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2014-2015-2016-2017-2018-2019

OF ALL SECONDARY BOARDS

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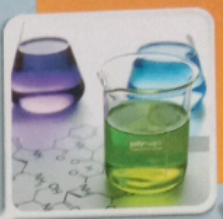

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CHEMISTRY 11

INTER PART I

- CHAPTER WISE QUESTIONS
- ANNUAL PAPERS

(FROM PREVIOUS ALL PUNJAB & AJK BOARD PAPERS)

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CHEMISTRY

- CHAPTERWISE QUESTIONS
- ANNUAL PAPERS

11

INTER PART I

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Smart Syllabus Chemistry (Intermediate Part-I)

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Homework: Q.7, Q.8, Q.9, Q.10, Q.11, Q.12, Q.13, Q.14 (a, b).

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Rate of Reaction (308-313), Energy of Activation, Finding of Order of Reaction. (Pg. 316-319). Arrhenius Equation (Pg. 322-324).

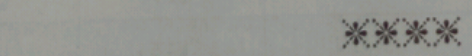
Classwork: Q.1, 2, Q.3(i, ii, iv, v), Q.8, Q.19, Q.20, Q.21, Q.22.

Homework: Q.4, Q.5, Q.6, Q.7 (i, iii, iv), Q.9, Q.15.

LIST OF EXPERIMENTS, CHEMISTRY (PART - 1)

1. Crystallization of benzoic acid from water.
2. To separate a mixture of various inks by paper chromatography.
3. Separation and Identification of lead and cadmium ions in a mixture solution by paper chromatography.
4. Determination of heat of neutralization of NaOH and HCl.
5. Preparation of standard solution of alkalies and acids e.g., NaOH, KOH, Oxalic acid, succinic acids.
6. Preparation of solution of H_2SO_4 of approximate strength and then determination of its exact strength with the help of standard Na_2CO_3 solution.
7. To prepare a standard solution of oxalic acid and standardize a solution of NaOH.
8. To determine the solubility of oxalic acid at room temperature .You are provided with 0.1 M NaOH.
9. Determination of acetic acid in vinegar.
10. The given solution contains 15 g of mixture of NaOH and Na_2SO_4 per dm^3. Calculate the amount of NaOH in 45 grams of the mixture. 0.1 M HCl is given.
11. Determination of free alkali in soap.
12. Determination of Na_2CO_3 in washing soda.
13. Determination of percentage of purity of Na_2CO_3 in the given solution containing
14. 10 g. of impure Na_2CO_3 sample/dm^3. You are provided with 0.1 M HCl solution.
15. 28.6 grams of washing soda (Na_2CO_3. xH_2O) have been dissolved/dm^3. Calculate the number of water molecules of crystallization. You are provided with 0.1 M HCl solution.

16. Determination of $NaHCO_3$ in the given sample of baking soda. 0.1M HCl solution is provided.
17. 8.4 gram M HCO_3 are dissolved per dm^3 of solution. Find out atomic weight of M. 0.05 M H_2SO_4 is given.
18. You are given the solution of $KMnO_4$. Calculate its volume required to prepare 1.0 dm^3 of 0.002M $KMnO_4$ solution.
19. The given solution 'A' contains 10 grams of a mixture of H_2SO_4 and oxalic acid dissolved/dm3. Determine the percentage of H_2SO_4 in the mixture. 0.02M $KMnO_4$ is given.
20. Determine the number of molecules of water of crystallization in a given sample of oxalic acid by permanganate titration. The amount of oxalic acid dissolved per dm^3 is 6.3 g.
21. Determination of solubility of oxalic acid at room temperature.
22. To determine the strength of ferrous sulphate solution by titrating it against 0.02M $KMnO_4$.
23. The given solution contains 30 gram of partially oxidized $FeSO_4.7H_2O$ dissolved per dm^3. Determine the %age of oxidation of the given sample.
24. To determine the strength of given ferrous ammonium sulphate (Mohr's salt) by titrating it against standard potassium permanganate solution.
25. The given solution contains 40g. of $FeSO_4(NH_4)2SO_4.xH_2O$ dissolved per dm^3. Determine the value of x.
26. Determine the solubility of given sample of Mohr's salt at room temperature. You are provided with 0.02M $KMnO_4$.
27. Prepare a standard (M/10) 250 cm^3. Solution of iodine. 0.1 M $Na_2S_2O_3$ is provided.
28. 24.8 grams of a sample of alkali thiosulphate ($M_2S_2O_3$) are dissolved in 1 dm^3 of the given solution. Calculate the atomic weight of the metal by a volumetric method. Given M/10 iodine solution.
29. 20 gram of $Na_2S_2O_3$ are dissolved in one dm^3 solution. Find out the %age of sulphur. You are provided with 0.05M iodine solution.



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Chapter Wise Questions 2014 - 2019

ANNUAL PAPERS 2014 - 2019

CHAPTER 01

BASIC CONCEPTS

MULTIPLE CHOICE QUESTIONS (MCQ's)

1. **The largest number of molecules are present:**
(GRW. FBD. LHR. 2014)(AJK. DGK. GII, FBD. 2016)(RWP. GI, MLN. GII, FBD. LHR. GII, 2017)
(GRW. 2018)(LHR. GI, FBD. GI, MLN. GI, SGD. GI, 2019)
(A) 3.6 g of H_2O (B) 4.8 g of C_2H_5OH (C) 2.8 g of CO (D) 5.4 g of N_2O_4

2. **Cadmium has isotopes:** (SWL. DGK. GI, MLN. GI 2017)(SGD. 2018)
(A) 3 (B) 4 (C) 5 **(D)** 9

3. **Palladium has isotopes:** (BWP. 2014)
(A) 6 (B) 7 (C) 8 (D) 9

4. **Bromine has isotopes:** (SGD. GII, 2017)
(A) 8 (B) 6 (C) 4 **(D)** 2

5. **Nickel has isotopes:** (DGK. GII, 2017)
(A) 3 **(B)** 5 (C) 6 (D) 11

6. **Tin has isotopes:** (DGK. GI, 2014)(BWP. 2015)
(A) 9 (B) 10 **(C)** 11 (D) 12

7. **A limiting reactant is the one which:** (GRW. 2017)
(A) Gives maximum amount of the product
(B) Gives minimum amount of the required product
(C) is taken in lesser quantity in grams as compared to other reactants
(D) Is taken in lesser quantity in volume as compared to the other reactants

8. **Isotopes differ in:** (MLN. DGK. GII, 2016)(BWP. 2018)
(A) Properties which depend upon mass (B) Arrangement of electrons in orbitals
(C) Chemical properties
(D) The extent to which they may be affected in

9. **Which of the following statements is true?** (MLN. GII, 2016)
(A) Isotopes with even atomic masses are comparatively abundant.
(B) Isotopes with odd atomic masses are comparatively abundant.
(C) Isotopes with even atomic mass and even atomic numbers are comparatively abundant.
(D) Isotopes with even atomic masses and odd atomic numbers are comparatively abundant.

10. **The volume occupied by 16 g of CH_4 at STP.** (AJK. 2017)
(A) 224.14 dm^3 **(B)** 22.4 dm^3 (C) 1.12 dm^3 (D) 2.24 dm^3

11. **27 g of Al will react completely with how much mass of O_2, to produce Al_2O_3.**
(LHR. GII, DGK. GII, 2015)(MLN. GII, RWP. 2016)(RWP. GII, GRW. GI, SGD. GI, MLN. GI, 2017)
(LHR, DGK. GI, BWP. GII, AJK. 2018)(GRW. GI, MLN. GII, RWP. BWP. 2019)
(A) 8 g of oxygen (B) 16 g of oxygen (C) 32 g of oxygen **(D)** 24 g of oxygen

12. **Number of isotopes of arsenic are:** (LHR. GII, 2018)
(A) 1 **(B)** 2 (C) 9 (D) 11

SHORT ANSWER QUESTIONS

1. **One mole of H_2O has two moles of bonds, three moles of atoms, ten moles of electrons and twenty eight moles of the total fundamental particles present in it.**
(LHR. GII, BWP. 2016)(GRW. 2018)

Ans. The molecule of H–O–H has two bonds in it. Therefore, one mole of H_2O contains two

moles of bonds and three moles of atoms. Similarly, there are eight electrons in oxygen and one electron in each of the two H atoms. One molecule of H_2O has 10 electrons. So one mole of water contains 10 moles of electrons. There are 28 moles of all fundamental particles in one mole of water 10 moles of electrons, 10 moles of protons, 8 moles of neutrons. (MLN. GII, 2015)

2. Calculate the number of molecules in 10.0 grams of ice?

Ans. Mass of ice (water) = 10.0 gm

Molar mass of water = 18 $gmol^{-1}$

Number of molecules of water = ?

Number of molecules of water

$$= \frac{\text{Mass of water in gram}}{\text{Molar mass of water in gmol}^{-1}} \times \text{Avogadro's number} = \frac{10}{18\,\text{gmol}^{-1}} \times 6.02 \times 10^{23}$$

$$= 0.55 \times 6.02 \times 10^{23} = 3.31 \times 10^{23}$$

3. No individual Neon (Ne) atom in the sample of the element has a mass of 20.18 amu why? (SGD. GI, 2014)(MLN. GI, DGK. GII, 2015)(BWP. GII, SGD. GII, MLN. GII, GRW. GII, 2017)

Ans. Neon has three isotopes of atomic masses 20,21 and 22 with relative abundances as 90.92%, 0.26% and 8.82%. The relative atomic mass of neon, comes out to be 20.18 a.m.u. So 20.18 a.m.u. is the average atomic mass of all the three isotopes and there is no atom of Ne with this atomic mass.

$$\text{At.mass of Ne} = \frac{(20 \times 90.92) + (21 \times 0.26) + (22 \times 8.82)}{100} = 20.18 \text{ amu}$$

4. Define Isotope. Give an example. (AJK. 2016)

Ans. Isotope: The atoms of the same element having different masses but same atomic numbers. Such atoms of an element are called Isotopes.

Examples: (i) Hydrogen: H^1, H^2, H^3 **(ii) Oxygen:** O^{16}, O^{17}, O^{18}

5. A compound may have same empirical as well as molecular formula. Justify? (LHR. GI, 2015)(MLN. GI, 2016)

Ans. A compound may have same empirical as well as molecular formula as the value for simple multiple "n" may be equal to one.

Examples: In case of $CC\ell_4$, CH_4, $HC\ell$, H_2O, NH_3 etc. Both the empirical and molecular formula are identical.

6. Define Avogadro's number. How does it relate to the masses of chemical substances? (GRW. GI, 2015)(BWP. GII, 2018)(MLN. GII, DGK. GI, 2019)

Ans. Avogadro's number: Avogadro's number is the number of atoms, molecules or ions in one gram atom of an element, one gram mole of a compound or one gram ion of ionic substance. Avogadro's number is denoted by N_A.

Relationship between Avogadro's number and masses of chemical substances:

There are three useful relationships:

(i) Number of atoms of an element:

$$= \frac{\text{Mass of element}}{\text{Atomic mass}} \times NA$$

(ii) Number of molecules of a compound:

$$= \frac{\text{Mass of compound}}{\text{Molecular mass}} \times NA$$

(iii) Number of ions of ionic specie:

$$= \frac{\text{Mass of ions}}{\text{Ionic mass}} \times NA$$

7. **Define Avogadro's law and molar volume.** (GRW. GII, LHR. GII, 2017)

Ans. Avogadro's number:
Avogadro's number is the number of atoms, molecules or ions in one gram atom of an element, one gram mole of a compound or one gram ion of ionic substance. Avogadro's number is denoted by NA.

$$\text{Mass of element} = \frac{\text{Number of atoms of element}}{N_A} \times \text{At. mass}$$

Molar volume: The volume occupied by one mole of an ideal gas at standard temperature and pressure 22.414 dm^3 is called the molar volume.

8. **Law of Conservation of mass has to be obeyed during stoichiometric calculations. Give reason.** (LHR. GI, 2014)(LHR. GI, RWP, DGK. 2018)(DGK. GII, 2019)

Ans. Stoichiometric calculation obeys law of conservation of mass:
Stoichiometric calculations are those in which balanced chemical equation is used.Balanced chemical equation means that mass of reactant and product are same. This means that law of conservation of mass has to be obeyed. Otherwise no calculation will be correct.

9. **How is the efficiency of a reaction expressed?** (MLN. GI, 2014)(FBD. 2018)(FBD. GII, BWP. GI, 2019)

Ans. The efficiency of a reaction can be expressed as:

$$\% \text{ yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$$

Significance: (i) % yield indicates efficiency of reaction.
(ii) More is the % yield; higher will be the efficiency of reaction.

10. **Mg atom is twice heavier than that of carbon atom. Justify.** (GRW. 2014)(BWP. 2015) (BWP. 2016)(LHR. GI, SWL. GII, GRW. GII, AJK. GII, 2017)(MLN. GII, SWL. 2018)(SWL GII, 2019)

Ans. The atomic mass of Mg is 24 $g\,mol^{-1}$ which is twice in mass as compared to the atomic mass of C i.e.12 $gmol^{-1}$. So Mg atom is twice heavier than carbon atom.

11. **180 g of glucose and 342 g of sucrose have the same number of molecules but different number of atoms present in them.** (FBD. GI, 2014)(GRW. GI, 2019)

Ans. 180 grams of glucose ($C_6H_{12}O_6$) and 342 grams of sucrose ($C_{12}H_{22}O_{11}$) are one mole of each. One mole of various substances contain equal number of molecules i.e. 6.02×10^{23}. One molecule of ($C_6H_{12}O_6$) has 24 atoms. The total number of atoms of glucose in one mole is $24 \times 6.02 \times 10^{23}$. One molecule of ($C_{12}H_{22}O_{11}$) has 45 atoms. The total number of atoms of sucrose in one mole of sucrose is $45 \times 6.02 \times 10^{23}$. It means that one mole of both glucose and sucrose will have different number of atoms.

12. **Two grams of H_2, 16 g of CH_4 and 44 g of CO_2 occupy separately the volumes of 22.414 dm^3, although the sizes and masses of molecules of three gases are very different from each other.** (LHR. GI, 2017)(LHR. GII, 2018)

Ans. One mole of an ideal gas at S.T.P occupies a volume of 22.414 dm^3. Size and masses of molecules of different gases do not affect the volume. Normally it is known that in the gaseous state, the distance between the molecules is 300 times greater than their diameter. Therefore two grams of H_2, 16g of CH_4 and 44g of CO_2 (1 mole of each gas) separately occupy a volume of 22.4 dm^3. This is called molar volume (V_m).

13. **Moles of O atoms in 9.00 g, $Mg(NO_3)_2$** (LHR. GI, 2015)

Ans. Mass of $Mg(NO_3)_2$ = 9 g

Molar mass of $Mg(NO_3)_2$ $= 24 + 2(14 + 3 \times 16)$
$= 148\ g\,mol^{-1}$

Mass given of $Mg(NO_3)_2$

$$\text{Number of moles} = \frac{\text{Mass of } Mg(NO_3)_2}{\text{Molar mass of } Mg(NO_3)_2}$$

$$= \frac{9\text{ g}}{148\text{ g mol}^{-1}} = 0.06$$

1 mole of $Mg(NO_3)_2$ contains moles of O atoms = 6 0.06 moles of $Mg(NO_3)_2$ contain moles of O atoms = 0.06×6 = 0.36 moles of O atoms.

14. Number of O atoms in 10.037 g of $CuSO_4.5H_2O$ (DGK. GI, 2017)

Ans. Mass of $CuSO_4.5H_2O$ = 10.037 g

Molar mass of $CuSO_4.5H_2O = 63.5 + 32 + 4 \times 16 + 5 \times 18 = 249.5\text{ g mol}^{-1}$

Formula applied:

$$\text{Moles of } CuSO_4\,5H_2O = \frac{\text{Mass of } CuSO_4.5H_2O}{\text{Molar Mass of } CuSO_4.5H_2O}$$

$$\text{Moles of } CuSO_4\,5H_2O \frac{10.037\text{ g}}{249.5\text{ g mole}^{-1}} = 0.04$$

So, 1 mole of $CuSO_4.5H_2O$ has moles of 'O' = 9

0.04 moles of $CuSO_4.5H_2O$ have moles of 'O' = 9×0.04 =0.36

Now we calculate number of 'O' atoms

Formula applied:

Number of 'O' atoms = number of moles × N_A

Number of 'O' atoms = $0.36 \times 6.02 \times 10^{23} = 2.1672 \times 10^{23}$

15. One mole of H_2SO_4 should completely react with two moles of NaOH. How does Avogadro's number help to explain it? (LHR. GII, 2016)(GRW. 2018)

Ans. The balanced chemical equation between $H_2SO_4$4 and NaOH.

$$H_2SO_4 + 2\,NaOH \longrightarrow Na_2SO_4 + 2H_2O$$

One mole of H_2SO_4 releases two moles of H^+ in the solution. It needs two moles of OH^- ions for complete neutralization.

16. Differentiate between actual yield and theoretical yield.

(RWP. FBD. GI, DGK. GII, 2015)(DGK. GII, BWP. GII, 2017)(DGK. GI, 2018)

Ans. Differentiate between actual yield and theoretical yield.

Actual yield	Theoretical yield
(i) It is the amount of product which is actually obtained in chemical reaction	(i) It is the amount of product which is calculated from balanced chemical equation.
(ii) It is also known as experimental yield.	(ii) It is also known as calculated or expected yield.
(iii) It is mostly in fewer amounts as compared to the theoretical yield.	(iii) It is always greater than actual yield.
(iv) It is obtained by weighing the purified and dried product obtained as a result of chemical reaction.	(iv) This is maximum yield of product that can be produced in a chemically reaction

17. 23 g of sodium and 238 g of uranium have equal number of atoms in them.

(MLN. GI, 2014)(LHR. GI, RWP. GII, 2017)(SWL. 2018)(MLN. GII, 2019)

Ans. 23 g is atomic mass of Na, 238 g is atomic mass of U. As mass taken in gram is 1 mole of the substance. Both are one mole each, so both have 6.02×10^{23} atoms in them individually.

18. **Define mole with example.** (FBD. GI, 2015)(RWP. GI, 2017)

Ans. **Mole:** A quantity which contains Avogadro's number of units i.e atoms, molecules and ions under consideration is called a mole.

Examples: (i) One mole of carbon is 12 gm (ii) One mole of magnesium is 24 gm.

19. **Define Stoichiometry and give two assumptions for stoichiometric calculations.** (GRW. GI & GII, 2014)(LHR. GII, DGK. GI, BWP. 2015)(RWP. MLN. GII, DGK. GI, DGK. GII, 2016)(MLN. GI & GII, 2017)(MLN. GI, 2019)

Ans. **Stoichiometry:** Stoichiometry is the branch of chemistry which tells us the quantitative relationship between reactants and products in a balanced chemical equation.

Assumptions for Stoichiometry:

To perform stoichiometric calculations following assumptions are necessary:

(i) All the reactants are completely converted into the products.

(ii) No side reaction occurs.

20. **Many chemical reactions taking place in our surrounding involve the limiting reactants. Explain with examples.** (BWP. 2014)(FBD. GII, 20117)(LHR. GI, FBD. 2018)(BWP. GII, 2019)

Ans. Many chemical reactions taking place in our surrounding involve the limiting reactants. Some examples are as follows:

Example 1: In a chemical reaction, a large quantity of oxygen makes the things to burn rapidly. As oxygen used in excess is left behind, when reaction is completed sothe other reagent is consumed completely and the reactant which is consumed earlier is known as limiting reactant.

Example 2: A person who has caught fire is enveloped with a blanket to stop supply of oxygen. Stopping oxygen makes it a limiting reactant.

21. **N_2 and CO have the same number of electrons, protons and neutrons. Explain.** (SWL. GRW. GI & GII, BWP. 2014)(GRW. GII, FBD. GI, 2015)(LHR. GI & GII, FBD. GI, DGK. GII, 2016)(FBD. GII, MLN. GII, DGK. GII, 2017)(GRW, MLN. GI, AJK. 2018)(GRW. GII, SWL. GII, 2019)

Ans. No of electrons in $N_2 = 7 + 7 = 14$, number of protons in $N_2 = 7 + 7 = 14$ and number of neutrons $= 7 + 7 = 14$.

In CO, number of protons in C=6, number of protons in O=8 total number of protons = 6 8 =14.

Number of electrons in C = 6, number of electrons in O=8, total number of electrons = 6 8= 14.

Number of neutrons in C = 6, number of neutrons in O=8, total number of neutrons 6+8=14.

22. **What are isotopes? Why they have same chemical but different physical properties.** (LHR. GII, 2015)(DGK. GI, 2016)(AJK. GII, 2017)(LHR. GII, 201

Ans. **Isotopes:** The atoms of the same element having different masses but same atomi numbers. Such atoms of an element are called Isotopes.

Properties of Isotopes: They have similar chemical properties because isotopes of a element have the same number of electrons as an atom of that element. The electro arrangement is the same owing to same chemical properties. However they have differe numbers of neutrons, which affects the mass number. Mass number determines th physical properties such as boiling point melting and density etc.

23. **Calculate %age of Nitrogen in NH_2 CO NH_2 (at mass of N=14, C=12, H=1, O=16).**

Ans. **NH_2CONH_2 (Urea)** (RWP. GII, 2017)(BWP. GI, 2018)(LHR. GI, 201

Molar mass of urea $= 14 + 2 + 12 + 16 + 14 + 2 = 60$ g mol^{-1}

Mass of nitrogen in the molecule = 28 g mol' % age of nitrogen=?

Formula applied:

$$\% \text{ age of nitrogen} = \frac{\text{Mass of nitrogen in molecule}}{\text{Molar mass}} \times 100 = \frac{28 \text{gmol}^{-1}}{60 \text{ gmol}^{-1}} \times 100$$

$$= 46.67\%$$

24. Define molar volume with example: (DGK. GII, 2014)(FBD. GI, 2015)(DGK. G1, 2017)(GRW. GII, 2019)

Ans. Molar volume: The volume occupied by one mole of an ideal gas at standard temperature and pressure 22.414 dm^3 is called the molar volume.

Examples:

(i) 2.016g of H_2 = 1 mole of $H_2 = 6.02\times10^{23}$ molecules of H_2 = 22.414 dm^3 of H_2 at S.T.P

(ii) 16g of CH_4 =1 mole of $CH_4 = 6.02\times10^{23}$ molecules of CH_4 = 22.414 dm^3 of CH_4 at S.T.P

25. How limiting reactant is identified?

(SGD. GI, FBD. GI, 2014)(DGK. GI, 2015)(MLN. GI, 2016)(RWP. GII, 2017)(GRW. GII, 2019)

Ans. Identification of limiting Reactant: To identify a limiting reactant, the following three steps are performed:

(i) Calculate the number of moles from the given amount of reactant.

(ii) Find out the number of moles of product with the help of a balanced chemical equation.

(iii) Identify the reactant which produces the least amount of product as limiting reactant.

26. Give the reason to explain that actual yield is less than the theoretical yield.

(DGK. GII, SWL, BWP, 2014)(AJK. LHR. GI, 2015)(FBD. GI, 2016)(SGD. GII, SGD. GI, RWP. GI, 2017) (MLN. GI, BWP. GII, 2018)(DGK. GII, 2019)

Ans. Following are the reason due to which actual yield is always less than theoretical yield:

(i) Mechanical loss of product during

(a) Filtration (b) Separation by distillation (c) Separation by separating funnels

(d) Washing (e) Drying (f) Crystallization etc.

(ii) Reactions are reversible

(iii) Side reactions take place which reduce the amount of required product.

27. 4.9 g of H_2SO_4 when completely ionized in water, have equal number of positive and negative charges but the number of positively charged ions are twice the number of negatively charged ions.

