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सत्यमेव जयते

Important for UPSC and UP PCS Prelims 2023

-Chemistry-

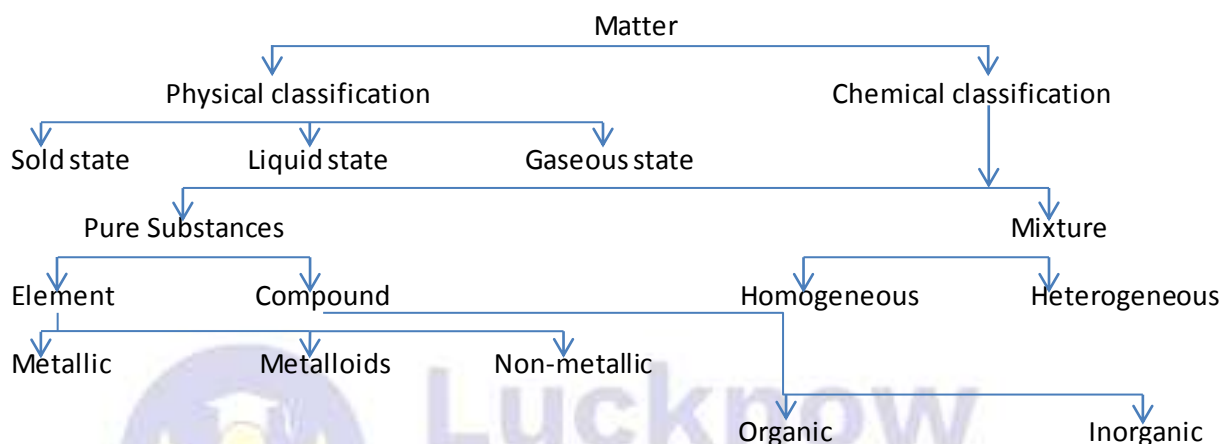
Introduction: Matter and its types

Short Notes with practice Questions

1 Introduction

Chemistry is the branch of science which deals with the composition of matter and also the Physical and Chemical characteristics associated with the different material objects.

Lavoisier a French chemist, is known as father of modern chemistry known as atoms.



Solid State: A solid possesses definite shape and definite volume.

- It cannot be compressed on applying pressure.
- Solids are generally hard and rigid
- Example-metals, wood, bricks, copper etc.

Liquid State: A liquid possesses definite volume but no definite shape.

- This means that the liquid can take up the shape of container in which it is placed.
- Example wake milk, oil, alcohol etc.

Gaseous State: A gas does not have either a definite volume or definite shape.

- It can be compressed to large extent on applying pressure and also takes the shape of the container where it is enclosed.
- Examples:- Air Oxygen, Nitrogen, Ammonia, Carbon dioxide etc.



Ice (Solid) heat → cool ← water (liquid) heat → water ← Vapour (Gas)

- The three states of matter are Solid, liquid and Gaseous state.

- The fourth state of matter is plasma state and fifth state of matter Bose-Einstein Condensation state.

Plasma state: Plasma state consists of super energetic and super excited particles.

- These particles are in the form of ionised gases.
- Plasma can occur when matter is heated to a very high temperature.
- The matter in plasma state is a collection of free highly energetic and highly excited electrically charged particles.
- The fluorescent tubes and neon sign bulbs contain inert gases, when electric current is passed through them; they produce glowing plasma, having a characteristic colour depending upon the nature of the gas.
- It is the presence of plasma that makes CFL tube glow.

Bose-Einstein Condensation State: In 1920, on the basis of statistical calculation, satyendra Nath Bose gave the concept of fifth state of matter.

- The Bose- Einstein state is formed by supercooling a gas of extremely low density, about one hundred thousandth of the density of normal air, to super low temperature.
- This process is known as Bose-Einstein condensation and this state of matter is known as Bose-Einstein Condensate state.

