undergo ceaseless random zig-zag motion in all directions in a fluid. This motion of dispersed phase particles is called* ***Brownian motion****.*

ii. Cause of Brownian motion:

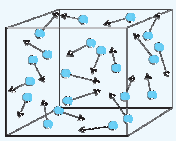
a. Particles of the dispersed phase constantly collide with the fast-moving molecules of dispersion medium (fluid).

b. Due to this, the dispersed phase particles acquire kinetic energy from the molecules of the dispersion medium.

c. This kinetic energy brings about Brownian motion.

READING BETWEEN THE LINES

i. British botanist, Robert Brown, observed such motion of pollen grains under a microscope. The random motion was explained by Albert Einstein in 1905.



Brownian motion

ii. Brownian motion diagramatically can be represented as follows:

Q.79. Internet my friend. *(Textbook page no. 172)*

i. Brownian motion

Students can search relevant videos on YouTube to visualize Brownian motion.

ii. Collect information about Brownian motion.

Students are expected to refer Q.78. and collect additional information on their own.

Students can scan the adjacent Q. R. Code in *Quill - The Padhai App* to visualize Brownian motion.

Q.80. Give three examples each: **[1 Mark Each]**

i. Positively charged sols

ii. Negatively charged sols

Ans:

i. Positively charged sols: $Al_2O_3.xH_2O$, haemoglobin, TiO_2 sol

ii. Negatively charged sols: Au sols, Congo red sol, clay

Note: Some common sols with the nature of charge on the particles are listed in the table below.

(Textbook page no. 170)

Positively charged sols	Negatively charged sols
Hydrated metallic oxides: $Al_2O_3.xH_2O$, $CrO_3.xH_2O$, $Fe_2O_3.xH_2O$.	Metals: Cu, Ag, Au sols Metallic sulphides: As_2S_3, Sb_2S_3, CdS
Basic dye stuff, methylene blue sols	Acid dye stuff, eosin, Congo red sol
Haemoglobin (blood)	Sols of starch, gum
Oxides: TiO_2 sol	Gelatin, clay, gum sols

***Q.81. Define the term: Electrophoresis** **[1 Mark]**

Ans: *The movement of colloidal particles under an applied electric potential is called* ***electrophoresis.***

***Q.82. Explain electrophoresis in brief with the help of diagram. What are its applications?** **[4 Marks]**

Ans:

i. Electrophoresis: Electrophoresis set up is shown in the diagram below.

a. The diagram shows U tube set up in which two platinum electrodes are dipped in a colloidal solution.

b. When electric potential is applied across two electrodes, colloidal particles move towards one or other electrode.

c. The movement of colloidal particles under an applied electric potential is called electrophoresis.

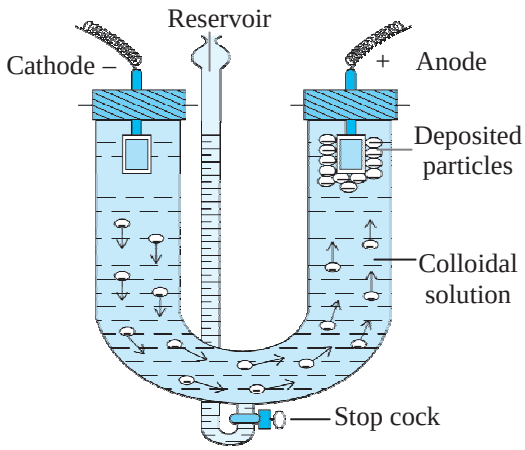
d. Positively charged particles move towards cathode while negatively charged particles migrate towards anode and get deposited on the respective electrode.

ii. Applications of electrophoresis:

a. On the basis of direction of movement of the colloidal particles under the influence of electric field, it is possible to know the sign of charge on the particles.

b. It is also used to measure the rate of migration of sol particles.

c. Mixture of colloidal particles can be separated by electrophoresis, since different colloidal particles in mixture migrate with different rates.



Electrophoresis

Q.83. Explain the term electroosmosis. [2 Marks]

Ans:

i. Movement of dispersed particles can be prevented by suitable means such as use of membrane.

ii. On doing so, it is observed that the dispersion medium begins to move in an electric field. This is known as electroosmosis.

Q.84. What is coagulation? [1 Mark]

Ans: *The precipitation of colloids by removal of charge associated with colloidal particles is called* ***coagulation.***

Q.85. How can we bring about precipitation of lyophobic colloids? [1 Mark]

Ans:

i. The charge on the colloidal particles is due to the preferential adsorption of ions on their surface.

ii. Hence, lyophobic colloids can be precipitated out by removing the charge on the colloidal particles (dispersed phase).

