Chemistry

CHAPTER 1

Matter

Introduction

- Anything which has mass and occupies space is called matter. Matter is found in five physical states. Solid, liquid gas, plasma and Bose-Einstein condensate. Out of which former three are more common.
- **Solids** Have a fixed shape, volume and high density. Solids neither flow and nor fill their container completely.
- **Liquids** Have a fixed volume but no fixed shape and have moderate to high densities. Liquid do not fill their container completely and generally flow easily.
- **Gases** Have neither a fixed shape nor a fixed volume, and have very low densities. Gases fill their container completely and flow easily.

Boiling Point

- Boiling point of a liquid is the temperature at which its vapour pressure becomes equal to atmospheric pressure.
- Boiling point increase in the presence of impurity.

At high altitude, boiling point decrease because atmospheric pressure is low. Hence, food takes more time for cooking.

Elements

- Elements are made up of only one kind of atoms (*i.e.*, all having the same atomic number) *e.g.*, diamond, sulphur (S_8), ozone (O_3) etc.
- There are 118 atoms/elements known at present, out of which 92 occur in nature while the remaining 23 elements have been prepared artificially.

Compounds

- Compounds are made up of two or more atoms combined in a fixed ratio. A compound cannot be separated into its components by physical methods.
- The properties of a compound are entirely different from those of its constituent elements (atoms).
- A compound has a fixed melting point, boiling point etc.
- A compound is a homogeneous substance.

Mixture

- A mixture is a substance made up of two or more elements or compounds, not chemically combined together in any ratio.
- These can be separated into its constituents by the physical methods. A mixture does not have a fixed melting point, boiling point etc., and shows the properties of its constituents.
- A mixture does not have a definite formula.
- There are two types of mixtures
- Homogenous mixture have uniform composition through out. *e.g.*, air, salt solution, sugar solution.
- Heterogeneous mixture does not have uniform composition and properties through out *e.g.*, oil and water, sandy water, orange juice with pulp.

Atomic, Molecular and Equivalent Masses

- **Atomic mass** is the mass of atom and is defined as how many times an atom of the element is heavier than $\frac{1}{12}$ of the mass of C-12 atom.
- **Molecular mass** is the mass of a molecule. Molecular mass is an additive property and is calculated by adding the atomic masses of total atoms present in a molecule. *e.g.*, $NH_3 = 14 + (1) \times 3 = 17$
- **Equivalent weight** is obtained by dividing molecular and or atomic mass by valency.

$$\text{Equivalent weight} = \frac{\text{Molecular mass / or atomic mass}}{\text{Valency}}$$

(*i.e.*, Eq. wt. is affected by change in valency).

Mole Concept

- The number of molecules present in 12 g of C–12 is called one mole.

$$1 \text{ mole} = 6.022 \times 10^{23} = \text{Avogadro's number } (N_A)$$

- Number of moles $= \frac{\text{Mass (in g)}}{\text{Atomic or molecular mass (g mol}^{-1})}$
- 1 g-atom = 1 mole atom $= 6.022 \times 10^{23}$ atoms
- 1 g-molecule = 1 mole molecules $= 6.022 \times 10^{23}$ molecules

Physical and Chemical Changes

- In physical changes, only the physical properties of matter like colour, hardness, density etc., change while the chemical properties and composition remain the same.
- Crystallisation, boiling, dissolution of salt and sugar, vaporisation, burning of candle etc, are examples of physical change.
- In chemical change, the chemical composition as well as chemical properties of the matter change and a new substance is formed. Burning of any substance, photosynthesis, ripening of fruits etc., are examples of chemical change.
- Physical changes are reversible (*i.e.*, can be inverted to obtain the original substance) while chemical changes are irreversible.

Points to be Remember

- Evaporation is a process of conversion of a liquid into gas at any temperature while boiling is the conversion of a liquid into gas at its boiling points.
- Sublimation is the process of heating a solid so that it converts directly into gas. *e.g.*, naphthalene, camphor.
- Freezing is the process of conversion of a liquid into solid at its freezing point and melting is the process of conversion of a solid into liquid.