Pure substances: A single substance (*or matter*) which cannot be separated into other kinds of matter by any physical process is called pure substance. Pure substances have been classified as elements and compounds.

Elements: The simplest form of a pure substance which can neither be broken into nor built from simpler substances by ordinary physical and chemical methods is called element. **Example- Gold, Silver, Hydrogen etc.**

Elements are further classified into three types

1. Metals
2. Non-metals and
3. Metalloids.

Approximate relative abundance of some elements in the earth crust

Elements	% in Earth crust
Oxygen	46.6
Silicon	27.7
Aluminum	8
Iron	5
Calcium	3.6
Potassium	2.8
Magnesium	2.1
Hydrogen	0.14
Phosphorus	0.12

Metals: Metals are solids (*exception mercury which is liquid at room temperature*) are normally hard.

- They have lustre, high melting point (*mp*) and boiling point (*bp*) and also good conductor of electricity and heat.
- The conductivity of metal decreases with increase in temperature due to vibration of positive ions at their Lattice points.
- **Examples:** Iron, Copper, Silver, Gold, Aluminium, Zinc etc.

Non-metals: Non-metals are the elements with properties opposite to those of the metals.

- They are found in all states of matter.
- They do not possess lustre (*exception-iodine*).
- They are poor conductors of electricity (*exception-graphite*) and they are not malleable and ductile.
- **Examples:** Hydrogen, Carbon, Oxygen, Nitrogen, Sulphur, Phosphorous etc.

Approximate percentage of elements in human body

Elements	Percentage
Oxygen	65
Carbon	18
Hydrogen	10
Nitrogen	3
Calcium	2
Phosphorus	1
Potassium	0.35
Sodium	0.15
Chlorine	0.15
Magnesium	0.05
Iron	0.0004

Metalloids: Metalloids are the elements which have common properties of both metals and non-metals.

- **Examples:-** Arsenic, Antimony, Bismuth etc.

Compounds: Compounds are pure substances that are composed of two or more different elements in fixed proportion by mass.

- The properties of a compound are entirely different from those of the elements from which it is made.
- Example: Water, Sugar, Salt, chloroform, Alcohol, Ether etc.

Compounds are classified into two types:

1. **Organic Compounds:** The Compounds obtained from living sources are called organic compounds.
 - The term organic is now applied to hydrocarbons and their derivatives.
 - **Examples-** Carbohydrates, Proteins, Oils, Fats etc.
2. **Inorganic Compounds:** The Compounds obtained from non-living sources such as rocks and minerals are called inorganic compounds.
 - **Examples-** Common Salt, Marble, Washing Soda etc.

Mixtures: A material obtained by mixing two or more substances in any indefinite proportion is called a mixture.

- The properties of the components in a mixture remain unchanged.

- **Example:**-Milk, Sea water, Petrol, Paint, Glass, Cement, Wood etc.
- There are two types of mixture
 - Homogeneous mixture and
 - Heterogeneous mixture.

Homogeneous mixture: A mixture is said to be homogeneous if it has a uniform composition throughout and there are no visible boundaries of separation between constituents.

- Moreover, the constituents cannot be seen even by a microscope.
- **Examples**-Common salt dissolved in water, sugar dissolved in water, iodine dissolved in CCl₄, benzene in toluene and methyl alcohol in water.

Heterogeneous mixture: A mixture is said to be heterogeneous if it does not have a uniform composition throughout and has visible boundaries of separation between the various constituents.

- The different constituents of the heterogeneous mixture can be seen even with naked eye.
- **Example:**-A mixture of Sulphur & Sand, A mixture of Iron filings & Sand etc.

Separation of mixture: Some methods of separation of mixtures are given below-

1. **Sublimation:** Sublimation is a process of conversion of a solid into vapour without passing through the liquid state and this method can be used for the substances which are sublime in their separation from non-sublimate materials.

- **Examples of sublimates are** Naphthalene, Iodine, Ammonium Chloride, Camphor etc.