FOR YOUR KNOWLEDGE

Coagulation of lyophilic colloids:

i. Lyophilic colloids differ from lyophobic colloids in respect of coagulation by the addition of electrolytes.

ii. Lyophobic colloids require smaller amount of electrolyte whereas lyophilic colloids require much larger amounts of electrolytes that needs to be added for their precipitation.

iii. This is because the lyophilic particles are surrounded by layer of medium through which penetration of ions is difficult. The higher concentration of electrolytes removes this layer of medium surrounding the particles and then neutralises their charge resulting in their coagulation.

Q.86. Discuss various methods that are used to bring about coagulation of lyophobic sols. [3 Marks]

Ans: Coagulation of the lyophobic sols can be carried out in the following ways.

i. By electrophoresis: The colloidal particles move towards oppositely charged electrodes, get discharged and precipitate.

ii. By mixing two oppositely charged sols: Oppositely charged sols when mixed in almost equal proportions neutralize their charges and get precipitated.

e.g. Mixing of hydrated ferric oxide (positive sol) and arsenious sulphide (negative sol) brings them in the precipitated forms. This type of coagulation is called mutual coagulation.

iii. By boiling: When a sol is boiled, the adsorbed layer is disturbed as a result of increased collisions with molecules in the dispersion medium. This reduces charge on the particles and subsequently particles settle down as a precipitate.

iv. By persistent dialysis: On prolonged dialysis, traces of the electrolyte present in the sol are removed almost completely. The colloids then become unstable and finally precipitate.

v. By addition of electrolytes: When excess of an electrolyte is added, the colloidal particles are precipitated.

***Q.87. Write note on: Hardy–Schulze rule.** [2 Marks]

Ans:

i. Generally, greater the valency of the flocculating ion added, greater is its power to cause precipitation. This is known as Hardy–Schulze rule.

ii. In the coagulation of negative sol, the flocculating power follows the following order:
$Al^{3+} > Ba^{2+} > Na^{+}$

iii. Similarly, in the coagulation of positive sol, the flocculating power is in the following order:
$[Fe(CN)_6]^{4-} > PO_4^{3-} > SO_4^{2-} > Cl^{-}$

***Q.88. Write Hardy–Schulze rule.** [1 Mark]

Ans: *Refer Q.87. (i)*

*Q.89. **Explain the term emulsion and types of emulsions.** [3 Marks]

Ans:

i. *A colloidal system in which one liquid is dispersed in another immiscible liquid is called an **emulsion**.*

ii. There are liquid-liquid colloidal systems in which both liquids are either completely or partially immiscible.

iii. There are two types of emulsions:

a. **Emulsion of oil in water (o/w type):** *An emulsion in which dispersed phase is oil and dispersion medium is water is called **emulsion of oil in water**.*

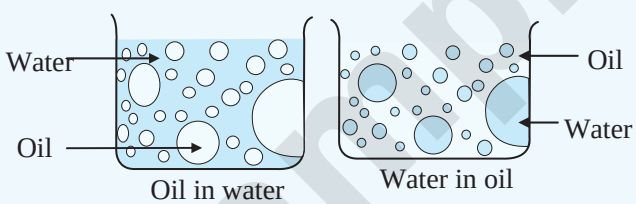
e.g. 1. Milk consists of particles of fat dispersed in water.
2. Other examples include vanishing cream, paint, etc.

b. **Emulsion of water in oil (w/o type):** *An emulsion in which dispersed phase is water and dispersion medium is oil is called **emulsion of water in oil**.*

e.g. 1. Cod liver oil consists of particles of water dispersed in oil.
2. Some other examples of this type include butter, cream, etc.

FOR YOUR KNOWLEDGE

Two types of emulsions can be represented diagrammatically as follows:



Emulsion

*Q.90. **Write note on: Types of emulsion** [2 Marks]

Ans: *Refer Q.89. (iii)*

Q.91. Differentiate between oil in water and water in oil emulsions. [2 Marks]

Ans:

Sr. no.	Oil in water	Water in oil
i.	Oil is the dispersed phase and water is the dispersion medium.	Water is the dispersed phase and oil is the dispersion medium.
ii.	If water is added, it will be miscible with the emulsion.	If oil is added, it will be miscible with the emulsion.
iii.	Addition of small amount of an electrolyte makes the emulsion conducting.	Addition of small amount of an electrolyte has no effect on conducting power.
iv.	Continuous phase is water.	Continuous phase is oil.
v.	Basic metal sulphates, water soluble alkali metal soaps are used as emulsifiers.	Water insoluble soaps such as those of Zn, Al, Fe, alkaline earth metals are used as emulsifiers.

Q.92. What are the properties of emulsion? [2 Marks]

Ans: Properties of emulsion:

i. Emulsion can be diluted with any amount of the dispersion medium. On the other hand, the dispersed liquid when mixed forms a separate layer.

ii. The droplets in emulsions are often negatively charged and can be precipitated by electrolytes.

iii. Emulsions show Brownian movement and Tyndall effect.

iv. The two liquids in emulsions can be separated by heating, freezing, centrifuging, etc.