Ans. $H_2SO_4 \longrightarrow 2H^+ + SO_4^{-2}$

When one molecule of H_2SO_4 ionizes, it produces two H^+ and one SO_4^{-2} ion. Hydrogen ion contains +1 charge while sulphate ion has -2 charges. The ions produced by complete ionization of 4.9 grams of H_2SO_4 in water will have equal positive and negative charges but the number of H^+ ions is twice than number of negatively charged sulphte ions.

28. Calculte mass in grams of 2.4 moles of $KMnO_4$. Formula mass of $KMnO_4$ is $158 mol^{-1}$.

Ans. Moles of $KMnO_4$ given = 2.74 (GRW. GII, 2017)

Molar mass of $KMnO_4$ = $39 + 55 + 4 \times 16 = 158$ g mol^{-1}

Formula applied:

$$\text{Number of moles} = \frac{\text{Mass of } KMnO_4}{\text{Molar mass of } KMnO_4}$$

So, Mass of $KMnO_4$ = number of moles × molar mass

Putting the values:

2.74 moles of $KMnO_4$ has mass = 2.74×158 g = 432.92g

29. Calculate mass in kilogram of 2.6×10^{20} molecules of SO_2.

Ans. Number of molecules of $SO_2 = 2.6\times10^{20}$ Molar mass of $SO_2 = 32 + (2\times16) = 64$ (DGK. GII, 2015)

Mass of SO_2 =?

$$\text{No. of molecules} = \frac{\text{mass}}{\text{molar mass}} \times N_A$$

$$\text{Mass} = \frac{\text{No of molecules} \times \text{molar mass}}{N_A} = \frac{2.6\times10^{20}\times64}{6.02\times10^{23}} = 27.64\times10^{-3}$$

Mass = 2.7×10^{-5} Kg

30. How has one mg of K_2CrO_4 thrice the number of ions than the number of formula units when ionized in water? (LHR. GII, 2018)

Ans. One mg of K_2CrO_4 has thrice the number of ions. Then number of formula unit when ionized in water.

$$K_2CrO_4 \xrightleftharpoons{H2O} 2K^+ + CrO_4^{-2}$$

The equation show that 1mg of formula unit K_2CrO_4 ionizes into three ions ($2K^+$ and CrO_4^{-2}) hence the number of ions is thrice the number of formula unit of K_2CrO_4 One mg will have same values.

31. What are monoisotopic elements? Give one example. (AJK. 2018)(DGK. GI, 2019)

Ans. Monoisotopic Elements: The element like arsenic, fluorine, iodine and element gold etc have only single elements isotopes. They are called mono-isotopic element.
e.g: Gold

32. 2g H_2, 16g CH_4, 44g CO_2 occupy same volume. Why? (FBD. GII, 2019)

Ans. 2g of H_2 = 1mole = 6.02×10^{23} molecule = 22.44dm³ volume at STP
16 g of CH_4 = 6.02×10^{23} molecule = 22.414dm³ volume at STP
44 g of CO_2 = 1 mole = 6.02×10^{23}molecule = 22.414 dm³ volume at STP
According to Avagadro law equal number of molecules of all gas occupy same volume at same temperature and presure. Since H_2, CH_4, CO_2 have same number of molecules that is why these occupy same volume.

ESSAY TYPE QUESTIONS

1. The combustion analysis of an organic compound shows it to contain 65.44% carbon, 5.50% hydrogen and 29.06% of oxygen. What is the empirical formula of the compound? If the molecular mass of this compound is 110.15 $gmol^{-1}$. Calculate the molecular formula of the compound. (RWP. LHR. GII, 2016)(RWP. GI, 2019)

2. Define the following and given one example of each.
(i) Mole (ii) Isotopes (iii) Molecuiar ion (DGK. GII, 2014)

3. Write down the combustion analysis for the determination of empirical formula of a compound.

4. Explain Isotopes with their relative abundance. (DGK. GI, 2014)

5. When limestone ($CaCO_3$) is roasted, quick lime (CaO) is produced according to the following equation. The actual yield of CaO is 2.5 Kg, When 4.5 Kg of lime stone is roasted. What is percentage yield of this reaction (Ca=40, C=12, 0=16)

$$CaCO_3 \longrightarrow CaO + CO_2$$

(SWL. 2014)(FBD. GI, 2016)(SGD. GI, 2017)(RWP. GI, RWP. GII)(FBD. GII, 2017)

6. Mg reacts with HCℓ to give hydrogen gas. What is the minimum volume of HCℓ solution (27% by weight) required to produce 12.1 gm of H_2? The density of HCℓ solution is 1.14 g/cm³.

$$Mg + 2HC\ell \longrightarrow MgC\ell_2 + H_2$$ **At. Wt of Mg is 24 amu**

(RWP. GI, GRW. 2014)(DGK. GI, FBD. GI, GRW. GII, 2015)(DGK. GII, 2017)

7. NH_3 can be produced by heating together two solids $NH_4C\ell$ and Ca $(OH)_3$. If a

mixture containing 100g of each solid is heated then how many grams of NH_3 is produced? Atomic mass of Ca = 40.

$$2NH_4C\ell + Ca(OH)_2 \longrightarrow CaC\ell_2 + 2NH_3 + 2H_2O$$

(SGD. GI, SGD. GII, 2014)(DGK. GII, LHR. GII, 2015)(MLN. GI, LHR. GI, 2016)(BWP. GII, 2017)

8. Describe combustion analysis for the determination of percentage of C, H, and O in an organic compound. (GRW. GI, 2015)(LHR. GI, MLN. GI, 2019)

9. Ethylene glycol is used as automobile antifreeze. It has 38.7% carbon, 9.7% hydrogen and 51.6% oxygen. Its molar mass is 62.1 grams mol1. Determine its empirical and molecular formula. (LHR. GI, 2017)(LHR. GI, SGD, BWP. GI, 2018)

10. When 100 kg sand is reacted with excess of carbon, 51.4 Kg of SiC is produced. What is the percentage yield of SiC? (MLN. GI, 2015)

11. A well known ideal gas is enclosed in a container having volume 500 cm^3 at S.T.P. Its mass comes out to be 0.72g. What is the molar mass of this gas. (AJK. MLN. GII, 2016)(MLN. GI, AJK. GII, DGK. GI, 2017)(SWL. BWP. GII, 2018)

12. Calculate the number of gm of K_2SO_4 and water produced when 14g of KOH are reacted with excess of H_2SO_4. Also calculate the number of molecules of water produced.
(K = 39, S = 32, O = 16, H = 1.008 amu) (BWP. RWP. 2015)(LHR. GII, 2017)

13. Serotenin (Molar Mass =176 g/mol) is a compound that conducts nerve impulses in brain and muscles. It contains 68.2 %C, 6.86% H, 15.09% N and 9.08% O. What is its Molecular Formula? (BWP. GI, 2017)

14. Silicon carbide (SiC) is an important ceramic material. It is produced by allowing sand (SiO_2) to react with carbon at high temperature. (LHR. GI, DGK. 2018)

$$SiO_2 + 3C \longrightarrow SiC + 2CO$$

15. A mixture of two liquids, hydrazine N_2H_4 and N_2O_4 are used in rockets. They produce N_2 and water vapours. How many grams of N_2 gas will be formed by reacting 100g of N_2H_4 and 200 g of N_2O_4? (LHR. GI, AJK. 2015)(MLN. GI, 2018)

$$2N_2H_4 + N_2O_4 \longrightarrow 4H_2O + 3N_2$$

16. What is difference between actual yield and theoretical yield? Why actual yield is less than the theoretical yield? (FBD. GI, 2014)(BWP. GI, MLN. GII, RWP. GII, 2019)

17. An unknown metal 'M' reacts with S to form a compound with a formula M2S3 if 3.12 g of 'M' reacts with exactly 2.88g of sulphar. What are the names of metal 'M' and the compound M2S3? (GRW. 2018)

18. 8.657g of compound were decomposed into elements and gave 5.217g of carbon, 0.962g of hydrogen, 2.478g of oxygen. Calculate the percentage composition of the compound under study. (FBD. 2018)

19. Ascorbic acid (vitamin C) contains 40.92% carbon, 4.58% hydrogen and 54.5% of oxygen by mass. What is the empirical formula of ascorbic acid? (RWP. 2018)

20. Write detailed note on : (i) Avogadro's number (ii) Molar volume. (LHR. GII, 2019)

21. Write a note on Limiting reactant. Explain it giving at least two examples. (GRW. GI, DGK. GII, SWL. GII, BWP. GII, 2019)

22. Define yield. How do we calculate the percentage yield of chemical reaction? Also mention the factors which are responsible for low yield of products. (FBD. GI, SGD. GI, 2019)

23. Define stoichiometry. Give its assumptions. Mention two important laws which help to perform the stoichiometric calculation. (DGK. GI, 2019)

CHAPTER 02

EXPERIMENTAL TECHNIQUES IN CHEMISTRY

MULTIPLE CHOICE QUESTIONS (MCQ's)

1. **The comparative rates at which the solutes move in paper chromatography, depends on:** (RWP. FBD. GI, AJK. LHR. GI, 2016)(SGD. GI, LHR. GI, RWP. GI, 2017) (GRW, FBD, SGD, RWP. 2018)(FBD. GI & GII, MLN. GI, SGD. GII, BWP. GII. 2019)
   (A) The size of paper used (B) Their R_f values solutes
   (C) Temperature of the experiment (D) Size of the chromate graphic tank
2. **The drying agent used in a desiccator.** (MLN. GI, 2014)
   (A) $AgC\ell$ (B) $NH_4C\ell$ (C) P_2O_5 (D) $A\ell C\ell_3$
3. **Which one is not example of a sublimate?** (DGK. G1, 2015)
   (A) Ammonium chloride (B) Iodine
   (C) $NaC\ell$ (D) Benzoic acid
4. **During chromatography strip should be dipped into solvent mixture to a depth of:** (DGK. GI, 2014)
   (A) 3-4 mm (B) 4-5 mm (C) 5-6 mm (D) 6-7 mm
5. **Solvent extraction method is particularly useful technique for separation when the product to be separated is:** (LHR. 2014)(MLN. GI, DGK. GII, LHR. GI & GII, 2016) (AJK. GII, 2017)(BWP. GII, 2018)(LHR. GI, SGD. GI, RWP. 2019)
   (A) Non-volatile or thermally unstable (B) Volatile or thermally stable
   (C) Non-volatile or thermally stable (D) Volatile or thermally unstable
6. **Compound which under go sublimation is:** (SWL. G, 2017)
   (A) $KMnO_4$ (B) $CaCO_3$ (C) $NH_4C\ell$ (D) Na_2CO_3
7. **Chromatography in which the stationary phase is a solid is classified as:** (MLN. GI, 2017)
   (A) Partition chromatography (B) Gas Chromatography
   (C) Adsorption Chromatography (D) Thin layer Chromatography
8. **Solvent extraction is an equilibrium process and is Controlled by:** (SGD. SWL. BWP. MLN. GI, GRW. GI & GII, 2014)(LHR. GI, AJK. RWP. FBD. GI, BWP. 2015) (MLN. GII, DGK. GI, AJK. BWP. 2016)(FBD. DGK. GII, RWP. GII, LHR. GII, BWP. GI, 2017) (GRW. GII, DGK. GII, BWP. GI, 2018)(GRW. GI & GII, MLN. GII, SWL. BWP. GI, 2019)
   (A) Law of mass action (B) The amount of solvent used
   (C) Distribution law (D) The amount of Solute
9. **A component having small value of K (distribution coefficient) mostly remains in the:** (SGD. GI, 2014)
   (A) Stationary phase (B) Mobile phase
   (C) Chromatographic tank (D) solvent
10. **During paper chromatography, the stationary phase is.** (RWP. 2014)
    (A) Solid (B) Liquid (C) Gas (D) Plasma
11. **The chromatography in which stationary phase is liquid is called:** (LHR. GI, 2018)
    (A) Thin layer chromatography (B) Partition chromatography
    (C) Absorption chromatography (D) Gel chromatography
12. **In _____ technique a solute distribute between two immiscible liquids.** (MLN. GII, 2018)
    (A) Crystallization (B) Solvent extraction (C) Filtration (D) Distillation
13. **Which one of the following compound is purified by sublimation:** (LHR. GII, 2019)
    (A) Benzoic acid (B) SiO_2 (C) CS_2 (D) NaI

(DGK. GI, 2019)

14. **Direct conversion of solid into its vapour is called:**
(A) Crystallization (B) Sublimation (C) Vapourization (D) Distribution

(AJK. 2019)

15. **Which one of the following is not purified by sublimation:**
(A) Naphthalene (B) Silicon dioxide (C) I_2 (D) Benzoic acid

SHORT ANSWER QUESTIONS

(GRW. GII, 2017)

1. **Define sublimate. Give two examples.**

Ans. Sublimate: Sublimate is the substance which is directly converted into vapours without passing through the liquid phase.

Example: (i) Ammonium Chloride (ii) Iodine (iii) Naphthalene

2. **What is solvent extraction technique? Give an example also.**
(GRW. GI, RWP, 2015)(LHR. GI, BWP. GI, 2017)(BWP. GII, MLN. GI, 2019)

Ans. Solvent Extraction: Solvent extraction is a technique in which a solute can be separated from a solution by shaking the solution with a solvent in which the solute is more soluble and the added solvent does not mix with the solution.

Example: In a typical organic synthesis, the aqueous solution containing the organic product is shaken up with ether in a separating funnel and allowed to separate. The inorganic impurities remain in aqueous phase whereas the organic compound goes to the ether layer. The ether layer is separated and the organic product is obtained by evaporating the ether.

3. **Define chromatography. Give formula of distribution coefficient.** (BWP. GII, 2017)

Ans. Chromatography: Chromatography is a technique which is used primarily for the separation of a sample of mixture. It involves the distribution of a solute between a stationary phase and a mobile phase.

Distribution Co-efficient formula:

The distribution of the components of a mixture between the two phases is governed by distribution coefficient K.

$$K = \frac{\text{Conc. of solute in organic phase}}{\text{Conc. of solute in aqueous phase}}$$

4. **What is difference between qualitative analysis and quantitative analysis?**
(LHR. GI, 2015)(SWL. GII, BWP. GI, 2017)(LHR. GI, 2018)

Ans. Difference between qualitative and quantitative analysis:

Qualitative Analysis	Quantitative Analysis
In qualitative analysis, the chemist is concerned with the detection or identification of the elements present in a compound.	In quantitative analysis, the relative amounts of the elements are determined.

5. **Define Sublimation and Chromatography.** (BWP. GII, 2017)(DGK. GII, 2018)

Ans. Sublimation: It is a process in which a solid, when heated, vapourizes directly without passing through the liquid phase.

Chromatography: It is an analytical technique used for the separation of a mixture due to different distribution of substance between stationary and mobile phase.

6. **In a solvent extraction technique, repeated extraction using small portions of solvent are more efficient than using a single extraction, but larger volume of solvent comment.**

Ans. Small portions of fresh solvent have zero concentration of solute in them. The distribution

co-efficient favours the solute concentration in fresh solvent. Thus repeating extractions using small portions of solvent are more efficient than using a single but larger volume of solvent.

7. **What is R_f value? Why it has no units?**
(MLN, GI, 2016)(GRW, GII, MLN, GI, AJK, 2017)(FBD, 2018)(SGD, GI, 2019)

Ans. Retardation Factor (R_f):
A component of a mixture may be identified by a specific retardation factor called R_f value. It is related to the partition coefficient by the following relationship.

Formula:

$$Rf = \frac{\text{Distance travelled by a component from the original spot}}{\text{Distance travelled by a component from the original spot}}$$

R_f has no units because it is ratio between component travelled distance from the original spot and solvent travelled distance from the original spot.

8. **State the distribution law with two examples.**
(DGK, GI, BWP, SGD, GII, BWP, GI, GRW, GII, 2014)(GRW, GII, LHR, GII, BWP, 2015)(BWP, AJK, 2016)(GII, 2016)
(GRW, GII, LHR, GII, BWP, GII, MLN, GII, 2017)(LHR, GI, BWP, GI, 2018, GI, AJK, 2019)

Ans. Distribution law of partition:
This law states that a solute distributes itself between two immiscible liquids in a constant ratio of concentrations irrespective of the amount of solute added.

Mathematically: $K = \frac{\text{Conc. of solute in organic phase}}{\text{Conc. of solute in aqueous phase}}$

Where K is known as distribution Co-efficient.

Distribution Law in Solvent extraction:
Let us consider distribution of Iodine between two immiscible solvents, water in the presence of KI and $CC\ell_4$.

$$I_2 + I^-_{(aq)} \rightleftharpoons I^-_{3(aq)}$$

(soluble in $CC\ell_4$) **(soluble in water)**

At equilibrium, the rate at which iodine passes from $CC\ell_4$ to water equals the rate at which it passes from water to $CC\ell_4$.

So, iodine will transfer from aqueous layer into organic layer. As a result brown color of I_2 fades and purple colour of free iodine molecule appears in organic layer. For good separation, the two liquids are gently shaken, no matter how much iodine is used, the ratio of final concentrations at equilibrium is constant. According to distribution law.

$$K = \frac{[I_2(CC\ell_4)]}{[I^-_{3(aq)}]}$$

9. **Define chromatography. Give its two uses.**
(DGK, GI, FBD, GI, 2016)(AJK, GII, BWP, GI, 2017)(BWP, GI, 2018)(DGK, GII, FBD, GI, 2019)

Ans. Chromatography:
Chromatography is a technique which is used primarily for the separation of a sample of mixture. It involves the distribution of a solute between a stationary phase and a mobile phase.

Uses of Chromatography:

(i) It is used to obtain pure compounds from mixtures.

(ii) Chromatography is used for quality control in the food industry, by separating and

analyzing additives, vitamins, preservatives, proteins, and amino acids.

10. What is sublimation? Give examples of substances which show sublimation.
(RWP. GI, SWL. DGK. GI, 2014)(GRW. GI, LHR. GI & GII, DGK. GII, BWP. 2015)
(BWP. GI, RWP. GII, 2017)(GRW. GII, RWP. 2019)

Ans. Sublimation:

Sublimation is a process in which a solid, when heated vaporizes directly without passing through the liquid phase and these vapours can be condensed to form the solid again.Sublime substances can be purified by this technique.

Substances Purified by sublimation:

Following substances are purified by sublimation:

(i) Ammonium chloride
(ii) Iodine
(iii) Naphthalene
(iv) Benzoic acid

11. What is difference between adsorption and partition chromatography?
(SGD. GI, MLN. GI, BWP. 2014)(MLN. GI, LHR. GII, 2015)(AJK. RWP. 2016)
(FBD. GII, LHR. GII, MLN. GII, 2017)(GRW, RWP, BWP. GII, 2018)(GRW. GI & GII, MLN. GII, 2019)

Ans. Difference between adsorption and partition chromatography:

Adsorption Chromatography	Partition Chromatography
(i) Adsorption Chromatography is in which the stationary phase is a solid.	(i) Partition chromatography is in which the stationary phase is a liquid.
(ii) In this type, the substances leave the mobile phase to become adsorbed on the surface of the solid phase.	(ii) In this type, the substances being separated are distributed throughout both the stationary and mobile phases.
(iii)In this type the physical forces are involved in retentive ability of stationary phase. *Example:* Thin layer chromatography (TLC)	(iii) In this type the distribution and separation of components are involved. *Example:* Paper chromatography

12. Write down the uses of chromatography.
(DGK. GII, 2014)(MLN. GI, DGK. GII, 2015)(SGD. GI, 2017)(SWL, SGD, BWP. GI, 2018)

Ans. Uses of chromatography:

The techniques of chromatography are very useful in organic synthesis for:

(i) Separation, isolation and purification of the products.
(ii) It is very important in qualitative and quantitative analysis.
(iii) It is very important for determination of the purity of a substance.

13. Name the various experimental techniques which are used for purification of substances.
(LHR. GII, 2018)

Ans. The name of various experimental techniques which are used for purification of substance are:

1. Affinity purification
2. filtration
3. centrifugation
4. Evaporation
5. Liquid liquid extraction
6. Crystallization
7. crystallization
8. smelting
9. Adsorption
10. Smelting.

14. **Define Solvent Extraction and Partition Law.** (MLN. GI, BWP. 2018)

Ans. **Solvent Extraction:** It is a technique in which a solute can be separated from a solution by shaking the solution with solvent in which the solute is more soluble and the added solvent does not mix with solution.

Partition Law:

This law states that if a system consisting of two mutually imiscible liquids a subtance which is solulde in both liquid is dissolved, it distibutes between the two layer is constant at molar concentration.

15. **Mention only steps involved in complete quantitative determination.** (BWP. GI, 2018)

Ans. A complete quantitative determination generally consists of four major steps:

1. Obtaining a sample for analysis.
2. Separation of the desired constituent.
3. Measurement, and calculation of results.
4. Drawing conclusion from the analysis.

16. **Define extraction.** (LHR. GII, 2019)

Ans. This method is used to separate the products of organic synthesis from water. In a typical organic synthesis, the aqueous solution containing the organic product is shaken up with ether in a separating funnel and allowed to separate. The inorganic impurities remain in aqueous phase, where as the organic compound goes to the ether layer. The ether layer is separated and organic product is obtained by evaporating the ether.

17. **Give the salient features of an ideal solvent used in the process of crystallization.**
(RWP. FBD. GI, DGK. GI, 2015)(BWP. LHR. GI, 2016)(MLN. GII, LHR. GI, DGK. GI, RWP. GI, 2017)
(GRW, MLN. GI & GII, DGK. GI, 2018)(SGD. GII, BWP. GI, DGK. 2019)

Ans. **Salient features of an ideal solvent:**

An ideal solvent should have the following features.

(i) It should dissolve a large amount of the substance at its boiling point and only a small amount at the room temperature.

(ii) It should not react chemically with the solute.

(iii) It should either not dissolve the impurities or the impurities should not crystallize from it along with the solute.

(iv) On cooling it should deposit well-formed crystals of the pure compound.

(v) It should be inexpensive.

(vi) It should be safe to use and should be easily removable.