Note: The process of direct conversion of vapour into solid is called Hoar Frost.

2. **Filtration:** This is a process for quick and complete removal of suspended solid particles from a liquid, by passing the suspension through a filter paper.

Examples –

1. Removal of solid particles from the engine oil in car engine.
2. Filtration of tea from tea leaves in the preparation of tea etc.

3. **Evaporation:** The process of conversion of a liquid into its vapours at room temperature is called evaporation.

Evaporation causes cooling.

Example-

1. Evaporation of water in summer from Ponds, wells & lakes.

2. Preparation of common salt from sea water by evaporation of water.
 - During summer, water kept in an earthen pot become cool because of the evaporation.
4. **Crystallization:** This method is mostly used for separation and purification of solid substances.
 - In this process, the impure solid or mixture is heated abs with suitable solvent (e.g. *alcohol, water, acetone, chloroform*) to its boiling point and the hot solution is filtered.
 - The clear filtrate is cooled slowly to room temperature, when pure solid crystallizes out.
 - This is separated by filtration and dried.
 - For the separation of more complex mixtures, fractional crystallization is used, in which the components of the mixtures crystallize out at different interval of time.
5. **Distillation:** It is a process of converting a liquid into its vapour by heating and then condensing the vapour again into the same liquid by cooling.
 - Thus, distillation involves vaporisation and condensation both
 - *Distillation = Vaporisation + Condensation*
 - This method is employed to separate the liquids which have different boiling points or a liquid from non volatile solid or solids either in solution or suspension.
 - **Example**-A mixture of copper sulphate and water or a mixture of water (B.P 100°C) and methyl alcohol (B.P 45°C) can be separated by this method.
6. **Fractional distillation:** This process is similar to the distillation process except that a fractionating column is used to separate two or more volatile liquid which have different boiling points.
Example:-
 1. Methyl alcohol (bp = 338 K) and acetone (bp = 329 K) can be separated by fractional distillation process.
 2. Separation of petrol, diesel oil, kerosene oil, heavy oil etc. from crude petroleum.
 3. Separation of oxygen, nitrogen inert gasses and carbon dioxide from liquid air etc.
7. **Chromatography:** The name chromatography is derived from Latin word 'Chroma' meaning colour.
 - The technique of chromatography is based on the difference in the rates at which the components of a mixture are absorbed in the suitable absorbent.
 - There are many types of chromatography.

- Column (*absorption*) Chromatography
- Thin layer chromatography
- Paper-chromatography
- High pressure liquid chromatography
- Ion-exchange chromatography
- Gas chromatography

8. **Sedimentation and Decantation:** This method is used when one component is a liquid and other is an insoluble solid, heavier than liquid. i.e., mud and water.

- If muddy water is allowed to stand undisturbed for sometime in a beaker, the particles of earth (*clay Hand sand*) settle at the bottom.
- This process is called sedimentation. The clear liquid at the top can be gently transferred into another beaker.
- This process is known as decantation.

Concept of change in state:

a) **Melting Point:** The constant temperature at which a solid becomes liquid upon absorbing heat under normal pressure is called **melting point** of that solid m.p. of ice is 0°C and m.p. of Sodium Chloride (NaCl) is 800°C . The melting point of a substance is a fixed temperature. But if there are impurities in a substance, the melting point of that substance can change considerably.

- **For example** the m.p of mixture of ice and salt i.e. freezing mixture is -15°C .

b) **Boiling point:** The constant temperature at which a liquid changes to vapour state under normal atmospheric pressure is called **boiling point**.

Liquid	Water	Ethanol	Chloroform	Acetone
B.P.	100°C	78.3°C	62°C	46°C

- The boiling point decreases with decrease in atmospheric pressure. Soluble impurities increase the boiling point of liquid.

c) **Freezing Point:** The constant temperature at which a liquid changes into a solid by giving out heat energy is called freezing point of that liquid. F.P of water = 0°C .

d) **Evaporation:** The process of conversion of a liquid into its vapours at room temperature is called evaporation.