Q.93. Give applications of colloids. [4 Marks]

Ans: Applications of colloids:

i. Electrical precipitation of smoke:

a. Smoke is a colloidal solution of solid particles of carbon, arsenic compound, dust, etc. in the air.

b. When smoke is allowed to pass through chamber containing charged plates, smoke particles lose their charge and get precipitated. The particles then settle down on the floor of the chamber.

c. The precipitator used is called Cottrell precipitator.

ii. Purification of drinking water:

a. Water obtained from natural sources contains colloidal impurities.

b. By addition of alum to such water, colloidal impurities get coagulated and settle down. This makes water potable.

iii. Medicines:

a. Usually medicines are colloidal in nature.

b. Colloidal medicines are more effective owing to large surface area to volume ratio of a colloidal particle and easy assimilation.

e.g. Argyrol is a silver sol used as an eye lotion. Milk of magnesia, an emulsion is used in stomach disorders.

iv. **Rubber industry:** Rubber is obtained by coagulation of latex.

v. Cleansing action of soaps and detergents.

vi. Photographic plates, films, and industrial products like paints, inks, synthetic plastics, rubber, graphite lubricants, cement, etc. are colloids.

Q.94. Name the following. **[1 Mark Each]**

i. Name the kinetic property associated with colloidal particles.

ii. An optical property which is useful in determining the number of particles and the particle size in a colloidal system.

iii. A process that allows dissolved material to be removed from colloidal solution by diffusion through a suitable membrane.

Ans:

i. Brownian motion ii. Tyndall effect

iii. Dialysis

Q.95. Internet my friend. *(Textbook page no. 172)*

i. Collect information about surface chemistry.

Ans:

a. Surface or interface represents the boundary which separates two bulk phases.

e.g. Boundary between water and its vapour is a liquid-gas interface.

b. Certain properties of substances, particularly of solids and liquids, depend upon the nature of the surface.

c. An interface usually has a thickness of a few molecules. However, its area depends on the size of the bulk phase particles.

d. Commonly considered bulk phases may be pure compounds or solutions.

e. A number of important phenomena, namely, dissolution, crystallization, heterogeneous catalysis, electrode processes and corrosion take place at an interface.

f. Thus, study of chemistry of surfaces is critical to many applications in industry, analytical investigations and day-to-day activities such as cleaning and softening of water.

g. The branch of chemistry which deals with the nature of surfaces and changes occurring on the surfaces is called surface chemistry.

h. Study of surfaces requires a rigorously clean surface. An ultra-clean metal surface can be obtained under very high vacuum, of the order of 10^{-8} to 10^{-9} pascal.

i. Adsorption, catalysis and colloids (such as emulsions and gels) are some of the important aspects of surface chemistry.

***[Note:** Students are expected to collect additional information about surface chemistry on their own.]*

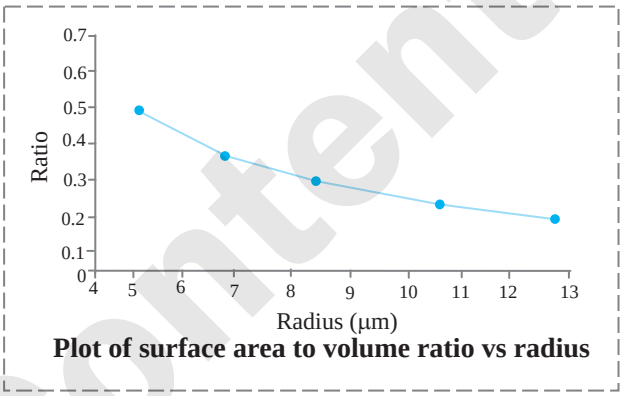
ii. Collect information about adsorption.

Students are expected to collect information about adsorption on their own.

Q.96. Activity. *(Textbook page no. 172)*

Calculate surface area to volume ratio of spherical particle. See how the ratio increases with the reduction of radius of the particle. Plot the ratio against the radius.

Ans: The graph shows that as the radius of the spherical particle decreases, the surface to volume ratio increases steadily.



Plot of surface area to volume ratio vs radius

***Q.97. Activity: Collect the information about methods to study surface chemistry.**

Ans: Following are the few methods that are employed to study surface chemistry.

i. X-ray photoelectron spectroscopy:

It is a surface-sensitive spectroscopic technique which is used to measure elemental composition of the surface, to determine elements that are present as contaminants on the surface, etc.

ii. Auger electron spectroscopy:

It is a common analytical technique which is used to study surfaces of materials.

iii. Temperature programmed desorption (TPD):

Adsorbed molecules get desorbed when the surface temperature is increased. TPD technique is used to observe these desorbed molecules and helps in providing information about binding energy between the adsorbate and adsorbent.

iv. Scanning Electron Microscopy:

In this technique, a scanning electron microscope is used to focus electron beam over the surface of the sample to be examined. The electron beam interacts with the sample and an image is obtained. This image provides information about surface structure and composition of the sample.