Exercise

1. Which one is not a metal?
   (a) Sulphur (b) Sugar
   (c) Nitrogen (d) All of these
2. Milk is a
   (a) mixture (b) element
   (c) metal (d) None of these
3. The father of modern chemistry is
   (a) Priestley (b) Lavoisier (c) Dalton (d) Mendeleef
4. Which one of the following mixture is homogeneous?
   (a) Starch and sugar
   (b) Methanol and water
   (c) Graphite and charcoal
   (d) Calcium carbonate and calcium bicarbonate
5. Which one of the following substances does not have a melting point?
   (a) Bromine (b) Sodium chloride
   (c) Mercury (d) Glass
6. A close bottle containing water at room temperature was taken to the Moon and then the lid is opened. The water will **(CDS 2011 I)**
   (a) freeze
   (b) boil
   (c) decompose into oxygen and hydrogen
   (d) not change at all
7. Which one of the following is a mixture?
   (a) NaCl (b) Air
   (c) Sugar (d) Liquid oxygen
8. Which of the following is an element?
   (a) Plastic (b) Cadmium
   (c) Alcohol (d) Ice
9. Which one among the following would expand the most on being heated? **(CDS 2011 I)**
   (a) Water (b) Alcohol (c) Glass (d) Air
10. According to Dalton's atomic theory atoms of different elements are
    (a) similar (b) identical
    (c) same (d) different
11. **Statement I** All liquids are conductors of electricity.
    Statement II Under the condition of low pressure and high voltage, liquids can be made conducting. **(CDS 2011 II)**
    (a) Statement I and statement II both are correct and statement II is the correct explanation of statement I.
    (b) Statement I and statement II both are correct and statement II is the correct explanation of statement I.
    (c) Statement I is true but statement II is false.
    (d) Statement I is false but statement II is true.
12. Which of the following is a compound?
    (a) Air (b) Oxygen
    (c) Ammonia (d) Mercury
13. Which one of the following is not a mixture? **(CDS 2010 II)**
    (a) Toothpaste (b) Toilet soap
    (c) Baking soda (d) Vinegar
14. Which of the following is a physical change?
    (a) Decomposition (b) Oxidation
    (c) Sublimation (d) Reduction
15. Which one of the following is not a chemical change? **(CDS 2009 I)**
    (a) Burning of coal in air
    (b) Fermentation of sugarcane juice
    (c) Crystallisation of table salt from sea water
    (d) Cracking of petroleum
16. Which one of the following properties changes with valency? **(CDS 2009 I)**
    (a) Atomic weight (b) Equivalent weight
    (c) Molecular weight (d) Density
17. Combustion of a candle is a
    (a) photochemical reaction (b) endothermic reaction
    (c) exothermic reaction (d) natural reaction
18. Which one of the following is an element? **(CDS 2009 I)**
    (a) Topaz (b) Diamond
    (c) Ruby (d) Sapphire

19. Match the following.

Process	Changes
A. Evaporation	1. Liquid into gas
B. Sublimation	2. Gas into liquid
C. Freezing	3. Solid into gas
D. Melting	4. Solid into liquid
	5. Liquid into solid

Codes

	A	B	C	D
(a)	2	1	3	4
(b)	1	3	5	4
(c)	4	3	2	1
(d)	5	3	1	2

20. Which one of the following metals has the highest density?
(a) Gold (b) Iron
(c) Platinum (d) Lead

21. 44 g of carbon dioxide at STP contains
(a) 6.02×10^{23} molecules (b) 3.01×10^{23} molecules
(c) 6.02×10^{24} molecules (d) 3.01×10^{23} molecules

22. On addition of salt to water its
(a) boiling point increases
(b) boiling point decreases
(c) boiling point is not affected
(d) freezing point increases

Answers

1. (d)	**2.** (a)	**3.** (b)	**4.** (b)	**5.** (d)	**6.** (a)	**7.** (b)	**8.** (b)	**9.** (d)	**10.** (d)
11. (d)	**12.** (c)	**13.** (c)	**14.** (c)	**15.** (c)	**16.** (b)	**17.** (c)	**18.** (b)	**19.** (b)	**20.** (c)
21. (a)	**22.** (a)								

Hints and Solutions

6. A close bottle containing water at room temperature was taken to the Moon and then the lid is opened. The water will freeze because on Moon the temperature is below the freezing point, *i.e.*, very low.

7. Air is the mixture of different gases. It contains
78%-nitrogen
21%-oxygen
0.03%-carbon dioxide etc.

9. Air would expand the most on being heated.

11. All liquids are not conductors of electricity. The liquids which contain free ions or electrons, can conduct electricity while the liquids which do not contain free ions or electrons cannot conduct electricity.

13. Sodium bicarbonate also known as baking soda, is the chemical compound with the formula $NaHCO_3$. It is a white solid that is crystalline but often appears as a fine powder. It is sparingly soluble in water.

15. In a chemical change a new substance is formed. During crystallisation of table salt from sea water no new substance is formed hence, it is not a chemical change.

16. Equivalent weight changes with valency while atomic weight, molecular weight and density do not change with valency.

$$\text{Eq. wt. of the element} = \frac{\text{Atomic weight}}{\text{Valency}}$$

17. Exothermic reaction means it release heat to the atmosphere in the form of light, along with other product. Endothermic reactions need heat to be performed. Photochemical reaction takes place only in presence of light or any other radiation.

18. Diamond is an element of carbon. It is an allotropic form of carbon. While ruby, topaz and sapphire are mineral (*i.e.*, compounds). These are the valuable gemstones.

21. At STP 44 g carbon dioxide $= 6.02\times10^{23}$ molecules.