- Evaporation causes cooling. Actually, during evaporation, the molecules having higher kinetic energy escape from the surface of the liquid.

- Therefore, average kinetic energy of the rest of the molecules decreases.
 - Therefore cooling takes place during evaporation because temperature of liquid is directly proportional to average kinetic Energy.
 - Evaporation is affected by following factors,
 1. Nature of liquid
 2. Temperature
 3. Surface area.
- e) **Vapour pressure:** The pressure exerted by the vapours of liquid in equilibrium with liquid at a given temperature is called vapour pressure.
- Vapour pressure depends upon-
 - Its nature and
 - Temperature.
 - Higher the vapour pressure of a particular liquid lesser will be the magnitude of intermolecular forces present in molecules.
 - Vapour pressure of a liquid increases with increase in temperature.
- f) **Condensation (Liquefaction):** Condensation is the process of change of a substance from its gaseous to liquid state at a particular temperature.
- On cooling the gas particles lose their kinetic energy.
 - Motion of particles slows down and they come very close to one another and ultimately they are liquefied.

Practice Question

1: Process of solid camphor into camphor vapour is called:

- a) Vaporisation
- b) Melting
- c) Freezing
- d) Sublimation

2: The technique of chromatography is used to –

- a) Identify colour substances
- b) Determine the structure of substances
- c) Dry distillation of colouring substances
- d) Separate the substances from a mixture

3: With reference to Boiling point consider the following statements.

- 1. It decreases with increases in atmospheric pressure.
- 2. Impurities increase the boiling point.

Choose the correct statement from the code given below.

- a) 1 only
- b) 2 only
- c) Both 1 and 2
- d) Neither 1 nor 2

4: Which one of the following is the example of Metalloid?

- a) Arsenic
- b) Graphite
- c) Iodine
- d) Sulphur

5: Change of a substance from its gaseous state to liquid state at a particular temperature is known as:

- a) Evaporation
- b) Condensation
- c) Decantation
- d) Sublimation

6: With reference to vapour pressure, consider the following statements.

1. Higher the vapour pressure of a particular liquid lesser will be the magnitude of intermolecular forces present in molecules.
2. Vapour pressure of a liquid increases with increase in temperature.

Choose the correct statement from the code given below.

- a) 1 only
- b) 2 only
- c) Both 1 and 2
- d) Neither 1 nor 2

7: With reference to Crystallization, consider the following statement.

1. In this process liquid converts into its vapour by heating and then condensing the vapour again into the same liquid by cooling.
2. This method is employed to separate the liquids which have different boiling points or a liquid from non-volatile solid or solids either in solution or suspension.

Choose the correct statement from the code given below.

- a) 1 only
- b) 2 only
- c) None of them are correct
- d) All are correct

8: Arrange them in the increasing order of their percentage of abundance in the earth's crust?

1. Iron
2. Calcium
3. Hydrogen
4. Silicon

Codes:

- a) 2,3,1,4
- b) 1,3,2,4
- c) 3,2,1,4
- d) 4,3,2,1

9: With reference to plasma state of matter, consider the following statements.

1. The matter in plasma state is a collection of free highly energetic and highly excited electrically charged particles.
2. These particles are in the form of ionised gases.
3. It is the presence of plasma that makes CFL tube glow.

Choose the incorrect statements from the code given below.

- a) Any 1 is incorrect
- b) Any 2 is incorrect
- c) All are incorrect
- d) None of them are incorrect

10: Which one of the following pair is not matched correctly?

- a) Napthalene- Sublimation
- b) Antimony- Metalloid
- c) Methyl Alcohol with water- Heteogenous Mixture
- d) Chloroform- Compound

Answer Key:

1 d	2 d	3 b	4 a	5 b	6 c	7 c	8 a	9 d	10 d
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