***[Note:** Students are expected to collect additional information about surface chemistry on their own.]*

Brain Teasers

Q.98. In drinking water treatment, often alum is added for the complete removal of suspended impurities. On complete dissolution, alum produces positive charge which neutralizes the charge on the suspended particles and thus, impurities are easily removed.

i. Name and define the process involved due to which charge on particles get neutralized.

ii. What is the role of alum in the above mentioned process?

Ans:

i. a. Charge on particles get neutralized due to coagulation.

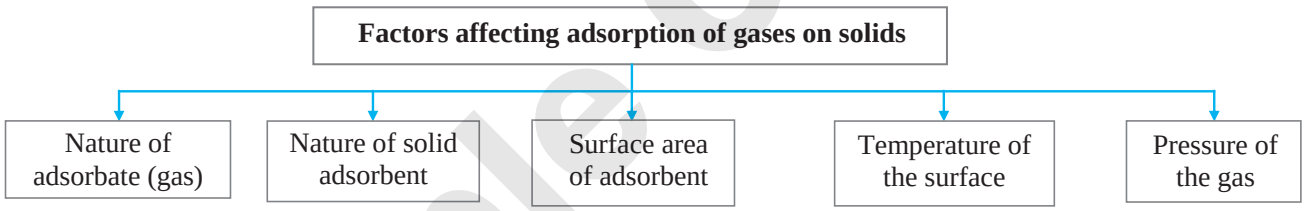
b. *The precipitation of colloids by removal of charge associated with colloidal particles is called* ***coagulation.***

ii. Alum acts as a reagent that helps in coagulation of the suspended particles by the removal of the charge associated with these particles.

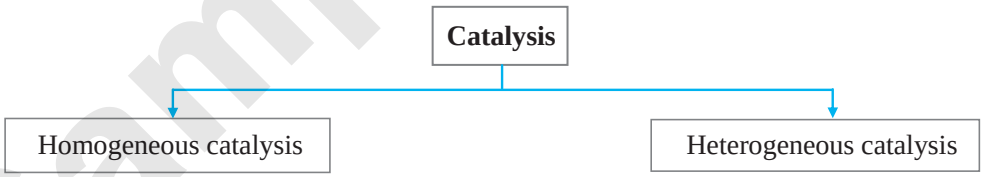
Quick Review

➢ **Types of adsorption:**

➢ **Factors affecting adsorption of gases on solids:**



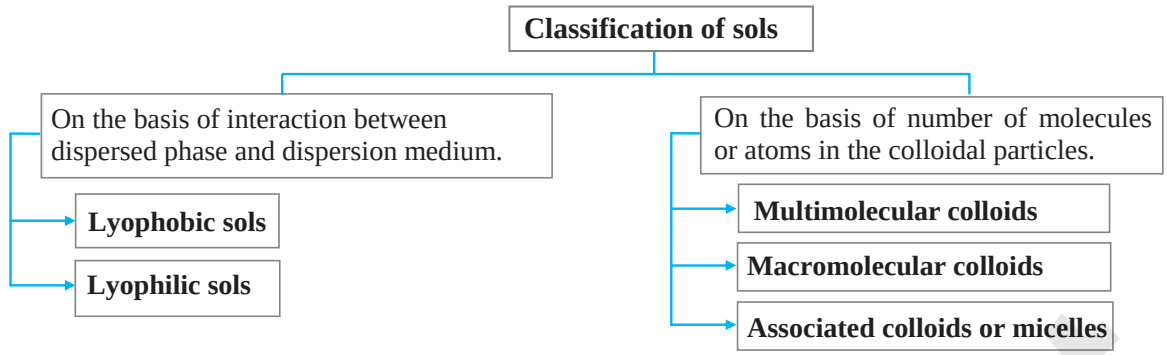
➢ **Types of catalysis:**



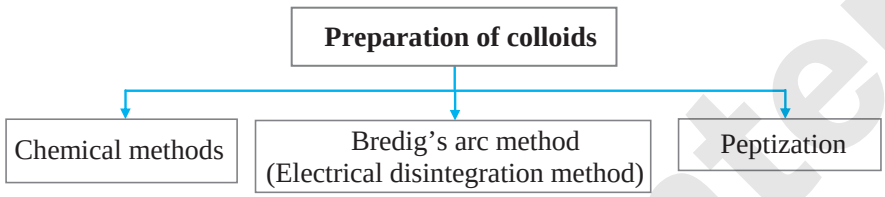
➢ **Types of colloids based on the physical states of dispersed phase and dispersion medium:**