CHAPTER 03

GASES

MULTIPLE CHOICE QUESTIONS (MCQ's)

1. The temperature of natural plasma is about: (DGK. GI, 2017)
(A) 20000 °C (B) 10000 °C (C) 5000 °C (D) 1000 °C

2. Pressure remaining constant at which temperature the volume of a gas will become twice of water it is at 0°C: (MLN. GI, 2017)(BWP. GII, AJK. 2018) (GRW. GI, & GII, FBD. GI, SWL. SGD. GI, & GII, RWP. BWP. GI, 2019)
(A) 546° C (B) 200° C (C) 546 K (D) 273 K

3. Formula used for the conversion of F° into C°is: (RWP. 2014)
(A) $°F = \frac{9}{5}(°C) + 32$ (B) $°C = \frac{5}{9}[°F - 32]$ (C) $°F = \frac{5}{9}(°C) + 32$ (D) $°C = \frac{9}{5}[°F - 32)$

4. The molar volume of CO_2 is maximum at: (GRW. DGK. 2014)(BWP. GI, RWP. GI & GII, 2017)(FBD, BWP. GI, AJK. 2018) (LHR. GII, GRW. GII, FBD. GI, & GII, MLN. GII, SWL. BWP. GII, 2019)
(A) STP (0°C and 1 atm) (B) 127°C and 1 atm
(C) 0°C and 2 atm (D) 273°C and 2 atm

5. If absolute temperature of the gas is doubled and the pressure is reduced to one half the volume of the gas will: (SGD. GII, 2014)(MLN. GII, LHR. GI, 2017)(DGK. GI, AJK. 2018)(GRW. GI, 2019)
(A) Remains uncharged (B) Increase four times (C) Reduce to $\frac{1}{4}$ (D) be doubled

6. The number of molecules in one dm^3 of water is close to: (BWP. 2014)(AJK. LHR. GI, DGK. GI, BWP. 2016)(BWP. GII, SGD. GII, 2017)(SGD. GII, AJK. GI, 2019)
(A) $\frac{6.02}{22.4} \times 10^{23}$ (B) $\frac{12.04}{22.4} \times 10^{23}$ (C) $\frac{18}{22.4} \times 10^{23}$ (D) $55.6 \times 6.02 \times 10^{23}$

7. Equal masses of methane and oxygen are mixed in an empty container at 25°C. The fraction of total pressure exerted by oxygen is: (FBD. DGK, 2014)(LHR. GII, 2017)(LHR. GI, DGK. GII, 2018)
(A) $\frac{1}{3}$ (B) $\frac{8}{9}$ (C) $\frac{1}{9}$ (D) $\frac{16}{17}$

8. Partial pressure of oxygen in the air is: (DGK. GII, 2014)(SGD. GII, 2017)(LHR. GII, 2018)
(A) 156 torr (B) 157 torr (C) 158 torr (D) 159 torr

9. Feeling uncomfortable breathing in unpressurized cabins is due to: (BWP. 2014)
(A) High pressure of CO_2 (B) Low Pressure of O_2
(C) Fatigue (D) Low pressure of CO_2

10. The partial pressure of oxygen in lungs is: (FBD. GI, 2014)(LHR. GII, 2017)
(A) 760 torr (B) 320 torr (C) 159 torr (D) 116 torr

11. The order of the rate of diffusion of gases NH_3, SO_2, $C\ell_2$ and CO_2 is: (DGK. 2014)(SGD. GI, BWP. GI, FBD. MLN. GII, 2017)(SGD, RWP. 2018)(LHR. GI, MLN. GI, AJK. 2019)
(A) $NH_3 > SO_2 > C\ell_2 > CO_2$ (B) $NH_3 > CO_2 > SO_2 > C\ell_2$
(C) $C\ell_2 > SO_2 > CO_2 > NH_3$ (D) $NH_3 > CO_2 > Cd_2 > SO_3$

12. Which of the following will have the same number of molecules at STP?
(A) 280 cm^3 of CO_2 and 280 cm^3 of N_2O (B) 11.2 dm^3 of O_2 and 32 g of O_2
(C) 44 g of CO_2 and 11.2 dm^3 of CO (D) 28 g of N_2 and 5.6 dm^3 of oxygen

13. **How should the conditions be changed to prevent the volume of a given gas from expanding when its mass is increased?**
(A) Temperature is lowered and pressure is increased
(B) Temperature is increased and pressure is lowered
(C) Temperature and pressure both are lowered.
(D) Temperature and pressure both are increased.

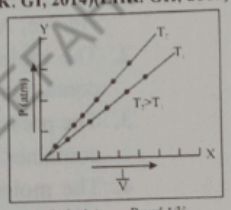
14. **Volume occupied by one mole of gas at standard temperature and pressure is:** (DGK. GI, 2019)
(A) 54 dm^3 (B) 22.414 dm^3 (C) 2.24 dm^3 (D) 2.4 dm^3

15. **At 323 torr Boiling point of H_2O is:** (AJK. 2019)
(A) 120°C (B) 100°C (C) 69°C (D) 110°C

SHORT ANSWER QUESTIONS

1. **The line obtained when a graph is plotted between V on x-axis and pressure P on the y-axis for a gas at two different temperatures.** (DGK. GI, 2014)(LHR. GII, 2019)

Ans. Change in the position of a straight line obtained when a graph is plotted between $\frac{1}{V}$ on X-axis and pressure P on the Y-axis for a gas at two different temperatures is when T is increased and inverse of V decreases so graph moves towards P axis at higher T, $T_2 > T_1$.



A plot between P and 1/V

2. **Define absolute zero. What is its value?** (DGK. GII, MLN. GI, 2014)(FBD. GI, 2015) (FBD. GI, LHR. GII, 2016)(LHR. GII, DGK. GI, 2017)(FBD. GI, SGD. GI, DGK. GI, 2019)

Ans. Absolute Zero: The temperature of –273.16°C at which the volume of a gas theoretically becomes zero is called absolute zero.
It is taken as zero on the Kelvin scale of temperature.

3. **Convert 80°C into °F.** (DGK. GI, 2015)

Ans. Conversion of 80°C to °F:

Formula $^\circ F = \frac{9}{5}(^\circ C) + 32$

$F = \frac{9}{5}(80 + 32)$

$F = \left[\frac{9}{5}(112)\right]$

$F = 201.6$

4. **Define Avogadro's law with two suitable examples.** (DGK. GII, LHR. GI, 2016)(GRW. GII, DGK. GI, 2017)(FBD, BWP. GII, 2018)

Ans. Avogadro's law: According to this law, "equal volumes of all the ideal gases at the same temperature and pressure contain equal number of molecules".

Examples:

(a) 2.016 g H_2 = 1 mol of H_2 = 22.414 dm^3 of H_2
= 6.02×10^{23} molecules of H_2

(b) 16 g CH_4 = 1 mol CH_2 = 22.414 dm^3 of CH_4
= 6.02×10^{23} molecules of CH_4

5. **Why deep sea divers take oxygen mixed with an inert gas, Like (He)?** (DGK. GI, 2014)(RWP. 2016)(DGK. GI, 2017)

Ans. Deep sea divers take oxygen mixed with an inert gas like He to adjust the pressure of

oxygen according to the requirement. Actually, in sea after every 100 ft. depth, the diver experiences approximately 3 atm pressure, so normal air cannot be breathed in depth of sea. Moreover, the pressure of N_2 increases in depth of sea and it diffuses in the blood.

6. Explain the process of Respiration obeys Daltons Law of partial pressure. (SGD. GII, 2014)

Ans. The process of respiration obeys Dalton's Law of partial pressure because respiration process depends upon the partial pressure difference, when animal inhale air then oxygen moves into lungs as the partial pressure of oxygen in the air is 159 torr, while the partial pressure of oxygen in the lungs 116 torr. CO_2 moves out in the opposite direction as its partial pressure is more in the lungs than that in air.

7. Write down four postulates of kinetic molecular theory of gases responsible for the deviation of gases from ideal behaviour. (BWP. GII, 2017)(SWL. DGK. GI, 2018)

Ans. Following are the some postulates of the kinetic molecular theory of gases;

1. Every gas consists of a large number of very small particles called molecules. Gases like He, Ne, Ar have monoatomic molecules.
2. The molecules of a gas move colliding among themselves and with the walls of the container and change their directions.
3. The pressure exerted by a gas is due to the collisions of its molecules with the walls of a container. The collisions among the molecules are perfectly elastic.
4. The molecules of a gas are widely separated from one another and there are sufficient empty spaces among them.

8. Write down two characteristics of plasma. (RWP. GI, 2014)(AJK. 2015)(BWP. GI, 2017)(LHR. GII, GRW, 2018)(LHR. GI, SWL. 2019)

Ans. Characteristics of plasma.

1. Plasma must have sufficient number of charged particles so as a whole; it exhibits a collective response to electric and magnetic fields. The motions of the particles in the plasma generate magnetic fields and electric currents from within plasma density. It refers to the density of the charged particles. This complex set of interactions makes plasmas a unique, fascinating, and complex state of matter.
2. Although plasma includes electrons and ions and conducts electricity, it is macroscopically neutral. In measurable quantities the number of electrons and ions are equal.

9. Why do we feel comfortable in expressing the densities of gases in the units of g/dm^3 rather than g/cm^3, a unit which is used to express the densities of liquids and solids? (DGK. GII, 2016)(LHR. GI, 2017)

Ans. The gases have very low densities as compared to liquids and solids. So to express the density, of gases we choose the unit of dm^3 instead of cm^3, so that the density of a gas may be written in a convenient manner.

10. Derive molecular mass of a gas by general gas equation.

Ans. Calculating Molar Mass using the Ideal Gas Equation: (LHR. GI, 2017)

The molar mass of an ideal gas can be determined using yet another derivation of the Ideal Gas Law:

$$PV = nRT.$$

We can write, number of moles, as follows:

$$n = m/M$$

where "m" is the mass of the gas, and "M" is the molar mass. We can put this into the Ideal Gas Equation:

$$PV = (m/M)RT$$

Rearranging, we get:

$$PV/RT = m/M$$

Finally, putting the equation in terms of molar mass, we have:

$$M = mRT/PV$$

This derivation of the Ideal Gas Equation is useful in determining the molar mass of an unknown gas.

11. State Graham's Law of diffusion and write its mathematical form.

(MLN. GII, 2016) (BWP. GII, 2017)(GRW. GII, DGK. GI & GII, 2019)

Ans. Graham's Law of diffusion: The rate of effusion or diffusion of a gas is inversely proportional to the square root of density of the gas.

Mathematically: Rate of diffusion, $r \propto \frac{1}{\sqrt{d}}$ or $r = \frac{k}{\sqrt{d}}$

OR $r \times \sqrt{d} = k$

If we have two gases which are diffusing into each other, then $r_1 \times \sqrt{d_1} = k$

$r_2 \times \sqrt{d_2} = k$

Dividing the two equations, and rearranging them

$$\frac{r_1}{r_2} = \times \sqrt{\frac{d_2}{d_1}}$$

Where r_1 = the rate of diffusion of gas 1

r_2 = the rate of diffusion of gas 2

d_1 and d_2 are their densities.

12. How do you justify from general gas equation that increase in temperature or decrease of pressure decreases the density of the gas?

Ans. The formula for the density of an ideal gas is $d = \frac{PM}{RT}$

According to this equation density is directly proportional to the pressure of the gas and inversely proportional to the temperature. So greater the temperature of the gas lesser the density. The increase of temperature increases the volume and so the density falls down.

When we decrease the pressure, the molecules go away from each other, volumes increase and density is decreased.

13. Calculate the value of gas constant "R" in SI units.

(BWP. SGD. GI & GII, GRW. GI & GII, 2014)(DGK. GRW. GII, MLN. GII, 2015)
(MLN. GII, LHR. GI, 2016)(FBD. GII, DGK. GII, MLN. GII, SGD. GI & GII, 2017)(LHR. GII, FBD. 2018)
(LHR. GI & GII, GRW. GI, FBD. GI, MLN. GI, SGD. GII, BWP. GI, BWP. GI, 2019)

Ans. By using SI units of pressure, volume and temperature in the general gas equation, the value of "R" is calculated as follows:

The SI units of pressure are Nm^{-2} and of volume are m^3. By using Avogadro's principle.

1 atm = 760 torr = 101325 Nm^{-2}

$1m^3$ = 1000 dm^3

n = 1 mole

T = 273.16 K

P = 1 atm = 101325 Nm^{-2}

V = 22.414 dm^3 = 0.0022414 m^3

Putting these values, along with units.

$$R = \frac{PV}{nT} = \frac{101325 Nm^{-2} \times 0.022414 m^3}{1 mol \times 273.16 K}$$

$R = 8.3143\ NmK^{-1}\ mol^{-1}$

$= 8.3143\ JK^{-1}\ mol^{-1}$ (1Nm = 1J) (AJK. 2)

14. Give two statements of Boyle's Law.

Ans. Boyle's law:

(i) "The pressure of a gas tends to increase as the volume of the container decreases".

A modern statement of Boyle's law is

(ii) "The absolute pressure exerted by a given mass of an ideal gas is inverse proportional to the volume it occupies if the temperature and amount of gas rema unchanged within a closed system."

Mathematical Form of Boyle's law:

Mathematically, Boyle's law can be stated as

When the temperature and number of moles are constant

$$V = \frac{K}{P}$$

$$PV = K$$

where P is the pressure of the gas, V is the volume of the gas, and k is a constant.

15. Throw some light on the factor in Charles's Law. (GRW. GI. 2015)(RWP. GII. 20

Ans. Factor of $\frac{1}{273}$ is very important in Charles's law. The volume of given mass of the g increases or decreases by $\frac{1}{273}$ of its volume at 0°C. Following equation helps us t calculate the volume of gas at any temperature.

$$V_T = V_0\left(1 + \frac{T}{273}\right)$$

16. Derive Boyle's Law from Kinetic molecular theory of gases.

(SGD. GII, RWP. GI, 2017)(DGK. GI, 2018)(GRW. GII, MLN. GII, 20

Ans. According to one of the postulates of kinetic theory of gases, the kinetic energy is direct proportional to the absolute temperature of the gas. Therefore, The kinetic energy of molecule is

$$\frac{1}{2}mN\bar{C}^2$$

So, $\frac{1}{3}mN\bar{C}^2 \propto T$

$$\frac{1}{2}mN\bar{C}^2 = KT \quad \text{____ (1)}$$

Where K is the proportionality constant. According to the Kinetic equation if gases

$$PV = \frac{1}{3}mN\bar{C}^2$$

Multiplying and dividing by 2 on right hand side

$$PV = \frac{2}{3}\left(\frac{1}{2}mN\bar{C}^2\right) \quad \text{____ (2)}$$

Putting equation (1) into equation (2)

$$PV = \frac{2}{3}kT \quad \text{____ (3)}$$

If the temperature (T) is constant then right hand side of equation (3) will be equal to KT is constant. Let that constant be K'.

So, $PV = k'$ (which is Boyle's law)

Hence, at constant temperature and number of moles, the product PV is a constant quantity.

17. Prove that $d = \frac{PM}{RT}$ (FBD. GI, 2015)(RWP. 2016)(LHR. GII, DGK. GII, 2017)(SGD. GI, 2019)

Ans. $d = \frac{PM}{RT}$

The density of an ideal gas can be calculated by substituting the value of number of moles (n) of the gas in terms of the mass (m), and the molar mass (M) of the gas.

Mathematically:

$$n = \frac{m}{M}$$

We know that

$$PV = nRT$$

So, $$PV = \frac{m}{M}RT$$

This is another form of general gas equation which is used to calculate the mass of a gas.

On rearrangement:

$$PM = \frac{m}{v}RT$$

So, $$d = \frac{m}{v}$$

$$PM = dRT$$

$$d = \frac{PM}{RT}$$

Hence the density of an ideal gas is directly proportional to its molar mass and inversely proportional to temperature.

18. Why pilots feel uncomfortable breathing in unpressurised cabin?
(SGD, GII, 2017)(MLN. GII, SWL. 2018)

Ans. At higher altitudes, the pilots feel uncomfortable breathing in cabin because the partial pressure of oxygen in the un-pressurized cabin is low around 150 torr, which is less then 159 torr that is necessary pressure required to human beings to breath comfortabley.

19. What is plasma? How it is formed?
(FBD-GI, DGK. GII, MLN. GI, 2014)(LHR. GI, 2015)(MLN. GI, BWP. 2016)(GRW. GI, BWP. GI, 2019)

Ans. Plasma: Plasma is an ionized gas mixture, consisting of ions, electrons and neutral atoms. It means that plasma is a distinct state of matter containing a significant number of electrically charged particles a number sufficient to affect its electrical properties and behaviour.

Formation of Plasma: Plasma can be created by heating a gas or subjecting it to a strong electromagnetic field applied with a laser or microwave generator. This decreases or increases the number of electrons, creating positive or negative charged particles called ions,and is accompanied by the dissociation of molecular bonds, if present.

20. Derive Charles's law by kinetic equation of gases.
(DGK. GII, 2014)(RWP. 2015)(LHR. GI, BWP. GII, 2017)(RWP. 2019)

Ans. Charles's Law: Charles's Law is a quantitative relationship between temperature and volume of a gas.

According to this law: "The volume of the given mass of a gas is directly proportional to the absolute temperature when the pressure is kept constant.

Mathematically: $V \propto T$ (When pressure and number of moles are constan)

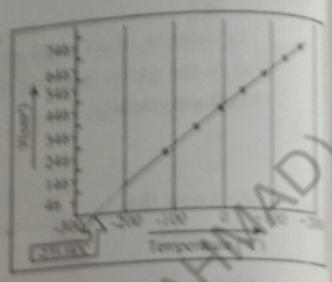
$V = KT$

$\frac{V}{T} = K$

21. **How absolute zero is explained by drawing graph?** (SGD. GI. 201

Ans. Graphical Explanation of Absolute Zero:

If we plot a graph between "T" on x-axis and the "V"of one mole of an ideal gas on y-axis. Then we get a straight line which cuts the temperature axis at -273.16°C. It can be possible only if we extra plot the graph upto -273.16°C. This temperature is the lowest possible temperature, which would have been achieved if the substance remains in the gaseous state then all the gases are converted into liquids above this temperature.



22. **Convert 40°C into F°.** (RWP. GI. 2014)(RWP. FBD. GI. 2016)(RWP. BWP. GII. 201

Ans. Conversion of 40°C into F°.

Formula $F° = \frac{9}{5}(°C) + 32$

Putting Value of 40°C

$F° = \left[\frac{9}{5}(40)\right] + 32$

$°F = 72 + 32$

$°F = 104°$

So, 40°C = 104°F

23. **Convert 37°C into °F scale.** (SWL. GII. 2017)(AJK. 201

Ans. we know that

$F = \frac{9}{5}(C) + 32$

So, by putting the values

$°F = 9/5 \times 37 + 32$

$°F = 1.8 \times 37 + 32$

$°F = 66.6 + 32 = 98.6$

$°F = 98.6$

24. **Derive an expression to find out the partial pressure of gas.** (BWP. 201

Ans. The partial pressure of any gas is obtained by multiplying the mole fraction of gas with th total pressure of the mixture.

Consider a mixture of two gases A and B in a container having volume V and Temperature T. Partial pressure of A and B is PAand PB respectively. Applying General Gas Equation:

$P_A V = n_A RT$ ..... (1)

$P_B V = n_B RT$ ..... (2)

$P_t V = n_t RT$ ..... (3)

Dividing Eq. (1) by (3)

$$\frac{P_A V}{P_t V} = \frac{n_A RT}{n_t RT}$$

$$\Rightarrow \quad P_A = \frac{n_A}{n_t} P_t$$

$$P_A = X_A P_t$$

Similarly $P_B = X_B P_t$

X_A and X_B are mole fractions of A and B respectively.

25. Apply Datton's Law of partial pressure to determine the partial pressure of a dry gas? (MLN. GI, 2016)(DGK. GII, 2018)

Ans. Some gases are collected over water in the laboratory. The gas during collection gathers water vapours and becomes moist. The pressure exerted by this moist gas is, therefore, the sum of the partial pressures of the dry gas and that of water vapours. The partial pressure exerted by the water vapours is called aqueous tension.

$P_{moist} = P_{dry} + P_{w.vap}$

$P_{moist} = P_{dry}$ + aqueous tension

$P_{dry} = P_{moist}$ – aqueous tension

26. Some of the postulates of KMT are faulty. Justify.
(GRW. GII, 2014)(LHR. GI, GRW. GII, RWP. 2015)(BWP. GI & GII, 2017)(GRW. GII, 2019)

Ans. **(a)** According to KMT there are no forces of attraction between the gas molecules but it has been observed that molecules of gases have forces of attraction when they are pressurized.

(b) Actual volume of the gas molecules is negligible as compared to the occupied volume gas. This is also true under normal temperature and pressure but under highly compressed state the actual volume no longer remains negligible. Hence at high P and low T gases behave non-ideally.

27. Write two uses of plasma.
(SGD. GII, GRW. GI, 2014)(BWP. DGK. GII, LHR. GII, MLN. GI, 2015)(MLN. GII, DGK. GI, AJK. 2016)
(MLN. GII, LHR. GII, SGD. GI, FBD. GII, 2017)(SGD, AJK. 2018)(FBD. GI, DGK. GII, AJK. 2019)

Ans. Uses of Plasma:

(i) A fluorescent light bulb is not like regular light bulbs. Inside the long tube is a gas. When the light is turned on, electricity flows through the tube. This electricity acts as that special energy which charges up the gas. This charging and exciting of the atoms creates glowing plasma inside the bulb.

(ii) Neon signs are glass filled with gas. When they are turned on then the electricity flows through the tube. The electricity charges the gas, possibly neon, and creates plasma inside the tube. The plasma glows with a special color depending on what kind of gas is inside.

(iii) They find application such as plasma processing of semiconductors, sterilization of some medical products, lamps, lasers, diamond coated films, high power microwave sources and pulsed power switches.

(iv) Plasma light up our offices and homes, make our computers and electronic eguipment work.

28. Where do natural plasma and artificial plasma exist? (LHR. GI, 2018)

Ans. Artificial plasma can be created by ionization of a gas. As in neon signs. Plasma at low temperatures is hard to maintain because outside a vacuum low temperature plasma reacts rapidly with any molecule it encounters. This aspect makes this material, both very useful and hard to use.

Natural plasma exists only at very high temperatures, or low temperature vacuums. Natural plasma does not breakdown or react rapidly, but is extremely hot (over 20,000°C minimum). Its energy is so high that it vaporizes any material it touches.

29. Derive expression of density of gas with help of general gas equation. (LHR. GII, 2018)

Ans. For calculating the density of ideal gas we substitute the value of number moles (m) of the

gas in terms of the mass (m) and molar mass (m) of the gas.

$n = m / M$

$PV = m/M\ RT - (1)$

Eq.1 is am other form of gas equation that can be employed to calculate mass of a gas whose P. V. T and molar mass are known reasoning.

$PM = m / V\ RT$

$dV = dRT \qquad (d = m / v)$

$d = \frac{PM}{RT} - (2)$

density of gas is directly proportional to molar mass we can calculate the releative molar mass of a ideal gas of its temperature P and density are known.

30. Write future horizon of Plasma, briefly. (DGK. GI, 2018)

Ans. Scientists are working on putting plasma to effective use. Plasma would have to be low energy and should be able to survive without instantly reacting and degenerating. The application of magnetic field involves the use of plasma. The magnetic field used to create to low temperature plasma give the plasma molecules, which do not until they collide.

31. Derive Graham's law of diffusion from kinetic equation. (LHR. GI, 2019)

Ans. According to Kinetic molecular Equation.

$$Pv = \frac{1}{3}mNc^{-2} \longrightarrow (i)$$

For one mole of gas having

Avogadro's Number of Molecules then Eq(i) become

$$Pv = \frac{1}{3}mNAc^2 \qquad (M = mNA)$$

'M' is molar mass of Gas

We Know $C^{-2} = \frac{3PV}{M} \longrightarrow (ii)$

We Know that $d = \frac{M}{V}$ and $\frac{1}{d} = \frac{V}{M}$

Putting the value of $\frac{V}{M}$ in Equation (ii)

$$C^{-2} = \frac{3P}{d}$$

or $\sqrt{C^2} = \sqrt{\frac{3P}{d}}$

where $\sqrt{C^2} \propto r$

$$Crms = \frac{3P}{d}$$

$$r \propto \frac{1}{d}$$

This is called Graham's law

32. State Dalton's law of partial pressure. Give its mathematical form. (FBD. GI, 2019)

Ans. Dalton's law of partial pressure state that the total pressure exerted by a mixture of non-reacting gases is equal to the sum of the individual partial pressure of all the gases present in a mixture. For example four gases have the partial pressure P_1, P_2, P_3 and P_4

then Mathematically.

$P_t = P_1+P_2+P_3+P_4$

33. **–273. 15°C is known to be the lowest temperature of an ideal gas. Give reason.** (SWL. 2019)

Ans. The temperature (–273.16°C) is the lowest possible temperature, which would have been achieved if the substance remains in the gaseous state. Actually all the gases are converted into liquid above this temperature which shows that this temperature can not be attained for a real Gas.