Dispersed phase	Dispersion medium	Type of colloid	Examples
Solid	Solid	Solid sol	Coloured glasses, gem stones, porcelain, paper
Solid	Liquid	Sols and gels	Paints, cell fluids, gelatin, muddy water, starch solution
Solid	Gas	Aerosol	Smoke, dust
Liquid	Solid	Gel	Cheese, butter, jellies
Liquid	Liquid	Emulsion	Milk, hair cream
Liquid	Gas	Aerosol	Fog, mist, cloud, hair sprays, insecticide sprays
Gas	Solid	Solid sol	Pumice stone, foam rubber, plaster
Gas	Liquid	Foam	Froth, whipped cream, soap lather

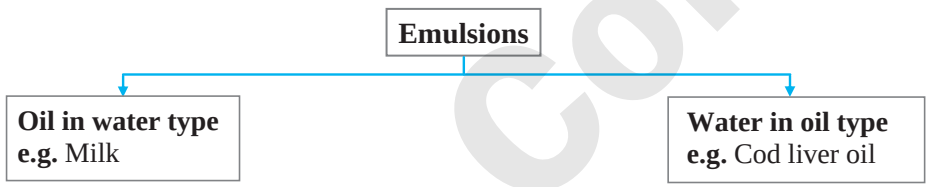
➢ **Classification of colloids (sols):**



➢ **Methods of preparation of colloids:**



➢ **Types of emulsions:**



Exercise

11.2 Adsorption

1. Give any two examples of adsorption from daily life. **[2 Marks]**

Ans: *Refer Q.1. (i and ii)*

2. Why adsorption is said to be a surface phenomenon? **[2 Marks]**

Ans: *Refer Q.2.*

3. What is adsorption? **[1 Mark]**

Ans: *Refer Q.3.*

4. Define the following terms: **[1 Mark Each]**

i. Surface tension ii. Adsorbate

Ans:

i. *Refer Q.6.* ii. *Refer Q.7. (ii)*

5. Differentiate between: Adsorption and absorption **[2 Marks]**

Ans: *Refer Q.11.*

11.3 Types of adsorption

6. Name the following. **[1 Mark Each]**

i. The type of adsorption in which van der Waals forces are present.

ii. The type of adsorption in which compound is formed.

Ans:

i. *Refer Q.14* ii. *Refer Q.15*

7. What is chemisorption? State its characteristics. **[3 Marks]**

Ans: *Refer Q.17.*

8. Distinguish between: Physisorption and chemisorption. **[3 Marks]**

Ans: *Refer Q.19.*

11.4 Factors affecting adsorption of gases on solids

9. Explain: Adsorption of gases by solids depend on the nature of the adsorbate. **[1 Mark]**

Ans: *Refer Q.21. (i-a)*

10. How does adsorption of gases by solids depend on surface area of the adsorbent? **[1 Mark]**

Ans: *Refer Q.21. (ii)*

11. Give reason: Finely divided substance is more effective adsorbent. **[2 Marks]**

Ans: *Refer Q.22.*

12. Explain the effect of pressure of the gas on the rate of adsorption of gases by solids. **[2 Marks]**

Ans: *Refer Q.23. (ii)*

13. Write any four characteristics of adsorption. **[2 Marks]**

Ans: *Refer Q.24.*

11.5 Adsorption isotherm

14. Define adsorption isotherm. **[1 Mark]**

Ans: *Refer Q.25.*

15. Describe Freundlich adsorption isotherm graphically. **[4 Marks]**

Ans: *Refer Q.26.*

16. Give equation for Freundlich adsorption isotherm and explain the terms involved. **[2 Marks]**

Ans: *Refer Q.26. (i)*

11.6 Applications of adsorption

17. Give any three applications of adsorption. **[1 Mark Each]**

Ans: *Refer Q.28.*

11.7 Catalysis

18. Define catalyst. **[1 Mark]**

Ans: *Refer Q.34.*

19. What is catalysis? **[1 Mark]**

Ans: *Refer Q.36.*

20. Give reason: Lead chamber process is an example of homogeneous catalysis. **[2 Marks]**

Ans: *Refer Q.39.*

21. What is heterogeneous catalysis? Explain using an example. **[3 Marks]**

Ans: *Refer Q.40.*

22. Why automobiles with catalytic converters require unleaded petrol? **[1 Mark]**

Ans: *Refer Q.43. (ii)*

23. What are inhibitors? Give one example of inhibition. **[2 Marks]**

Ans: *Refer Q.45.*

11.8 Adsorption theory of heterogeneous catalysis

24. Explain the mechanism involved in catalytic action of a heterogeneous catalyst. **[3 Marks]**

Ans: *Refer Q.48.*

25. Give one example of catalytic selectivity. **[1 Mark]**

Ans: *Refer Q.50.*

26. Why are zeolites termed as shape selective catalysts? **[2 Marks]**

Ans: *Refer Q.51. (ii)*

27. What are zeolites? Write its one use. **[3 Marks]**

Ans: *Refer Q.51. (i and iii)*

11.9 Colloids

28. What do you mean by dispersion medium? **[1 Mark]**

Ans: *Refer Q.53. (ii)*

29. What is the dispersed phase and dispersion medium in milk? **[1 Mark]**

Ans: Dispersed phase: Fat
Dispersion medium: Water

30. State the differences between lyophobic and lyophilic sols. **[2 Marks]**

Ans: *Refer Q.62.*

31. Explain the following terms giving examples. **[1 Mark Each]**

i. Multimolecular colloids
ii. Macromolecular colloids

Ans:

i. *Refer Q.63. (i)* ii. *Refer Q.63. (ii)*

32. Explain chemical method of preparing colloids. **[2 Marks]**

Ans: *Refer Q.66.*

33. Describe Bredig's arc method with a neat and labelled diagram. **[3 Marks]**

Ans: *Refer Q.67.*

34. Draw a neat and labelled diagram of apparatus used for dialysis. **[2 Marks]**

Ans: *Refer Q.71. (diagram)*

35. Explain Tyndall effect. **[4 Marks]**

Ans: *Refer Q.74.*

36. What are the uses of electrophoresis technique? **[2 Marks]**

Ans: *Refer Q.82. (ii)*

37. Explain any two methods used to bring about coagulation of lyophobic sols. **[1 Mark]**

Ans: *Refer Q.86.*

38. Define emulsion and explain its types. **[3 Marks]**

Ans: *Refer Q.89.*

Multiple Choice Questions

[1 Mark Each]

1. A substance which adsorbs another substance on its surface is called _____.

(A) adsorbate (B) absorbate
(C) adsorbent (D) absorbent

2. Which of the following is responsible for adsorption phenomenon?
(A) Hydrogen bonding
(B) Dipole-dipole forces
(C) Ion-dipole forces
(D) Dispersion forces

3. During adsorption, the molecules of the substance which gets adsorbed are termed as _____.
(A) adsorbent (B) adsorbate
(C) absorbent (D) absorbate

4. In adsorption of acetic acid on charcoal, acetic acid is _____.
(A) adsorbate (B) adsorbent
(C) absorbent (D) absorbate

5. The process of removal of an adsorbed substance from the surface is known as _____.
(A) sorption (B) oxidation
(C) reduction (D) desorption

6. _____ is the process in which adsorbate molecules are held on the surface of the adsorbent by weak van der Waals forces.
(A) Chemisorption (B) Absorption
(C) Physisorption (D) Biosorption

7. Which of the following is an example of physical adsorption?
(A) Adsorption of acetic acid in solution by charcoal
(B) Adsorption of O_2 on tungsten
(C) Adsorption of N_2 on Fe
(D) Adsorption of H_2 on Ni

8. Chemisorption is a slow process because _____.
(A) it forms multimolecular layer
(B) it is reversible
(C) it takes place at normal temperature
(D) it requires high activation energy

9. The number of layer(s) formed on adsorbent in chemical adsorption is _____.
(A) one (B) two
(C) three (D) many

10. Which of the following statements is CORRECT regarding chemical adsorption?
(A) It is highly specific in nature.
(B) It is relatively strong.
(C) It involves the formation of monolayer of adsorbed particles.
(D) All of these.

11. Which of the following is adsorbed to maximum extent on charcoal?
(A) H_2 (B) N_2
(C) Cl_2 (D) O_2

12. The relation between the amount of substance adsorbed by an adsorbent and the equilibrium pressure or _____ at any constant temperature is called adsorption isotherm.
(A) surface area (B) volume
(C) circumference (D) concentration

13. For equilibrium pressure (P), the mass of gas adsorbed (x) and mass of adsorbent (m) may be expressed as Freundlich adsorption isotherm as _____.
(A) $\frac{m}{x} = kP^{\frac{1}{n}}$ (B) $\frac{x}{m} = kP^{\frac{1}{n}}$
(C) $xm = kP^{\frac{1}{n}}$ (D) $\frac{x}{m} = k\left(\frac{1}{P}\right)^n$

14. When log x/m is plotted against log P, the intercept obtained _____.
(A) on Y axis is equal to log K
(B) on Y axis is equal to K
(C) on X axis is equal to log K
(D) on X axis is equal to K

15. The adsorption isotherm tends to saturate at _____ pressure.
(A) low (B) moderate
(C) all of these (D) high

16. In Haber process for manufacture of NH_3, the catalyst used is _____.
(A) iron
(B) copper
(C) vanadium pentoxide
(D) nickel

*17. In Haber process of production of ammonia, K_2O is used as _____.
(A) catalyst (B) inhibitor
(C) promoter (D) adsorbate