ESSAY TYPE QUESTIONS

1. **Calculate the mass in dm^3 of NH_3 gas at 30°C and 1000 mm Hg pressure, considering that NH_3 is behaving ideally.** (BWP. MLN. GI, 2014)(GRW. GII, DGK. GII, 2019)
2. **Prove general gas equation (PV = nRT).** (DGK. GI, 2015)
3. **What is ideal gas constant "R"? Calculate its value in different units?** (MLN. 2015)(BWP. 2016) (SGD. GI, 2017)
4. **250cm^3 of the sample of hydrogen effuses four times as rapidly as 250cm^3 of unknown gas. Calculate the molar mass of unknown gas.** (GRW. GII, 2014)(SWL. 2019)
5. **Derive an expression from qeneral gas equation to calculate the density of gas.** (DGK. GI, 2016)
6. **State and explain general gas equation. Calculate value of 'R' in Si-units.** (DGK. GI, LHR. GII, 2017)
7. **State Dalton's law of partial pressure. Write down its four applications also.** (LHR. GI, 2016)(BWP. GI, 2014)(MLN. GI, LHR. GI & GII, 2015) (RWP. GII, SWL. GII, FBD. GII, 2017)(SGD, RWP, DGK. GI, BWP. GII, 2018)
8. **What is graham's Law of diffusion? Also qive its experimental verification.** (RWP. AJK. 2015)(DGK. GII, RWP. MLN. GII, FBD. GI, 2016) (BWP. GII, DGK. GII, LHR. GI, 2017)(GRW, DGK. GII, AJK. 2018)(RWP. 2019)
9. **Explain the Boyle's Law and Avogadro's Law on the basis of Kinetic molecular theory of gases.** (DGK. GII, 2015)(MLN. GII, 2017)
10. **What is Joule Thomson effect and describe Linde's method of liquefaction of gases?** (SWL. 2014)(MLN. GII, 2015)(AJK. 2016)(AJK. GII, 2017)(BWP. GI, 2018)
11. **What is an ideal gas? Real gases deviate more from ideal behaviour at low temperature and under high pressure explain.** (GRW. GI, 2014)(GRW. GII, 2015)
12. **Derive the van der Waal's equation for real gases and give the physical significance of van der Waal's constant "a" and "b".** (SGD. GII, 2014)
13. **What is Kinetic molecular theory of gases? Give its postulates.** (SGD. GI, 2014)(LHR. GII, 2016)(MLN. GI, 2017)(SWL. 2018)
14. **Derive Boyle's law and Charles's law from kinetic equation.** (LHR. GI, 2018)
15. **Define plasma state. How is it formed? Describe its four applications.** (FBD. 2018)
16. **Define critical temperature of gases. What is its importance in liquefaction of gases?** (MLN. GI, 2018)
17. **Assuming NH_3 gas to be ideal. Calculate its mass in grams if 1.00 dm^3 of NH_3 is enclosed in a container at 30°C and 1000 mmHg.** (FBD. GI, 2019)

CHAPTER 04

LIQUIDS AND SOLIDS

MULTIPLE CHOICE QUESTIONS (MCQ's)

1. **Acetone and chloroform are soluble in each other due to:** (BWP. GRW. SGD. 2014)(BWP. FBD. AJK. RWP. MTN. GII, 2016)(FBD. GII, 2017) (SGD, AJK. 2018)(FBD. GI, MLN. GII, BWP. GI, & GII, DGK. GI, 2019)
   (A) Intermolecular hydrogen bonding (B) Dipole-dipole interaction
   (C) Instantaneous dipoles (D) all of the above

2. **The boiling point of water at Muree Hills:** (DGK. GI, 2016)(GRW. 2018)
   (A) 90°C (B) 98°C (C) 100°C (D) 120°C

3. **Which of the given has Hydrogen Bonding:** (BWP. GII, 2017)
   (A) CH_4 (B) $CC\ell_4$ (C) NH_3 (D) $NaC\ell$

4. **London dispersion forces are the only forces present among the:** (LHR. GRW. 2014)(DGK. GII, MLN. GII, 2016)(BWP. GI, 2017)(MLN. GII, RWP. 2019)
   (A) Molecules of water in liquid state
   (B) Atoms of helium in gaseous state at high temperature
   (C) Molecules of solid iodine (D) Molecules of hydrogen chloride gas

5. **The boiling point of pure water at 1 atm pressure is:** (MLN. GII, 2017)
   (A) 98°C (B) 100°C (C) 69°C (D) 120°C

6. **If $a \neq b \neq c$ and $\propto = \gamma = 90° \beta \neq 90°$ then crystal system is:** (DGK. GI, 2014)
   (A) Monoclinic (B) Diclinic (C) Triclinic (D) Polyclinic

7. **NH_3 shows a maximum boiling point among the hydrides of V-A group elements** due to: (RWP. GI, 2017)
   (A) Very small size of nitrogen (B) Lone pair of electrons present on nitrogen
   (C) Enhanced electronegative character of nitrogen
   (D) Pyramidal structure of NH_3

8. **Allotropy is the property of:** (SGD. GI, 2014)
   (A) Compound (B) element (C) Atom (D) Mixture

9. **Transition temperature of KNO_3 is** (SWL. GII, 2017)(MLN. GII, 2018)
   (A) 13.2°C (B) 95.5°C (C) 128°C (D) 32.2°C

10. **Crystal of diamond is:** (SGD. GII, 2017)(DGK. GI, 2019)
    (A) Ionic (B) Covalent (C) Molecular (D) Metallic

11. **The distillation of liquid under reduced pressure is called:** (SGD. GI, 2014)
    (A) Destructive distillation (B) Vaccum distillation
    (C) Fractional distillation (D) Simple distillation

12. **The Axis (unit cell length) for Cu is:** (RWP. GI, 2014)
    (A) $a \neq b = c$ (B) $a \neq b \neq c$ (C) $a = b \neq c$ (D) $a = b = c$

13. **The dipole - dipole forces are present among:** (SGD. GII, 2017)
    (A) Molecules of Iodine (B) Atoms of Neon in gaseous state
    (C) Chloroform molecules (D) $CC\ell_4$ molecules

14. **The liquid having highest boiling point is:** (FBD. 2018)
    (A) Hydrofluoric acid (B) Water (C) Hydrogen sulphide (D) Ammonia

15. **The strongest acid among Halogen acids is:-** (MLN. GI, 2018)
    (A) HCl (B) HBr (C) HI (D) HF

16. **Dipole-induced dipole forces are also called:-** (MLN. GI, DGK. GI, 2018)
(A) Dipole-dipole forces (B) Ion-dipole forces
(C) Debye forces (D) London dispersion forces

17. **Which one of the following molecule do not obey the Octet rule?** (SWL. 2018)
(A) CH_4 (B) CO_2 (C) PF_5 (D) CS_2

18. **Which one of the following is in liquid state at room temperature?** (SWL. 2018)
(A) Methane (B) Ethane (C) Hexane (D) Propane

19. **Which of follow ing will have H-bonding in its molecules?** (AJK. 2018)
(A) C_2H_5OH (B) $CC\ell_4$ (C) I_2 (D) $NaC\ell$

20. **Density of ice is minimum at 4°C due to:** (LHR. GI, 2019)
(A) Empty spaces in structure of ice (B) Tetrahedral shape of crystal of ice
(C) Large bond lengths (D) Large bond angles

21. **The solid which has no definite crystalline shape.** (LHR. GI, 2019)
(A) Sugar (B) Salt (C) Glass (D) Dry ice

22. **Hydrogen bonding is maximum in:** (LHR. GII, 2019)
(A) HI (B) HBr (C) $HC\ell$ (D) H_2O

23. **Which of the halogen halides has the highest percentage of ionic character:** (GRW. GI, FBD. GI, MLN. GI, SGD. GI, RWP. DGK. GII, BWP. GII, AJK. 2019)
(A) $HC\ell$ (B) HBr (C) HF (D) HI

24. **Amorphous solids:** (MLN. GI, RWP. 2019)
(A) Have sharp melting points
(B) Undergo clean cleavage when cut with knife
(C) Have perfect arrangement of atoms
(D) Can possess small regions of orderly arrangement

25. **Transition temperature of S_8 (monoclinic) $\rightleftharpoons$ S_8 (Rhombic) is:** (DGK. GII, 2019)
(A) 13.2 °C (B) 95.5 °C (C) 128 °C (D) 110 °C

SHORT ANSWER QUESTIONS

1. **Differentiate between isomorphism and polymorphism.** (SGD. GII, 2014)(BWP. GI, 2016) (RWP. GII, LHR. GI, MLN. GI, & GII, 2017)(LHR. GI, 2018)(LHR. GII, 2019)

Ans. Difference between Isomorphism and polymorphism:

Isomorphism	Polymorphism
(i) Isomorphism is the phenomenon is which two different substances exist in the same crystalline form.	(i) Polymorphism is the phenomenon in which a compound exists in more than one crystalline form.
(ii) These different substances are called isomorphs of each other.	(ii) These crystalline forms are called polymorphs of each other.
(iii) Their physical and chemical properties are different from each other.	(iii) Polymorphs have same chemical properties, but they differ in the physical properties.
(iv) Isomorphic substances crystallize together in all proportions in homogenous mixtures, e.g. $NaNO_3$,KNO_3 (rhombohedral)	(iv) Polymorphic substances do not form homogeneous mixtures, e.g. $CaCO_3$ (Trigonal and orthorhombic)

2. **Define transition temperature and give two examples.** (SWL. 2014)(MLN. RWP. 2015)(FBD. GI, RWP. LHR. GI, DGK. GII, 2016)(MLN. GI, BWP. GI, 2018)

Ans. Transition temperature: Transition temperature is that temperature at which two crystalline forms of the same substance can co-exist in equilibrium with each other.

At this temperature, one crystalline form of a substance changes to another. Above and below this temperature, only one form exists.

Example:

(i) Grey tin (cubic) $\rightleftharpoons^{13.2^{\circ}C}$ White tin (tetragonal)

3. What are intramolecular forces of attaraction. Give one example. (MLN. GII, 2014)(SGD. GI, 201

Ans. Intermolecular forces are physical forces that exist between the molecules and hold them together. Such forces occur between the molecules of matter due to their polarity difference and the strength or weakness of intermolecular forces determines the state of matter of a substance (e.g., solid, liquid, gas) and some of the chemical properties (e.g., melting point, structure).

Intermolecular forces are classified as:

(i) Dipole - Induced dipole forces **(ii)** Dipoles dipole forces **(v)** Hydrogen bonds

(iii) London dispersion forces **(iv)** Ion-dipole forces

4. What is the role of Hydrogen bonding in biological compounds? (BWP. GII, 2017)

Ans. Role of Hydrogen Bonding in Biological Compounds:

Hydrogen bonding exists in the molecules of living system. Proteins are the important part of living organisms and its basic component amino acids shows hydrogen bonding. Similarly, Fibers found in the hair, silk and muscles consist of long chains of amino acids which coiled and spiral with one another to form a helix. Each spiral linked together by hydrogen bonds. The food materials like carbohydrates include glucose, fructose and sucrose. They all have -OH groups in them which are responsible for hydrogen bonding in them.

5. What are dipole-dipole forces? How they effect thermodynamic properties of substances. (DGK. GI, 2017)(GRW. GI, FBD. GII, 2019)

Ans. Dipole-dipole forces are attractive forces which exist between the positive end of one polar molecule and the negative end of another polar molecule.

These forces affect on many thermodynamic properties of substances in different ways.

For example:

(i) Melting and Boiling Points: Stronger the dipole dipole forces higher will be the melting and boiling points.

(ii) Viscosity: Stronger the dipole dipole forces higher will be the viscosity.

(iii) Surface Tension: Stronger the dipole-dipole forces higher will be the surface tension.

(iv) Vapour Pressure: Stronger the dipole-dipole forces lower will be the vapour pressure.

It means that thermodynamics properties of substance like viscosity, melting and boiling points etc; are a measure of how strong the Dipole-dipole forces are exist between individual atoms or molecules of substance.

6. What is isomorphism? Give an example.

(LHR. GII, BWP. 2015)(SWL. GII, AJK. GI, LHR. GI, 2017)(RWP. 2018

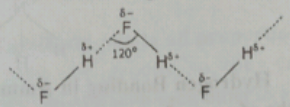
Ans. Isomorphism: Isomorphism is the phenomenon in which two different substances exist in the same crystalline form. These different substances are called Isomorphs of each other.

Example:

Isomorphs	Crystalline	Atomic ratio
$NaNO_3$, KNO_3	rhombohedral	1:1:3
K_2SO_4,K_2CrO_4	Orthorhombic	2:1:4
Cu, Ag	Cubic	1:1

7. In the hydrogen bonded structure of HF, which is the strongest bond: the shorter covalent bond or the longer hydrogen bond between different molecules?

Ans. The covalent bond between H and F is stronger because it is produced by the overlapping of orbitals and two electrons are shared to give a sigma bond.



The bond which is shown by the dotted lines is the hydrogen bond due to electrostatic forces of attraction. So it is a weaker bond.

8. Differentiate between intermolecular and intramolecular forces. (RWP. GII, SGD. GI, 2017)

Ans. Difference between intramolecular and intermolecular forces:

Intra-molecular force	Intermolecular forces
An intra-molecular force is any force of attraction that holds the atoms together by making a molecule or compound. In other words these are the forces that exerted within a molecule or compound	Intermolecular forces that exist between the neighbouring molecules, atoms or any other particles.
Such types of forces of attractions are present in all types of chemical bonds, intra-molecular forces are usually stronger than intermolecular forces.	Such types of forces are present in between atoms or molecules that are not bonded.
Examples:	These are weak forces than intra-molecular forces.
Covalent Bond, Ionic Bond and Metallic Bond	**Examples:** Hydrogen bonding, Ion- dipole forces. Dipole- dipole forces and London dispersion forces

9. What do you mean by cleavage and cleavage planes? (RWP. 2015)(DGK. GII, 2016)(LHR. GII, 2017)

Ans. Cleavage: Cleavage is the tendency of crystalline materials to split along definite crystallographic structural planes.

Cleavage Planes: Whenever the crystalline solids are broken, they do so along definite planes which are called the cleavage planes and they are inclined to one another at a particular angle for a given crystalline solid.

10. The vapour Pressure of diethyl ether is higher than that of water at the same temperature Give reason. (LHR. GII, 2015)(GRW. GI, 2019)

Ans. The vapour pressure of diethyl ether is higher than that of water at the same temperature is due to differencez in the strengths of their intermolecular forces. Actually, water has strong H-bonding in it while diethyl ether has weak van der wall's forces in it, due to these forces diethyl ether has high vapor pressure than water.

11. Lower alcohols are soluble in water but hydrocarbons are insoluble. Give reason. (DGK. GI, 2014)(AJK. 2015)(LHR. GI, 2018)(SWL. 2019)

Ans. Ethyl alcohol (C_2H_5OH) can dissolve in water because both can form hydrogen bonds with each other.

But hydrocarbons are not soluble in water at all, because they are non-polar compounds and there are no chances of hydrogen bonding between water and hydrocarbon molecules.

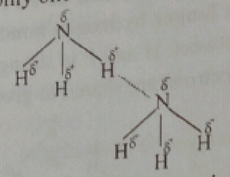
12. Define hydrogen bonding. Show hydrogen bonding in ammonia molecule. (DGK. GI & GII, 2014)(RWP. 2016)(RWP. GI, 2017)

Ans. Hydrogen bonding: Hydrogen bonding is the electrostatic force of attraction between a highly electronegative atom and a partial positively charged hydrogen atom.

Hydrogen Bonding in Ammonia molecule: Ammonia (NH_3) can form only one

hydrogen bond per molecule as it has only one lone pair on electronegative nitrogen atom.

Example:



Hydrogen Bonding in Ammonia molecule

13. Give the angles and lengths of axes of monoclinic system. **(DGK. GII, 2014)**

Ans. **Monoclinic System:** All the axes are of unequal length, two of these axes are at right angle to each other while the third angle is greater than 90°.

Monoclinic: (Axes) $a \neq b \neq c$

(Angles) $\alpha = \gamma = 90°, \beta \neq 90°$

Example: **(i)** sugar **(ii)** sulphur **(iii)** Borax

14. The transition temperature is shown by elements having allotropic forms and by compounds showing polymorphism. **(RWP. GI, 2016)(DGK. GI, 2019)**

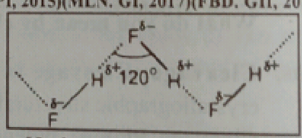
Ans. At transition temperature one crystalline form changes to other. So transition temperature is for all those elements which show allotropy and those compounds which show polymorphism, e.g.

(i) Sulphur S_8 (rhombic) $\xrightleftharpoons{95.5°C}$ Sulphur S_8 (monoclinic)

(ii) KNO_3 (orthorhombic) $\xrightleftharpoons{128°C}$ KNO_3 (rhombohedral)

15. Why HF is the weakest acid than other Hydrogen Halides?
(DGK. GI, GRW. PI, 2015)(MLN. GI, 2017)(FBD. GII, 2019)

Ans. **Low acidic strength of HF molecule:** HF molecule shows exceptionally low acidic strength as compared to HCℓ, HBr and HI due to strong hydrogen bonding, because the partial positively charged hydrogen is entrapped between two highly electronegative atoms.



Hydrogen bonding in HF molecule

The molecules of HF join with each other in a Zig zag manner.

16. Write four properties of solids. **(MLN. GI, 2016)(MLN. GI, 2019)**

Ans. **Four properties of solids:**

(i) The particles present in solid substances are very close to each other, Due to this reason solids are non- compressible and they cannot diffuse into each other.

(ii) Solids have strong attractive forces which hold the particles together firmly and for this reason solids have definite shape.

(iii) All solids have definite volume.

(iv) The solid particles possess only vibrational motion.

17. Define Polymorphims and Anisotorpy. Give one example of each.
(DGK. GII, AJK. GRW. GI, 2015)(MLN. GII, 2016)(SWL. GII, BWP. GI, 2017)(SGD. 2018)(MLN. GI, 2019)

Ans. **Polymorphism:** Polymorphism is a phenomenon is which a compound exists in more than one crystalline forms and these crystalline forms are called polymorphs of each other.

Example:

Element	Crystalline forms
Sulphur, S	Rhombic, monoclinic
Carbon, C	Cubic (diamond), hexagonal (graphite)

Anisotropy: Anisotropy is the phenomenon is which some of the crystals show variation in their physical properties that depends upon the direction. Such properties are called anisotropic properties.

Example: Electrical conductivity of graphite is greater parallel rather than perpendicular to the layers.

18. Water and ethanol (C_2H_5OH) can mix in all proportions. Give reason.

Ans. Water and ethanol both have OH^- groups, so, they can form the hydrogen bonding extensively. That is why they can mix with each other in all proportions.

19. Gasoline evaporates much faster than water. Give reason. (GRW. GII, 2014)

Ans. Gasoline evaporates much faster than water because the intermolecular forces are weak in Gasoline as compared to water which has strong intermolecular forces, thus in gasoline the rate of evaporation is faster.

20. Dynamic equilibrium is established during evaporation of a liquid in a closed vessel at constant temperature. (MLN. GI, 2016)

Ans. Dynamic equilibrium is established during evaporation of a liquid in a closed vessel at constant temperature because, if we put some liquid in a close vessel, evaporation starts. The vapors of liquid are collected over the surface and they cannot go out. The condensation of vapors also starts. Initially rate of evaporation is high but rate of condensation is very slow. After some time, rate of evaporation becomes equal to rate of condensation and in this way dynamic equilibrium is achieved.

$$\text{Rate of evaporation} \rightleftharpoons \text{Rate of condensation}$$

21. Describe cleaning action of soaps and detergents on the basis of H-bonding. (LHR. GI, 2017)(SGD. GI, 2019)

Ans. Soaps and detergents perform the cleansing action because the polar part of their molecules are water soluble due to hydrogen-bonding and the non-polar parts remain outside water, because they are alkyl or benzyl portions and are insoluble in water.

22. In a very cold winter the fish in garden ponds owe their lives to hydrogen bonding? (MLN. GI, 2019)

Ans. The hydrogen bonding in the solid state of H_2O adjust the molecules of water in such a way that empty spaces are left behind. So, the density of water in the solid state being less, ice floats on water. The liquid water at 4°C underneath ice, accommodates fish to survive in winter.

23. Why water is liquid at room temperature but H_2S and H_2Se are gases, comment? (GRW. GI, 2015)(DGK. GII, 2016)(MLN. GII, LHR. GII, 2017)

Ans. Water is liquid at room temperature which is due to the presence of strong hydrogen bonding among water molecules. On the other hand, H_2S and H_2Se are gases at room temperature which is due to the presence of weak dipole-dipole forces among H_2S and H_2Se molecules.

24. Write a note on the factors affecting the London forces. (BWP. GI, 2017)

Ans. London forces or Instantaneous dipole-induced dipole forces are weaker as compared to dipole-dipole intractions. The strength of London forces depends upon the following two factors:

(i) Size of electronic cloud: As the electronic cloud of atom or molecules increases, the London depression forces are more prominent.

(ii) Number of atoms in molecules: As the number of atoms in non-polar molecules increases, as polarizability of the molecules increases, so, London forces becomes stronger.

25. Define Anisotorpy and Allotropy. (LHR. GI, 2014)(MLN. GII, 2016)(RWP. GII, DGK. GI, 2017)

Ans. Anisotorpy: Anisotropy is the phenomenon is which some of the crystals show variation in their physical properties that depends upon the direction. Such properties are called anisotropic properties.

Allotropy: Allotropy is a phenomenon in which an element exists in more than one crystalline forms and these forms of the element are called allotropes or allotropic forms.

26. What are Pseudo-Solids (Amorphous-Solid). (BWP. GI, 2016)(RWP. GII, MLN. GII, LHR. GI, 2017)

Ans. Amorphous solids: Those solids in which the structural units i.e. atoms, ions or molecules are fixed in their positions but are not regularly arranged are called amorphous solids.

27. What is the relationship between polymorphism and allotropy? (LHR. GI, 2015)(SGD. GII, BWP. GI, 2017)

Ans. Relationship between polymorphism and Allotropy: Both polymorphism and allotropy are related to existence of a substance in more than one crystalline forms. But polymorphism is existence of a compound in more than one forms while allotropy is existence of an element in more than one crystalline forms.

28. Cleavage of crystals is itself anisotropic behaviour, explain. (MLN. GI, BWP. 2014)(AJK. 2015)(AJK. GII, 2017)

Ans. Cleavage is anisotropic behaviour: Cleavage is anisotropic property because when crystalline solids are broken they do so along definite planes. It means that cleavage depends upon direction. It proves that cleavage is itself anisotropic.

29. Ionic crystals do not conduct electricity in the solid state. Why? (DGK. GII, 2015)(MLN. GI, 2016)(SWL. GII, MLN. GI, RWP. GII, 2017)(SWL. DGK. GI, 2018)(DGK. GI, 2019)

Ans. Ionic crystals do not conduct electricity: In ionic crystals or ionic solids are tightly packed in a three dimensional way. They don't have translator motion. So they don't become responsible for carrying of current. Ionic crystals conduct electricity when they are in solution or in the molten state. In both cases ions become free.

30. Define symmetry and habit of crystal. (GRW. 2018)

Ans. Symmetry: The repetition of faces, angles or edges when a crystal is rotated by 360° along its axis is called symmetry.

Crystal: The shape of a crystal in which it usually grows is called habit of a crystal.

31. Explain the term 'Anisotropy' with an example. (SWL. 2018)

Ans. Anisotropy: Some of the crystals show variations in physical properties depending upon the direction such properties are called anisotropic properties and phenomenon is reffred to as anisotropy for e.g. electrical conductivity of graphite greater in one direction then in another.

32. Iodine dissolves readily in $CC\ell_4$. Why? (SGD. 2018)

Ans. Iodine is held together by covalent bonds and dissolve in solvents that unlike water are not held together by hydrogen bond. Carbon tetrachloride molecule are not so tightly held together. Iodine and $CC\ell_4$ are non polar molecules. According to solubility principle "like dissolve like" iodine dissolve $CC\ell_4$ readily neither will dissolve in water because water is a polar molecule.

33. Why ice occupies 9% more volume than liquid water? (LHR. GI, 2019)

Ans. When the temperature of water is decreased and ice is formed then the molecules become more regular and this regularity extends throughout the whole structure. Empty spaces are created in the structure. That is why when water freezes it occupies 9% more space and its density decreases.