18. A substance that decreases the rate of a chemical reaction is called _____.
(A) inhibitor (B) prohibitor
(C) promoter (D) reactor

19. Whether a given mixture forms a true solution or a colloidal dispersion depends on the _____.
(A) charge of solute particles
(B) size of solvent particles
(C) size of solute particles
(D) charge of solvent particles

*20. The size of colloidal particles lies between _____.
(A) 10^{-10} m to 10^{-9} m (B) 10^{-9} m to 10^{-6} m
(C) 10^{-6} m to 10^{-4} m (D) 10^{-5} m to 10^{-2} m

21. An aerosol is a dispersion of a _____.
(A) gas in a solid (B) liquid in a gas
(C) solid in a gas (D) both (B) and (C)

22. The dispersed phase in Pumice stone is _____.
(A) solid (B) liquid
(C) gas (D) none of these

*23. Fruit jam is an example of _____.
(A) sol (B) gel
(C) emulsion (D) true solution

24. Colloidal solution in which the dispersed phase has little affinity for the dispersion medium is called _____.
(A) lyophobic colloids
(B) lyophilic colloids
(C) hydrophilic colloids
(D) emulsions

*25. Gum in water is an example of _____.
(A) true solution (B) suspension
(C) lyophilic sol (D) lyophobic sol

26. Which of the following is NOT an example of macromolecular colloid?
(A) Starch (B) Proteins
(C) S_8 molecules (D) Nylon

27. Tyndall effect is useful _____.
(A) to identify colloidal dispersions
(B) to count number of particles in colloidal dispersion.
(C) to determine the size of the colloidal particles
(D) all of these

28. Brownian movement is a _____ type of property of the colloidal sol.
(A) electrical (B) optical
(C) kinetic (D) colligative

29. The migration of colloidal particles under the influence of an electric field is called _____.
(A) catalysis
(B) Brownian movement
(C) electrophoresis
(D) Tyndall effect

30. The capacity of an ion to coagulate a colloidal solution depends on _____.
(A) its shape
(B) its valency
(C) the sign of charge
(D) both (B) and (C)

31. Which of the following has highest precipitation power to precipitate negative sol?
(A) Al^{3+} (B) Mg^{2+}
(C) Na^{+} (D) K^{+}

32. _____ is an example of water in oil type of emulsion.
(A) Milk (B) Cod liver oil
(C) Vanishing cream (D) Paint

Answers to Multiple Choice Questions:

1.	(C)	2.	(D)	3.	(B)	4.	(A)
5.	(D)	6.	(C)	7.	(A)	8.	(D)
9.	(A)	10.	(D)	11.	(C)	12.	(D)
13.	(B)	14.	(A)	15.	(D)	16.	(A)
17.	(C)	18.	(A)	19.	(C)	20.	(B)
21.	(D)	22.	(C)	23.	(B)	24.	(A)
25.	(C)	26.	(C)	27.	(D)	28.	(C)
29.	(C)	30.	(D)	31.	(A)	32.	(B)

Competitive Corner

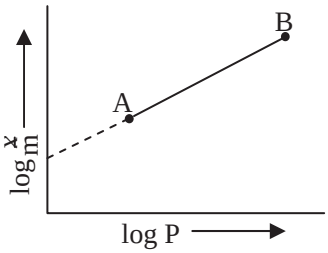
1. Which among the following is CORRECT decreasing order of precipitating power of ions? **[MHT CET 2019]**
(A) $Al^{3+} > Na^{+} > Mg^{2+}$
(B) $Na^{+} > Mg^{2+} > Al^{3+}$
(C) $Mg^{2+} > Al^{3+} > Na^{+}$
(D) $Al^{3+} > Mg^{2+} > Na^{+}$

2. The CORRECT option representing a Freundlich adsorption isotherm is _____. **[NEET (Odisha) 2019]**
(A) $\frac{x}{m} = kp^{-1}$ (B) $\frac{x}{m} = kp^{0.3}$
(C) $\frac{x}{m} = kp^{2.5}$ (D) $\frac{x}{m} = kp^{-0.5}$

3. In which of the sols, the colloidal particles are with negative charge? **[NEET (UG) P-II 2020]**
(A) Hydrated Al_2O_3 (B) TiO_2
(C) Haemoglobin (D) Starch

4. Choose the right option for the statement "Tyndall effect is exhibited by". **[NEET (UG) 2021]**
(A) Glucose solution (B) Starch solution
(C) Urea solution (D) NaCl solution

5. In Freundlich adsorption isotherm, slope of AB line is _____. **[JEE (Main) 2021]**



(A) n with (n, 0.1 to 0.5)
(B) log n with (n > 1)
(C) $\log \frac{1}{n}$ with (n < 1)
(D) $\frac{1}{n}$ with ($\frac{1}{n}$, 0 to 1)