34. Boiling point of water is greater than boiling point of HF, although hydrogen bonding is stronger in HF than in H_2O. Why? (LHR. GII, 2019)

Ans. The reason is that Fluorine atom can make only one hydrogen bond with electropositive hydrogen of a neighboring molecule. Water can form two hydrogen bonds per molecule, as it has two hydrogen atoms and two lone pair on oxygen atom.

35. Define isomorphism with example. (GRW. GII, 2019)

Ans. Isomorphism is the phenomenon in which two different substances exist in the same crystalline form.
e.g. $NaNO_3$, KNO_3 both are present in Crystalline form in the atomic Ratio of 1:1:3.

36. Why the density of ice is less than water? (FBD. GI, 2019)

Ans. In liquid water the molecules are extensively associated with each other due to strong H-Bonding. But this association is irregular, when temperature dropped to 0°C. The molecules of water arrange themselves in a regular pattern. Due to this empty space among H_2O molecule increase and hence density of ice decrease, so ice floats on water surface.

37. How liquid crystals act as temperature sensor? (FBD. GI, 2019)

Ans. Like solid crystals, liquid crystals can diffract light when one of the wave lengths of white light is reflected, from a liquid crystal it appears coloured. As the temperature changes, the distance between the layers of the molecules of liquid crystal change. Therefore the colour of reflected light charges accordingly. Thus liquid crystals can be used as temperature sensors.

38. Define Polarizibility. How it affects London dispersion forces? (MLN. GII, FBD. GII, 2019)

Ans. Polarizability is the quantitative measurement of the extent to which the electronic cloud can be polarized or distorted. The increased distortion of electronic cloud create stronger London forces and hence the boiling points also increased down the group.

39. What is meant by symmetry? Give elements of symmetry. (RWP. 2019)

Ans. The repetition of faces, angles, or edges when a crystal is rotated by 360° a long its axis is called symmetry. This is an important property of the crystal and there are various types of symmetry element found in a crystal like, center of symmetry, plane of symmetry and axis of symmetry etc.

40. Define crystal and crystallite. (RWP. 2019)

Ans. **Crystal:** A crystal is made up of atoms, ions or molecules which are located at definite position in space is called crystal.
Crystallites: The small part of amorphous solids which possess orderly arrangements of constituent particles are called crystallites.

41. What is habit of a crystal? Give one example. (RWP. 2019)

Ans. The shape of a crystal in which it usually grows is called habit of a crystal.
e.g. A cubic crystal of NaCl becomes needle like when 10% urea is present in its solution as a impurity.

ESSAY TYPE QUESTIONS

1. What is meant by the term hydrogen bonding? How does hydroqen bondinq explain, the properties of proteins. (RWP. GI, MLN. GI, 2016)(SGD. GI, 2017)

2. What is H-bonding? Discuss H-Bonding in biological compounds. (LHR. GII, 2015)

3. Define the following with example. (BWP. GII, 2019)
(i) Amorphous solids **(ii) Habit of crystal**
(iii) Allotropy **(iv) Transition temperature**

4. Explain seven crystal systems with angles and edges. (DGK. GI, 2014)

5. Define and explain London forces. Describe the factors affecting the London dispersion forces. (DGK. GII, 2014)

6. Define boiling point and how does it is effected by external pressure? Explain briefly. (MLN. GI, 2018)

7. Define liquid crystals; write down three uses of liquid crystals. (DGK. GII, 2018)(GRW. GII, 2019)

CHAPTER 05

ATOMIC STRUCTURE

MULTIPLE CHOICE QUESTIONS (MCQ's)

1. **Lyman series lies in spectral region:** (SGD. GI, 2014)(FBD. GI, 2015)(DGK. GII, 2017)(DGK. GI, 2019)
(A) Infrared **(B)** ultra violet (C) Visible (D) none of these

2. **Bohr's model of atom is contradicted by:** (LHR. MLN. BWP. 2014)(DGK. GI, 2016)(AJK. GII, LHR. GII, 2017)(SWL. 2018)(GRW. GI, DGK. GII, 2019)
(A) Planck quantum theory (B) Quantization of energy of electrons
(C) Heisenberg's uncertainty principle (D) Quantization of angular momentum

3. **The nature of positive rays depends on:** (SWL. 2014)(MLN. GI, 2016)(RWP. GI, 2017)(RWP. 2018) (GRW. GI, MLN. GII, RWP. 2019)
(A) the nature of electrode (B) the nature of discharge tube
(C) the nature of residual gas (D) all of the above

4. **When fast neutron carries nuclear reaction with nitrogen it ejects particles:** (RWP. GI, 2014)
(A) α (B) β (C) γ (D) δ

5. **Cathode rays strike alumina and produce a.....colour.** (GRW. GII, 2014)
(A) red (B) blue (C) yellow (D) green

6. **The e/m value for the positive rays in maximum for the gas.** (BWP. 2015)(AJK. 2018)
(A) Hydrogen (B) Helium (C) oxygen (D) Nitrogen

7. **Positive rays were discovered by:** (AJK. 2017)
(A) J.J Thomson **(B)** Goldstein (C) William Crookes (D) Ruther ford

8. **De-Broglie equation is represented by:** (DGK. GI, 2014)(DGK. GI, 2017)
(A) $h=\frac{\lambda}{mv}$ (B) $m=\frac{h}{\lambda v}$ (C) $m=\frac{\lambda}{hv}$ **(D)** $\lambda=\frac{h}{mv}$

9. **The velocity of photon is:** (SGD. GI, MLN. GII, RWP. GII, 2017)(GRW, RWP, BWP. GI, 2018)(LHR. GII, 2019)
(A) independent of its wavelength (B) depends on its wavelength
(C) equal to square of its amplitude (D) depends on its source

10. **Orbitals having same energy are called:** (RWP. GI, 2014)(LHR. GI, BWP. 2015)(FBD. GI, 2016)(BWP. GI, LHR. GI, SGD. GII, DGK. GI, 2017) (GRW. GII, FBD. GI, SGD. GI, & GII, DGK. GI, AJK. 2019)
(A) hybrid orbitals (B) valence orbitals **(C)** degenerate orbitals (D) d-orbitals

11. **Rutherford's model of atom failed because:** (DGK. GI, 2016)(LHR. GII, 2018)
(A) the atom did not have a nucleus and electrons
(B) it did not account for the attraction between protons and neutrons
(C) it did not account for stability of the atom
(D) there is actually no space between the nucleus and the electrons

12. **Which equation correctly presents the Heisenberg's uncertainty principle?** (SGD. GI, 2014)
(A) $\Delta X.\Delta\rho = \frac{h}{4\pi}$ (B) $\Delta X.\Delta\rho > \frac{h}{4\pi}$ **(C)** $\Delta X.\Delta\rho \geq \frac{h}{4\pi}$ (D) $\Delta X.\Delta\rho \leq \frac{h}{4\pi}$

13. **When one beta (β) particle is emitted from the nucleus of an atom its:** (FBD. 2018)
(A) Atomic number increases by 1 (B) Atomic number decreases by 1
(C) Atomic mass increases by 1 (D) Atomic mass decreases by 1

14. **The charge on proton is:** (FBD. 2018)
(A) 1.6022×10^{-11}C (B) 1.6022×10^{11}C (C) 1.6022×10^{-19}C (D) 1.6022×10^{19}C

15. **Name the electron is given by:** (SWL. 2018)
(A) William Crooks (B) Stoney (C) J.J. Thomson (D) Chadwick

16. **The limiting line of Balmer series lies in** (DGK. GII, 2018)
(A) Visible region (B) U.V. region (C) I.R. region (D) X-rays region

17. **The unit millibar is commonly used by:** (LHR. GII, 2019)
(A) Meterologists (B) Astronauts (C) Engineers (D) Dalton

18. **Splitting of spectral lines when atoms are subject to strong electrical field is called:** (LHR. GII, GRW. GII, SWL. BWP. GII, 2019)
(A) Zeeman effect (B) Stark effect
(C) Photoelectric effect (D) Compton effect

19. **The carbon atom in C_2H_4 uses following orbitals for making covalent bonds:**
(A) Sp^3 (B) Sp^2 (C) Sp (D) dsp^2

SHORT ANSWER QUESTIONS

1. **Calculate mass of an electron when e/m = 1.758×10^{11} C. kg^{-1}.** (LHR. BWP. 2015)(RWP. 2016)(FBD. GII, 2017)(FBD. GII, MLN. GI, 2019)

Ans. The value of charge on electron is 1.602×10^{-19} coulombs while $^{e}/_{m}$ is 1.758×10^{11} coulombs kg^{-1}. So,

$$\frac{e}{m}=\frac{1.6022\times10^{-19}\text{ coulombs}}{\text{Mass of electron}}=1.7588\times10^{11}\text{ coulombs kg}^{-1}$$

$$\text{Mass of electron}=\frac{1.6022\times10^{-19}\text{ C}}{1.7588\times10^{11}\text{ C kg}^{-1}}$$

$$\text{Mass of electron} = 9.1095\times10^{-31}\text{kg}$$

2. **The e/m values for positive rays are different for different gases, but that of cathode rays obtained from different gases is the same. Give reasons.** (BWP. 2014)(FBD. GII, 2017)

Ans. When we use hydrogen gas in the discharge tube, the positive rays are consisted of single protons. In cathode rays each ion is consisted of electrons. The proton is 1836 times heavier than that of electron. So $^{e}/_{m}$ value of proton is 1836 times smaller than that of electron.

3. **Differentiate between continuous spectrum and line spectrum.** (RWP. 2018)

Ans.

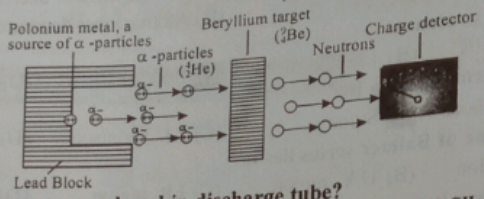
Continuous spectrum	Line spectrum
(i) In this spectrum, colours are diffused into each other and they are not separated.	(i) It consists of dark or bright lines separated by bright or dark bands.
(ii) There is no sharp boundary between the colours.	(ii) There is a sharp boundary between the colours.
Example: Rainbow	**Example:** Hydrogen spectrum

4. **How neutrons were discovered by Chadwick? Give the equation of nuclear reaction involved.** (LHR. GII, 2015)(MLN. GII, 2016)(LHR, MLN. GII, RWP, BWP. GII, 2017)(RWP. 2018)

Ans. **Discovery of Neutron:** Chadwick directed a stream of α- particles obtained from Polonium on beryllium target. He found that penetrating radiations were produced. The charge detector showed that these particles were neutral and hence called Neutrons. This is a sort of nuclear reaction in which Beryllium is converted to carbon.

$$^{4}_{2}He + ^{9}_{4}Be \longrightarrow ^{12}_{6}C + ^{1}_{0}n$$

(α–particle)



5. How positive rays are produced in discharge tube? (DGK. GI, 2014)(DGK. GII, AJK. 2015)(DGK. GI. 2018)

Ans. These positive rays are produced, when high speed cathode rays (electrons) collide with the molecules of a gas enclosed in the discharge tube. They knock out electrons from the gas molecules and positive ions are produced, which start moving towards the cathode.

$$M + e \longrightarrow M^{+} + 2e^{-}$$

6. Why is it necessary to decrease the pressure in discharge tube to get cathode rays? (AJK. 2014)(DGK. GII, 2017)(GRW, FBD. 2018)(GRW. GII, MLN. GII, SGD. GI, BWP. GI, BWP. GII. 2019)

Ans. At high pressure, there is over-crowding of gas molecules in the discharge tube. Under this condition, cathode rays fail to pass through due to hindrance. However, when pressure is reduced the molecules are less crowded and there is less hindrance for the free movement of cathode rays.

7. Cathode rays are material particles explain with reason. (GRW. GI, 2014)(AJK. GRW. GII, 2015)(LHR. GI, DGK. GI, 2016)(DGK. GI, 2018)

Ans. Cathode rays are material particles because these rays can derive a small paddle wheel placed in this path. This shows that these rays possess momentum and it is inferred that cathode rays are not rays but material particles having a definite mass and velocity.

8. The e/m value for positive rays obtained from hydrogen gas is 1836 times less than that of cathode rays. Explain it. (DGK. GI, 2015)(BWP. GII, 2018)

Ans. The e/m value for positive rays are different for different gases because positive rays are ionized gas particles and the nucleus of every gas has its own number of protons and neutrons. Greater the number of protons and neutrons of an atom of the molecule, smaller the e/m values. However, no matter which gas was used in the discharge tube. e/m Value of cathode rays (electron) obtained from different gases remains the same because they are simply electrons.

9. Write four Properties of Positive rays. (FBD. 2016)(DGK. GII, 2017)(FBD. GII, SGD. GI & GII, 2019)

Ans. Properties of Positive rays:

(i) They are deflected by an electric as well as a magnetic field showing, that these are positively charged.

(ii) These rays travel in a straight line in a direction opposite to the cathode rays.

(iii) They produce flashes on ZnS plate.

(iv) The e/m value for the positive rays is always smaller than that of electrons and depends upon the nature of the gas used in the discharge tube.

10. Write two postulates of Bohr's atomic model. (MLN. GI, 2014)(LHR. GI, MLN. GI, BWP. GI, 2017)

Ans. Postulates of Bohr's Atomic Model: The main postulates of Bohr's theory are;

(i) Electron revolves in one of the circular orbits outside the nucleus. Each orbit has a fixed energy and a quantum number is assigned to it.

(ii) Electron present in a particular orbit neither emits nor absorbs energy while moving in the same fixed orbits. The energy is emitted or absorbed only when an electron jumps from one orbit to another.

11. State Heisenberg uncertainty Principle and give its mathematical form.
(SWL. MLN. GI, 2014)(DGK. GI, LHR. GII, RWP. 2015)(LHR. GI, 2016)(MLN. GI & GII, 2018)(SWL. AJK. 2019)

Ans. Heisenberg uncertainity principle: It is difficult to determine the position as well as the momentum of the electron simultaneously.

Mathematical expression: If the ΔX represents the uncertainty of position and ΔP represents the uncertainly in the measurement of momentum of an electron, then.

$$\Delta X . \Delta P \geq \frac{h}{4\pi}$$

This relationship is called uncertainty principle.

12. What is the origin of Line Spectrum? **(MLN. GII, 2016)(DGK. GI, AJK. 2017)**

Ans. Electrons can revolve around the nucleus in only one of the definite circular orbits. When electron jumps from lower to higher orbit by absorbing certain energy (Atomic absorption spectrum) or comes back from higher to lower orbit by releasing energy (Atomic emission spectrum) radiations of definite energy are absorbed or emitted respectively and hence line spectrum originates.

13. The e/m value of positive rays is less than cathode rays. Justify. **(SWL. 2014)**

Ans. Positive rays are ionized gas particles. The highest e/m value is of positive ray is for proton which is the lightest gas. Cathode rays are basically electrons which are 1836 times lighter than proton, so they have higher e/m value than any positive rays, hence it is justified.

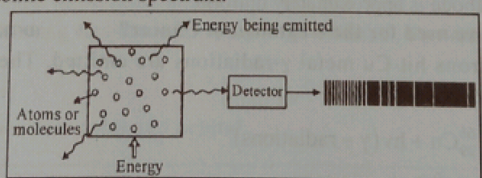
14. Why the nature of cathode rays is independent of the nature of gas used in discharge tube. **(GRW. GII, 2014)(MLN. GI, 2015)(MLN. GII, 2016)(RWP. GI, MLN. GI, & GII, 2017)**

Ans. The nature of the cathode rays remains same, whatever gas is used in the discharge tube because all the gases are consisted of atom or molecules, having electron in outer most orbitals. These electrons are detached by the high voltage become free. These electrons are repelled by the cathode and attracted towards the anode. They are called cathode rays. So they are always electrons nothing else.

15. What is atomic emission spectrum? **(DGK. GII, 2015)(AJK. GII, SWL. GII, 2017)(RWP. AJK. 2019)**

Ans. Atomic Emission Spectrum:

When solids are volatilized or elements in their gaseous states are heated to high temperature or subjected to an electrical discharge, radiations of certain wavelengths are emitted. The spectrum of this radiation contains bright lines against a dark back ground. This is called atomic emission spectrum.



Atomic Emission Spectrum

16. Which type of particles are formed by the decay of free neutron?
(FBD. GI, SGD. GI, 2014)(RWP. 2015)(RWP. GI, LHR. GI, 2017)(SGD. GI, 2019)

Ans. Free neutron decays into a proton ($^{1}_{+}P$) with the emission of an electron ($^{0}_{-1}e$) and a neutrino ($^{0}_{0}n$). Nuclear reaction in as follows:

$$^{1}_{0}n \longrightarrow ^{1}_{+1}P + ^{0}_{-1}e + ^{0}_{0}n$$

17. Narrate Properties of Cathode rays. **(RWP. DGK. GII, 2016)(LHR. GI, MLN. GII, 2017)**

Ans. Properties of Cathode Rays:

(i) Cathode rays can ionize gases.

(ii) They can cause a chemical change, because they have a reducing effect.

(iii) Cathode rays can pass through a thin metal foil like aluminium or gold foil.

(iv) The e/m value of cathode rays shows that they are simply electrons.

18. How charge to mass (e/m) ratio of electron in measured? (MLN. GI, LHR. GII, 2017)(RWP. 2018)

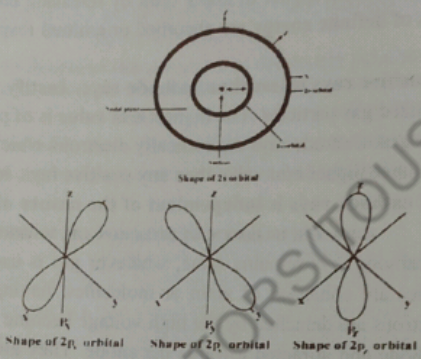
Ans. J.J. Thomson first measured the charge-to-mass ratio e/m of the fundamental particle of charge in a cathode ray tube in 1897, that was accepted as

$$e/m = 1.7588 \times 10^{11} \text{ Coulombs kg}^{-1}$$

Later in 1906, Robert Millikan determined the e/m value of the electron by 'oil drop" experiment. According to him e/m ratio of an electron was 1.59×10^{-19} Coulombs, which is very closed to recent value of e/m of electron 1.6022×10^{-19} Coulombs.

19. Draw shapes of 2s and 2px, 2py, 2pz orbitals. (GRW. GI, 2015)

Ans. Shapes of orbitals:



Shape of 2s orbital

Shape of $2p_x$ orbital Shape of $2p_y$ orbital Shape of $2p_z$ orbital

20. How will you prove that Cathode Rays travel in Straight Line? (BWP. GI, 2017)(FBD. GI, 2019)

Ans. Systematic investigations of scientists showed that "Unless disturbed by any magnetic or electric field, cathode rays always keep travelling in a straight line by following the law of inertia", until they hit the anode on the opposite side of the vacuum tube, because cathode rays are basically electrons travel in straight lines and tend to travel the shortest distance from cathode to anode in straight line when electric field or magnetic field applied between the anode and cathode is approximately uniform.

21. How Neutrons are used for the treatment of Cancer? (DGK. GII, 2016)(DGK. GI, 2018)

Ans. When free neutrons hit Cu metal γ-radiations are emitted. The radioactive $^{65}_{29}Cu$ is converted into $^{66}_{30}Zn$.

$$^{65}_{29}Cu + {}^{1}_{0}n \longrightarrow {}^{66}_{29}Cu + h\nu(\gamma - \text{radiations})$$

$$^{66}_{29}Cu \longrightarrow {}^{66}_{30}Zn + {}^{0}_{-1}e$$

The γ-radiations of this reaction are used in treatment of cancer.

22. How the wave nature of electron was verified experimentally? (GRW. GII, 2014)(AJK. 2015)(MLN. GI, SWL. 2019)

Ans. Experimental Verification of wave nature of electron:

In 1927, two American scientists, Davisson and Germer did an experiment to verify the wave nature of moving electron. Electrons were produced from heated tungsten filament and accelerated by applying the potential difference through charged plates. Davisson and Germer proved that the accelerated electrons undergo diffraction, like waves, when they fall on a nickel crystal. In this way, the wave nature of electron got verified.

23. Differentiate between atomic emission spectrum and atomic absorbtion spectrum. (LHR. SGD. GI, 2017)(BWP. GII, 2018)

Ans.

Atomic Emission spectrum	Atomic Absorption Spectrum
When solids are volatilized or elements in their gaseous states are heated to high temperature or subjected to an electrical discharge, radiation of certain wavelengths are emitted. The spectrum of this radiation contained bright lines against a dark background. This is called atomic emission spectrum. It is the opposite form of an absorption spectrum and it is formed by electromagnetic radiations emitted by a given source, characteristic of the source and the type of excitation inducing the radiations.	When a beam of white light is passed through a gaseous sample of an element, the element absorbs certain wavelengths while the rest of wavelengths pass through it. The spectrum of this radiation is called an atomic absorption spectrum. Atomic Absorption spectrum has characteristic pattern of dark lines or bands that occurs when electromagnetic radiation is passed through an absorbing medium into a spectroscope.

24. Describe behavior of cathode rays in magnetic field. (DGK. GII, 2014)(BWP. GI, 2017)

Ans. When cathode rays are passed through the magnetic field, they bend perpendicular to the joining line of two poles. This is due to the negative charge. Anyhow, positively charged particles will bend in opposite direction to that of electrons in the magnetic field.

25. Why positive rays are also called canal rays? (SWL. 2014)(BWP. 2015)(DGK. GI, RWP. GII, MLN. GI, 2017) (DGK. GII, BWP. GII, 2018)(GRW. GI & GII, MLN. GII, RWP. 2019)

Ans. Positive rays are also called canal rays because these rays can pass through the holes or canals present in the perforated cathode.

26. Differentiate between fast neutron and slow neutron. (RWP. 2016)(GRW. GII, 2017)(BWP. GI, 2019)

Ans.

Fast neutron	Slow Neutron
When Neutrons travel with an energy 1.2 Mev, they are called Fast Neutrons.	When Neutrons travel with an energy 1 ev, they are called slow Neutrons.

27. How do you come to know that the velocities of electrons in higher orbits are less than those in lower orbits of H atom? (SGD. GII, RWP. GI, 2014)(MLN. GI, 2015)(DGK. GII, 2019)

Ans. The electron should move faster nearer to the nucleus in an orbit of smaller radius because the radius of a moving electron is inversely proportional to the square of its velocity i.e.

$$r = \frac{Ze^2}{4\pi\varepsilon_0 mv^2}$$

28. Differentiate between orbit and orbital. (DGK. GII, 2018)(SWL. 2019)

Ans.

Orbit	Orbital
(i) It is a definite circular path at a definite distance from the nucleus in which the electron moves.	(i) It is a space around the nucleus within which the probability of finding an electron with a certain energy is maxiumum.
(ii) An orbit shows an exact position of an electron in an atom.	(ii) Orbital does not specify the exact position of an electron in an atom.
(iii) Orbit shows a certainty about the position and movement of an electron.	(iii) According to uncertainty principle, one is not sure about the position and movement of an electron in an orbital.

(iv) Orbit gives us the idea about the planer motion of electron.	(iv) Orbital gives the three dimensional motion of an electron.
(v) The maximum number of electrons in an orbit are given by $2n^2$.	(v) An orbital cannot accommodate more than 2 electrons.

29. What particles are formed by the decay of free neutron, give equation? (LHR. GI, 2018)

Ans. The transformation of free proton to a neutrons is energetically impossible since a free neutron has greater mass than a free proton.

$$^{66}_{29}Cu \rightarrow ^{66}_{30}Zn + ^{0}_{-1}e$$

30. Justify that the distance gaps between different orbits go on increasing from lower to the higher orbits. (LHR. GI, 2019)

Ans. The distance gaps between different orbits go on increasing from lower to the higher orbit due to its electric negative charge on it.

31. Write down any two postulate of Plank's quantum theory. (LHR. GII, 2018)(LHR. GII, 2019)

Ans. Postulate of Planck's Theory: Energy is not emitted or absorbed continuously rather it is emitted absorbed in a discontinuous manner and in the form of wave pakect in case of light. The quantum of energy associated is called photon.

The amount of energy is associated with quantum of radiation is proportional to the frequency (v) of the radiation.

32. Give two defects of Rutherford's atomic model.
(FBD, AJK. 2018)(LHR. GI, FBD. GI, FBD. GII, SGD. GII, DGK. GI, 2019)

Ans. Following are the defects in Rutherford's atomic model:

1. The outer electrons could not stationary.
2. The behaviour of electrons remains unexplained in the atom.

33. The potential energy of an electron in an atom is negative. Give reason. (MLN. GI, 2018)

Ans. The minus sign indicates that the potential energy of electron decreases, when it is brought from infinity to a point at a distance 'r' from the nucleus. At infinity, the electron is not being attracted by any thing and the potential energy of the system is zero. Whereas at a point nearer the nucleus, it will be attracted by the nucleus and the potential energy becomes less than zero. The quantity less than zero is negative.

34. What is line structure of Hydrogen spectrum? (MLN. GI, 2018)

Ans. When the familiar spectral line of the hydrogen spectrum is examined at very high resolution. It is found to be a closely spaced double. This splitting is called fine structure and was one of electron spin.

35. Give two defects in Bohr's atomic model. (MLN. GII, 2018)(LHR. GII, MLN. GII, 2019)

Ans. Defects in Bohr's Atomic Model:

1. Bohr's theory can successfully explain the origin of the spectrum of H-atom and the like He^{+1}, Li^{+2} and Be^{+3}, etc there are all one electron system. But this theory is not able to explain the spectrum of multi electron or poly electron system like He, Li and Be ect.
2. Bohr suggested circular orbits of electron around the nucleus of hydrogen atom but researches have shown that the motion of electron is not a single plane but takes places in three space. Actually the atomic model is flat.

36. Differentiate between frequency and wave number. (SGD. 2018)

Ans. Frequency: the number of waves passing through a point per second is called frequency (u) it unit are hertz (Hz).

Wave Number: The number of waves per unit length is called wave number of and is reciprocal of wave length. The wave number is expressed (m-1) or per meter.

37. Write down four properties of Neutron. ((BWP. 2014)(AJK. 2018)(DGK. GI, 2019)

Ans. Properties of Neutron: The properties of neutron are as follow:

1. Neutrons cannot ionize gases.
2. Neutrons are highly penetrating particles.
3. They can expel high speed protons from paraffin, water, paper and cellulose.
4. When neutrons travel with an energy 1.2 Mev (Mega electron volt), they are called fast neutrons but with energy below lev are called slow neutrons. Slow neutrons are usually more effective than fast ones for the fission purposes.

38. Explain continuous spectrum. (AJK. 2018)

Ans. Continuous Spectrum:

☆ In this spectrum lines are diffused into the one another.
☆ There is no sharp boundary between colour.
☆ It has one type.
e.g. Rainbow.

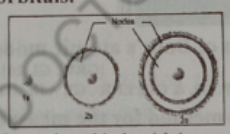
39. Write nuclear reaction for the production of neutron. (LHR. GII, 2019)

Ans. The chemical reactions involes nucles are called nucler reactions.

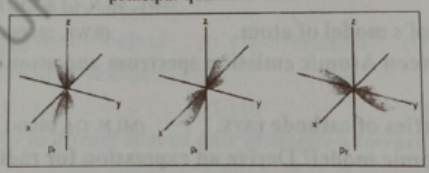
$$^{9}_{4}Be + ^{4}_{2}He \longrightarrow ^{12}_{6}C + ^{1}_{0}n$$

40. Draw shapes of 's' and 'p' orbitals. (GRW. GI, 2019)

Ans.



Shapes of s-orbitals with increasing principal quantum number



Shapes of p-orbitals

41. Give reason for the production of positive rays. (FBD. GI, 2019)

Ans. Positive rays are produced by the ionization of gas inside the discharge tube. Different Gases have different e/m ratio. Highest e/m ratio obtained by hydrogen gas. When high velocity electrons strike with gas molecules it split up into cations and electrons move toward anode and cation move toward cathode.

42. Derive de-Broglie equation $\lambda = \frac{h}{mv}$. (FBD. GI, AJK. 2019)

Ans. de-Broglie derived a mathmetical equation which relates the wavelength (λ) of the electron to the momentum of electrons.

$$\lambda = \frac{h}{mv} \quad \text{_____(i)}$$

Here λ = de-Broglie's wave length
m = mass of the particle.
v = velocity of Electron.

According to this equation The wave length associated with an electron is inversly

proportional to its momentum (mv).

This equation is derived as follow.

Accordig to Planck's Equation.

$E = hv$ _____(2)

According to Einstein's mass energy Relationship.

$E = mc^2$ _____(3)

Where 'm' is the mass of material particle which convert itself into Photon and 'c' is the velocity of equation two values of Energy:

$hv = mc^2$

Since $v = \frac{c}{\lambda}$

So $\frac{hc^2}{\lambda} = mc^2$

or $\boxed{\lambda = \frac{h}{mc}}$

43. How will you prove that cathode rays possess momentum? (DGK. GII, 2019)

Ans. Cathode rays can drive small paddle wheel placed in their path. This shows that these rays possess momentum.

ESSAY TYPE QUESTIONS

1. **Give the different postulates of Bohr's atomic model.** (GRW. GI, 2014)(GRW. GI, RWP. FBD. GI, DGK. GI, 2015) (RWP. AJK. FBD. GI, 2016)(RWP. GI, & GII, LHR. GI, AJK. GII, DGK. GI, 2017)(DGK. GI, BWP. GII, 2019)
2. **Describe Millikan's oil drop method for the measurement of charge on an electron.** (DGK. GI, SWL. 2014)(MLN. GII, BWP. 2015)(LHR. GI, MLN. GI, 2016) (SWL, MLN. GI & GII, RWP. 2018)(FBD. GI, AJK. 2019)
3. **Explain Rutherford's model of atom.** (RWP. 2014)(MLN. GI, 2015)(LHR. GII, 2017)
4. **Differentiate between Atomic emission spectrum and atomic absorption spectrum.** (MLN. GI, RWP. 2014)
5. **Discuss the properties of cathode rays.** (MLN. G1, 2014)(LHR. GII, 2015)(LHR. GII, 2019)
6. **What is Bohr's atomic model? Derive an expression for radius of hydrogen atom.** (BWP. SGD. GII, 2014)(GRW. GI, AJK. DGK. GII, 2015)(MLN. GII, 2016)(GRW, SGD. 2018)(SWL. 2019)
7. **What is spectrum? Explain Atomic Emission and Atomic absorption spectrum.** (DGK. GII, SWL. GII, 2016)
8. **Give four defects of Bohr's atomic model.** (FBD. GI, 2014)(LHR. GI, MLN. GI, 2019)
9. **How are positive rays produced in discharge tube? Give properties of these rays.** (GRW. GII, 2014)(GRW. GII, 2015)
10. **Describe J.J. Thomson's experiment for determining e/m value of electron.** (DGK. GI, BWP. 2016)(MLN. GI, DGK. GII, 2017)(LHR. GI, 2018)(SGD. GII, DGK. GII, 2019)
11. **Write down the four properties of neutron.** (LHR. GII, 2018)
12. **Derive the general formula to calculate the radius of 'nth' orbit of H-atom by using Bohr's atomic model.** (FBD. 2018)(FBD. GII, BWP. GI, 2019)
13. **Explain Heisenberg's uncertainty principle.** (DGK. GI, 2018)
14. **Write down any four properties of positive rays.** (GRW. GI, 2019)
15. **Define spectrum. Give difference between Continuous and Line spectrum.** (SGD. GI, 2019) (RWP. 2019)
16. **State and explain Plank's quantum theory.**

CHAPTER 06

CHEMICAL BONDING

MULTIPLE CHOICE QUESTIONS (MCQ's)

1. **The shape of $SnC\ell_2$ molecule is:** (DGK-GII, 2017)
(A) Linear (B) Angular **(C)** Trigonal planar (D) Tetrahedral

2. **The structure of water molecule is:** (DGK. GI, 2015)
(A) Angular (B) Linear (C) Trigonal (D) Trigonal pyramidal

3. **Which of the following has linear structure:** (LHR. GII, 2017)
(A) CO_2 (B) NH_3 (C) CH_4 (D) H_2O

4. **Which compound does not obey the octet rule?** (DGK. GII, 2014)(AJK. 2016)
(A) NH_3 **(B)** $BC\ell_3$ (C) H_2O (D) CH_4

5. **In methanol, bond between carbon and oxygen:** (RWP. GI, 2014)
(A) Ionic (B) non-polar **(C)** polar (D) co-ordinate

6. **Which of the following has coordinate covalent bond:** (SWL. GII, 2017)
(A) $NH_4C\ell$ (B) $NaC\ell$ (C) $HC\ell$ (D) $A\ell C\ell_3$

7. **The bond angle in NH_3 molecule is:** (BWP. GRW. GI, 2014)(DGK. GII, 2016)
(A) 109.5° **(B)** 107.5° (C) 104.5° (D) 108°

8. **Which element has highest ionization potential:** (SGD. GI, 2017)
(A) Li (B) Be (C) B **(D)** C

9. **The carbon atom in C_2H_4 is:** (SGD. GII, 2017)
(A) sp^3-hybridized **(B)** sp^2-hybridized (C) sp-hybridized (D) dsp^2-hybridized

10. **Carbon atom in methane in hybridized.** (FBD. GI, 2015)
(A) sp^3 (B) sp^2 (C) sp (D) dsp^2

11. **The tendency of an atom to attract shared pair of electron towards itself is called its:** (SGD. GII, 2014)
(A) Ionization energy (B) Electron Affinity **(C)** Electronegativity (D) Dipole moment

12. **Molecule in which the distance between two carbon atoms in the largest is:** (MLN. GI, 2014)
(A) C_2H_6 (B) C_2H_4 (C) C_2H_2 (D) C_6H_6

13. **The number of bonds in nitrogen molecule is:** (RWP. 2015)(AJK. DGK. GI, MLN. GII, BWP. 2016)(BWP. GI, GII, LHR. GI, GRW. GII, DGK. GI, 2017) (LHR. GI, BWP, AJK. 2018)(LHR. GI, FBD. GI, MLN. GI, 2019)
(A) One sigma oand one Pi **(B)** One sigma and two pi
(C) Three sigma oonly (D) Two sigma o and one Pi

14. **The bond order of N_2 molecule is:** (SGD. GII, 2014)(MLN. GII, AJK. GII, 2017)(SGD. 2018)(MLN. GII, 2019)
(A) 1 (B) 2 **(C)** 3 (D) 4

15. **Which of the following has bond angle of 120°:** (LHR. GI, 2017)
(A) $BeC\ell_2$ **(B)** BF_3 (C) CH_4 (D) NH_3

16. **The number of bonds in oxygen molecules.** (LHR. GII, 2015)
(A) One α and one π (B) One α and two π
(C) Three sigma only (D) Two α and two π

17. Which of the following species has unpaired electrons in anti bonding molecular orbitals? (AJK. 2015)(LHR. GII, RWP. 2016)(RWP. GI, & GII, FBD. GII, 2017)(BWP. GII, 2018) (GRW. GII, FBD. GII, SWL. SGD. GII, DGK. GI, BWP. GI, AJK. 2019)

(A) O_2 **(B)** N^{2-}_2 (C) B_2 (D) F_2

18. Which of the following Molecule Obey Octet Rule: (BWP. GII, 2017)

(A) BF_3 (B) BCl_3 (C) NH_3 (D) SF_6

19. The H - H bond energy in kJ $mole^{-1}$ is: (MLN. GI, 2017)

(A) 346 **(B)** 436 (C) 463 (D) 336

20. In nitrogen molecule (N_2), each nitrogen atom contributes in sharing for formation of bond: (FBD. 2018)

(A) One electron (B) Two electrons **(C)** Three electrons (D) Four electrons

21. Which one has highest value of ionization energy: (FBD. 2018)

(A) Be (B) C (C) O **(D)** F

22. In ethyne molecule the number and nature of bonds are:- (MLN. GI, 2018)

(A) One sigma two pi (B) Two sigma one pi

(C) Three sigma two pi (D) Two sigma two pi

23. _____ element has highest value of electron affinity. (MLN. GI, 2018)

(A) Fluorine (B) Chlorine (C) Bromine (D) Iodine

24. _____ is not paramagnetic. (MLN. GII, 2018)

(A) O_2^{-2} **(B)** O_2 (C) N_2^{-2} (D) None of these

25. Geometry of SO_2 molecule is (DGK. GI, 2018)

(A) Linear **(B)** Angular (C) Tetrahedral (D) Trigonal pyramidal

26. The amount of energy released by absorbing an electron in the valence shell of an atom is: (DGK. GII, 2018)

(A) Ionization energy **(B)** Electron affinity (C) Electro negativity (D) Bond energy

27. For HF molecule μ_{obs} is 1.90 D ; μ_{ionic} is 4.4 D. The percentage ionic character of HF molecule is: (LHR. GI, 2019)

(A) 100 (B) 80 (C) 57 **(D)** 43

28. The type of hybridization in $BeC\ell_2$ is : (LHR. GII, 2019)

(A) sp^3 **(B)** sp^2 (C) sp (D) dsp^2

29. Ammonia (NH_3) shows maximum boiling point among hydrides of group 5A, it is due to: (FBD. GII, 2019)

(A) Very small size of N atom (B) Least electronegative character of N atom

(C) Most electronegative character of N atom (D) Pyramidal structure of NH_3 molecule

30. One of the following molecule is polar in nature: (DGK. GI, 2019)

(A) CH_4 (B) CO_2 **(C)** SO_2 (D) CCl_4

31. An ionic compound A^+B^- is most likely to be formed when:

(A) The ionization energy of A is high and electron affinity of B is low

(B) The ionization energy of A is low and electron affinity of B is high

(C) Both the ionization energy of A and electron affinity of B are high

(D) Both the ionization energy of A and electron affinity of B are low

32. Which of the following statements is not correct regarding bonding molecular orbitals?

(A) Bonding molecular orbitals possess less energy than atomic orbitals from which they

are formed

(B) Bonding molecular orbitals have low electron density between the two nuclei

(C) Every electron in the bonding molecular orbitals contributes to the attraction between atoms

(D) Bonding molecular orbitals are formed when the electron waves undergo constructive interference

SHORT ANSWER QUESTIONS

1. How does electron affinity vary in periodic table? (RWP. 2015)(FBD. GII, 2017)(AJK. 2018)

Ans. Variation of electron Affinity in periodic table: In a period, the atomic radius decreases due to increase in the nuclear charge. Thus, the electron affinities of elements "increase from left to right" in the periodic table. That is why, the alkali metals have the lowest and the halogens have the highest electron affinities.

In groups, on the other hand, the atomic radii increase with the increase in the proton number due to successive increase of electronic shells. This also exerts a shielding effect on the force of attraction between the nucleus and the valence electrons. Thus, the electron affinities usually decrease from top to bottom.

2. Define Covalent bond. Give two examples. (RWP. GI, 2017)

Ans. According to Lewis and Kossel, a covalent bond is formed by the mutual sharing of electrons between two atoms. While sharing, each atom completes its valence shell and attains the nearest inert gas configuration. A covalent bond may be non-polar or polar in character.

Examples: Bond formation in Nitrogen (triple covalent Bond). Bond formation in oxygen.

3. What is co-ordinate covalent bond? Give one example.

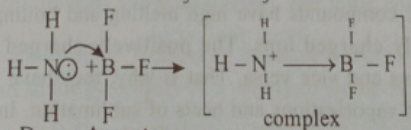
(SGD. GI, 2014)(DGK. GII, MLN. GII, 2015)(MLN. GI, AJK. BWP. 2016)
(BWP. GII, SWL. GII, DGK. GII, RWP. GI, 2017)(AJK. 2018)(SGD. GI, DGK. GII, 2019)

Ans. Co-ordinate covalent Bond: A co-ordinate covalent bond is formed between two atoms when the shared pair of electrons is donated by one of the bonded atoms.

The atom, ion or molecule which donates an electron pair is called donor and that which accepts a pair of electrons is called acceptor. The bond formed between donor and acceptor species is called co-ordinate covalent bond.

It is represented by an arrow (→) pointing from donor to acceptor.

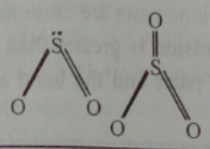
Example: Bond formation between NH_3 and BF_3.



Donor Acceptor complex

4. Draw the geometery of SO_2 and SO_3 on the basis of VSEPR Theory. (SGD. GII, 2017)

Ans. The geometrical shapes of SO_2 and SO_3 is AB_3-type with multiple bonds. In SO_2, one corner of triangle is occupied by a lone pair and two corners each by S=O double bond, while in SO_3 all three regions, each are occupied by S=O bonds. This structure of SO_3 is perfectly triangular.



5. What is hybridization at carbon atom in CH_4, C_2H_4 and C_2H_2?

Ans. The carbon atom in CH_4 cannot participate in multiple bonding where as C_2H_4 and C_2H_2 can form multiple bounds because the hybridization at the carbon atom in CH_4 is sp^3 where as the hybridization in C_2H_4 is sp^2 and in C_2H_2 is sp.

6. Differentiate between bonding and anti-bonding molecular orbitals. (DGK. GI, 2015)(RWP. GI, 2017)(BWP. GI, 2018)(DGK. GI, 2019)

Ans. Differentiate between bonding and anti-bonding molecular orbitals:

Bonding Molecular Orbital	Antibonding Molecular Orbital
(i) A molecular orbital which has lower energy than the isolated atomic orbitals from which it is formed is known as bonding molecular orbital.	(i) A molecular orbital which has higher energy than the isolated atomic orbitals from which it is formed is known as antibonding molecular orbital.
(ii) It has high electron density between the nuclei.	(ii) It has no electron density between the nuclei.
(iii) It is formed due to addition of electron waves of like signs.	(iii) It is formed due to subtraction of electron waves of unlike sign.
(iv) It has lower energy than the antibonding molecular orbital.	(iv) It has higher energy than the bonding molecular orbital.

7. Helium is diamagnetic in nature Justify. (SWL. GII, 2017)(BWP. GII, 2018)

Ans. Helium is diamagnetic in nature because its valence shell is totally filled and of helium gas have no need for bond with another atom. It is a noble gas that's why it is a diamagnetic in nature.

8. Why liquids are less common then solids and gases? (SWL. GII, 2017)

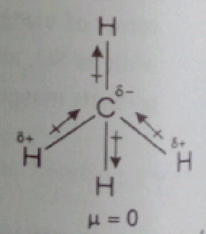
Ans. On Earth, all substances in which molecules held together by dipole-dipole forces are solid at S.T.P, while the molecules of substances those held together by weaker London forces are liquids or gasses, such as oils or noble gasses. Thus majority of substances have dipole-dipole interactions and they are mostly solids, where as in comparison to dipole-dipole interaction , London forces are weaker so it only requires a very little energy to change phase; that is why, most occurring substance on the earth then solids are liquid and noble gases due to non-polar and weak inter molecular forces then solids.

9. The melting points, boiling points, heat of vaporizations and heat of sublimations of electrovalent compounds are higher as compared with those of covalent compounds. (LHR. GI, 2016)

Ans. Electrovalent or ionic compounds have high melting and boiling points due to the close packing of oppositely charged ions. The positively charged ions are surrounded by negatively charged ions and vice versa. That is why; they have very high melting points, boiling points, heat of vaporizations and heats of sublimation. In covalent compounds the molecular crystals are formed which have less binding forces.

10. Bond angle in CH_4 is 109.5° but in H_2O is 104.5° although carbon and oxygen are sp^3 hybridized. Give reason. (MLN. GI, 2014)(DGK. GII, 2017)

Ans. Bond angle in CH_4 is 109.5° but in H_2O it is 104.5°, although carbon and oxygen are sp^3hybridized. CH_4 is perfectly tetrahedral with the angle of 109.5°. In case of water, there are two bond pairs and two lone pairs on oxygen atom. The lone pairs are close to the nucleus of oxygen. Lone pair lone pair repulsion is greater than lone pair bond pair repulsion. They repel bond pairs and the bond angle decreases from 109.5° to 104.5°.



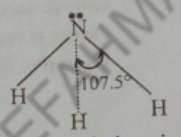
The dipole moment of CH_4 is zero, this is all due to the cancellation of individual bond moments i.e

11. State the geometry of NH_3 molecule on the basis of VSEPR theory.
(BWP. LHR. GII, 2015)(BWP. GI, AJK. GII, 2017)

Ans. According to VSEPR theory the charge cloud of non bonding electrons spreads out more than that of bonding electrons and tends to compress the bond angles in rest of the molecules.

Example: Structure of NH_3 molecule. $_7N = 1s^2, 2s^2, 2p_x^1, 2p_y^1 2p_z^1$

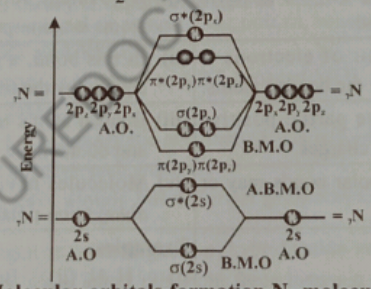
The non-bonding electron in 2s orbital takes up more space and exerts a strong repulsive force on the bonding electron pairs. Consequently, to avoid a larger repulsion, the bonding electron pairs move closer that reduces the ideal bond angle from 109.5° to 107.5°. This effect compels ammonia to assume a triangular pyramidal geometry instead of tetrahedral, as in methane.



12. Draw molecule orbital picture of N_2-molecule and also calculate its bond-order.
(MLN. GI, 2015)(FBD. 2016)

Ans. Molecular orbital structure of N_2 molecule: The atomic number of nitrogen is 7. Its electronic configuration is $1s^2, 2s^2, 2p_x^1\ 2p_y^1\ 2p_z^1$. There are five electrons in the valence shell. So, each nitrogen contributes five electrons to form nitrogen molecule. The distribution of 10 electrons occurs.

Bond order for N_2: $\text{Bond order} = \frac{6-0}{2} = 3$

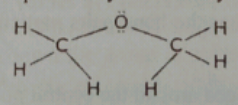


Molecular orbitals formation N_2 molecule.

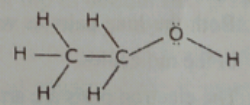
13. Why the covalent compounds show isomerism, but ionic compounds does not?
(RWP. GI, 2014)(LHR. GI, 2017)

Ans. The covalent compounds show isomerism because covalent compounds are rigid and directional. This leads to the possibility of a variety of isomerism:

Example:



Dimethyl ether



Ethanol

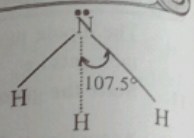
But ionic compound do not show isomerism because ionic compounds involve electrostatic lines of forces between oppositely charged ions, therefore, such bonds are non-rigid and non-directional.

14. Define lone pair and bond pair of electron. (DGK. GII, 2014)

Ans. Lone pair of electron: A lone pair refers to a pair of valence electrons that are not shared with another atom and is sometimes called a non-bonding pair.

Lone pairs are found in the outermost electron shell of atoms. They can be identified by using a Lewis structure.

Bond pair of electron: Pair of electrons involved in a covalent bond is called bond pair of electrons. For example in ammonia molecule NH_3 there is one lone pair of electron and three bond pair of electrons.