6. Identify the catalyst used in following reaction.
Vegetable oil + $H_2 \xrightarrow{\text{Catalyst}}$ vegetable ghee **[MHT CET 2021]**
(A) $Ni_{(s)}$ (B) $Mo_{(s)}$
(C) $Pb_{(s)}$ (D) $Fe_{(s)}$

7. Given below are two statements:
Statement I:
In the coagulation of a negative sol, the flocculating power of the three given ions is in the order – $Al^{3+} > Ba^{2+} > Na^{+}$
Statement II:
In the coagulation of a positive sol, the flocculating power of the three given salts is in the order – $NaCl > Na_2SO_4 > Na_3PO_4$
In the light of the above statements, choose the most appropriate answer from the options given below: **[NEET (UG) 2022]**
(A) Statement I is correct but Statement II is incorrect.
(B) Statement I is incorrect but Statement II is correct.
(C) Both Statement I and Statement II are correct.
(D) Both Statement I and Statement II are incorrect.

8. Which from following is an example of multimolecular colloid? **[MHT CET 2022]**
(A) Cellulose (B) Plastic
(C) S_8 molecule (D) Starch

9. Which one is an example of heterogeneous catalysis? **[NEET(UG) 2023]**
(A) Hydrolysis of sugar catalysed by H+ ions.
(B) Decomposition of ozone in presence of nitrogen monoxide.
(C) Combination between dinitrogen and dihydrogen to form ammonia in the presence of finely divided iron.
(D) Oxidation of sulphur dioxide into sulphur trioxide in the presence of oxides of nitrogen.

10. Which of the following gases is readily adsorbed by solid adsorbent? **[MHT CET 2023]**
(A) Cl_2 (B) N_2
(C) O_2 (D) H_2

11. Which from following phenomena is inversely proportional with adsorption? **[MHT CET 2023]**
(A) Critical temperature of gas
(B) Surface area of adsorbent
(C) Temperature of process
(D) Pressure of gas

Answers to Competitive Corner:

1.	(D)	2.	(B)	3.	(D)	4.	(B)
5.	(D)	6.	(A)	7.	(D)	8.	(C)
9.	(C)	10.	(A)	11.	(C)		

Topic Test

Time: 1 Hour 30 Min **Total Marks: 25**

SECTION A

Q.1. Select and write the correct answer: **[04]**

i. The size of colloidal particles lies between _____.
(A) 10^{-10} m to 10^{-9} m (B) 10^{-9} m to 10^{-6} m
(C) 10^{-6} m to 10^{-4} m (D) 10^{-5} m to 10^{-2} m

ii. For equilibrium pressure (P), the mass of gas adsorbed (x) and mass of adsorbent (m) may be expressed as Freundlich adsorption isotherm as _____.
(A) $\frac{m}{x} = kP^{\frac{1}{n}}$ (B) $\frac{x}{m} = kP^{\frac{1}{n}}$
(C) $xm = kP^{\frac{1}{n}}$ (D) $\frac{x}{m} = k\left(\frac{1}{P}\right)^{n}$

iii. Which of the following is NOT an example of macromolecular colloid?
(A) Starch (B) Proteins (C) S_8 molecules (D) Nylon

iv. Colloidal solution in which the dispersed phase has little affinity for the dispersion medium is called _____.
(A) lyophilic colloids (B) lyophobic colloids
(C) emulsions (D) hydrophilic colloids

Q.2. Answer the following: **[03]**

i. What is desorption?

ii. What is an adsorption isotherm?

iii. Define: Electrophoresis

SECTION B

Attempt any Four: **[08]**

Q.3. Write characteristics of adsorption.

Q.4. Write note on: Hardy–Schulze rule.

Q.5. Distinguish between adsorption and absorption.

Q.6. Mention factors affecting adsorption of gas on solids.

Q.7. Explain why finely divided substance is more effective as adsorbent?

Q.8. Explain the applications of adsorption with respect to following:
i. Chromatographic analysis ii. Separation of inert gases

SECTION C

Attempt any Two: **[06]**

Q.9. Explain how the adsorption of gas on solid varies with
i. nature of adsorbate and adsorbent
ii. surface area of adsorbent.

Q.10. Explain micelle formation in soap solution.

Q.11. Explain the term emulsion and types of emulsions.

SECTION D

Attempt any One: **[04]**

Q.12. i. Complete the following table.

Colloidal dispersion	Dispersed phase	Dispersion medium
Milk	-------	Liquid
Blood	-------	Liquid
Printing ink	Solid	-------
Fog	Liquid	-------

ii. Write an equation for Freundlich adsorption isotherm and explain the terms involved.

Q.13. i. Draw a neat labelled diagram of Tyndall effect.
ii. Justify: Lead chamber process is an example of homogeneous catalysis.

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