15. Why second ionization energy (I.E) of an element is always greater than first ionization energy (I.E)? (RWP. 2015)

Ans. Second I.E of an element is always greater than first ionization energy because if we remove second electron from mono-positive ion to form dispositive ion, large amount of energy is required because increased nuclear charge pulls electronic cloud strongly.

Example: In case of Mg

$$Mg_{(g)} \longrightarrow Mg^{+} + 1e^{-} \quad \Delta H_1 = 738\,kJmol^{-1}$$

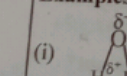
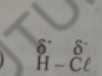
$$Mg^{+}_{(g)} \longrightarrow Mg^{2+} + 1e^{-} \quad \Delta H_2 = 1450\,kJmol^{-1}$$

16. Ionization energy is index to the metallic character. Why? (SGD. GI, 2014)(BWP. GII, 2017)(BWP. GII, 2019)

Ans. Ionization energy is an index to the metallic character. The elements having low ionization energies are metals and those having high ionization energies are non- metals. Those with intermediate values are mostly metalloids.

17. Differentiate between polar and non-polar covalent bonds with examples. (RWP. 2015)(SWL. GII, 2017)(RWP, AJK. 2018)(DGK. GII, 2019)

Ans. Difference between polar and non-polar covalent bonds:

Polar Bond	Non-polar Bond
(i) A covalent bond between two different atoms is a polar bond.	(i) A covalent bond between two similar atoms is a non-polar bond.
(ii) In this bond, a pair of electrons is shared unequally by the bonded atoms.	(ii) In this bond, a pair of electrons shared equally by the two bonded atoms.
(iii) Bonded atoms have partial positive and partial negative charges.	(iii) Bonded atoms remain electrically neutral and do not have partial charges.
(iv) Molecules having polar bonds may or may not be polar.	(iv) Molecules having non-polar bonds are always non-polar.
Examples: (i)  (ii) 	**Examples:** (i) H–H (ii) Br–Br (iii) S = C = S, O = C = O

18. Write down two postulates of VSEPR theory. (DGK. GI, 2016)(MLN. GII, 2019)

Ans. Postulates of VSEPR Theory:

(i) Both the lone pairs as well as the bond pairs participate in determining the geometry of the molecules.

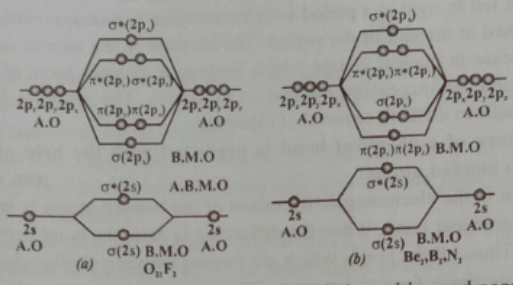
(ii) The electron paris are arranged around the central polyvalent atom so as to remain at a maximum distance apart to avoid repulsions.

19. NH_3 can form coordinate covalent bond with H^+ but CH_4 not Justify. (LHR. GII, 2017)

Ans. NH_3 can form coordinate covalent bond with H^+ but CH_4 not because NH_3 has lone pair of electrons on N atom which has ability to donate electron to a H^+ (electron deficient atom) to from a coordinate covalent bond. But in case of CH_4 there is no lone pair of electrons to donate H^+ for the formation of coordinate covalent bond. Therefore, NH_3 can form coordinate covalent bond with H^+ but not CH_4.

20. **Draw a diagram showing relative energies of bonding and antibonding molecular orbitals With reference to those of respective atomic orbitals.** (GRW. GI, 2015)(DGK. GII, 2016)

Ans.

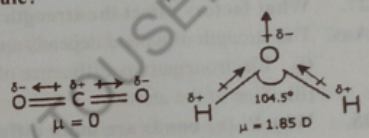


Molecular orbital energy diagram for O_2, F_2 and their positive and negative ions.

Molecular orbital energy diagram for Li_2, Be_2, B_2 and N_2.

21. **Why water is angular and CO_2 is linear molecule?** (DGK. GII, 2014)(RWP. 2016)

Ans. Water is angular because it has a bond angle 104.5° between the two O-H bonds and has dipole moment 1.85 D which ruled out linear structure of water. Where CO_2 has linear structure because it has zero dipole moment, where the dipoles being equal and opposite, cancel out each other's effect.



22. **Why molecular orbital theory is superior to that of VSEPR and VB theories?** (SGD. GII, DGK. GII, 2014)(FBD. GI, 2015)(MLN. GII, DGK. GI, 2016)(FBD. GI, SGD. GII, BWP. GI, 2019)

Ans. **MOT is superior to VBT and VSEPR:**

- Molecular orbital theory is superior to VBT because MOT tells us the reason for no bond between noble gases.
- It also tells us about the paramagnetic and diamagnetic nature of the substance but VBT and VSEPR theories not give such answers.

23. **Both NH_3 and BF_3 are tetra atomic but different geometries. Why.** (RWP. GII, 2017)(DGK. GII, 2018)

Ans. In NH_3 the central Nitrogen atom undergoes sp_3 hybridization and there is one lone pair on Nitrogen atom. Similarly, there exists repulsion force between lone pair and bond pair of electrons in NH_3 molecule because of which it acquires pyramidal shape. Where as in BF_3 the central atom Boron undergoes sp_3 hybridization and has no lone pair of electrons. Thus three Fluorine atoms will occupy three corners of triangular planar structure of BF_3.

24. **Why ionization energy (IE) values are decreased from top to bottom in a group?** (SWL. 2014)(LHR. GII, 2016)(LHR. GI, MLN. GI, BWP. GI, LHR. GII, 2017)

Ans. Ionization energy decreases down the group in spite of the increase in proton number or nuclear charge. This is due to the successive addition of electronic shells as a result of which the valance electrons are placed at a large distance from the nucleus. As the force of attraction between the nucleus and the outer electron decreases with the increase in distance, the electron can be removed more easily or with less energy. Moreover, the force of attraction also decreases due to increasing shielding effect of the intervening electrons.

25. **Define ionization energy. Also discuss it along the period with in periodic table.** (BWP. 2014)(SWL. GII, 2017)

Ans. **Ionization Energy:** Ionization energy of an element is the minimum energy required to remove an electron from its gaseous atom to form an ion. The process is called ionization.

Example: $Mg \longrightarrow Mg^{+} + 1\bar{e}\ \ \Delta H = 738\ kJmol^{-1}$

Variation of Ionization energy in Period: In the periodic table, the ionization energies increase from left to right in a period with the increase in proton number, until a maximum value is reached at the end of the period. The increase in the atomic number is associated with the increase in nuclear charge which leads to a stronger force of attraction between the nucleus and the increasing number of electrons. The stronger force of attraction, ultimately results in difficult removal of electrons.

26. How the nature of a chemical bond is predicted with the help of electronegativity values of two bonded atoms? (FBD. GI, 2014)(LHR. GI, 2015)

Ans. The difference in the electronegativity values of the bonded atoms is an index to the polar nature of the covalent bond. When the difference is zero, the bond between the two atoms is non-polar. Thus, all the bonds which are formed between similar atoms are non-polar in character, while those formed between different elements are mostly polar. Elements of widely different electro negativities form ionic bonds. A difference of 1.7 units shows roughly equal contributions of ionic and covalent bonds.

27. What factors affect the strength of a bond? (RWP. GI, 2014)(DGK. GII, 2016)

Ans. The strength of a bond depends upon the following factors.

(i) Electronegativity difference of bonded atoms.

(ii) Size of the atoms. **(iii)** Bond length.

28. Why Pi (π) bonds are more diffused than sigma bonds? (GRW. GI & GII, BWP. 2014)(MLN. GII, GRW. GII, 2015)(MLN. GI, RWP. 2016)(LHR. GII, 2017)(SWL. 2018)(MLN. GII, 2019)

Ans. π–bonds are more diffused than sigma bonds because σ bond is formed by head to head overlap of two half-filled atomic orbitals. The electronic cloud density is symmetrical along the bond axis. The electronic cloud density of π–bond is not symmetrical along the bond axis. It consists of two regions, above and below the bond axis. So, π–bond is more diffused.

29. Define covalent bond according to Lewis's concept and valence bond theory. (GRW. GI, 2015)

Ans. Covalent Bond According to Lewis concept: According to Lewis, a covalent bond is formed by the mutual sharing of electrons between two atoms.

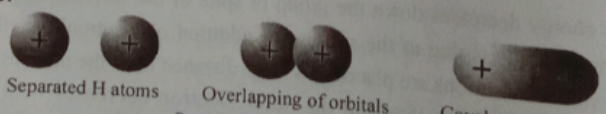
Example:

(i) H : H or H – H **(ii)** :Cl: :Cl: or Cℓ – Cℓ

Covalent Bond According to VBT:

Accordant to valence bond theory, covalent bond is formed, when half filled orbitals in valence shells of the two atoms overlap, so that a pair of electrons, one electron from each atom, occupies the over lapped orbitals, As a result of this overlap, the electrons with opposite spins become paired to stabilized themselves.

Example:



Separated H atoms Overlapping of orbitals Covalent bond in H_2

S and S orbital overlap in H_2

30. Why second Electron Affinity of oxygen atom is positive but first electron affinity is negative? (GRW. GI, 2015)

Ans. If we add an electron to the neutral gaseous atom to form anion, energy is released and the process will be exothermic. It is known as first electron affinity i.e.

$O_{(g)} + 1e_{(g)} \longrightarrow O^{-}\ \ \Delta H_1 = -141\ kJmol$

But if the second electron is added to an anion, the process will be endothermic "due to repulsion"; hence, energy will be supplied to form dinegative ion and sign will be positive. This is called second electron affinity i.e.

$$O^{-1} + 1\bar{e} \longrightarrow O^{2-} \quad \Delta H_2 = {}^{+}780 \text{ kJmol}^{-1}$$

31. Briefly explain the atomic and ionic radii with example. (LHR. GII, 2017)

Ans. Atomic Radii: "The atomic radius is the total or average distance from the nucleus of an atom to its outermost electronic shell".

Ionic radii: The ionic radius is defined as "the measure of an atom'. Ion in a crystal lattice". It is half the distance between two ions that are nearly touching each other in crystal Lattice. The units of Ionic radii are picometers (pm) or angstroms (Å), with 1 Å = 100 pm.

32. Why the radius of an atom cannot be determined precisely?
(GRW. GII, 2014)(RWP. 2015)(BWP. 2016)(RWP. GII, 2017)(BWP. GI, 2018)(SWL. DGK. GI, 2019)

Ans. The radius of an atom cannot be determined precisely due to the following reasons.

(i) There is no sharp boundary of an atom. The probability of finding an electron never becomes exactly zero even at large distances from the nucleus.

(ii) The electronic probability distribution is affected by neighboring atoms. For this reason, the size of an atom may change from one compound to another.

33. Why cationic radii are smaller than Anionic radii? (BWP. 2015)(RWP. 2018)

Ans. The cationic radii are smaller than Anionic radii because in cationic radius, there is removal of electron from the valence shell, resulting electronic cloud reduces. Here number of protons becomes greater than electrons.

More protons means increased nuclear charge which pulls electronic cloud strongly.

Example: In case of Na^+ the cationic radius is 95 pm.

Where as in anionic radius, there is addition of electrons in the valence shell, resulting electronic cloud expands. Examole:

In case of $C\ell^-$, the anionic radius is 181 pm.

34. How does ionization energy vary in a group of periodic table?
(GRW. GI, 2014)(GRW. GII, 2015)

Ans. Variation of Ionization energy in a group:

Ionization energy decreases down the group in spite of the increase in proton number or nuclear charge. This is due to the successive addition of electronic shells as a result of which the valance electrons are placed at a large distance from the nucleus. As the force of attraction between the nucleus and the outer electron decreases with the increase in distance, the electron can be removed more easily or with less energy. Moreover, the force of attraction also decreases due to increasing shielding effect of the intervening electrons.

35. Define electron affinity and give an example. (MLN. GI, 2015) (LHR. GII, 2016) (LHR. GII, 2017)

Ans. Electron Affinity: The electron affinity of an atom is the energy released when an electron adds to an empty or partially filled orbital of an isolated gaseous atom in its valence energy level to form an anion having a unit negative charge.

$$C\ell_{(g)} + e^-_{(g)} \longrightarrow C\ell^-_{(g)} \quad \Delta H = 349 \text{ kJmol}^{-1}$$

36. Write two points of valence Bonol Theory. (LHR. GII, AJK. 2016)(DGK. GI, AJK. GII, 2017)

Ans. (i) A covalent bond is formed due to the overlap of the partially filled atomic orbitals.

(ii) In overlapping orbital, electrons become paired with opposite spin to stabilize them.

(iii) Larger the overlap, more is the energy released and stronger will be the bond.

(DGK. GI, 2017)(GRW. GII, 2019)

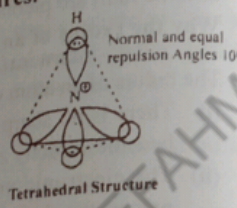
37. How Sigma and pi bonds are fomed?

Ans. Formation of Sigma and pi bonds:
Sigma bonds are the strongest type of covalent bonds those are formed by direct overlapping or end-to end over lapping or head-to-head overlapping between two adjacent orbitals of atoms. Electrons from the outer most shell of each atom combine to form an electron pair creating the sigma bond and electron density exist in between two nuclei of shared atoms. Similarly, pi (π) bonds (a type of weak covalent bonds) are formed by sideways or lateral overlapping half filled orbitals of two adjacent atoms. In pi (π) bonds, electron density is present above and below the joining line of nuclei of both adjacent atoms.

38. These species NH_2^-, NH_3, NH_4^+ have bond angles of 105°, 107.5° and 109.5° respectively. Justify these values by drawing their structures.

Ans. (i) $\ddot{N}H_4^+$

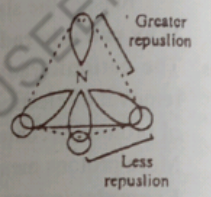
Nitrogen form three covalent and one coordinate covalent bond. After formation of four bonds, there remains no lone pair of electrons. So it has perfect tetrahedral structure with the angle of 109.5° All the bonds have equal status.



Tetrahedral Structure

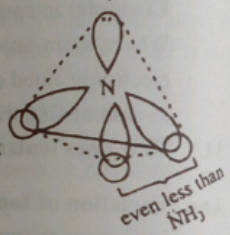
(ii) $\ddot{N}H_3$

Nitrogen forms three covalent bonds with hydrogen. There is one lone pair on nitrogen which repels bond pairs. Thus angle between bond pairs reduces from 109.5° to 107.5°. It has Trigonal pyramidal structure instead of tetrahedral.



(iii) $\ddot{N}H_2^-$

In NH_2, nitrogen forms two covalent bonds with two hydrogen atoms. Nitrogen has two lone pairs of electrons on it. According to valence shell electron pair repulsion theory lone-pair lone-pair repulsion is the highest. So in NH_2^-, there is greater repulsion than in NH_3. These lone pairs are repelled by each other. They also repel bond pairs. Hence, angle is further reduced to 105°.



39. Why the energy of antibonding molecular orbital is higher than corresponding bonding molecular orbital?

Ans. The energy of antibonding molecular orbital is higher than corresponding bonding molecular orbital because anti bonding molecular orbital has no electron density between the nuclei and is formed due to subtraction of $\bar{e}$ waves of unlike sign. So; it has higher energy than the bonding molecular orbital.

40. The C-C bond length in ethene (C_2H_4) is smaller than ethane (C_2H_6) give reason.

(AJK. 2015)

Ans. The C-C bond length in ethene C_2H_4 is 133 pm which is smaller than ethane bond length i.e 154 pm because s- orbital contribution increases from sp^3 to sp^2 and π - bonding also reduces the inter nuclear bond distance.

41. Define ionic and covalent radii.

(LHR. GI, 2017)

Ans. Ionic radii: The ionic radius is defined as "the measure of an atom's ion in a crystal lattice". It is half the distance between two ions that are nearly touching each other in crystal Lattice.

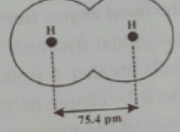
Unit: Ionic radii are measured in picometers (pm) or angstroms (Å), with 1 Å = 100 pm.

Covalent Radii: The covalent radius is defined as "a measure of the atomic size that forms part of one covalent bond is called atomic radii.

Unit: It is usually, measured in pico-metres (pm) or angstroms (Å), with 1 Å = 100 pm

42. Define Covalent Radius with an example. (MLN. GI, 2016)(LHR. GI, 2017)

Ans. The covalent radius of an element is defined as half of the single bond length between two similar atoms covalently bonded in a molecule.



Example: The covalent radius of H_2 is 37.7 pm, and it is half of the single bond length which is 75.4 pm.

43. What factors influence the ionization energy? (FBD. GI, 2015)

Ans. Factors influencing the Ionization Energies: Ionization energies of atoms depend upon the following factors.

(i) Atomic radius of atom.

(ii) Nuclear charge or proton number of the atom.

(iii) Shielding effect of inner electrons.

(iv) Nature of orbital.

44. Define shielding effect and how it varies along period. (FBD. GII, 2017)

Ans. Shielding effect: Shielding effect is a force of attraction which exist atomic nucleus and valance electrons. It depends on of an atom. In periodic table as the number of shell of elements remains constant along the period, therefore their shielding effect also remains constant.

45. Differentiation between Ionization Energy (IE) and Electron Affinity (EA). (MLN. GII, 2017)(DGK. GII, 2018)

Ans.

Ionization Energy (IE)	Electron Affinity (EA)
Ionization energy of an element is the minimum energy required to remove an electron from its gaseous atom to form an ion.	The electron affinity of an atom is the energy released when an electron adds to an empty or partially filled orbital of an isolated gaseous atom in its valence energy level to form an anion having a unit negative charge.

46. Define electronegativity and give its trend in periodic table. (MLN. GI, 2014)(BWP. RWP. 2015)(LHR. GII, 2016)(RWP. GI, 2017)(DGK. GII, 2018)

Ans. Electronegativity: The tendency of an atom to attract shared pair of electrons towards itself is called electronegativity.

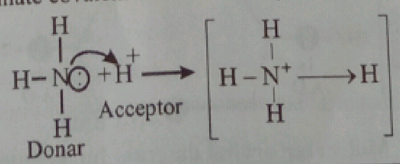
Variation of Electronegativity in Periodic table:

In groups: Electronegativity decreases from top to bottom in a group. This is due to the successive increase in the number of electronic shells. The addition of extra shells in larger atoms screens the shared pair from the nucleus and the pair is less attracted by the element in the combined state.

In Periods: Electronegativity values increase from left to right in the periods due to decrease in atomic size.

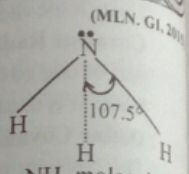
47. The distinction between a co-ordinate covalent bond and a covalent bond vanishes after bond formation in NH_4. Why? (DGK. GI, 2014)

Ans. The distinction between a co-ordinate covalent bond and a covalent bond vanishes after the formation of a co-ordinate covalent bond as in NH_4 formation

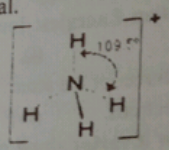


48. Why NH_3 molecule and NH_4^+ ion have different structures? (MLN. GI, 201

Ans. Ammonia has one lone pair on nitrogen atom and three bond pair with three hydrogen atoms. The charge cloud of lone pair electrons spreads out more than that of bonding electrons. As a result, somewhat large lone pair charge cloud tend to compress the bond angles from 190.5°to 107.5°' resulting ammonia has pyramidal structure. While in the ammonium ion, NH_4^+ The nitrogen has 5 outer electrons pulls another 4 from the four hydrogen's making a total of 9. But this is a positive ion. It has a 1+ charge because it has lost 1 electron. That leaves a total of 8 electrons in the outer level of the nitrogen. There are therefore 4 pairs, all of which are bonding because of the four hydrogen. NH_4^+ is tetrahedral.



NH_3 molecule



49. What is basic assumption of valance shell electron pair repulsion (VSEPR) theory? (FBD. GI, 2014)

Ans. Basic Assumption: The valence electron pairs (lone pairs and the bond pairs) are arranged around the central atom to remain at a maximum distance apart to keep repulsions at a minimum.

50. Differentiate between sigma and Pi bond. (SWL. 2014)(FBD. GI, 2015)

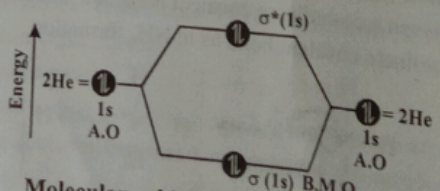
Ans. Difference between sigma and Pi bond:

Sigma (σ) Bond	Pi (π) Bond
(i) A bond formed between atoms by overlapping of two half-filled atomic orbitals is called sigma (σ) bond.	(i) A bond formed between atoms by the sideways "or" parallel overlapping of two half-filled atomic orbitals is called a pi (π) bond.
(ii) The electron cloud density is symmetrical along the bond axis.	(ii) The electron cloud density is not symmetrical along the bond axis.
(iii) It consists of one region of electron cloud density along the bond axis. **Example:** In CH_4 all bonds between carbon and hydrogen atoms are σ bonds.	(iii) It consists of two regions of electron cloud density above and below the bond axis. **Example:** In N≡N there are two π bonds and one α bond.

51. Discuss He-molecule on the basis of MOT. (BWP. 2015)

Ans. Molecular orbital structure of He-molecule: Each He-atom contributes two electrons. Two electrons enter bonding molecular orbital σ(1s) and the remaining two go to antibonding σ*(1s) molecular orbital.

The bond order for He_2 is zero i.e $\frac{(2-2)2}{2}=0$ and thus He molecule is not formed.



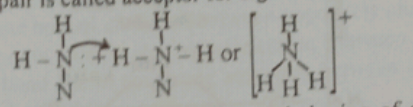
Molecular orbital diagram for helium

52. **Why sigma bond is stronger than Pi bond?** (FBD. GI, SGD. GI, BWP. 2014)(MLN. GII, 2016)(GRW. GII, LHR. GI, 2017)(RWP. 2018)

Ans. Sigma bond is stronger than pi-bond because bond strength of sigma bond is greater due to greater overlapping of orbitals than bond strength of pi-bond.

53. **Differentiate between co-ordinate covalent bond and covalent bond.** (LHR. GI, SGD. 2018)

Ans. **Co-ordinate covalent bond:** It is formed between two atom when shared pair of electron is denoted by one of bonded atom. The atom which give electron pair is called donor while which accept the electron pair is called acceptor for e.g. formation of $NH4^+$



Covalent Bond: The bond which is formed by mutual sharing of electron between two bonded atoms is called covalent bond.

54. **75.4 pm is compromise distance between the bonded hydrogen atoms. Justify.** (LHR. GII, 2018)(FBD. GII, 2019)

Ans. When atom approach each other for bond formation forces of attraction and repulsion Simultaneously act when they reached at a certain distance. The force of attraction are maximum and PE is maximum then this distance is called compromise distance.

55. **Why does lone pair of electrons occupy more space as compared to bond pair?** (GRW. 2018)(SGD. GII, 2019)

Ans. Non bonding electron pairs will always occupy more space than bonding electron pairs because electrons in a bond are much less excited than would be as free electron. Because the electrons in lone pair are more excited, they repel each other more and thus take up more space.

56. **Why does Helium not exist in the form of He_2?** (GRW. 2018)

Ans. Helium have all their orbital full. This is the most stable state for an atom. If 2 He atom combined to form a molecule, it would have more energy than the 2 original atoms, so the molecule would be unstable.

57. **Electronegativity difference between the bonded atoms is an index to the polar nature of covalent bond, justify.** (GRW. 2018)(SGD. GI, BWP. GII, 2019)

Ans. In a molecule the difference of electronegativity of bonded atom is considered an index of bond nature. It the difference of electro negativity is greater than 1.7 the bond will be ionic. If the difference of electronegativity is zero between two bonded atom the bond will be non polar.

58. **What are Debye forces? Explain.** (FBD. 2018)

Ans. **Debye Force:** The Debye force results from the interaction between the permanent dipoles of polar molecules and the dipoles they may induce in similar molecules and in initially non-polar molecules. The intermolecules forces appear in liquid and a lesser in gaseous state.

59. **What is bond order? Give an example.** (FBD. 2018)

Ans. **Bond Order:**

The number of bonds formed between two atoms after the atomic orbitals overlap, it called the bond order and taken as half of the difference between number of bonding electrons and anti-bonding electrons.

Example: The bond order for He2 is zero $\frac{2-2}{2}=\frac{0}{2}=0$ Thus He2 is not formed.

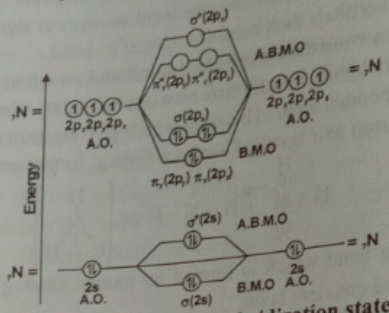
60. **Write two points of Valence Bond theory.** (MLN. GI, 2018)

Ans. 1. A covalent bond is formed due to overlap of the partially half filled atomic orbitals.

2. In overlapping orbital electron become paired with opposite spin to stablize them.

61. Draw molecular orbital picture of Nitrogen molecule. (MLN. GI, 2019)

Ans. $_7N$: $1s^2, 2s^2, 2p^3$



62. How bond length is effected by change of hybridization state? (MLN. GII, 2018)

Ans. The hybridization scheme is involved, in the explanation of shortening of bonds due to the predominant participation of s-orbitals. Since, the 2s-orbital of carbon has smaller mean radius than the 2p-orbitals, It would be expected that greater the s character in the hybrid orbitals used, the shorter will be the bond distance. Thus, the C-C bond lengths are 154, 133, and 120 pm for ethane, ethane and ethyne, respectively where s orbital contribution increases from sp^3 to sp. Further, p- bonding also reduce the internuclear bond distance.

63. Calculate bond order of N_2 molecule. (MLN. GII, 2018)

Ans. From the electronic configuration of N_2, it is clear that six electrons enter into three outer most bonding orbits while no dections enter into antibonding orbital thus the bond order in N_2molecules is:

$$\frac{6-0}{2}=\frac{6}{2}=3$$

64. Write the Lewis structures for the given compounds:. (a) HCN (b) CS_2 (SWL. 2018)

Ans. **(a) HCN:** Hydrogen Cyaride 1 + 4 + 5 = 10 H : C ::: N : after determining how many valence electron there HCN place then around central atom to complete the octet there are 10 valence electron for HCN lewis structure.

(b) CS_2: Carbon disulfide

$4 + 6(2) = 16$ $\quad$ $\ddot{S} :: C ::: \ddot{S} :$

$\ddot{S} = C = \ddot{S}$

There are 16 valence electron for CS_2 L.S. carbon is the least electron negative atom and goes in the center of this structure. Lewis structure for CS_2 require double bond between carbon and sulphur to fill the octet of carbon.

65. Explain the formation of coordinate covalent bond between NH_3 and BF_3.

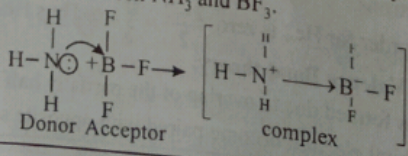
Ans. Co-ordinate covalent Bond: (SWL. 2018)(BWP. GI, 2019)

A co-ordinate covalent bond is formed between two atoms when the shared pair of electrons is donated by one of the bonded atoms.

The atom, ion or molecule which donates an electron pair is called donor and that which accepts a pair of electrons is called acceptor. The bond formed between donor and acceptor species is called co-ordinate covalent bond.

It is represented by an arrow (→) pointing from donor to acceptor.

Example: Bond formation between NH_3 and BF_3.



66. Define Electronegativity and Electron Affinity of an Atom. (BWP. GI, 2018)(GRW. GII, AJK. 2019)

Ans. Electronegativity: The tendency of an atom to attract a shared electron pair toward itself is called electronegativity.

Electron Affinity: The electron affinity of a atom is the energy released when on electron add to empty or partially filled orbital of an isolated gaseous atom in valence energy level to form an anion having a unit negative charge.

67. Ionic Bonds are stronger than Covalent Bonds, give reason. (BWP. GII, 2018)

Ans. Ionic bond result from the mutual attraction between oppositely charged ion while covalent bond is a bond that results from a sharing of electron between nuclei ionic tend to be stronger than covalent bond due to the strong attraction between ions of opposite charges, i.e. electrostatic force of attraction

68. Define ionization energy. Give its trend in periods and group of periodic table. (LHR. GI, 2019)

Ans. Ionization Energy: The minimum amount of energy required to remove and electron from valance shell of an Isolated gaseous atom to form gaseous positive ion is called Ionization Energy.

Trend in Period: Ionization energy increase as we move from left to right along the period with the increase in the proton number and shielding effect.

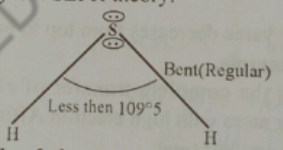
Trend in Group: Ionization energy decrease down the group as the atomic radius increase, nuclear charge also increase but shielding effect decrease.

69. How electronegativity changes in a group? (LHR. GI, 2019)

Ans. Electronegativity value decrease down the group due to increase in atomic Radius. As atomic size increase attraction for shared pair electron decreases. Hence electronegativity value decreases.

70. Explain geometry of H_2S molecule on the basis of VSEPR theory. (LHR. GII, 2019)

Ans. Geometry of H_2S according to VSEPR theory.



71. Define ionization potentials of elements. How the ionization potential vary across the periods? (LHR. GII, 2019)

Ans. The minimum amount of energy required to remove an electron from valance shell of an Isolated gaseous atom to form gaseous positive Ion is called Ionization Potential energy. Ionization potential increases along the period because size of atom decrease, nuclear charge and shielding effect increase.

72. Atomic Radii increase in group and decrease in period, explain it. (GRW. GI, 2019)

Ans. The increase in atomic radii in group is due to the increase in the number of shells and the screening effect. The decrease in atomic Radii is due to increase in nuclear charge. As the nuclear charge increases the pull on the electrons is increased and size of an atom decreases, while shielding effect remains same along the period.

73. Radius of cation is smaller than its corresponding atom. Why? (GRW. GII, 2019)

Ans. When an atom lose one or more electrons to form cation. In cations number of electrons are reduced but positive charge on nucleus remain same. Therefore nucleus forces attract outer electron more powerfully inward as a result size of cations decrased.

74. Why atomic radius is greather than cationic radius? (FBD. GI, 2019)

Ans. When an atom lose one or more electrons to form cation. In cations number of electrons are reduced but positive charge on nucleus remain same. Therefore nucleus forces attract outer electron more powerfully inward as a result size of cations decrased.

75. How ionization energy varies in periodic table? (FBD. GI, 2019)

Ans. Trend of Ionization Energy:

In Period: Ionization energy increase along the periods from left to right. It is due to number of shell remain same and nuclear charge increases so ionization energy also increase.

In Groups: Ionization energy decrease down the group although nuclear charge increase. It is due to increase in number of shells down the group.

76. Why energy of antibonding molecular orbitals are greater than that of bonding molecular orbitals? (FBD. GII, 2019)

Ans. When atomic orbitals are combine they form molecular orbitals. Some of these molecular orbitals have low energy and stability while some of these have high energy and are unstable than parent orbitals. These unstable molecules orbitals are called A.B.MO orbitals have high energy than B.M.O.

77. Discuss the trend of ionization energy in periodic table. (FBD. GII, 2019)

Ans. Trend of Ionization Energy:

In Period: Ionization Energy increase along the periods from left to right. It is due to number of shell remain same and nuclear charge increases so ionization energy also increases.

In Groups: Ionization energy decrease down the group although nuclear charge increase. It is due to increase in number of shells down the group.

78. Define Ionization energy. How does it vary in periodic table? (MLN. GI, 2019)

Ans. The minimum amount of Energy required to remove on electron from valance shell in gaseous state atom is called ionization energy.

In Period: Ionization energy increased along the period from left to right. It is due to the number of shell remain same and nuclear charge increase so Ionization energy also increase.

Ingroup: Ionization energy value decreases from top to bottom due to addition of shells.

79. Define Ionic bond with example. (MLN. GII, 2019)

Ans. "Ionic bond is formed by the complete transfer of electron from an atom with low ionization energy to another atom with high electron Affinity" e.g. formation of KCl.

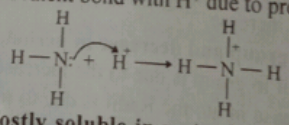
$$K_{(2,8,8,1)} \longrightarrow K^+_{(2,8,8)} + e^- \quad \Delta H = 419 \text{ kJ / mol.}$$

$$:\ddot{C}\ell\cdot + e^- \longrightarrow :\ddot{C}\ell:^- \quad \Delta H = -349 \text{ kJ / mol.}$$

$$K^+ + C\ell^- \longrightarrow KC\ell$$

80. NH_3 can form coordinate covalent bond with H^+. Explain. (SWL. 2019)

Ans. NH_3 can form coordinate covalent bond with H^+ due to presence of lone pair in NH_3.



81. Ionic compounds are mostly soluble in water but insolube in non-polar solvents. Give reason. (SGD. GI, 2019)

Ans. Mostly ionic compounds are soluble in water but insoluble in non-aqueous solvent. When a crystal of an ionic compound is placed in water, the polar water molecules detach the cations and anions from the crystal lattice by their electrostatic attraction. In Non-Polar solvents cations and anions are not formed so ionic compounds are not dissolved in non-polar solvents.

82. What factors influence the electron affinity? (RWP. 2019)

Ans. Factors influencing the electron Affinity.

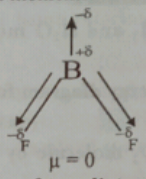
(i) Atomic Radius. **(ii)** The Nuclear charge.

(iii) The shielding effect of inner electrons.

As the forces of attraction between the valance electrons and the nucleus decreases with the increase in the atomic radius, the electron affinities usually decreases.

83. Why the molecule of BF_3 is triangular planar? (RWP. 2019)

Ans. Symmetrical triangular planer molecules of BF_3 have zero dipole moment. This is all due to the cancellation individual bond moments.



$\mu = 0$

84. Define Polar Bond. Give formulas of two diatomic molecules which have polar bonds. (BWP. GI, 2019)

Ans. The covalent bond in which bonding electrons are not shared equally by atoms is called polar covalent bond.

Examples: HF and HCl

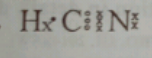
85. Define Electronegativity. State the element with highest value of Electronegativity. (BWP. GII, 2019)

Ans. "The tendency of an atom to attract a shared electron pair towards itself is called its electronegativity.

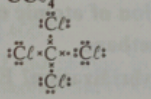
Fluorine has highest electronegativity value which is '4'.

86. Write the lewis structures for the following compounds.

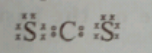
(i) HCN

Ans. 

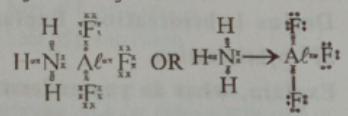
(ii) $CC\ell_4$

Ans. 

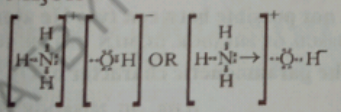
(iii) CS_2

Ans. 

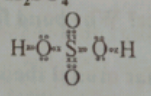
(iv) $H_3N \rightarrow A\ell F_3$

Ans. 

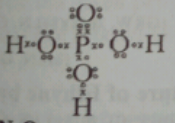
(v) NH_3OH

Ans. 

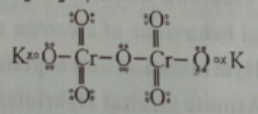
(vi) H_2SO_4

Ans. 

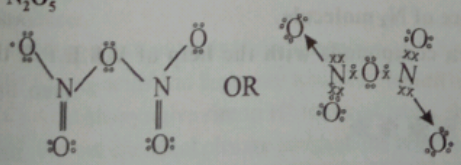
(vii) H_3PO_4

Ans. 

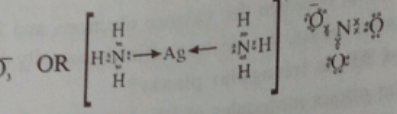
(viii) $K_2Cr_2O_7$

Ans. 

(ix) N_2O_5

Ans. 

(x) $Ag(NH_3)_2NO_3$

Ans. $[H_3N:Ag:NH_3]^+NO_3^-$ OR 

ESSAY TYPE QUESTIONS

1. Briefly explain shapes of NH_3 and H_2O molecule according to hybridization theory. (DGK. GI, 2015)(AJK. GII, 2017)(RWP. 2019)
2. Draw the molecular orbital energy diagram for nitrogen N_2 and give its electronic configuration. (GRW. GI, FBD. GI, MLN. GI, 2015)(SWL. GII, 2017)
3. Calculate the bond order of O_2 molecule by making energy level diagram. Also show that it is para magnatuic. (LHR. GI, 2016)(SWL. GII, LHR. GI, 2017) (RWP. 2018)(LHR. GI, SGD. GII, BWP. GII, 2019)
4. Explain Postulates of Molecular orbital theory. (DGK. GII, 2016)(MLN. GI, DGK. GI, 2017)(GRW. GI, 2019)
5. Explain Co-ordinate Covalent bond. (SGD. GII, 2017)
6. Explain VSEPR-Theory. Discuss the structure of CH_4 molecule with reference to this Theory. (DGK. GI & GII, SWL. GRW. GI & GII, 2014)(RWP. 2015)(LHR. GII, BWP. 2016) (SWL. GII, FBD. GI, MLN. GI, BWP. GI, LHR. GI & GII, 2017)(SGD. 2018)(GRW. GII, SGD. GI, 2019)
7. Write a note on sp hybridization and give example of ethyne. (LHR. GII, 2017)
8. What is ionization energy and discuss variation of ionization energy in periodic table also explain how ionization energy is an index of the metallic character? (MLN. GI, 2014)(AJK. 2015)(MLN. GI, 2016)(SGD. GI, DGK. GII, 2017)(BWP. GII, 2018)(FBD. GI, 2019)
9. Define hybridization of atomic orbitals. Discuss sp_3 hybrisdization in detail, draw the structure of methane. (BWP. SGD. GI, RWP. GI, FBD. GI, 2014)(SWL. 2019)
10. What is orbital hybridization? Explain the geometry of ethylene molecule on the basis of orbitals hybridization. (BWP. 2015)
11. Define hybridization. Explain the Geometry of Ethene on the basis of SP^2-hybridization.
12. Explain, what do you understand by the term electronegativity? Discuss its variation in the periodic table. (MLN. GI, 2016)
13. What is bond order? Why bond formation is not possible between two He atoms. (SWL. GII, 2014)(SGD. GI, 2016)(DGK. GI, MLN. GI, LHR. GII, 2017)
14. How does molecular orbital theory explain the paramagnetic character of O_2 molecule? Also calculate the bond order. (LHR. GII, 2018)(DGK. GI, 2019)
15. Define electron affinity. Give its trend in the periodic table. Also mention abnormal behaviour of electron affinity in different groups. (GRW. 2018)(MLN. GI, 2019)
16. Define Hybridization and explain sp^2-hybridization (MLN. GII, 2018)
17. Define Atomic Orbital Hybridization and describe the structure of Ethyne by it. (BWP. GI, 2018)(LHR. GII, 2019)
18. Explain molecular orbital structure of N_2 molecule. (AJK. 2018)
19. Explain the structure of the given compounds with the help of V.S.E.P.R theory (i) NH_3 (ii) H_2O (FBD. GII, 2019)

CHAPTER 07

THERMOCHEMISTRY

MULTIPLE CHOICE QUESTIONS (MCQ's)

1. **The Pressure of oxygen inside the bomb calorimeter is:** (LHR. GI, SGD. GI, BWP. GI, 2014)(MLN. GII, 2018)
   (A) 100 atm (B) 50 atm (C) 25 atm **(D) 20 atm**

2. **The born-Haber cycle is the best application of:** (RWP. GI, 2014)
   (A) Boyle's law (B) Dalton's law **(C) Hess's law** (D) Graham's law

3. **Enthalpies of all elements in their standard states are** (SGD. 2018)
   (A) Unity **(B) Zero** (C) Always Positive (D) Always negative

4. **The net heat change in a chemical reaction is same whether it is brought about in two or more different ways in one or several steps. It is known as:** (DGK. GI, 2014)(LHR. GI, 2016)(SGD. GI, 2019)
   (A) Henry's law **(B) Hess's law**
   (C) Joule's principle (D) Law of conservation of energy

5. **In endothermic reactions, the heat content of the:** (MLN. GI, 2016)(RWP. 2019)
   (A) Products is more than that of reactants (B) Reactants is more than that of products
   (C) Both A and B (D) Reactants and products are equal

6. **_____ is not state function.** (MLN. GII, 2018)
   (A) Pressure (B) Volume (C) Temperature **(D) Heat**

7. **The optimum temperature for the synthesis of NH_3 by Haber's process is:** (DGK. GII, 2017)
   (A) 200 °C (B) 300 °C **(C) 400 °C** (D) 500 °C

8. **For the reaction $NaOH + HC\ell \longrightarrow NaC\ell + H_2O$ the change in enthalpy is called:** (GRW. GI, SWL. GI, 2014)(DGK. GII, 2016)(BWP. GII, MLN. GII, LHR. GII, BWP. GII, 2017) (SWL, GRW, DGK, BWP, GI, 2018)(SGD. GII, 2019)
   (A) heat of reaction (B) heat of formation
   (C) heat of Neutralization (D) heat of combustion

9. **Calorie is equivalent to:** (LHR. GI, GRW. GI, BWP. GI, SGD. GII, GRW. GII, 2014)(LHR. GI, RWP. GI, FBD. GI, 2015) (AJK. GI, RWP. GI, 2016)(SGD. GI&GII, DGK. GI&GII, 2017)(GRW. GI & GII, FBD. GI, DGK. GI & GII, 2019)
   (A) 0.4184 J (B) 41.84 J **(C) 4.184 J** (D) 418.4J

10. **The change in heat energy of a chemical reaction at constant temperature and pressure is called:** (DGK. GI, 2016)(MLN. GI, BWP. GI, 2017)(RWP, AJK. 2018)(MLN. GI, BWP. GI, 2019)
    (A) enthalpy change (B) bond energy
    (C) heat of sublimation (D) internal energy change

11. **For the given process the heat changes at constant pressure (q_p) and constant volume (q_v) are related to each other as:** (LHR. GII, MLN. GI, BWP. GII, 2018)(MLN. GII, SWL. BWP. GII, AJK. FBD. GII, 2019)
    (A) $q_p = q_v$ (B) $q_p < q_v$ **(C) $q_p > q_v$** (D) $q_p = q_v / 2$

12. **Enthalpy of neutralization of all the strong acids and strong bases has the same value because:**
    (A) Neutralization leads to the formation of salt and water
    (B) Strong acids and bases are ionic substances
    (C) Acid always give rise to H^+ ions and bases always furnish OH^- ions
    (D) The net chemical change involves the combination of H^+ and OH^- ions to form water

13. **Which of the following statement is contrary to the first law of thermodynamic?**
(A) An equivalent amount of heat energy can neither be created nor destroyed
(B) One form of energy can be transferred into an equivalent amount of other kinds of energy
(C) In an adiabatic process, the work done is independent of its path
(D) Continuous production of mechanical work without supplying an equivalent amount of heat is possible

SHORT ANSWER QUESTIONS

1. **Define system and surrounding with suitable examples.**
(GRW. GI, 2014)(GRW. GI & GII, 2015)(BWP. 2016)(DGK. GI, LHR. GII, AJK. GII, 2017) (GRW. GII, BWP. GI, BWP. GII, 2019)

System	Surroundings
(i) A material or a collection of materials, which is under study, is called a system. (ii) A specific amount of on one or more substances constitutes a system. **Example:** The reactions between Zn and $CuSO_4$ solution under observation.	(i) The environment containing the system are called surrounding. (ii) The cylinder, the piston and all other objects outside the cylinder are surroundings. **Example:** The flask, the air, etc are the surroundings.

2. **Define standard enthalpy of combustion. Give one example.**
(FBD. GI, 2014)(MLN. GI, RWP. GI, 2016)(BWP. GI, DGK. GII, RWP. GI, 2017)

Ans. Standard enthalpy of combustion: The standard enthalpy of combustion of a substance is the amount of heat evolved when one mole of a substance is completely burnt in excess of oxygen under standard conditions. It is denoted by ($\Delta H°c$)

Example: $C_2H_5OH_{(\ell)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O(\ell)$ $\Delta H_c^\circ = -1368 kJmo\ell^-$

3. **What is standard enthalpy of solution? Give one example.** (SGD. GI, 2014)(FBD. GI, 2015) (MLN. GII, 2016)(LHR. GI, 2018)

Ans. Standard Enthalpy of solution ($\Delta H°_{sol}$):
The standard enthalpy of solution is the amount of heat absorbed or evolved when one mole of a substance is dissolved in so much solvent that further dilution results in no detectable heat change.

Example: Enthalpy of ($\Delta H°sol$) of ammonium chloride is + 16.2 $kJmo\ell^{-1}$ and that of sodium carbonate is –25.0 $kJmo\ell^{-1}$.

4. **Define enthalpy of formation with one example.**
(DGK. GII, 2016)(LHR. GII, FBD. GII, RWP. GII, 2017)

Ans. The standard enthalpy of formation of a compound is the amount of heat absorbed or evolved when one mole of the compound is formed from its elements. It is denoted by $\Delta H°f$.

Example: The enthalpy of formation $\Delta H°$ f for $Mgo_{(s)}$ is -692 $KJmol^{-1}$

$$Mg_{(s)} + \frac{1}{2}O_{2(g)} \longrightarrow MgO_{(s)} \Delta H°f = -692 kJmo\ell^{-1}$$

5. **Define the terms standard enthalpy of neutralization and standard enthalpy of atomization.**
(SGD. GII, 2017)(MLN. GII, SGD. GII, BWP. GI, 2019)

Ans. Standard Enthalpy of Neutralization: (ΔHn): The standard enthalpy of neutralization is the amount of heat evolved when one mole of hydrogen ions H^+ form an acid and react with one mole of hydroxide ions OH^- from a base to form one mole of water.

Example: The standard enthalpy of neutralization of sodium hydroxide by hydrochloric

acid is -57.4 kJ mol^{-1}.

A strong acid HCℓ and a strong base, NaOH, ionize completely in dilute solutions as follows.

$$HC\ell\,(aq) \longrightarrow H^{+}"(aq) + C\text{–}\ell\,(aq)$$

$$NaOH\,(aq) \longrightarrow "Na^{+}\,(aq) + OH^{-}(aq)$$

Standard enthalpy of atomization: "The amount of heat absorbed when one mole of gaseous atoms is formed from the element under standard conditions, is called standard enthalpy of atomization of that element." It is denoted by "ΔHato"

Example: the standard enthalpy of atomization of hydrogen is = 218kJ mol^{-1}. Various methods use for the determination of enthalpies of atomization of elements.

6. **The enthalpy of neutralization of all the strong acids and strong bases has the same value. Justify.** (GRW. GII, DGK. GI, 2014)(LHR. GII, MLN. GI, DGK. GI, 2018)

Ans. The enthalpy of neutralization of all the strong acids and strong bases has the same value because when these solution are mixed together during the process of neutralization, the only change that actually occurs in the formation of water molecules leaving the sodium ions and the chloride ions as free ions in solution. Thus, the enthalpy of neutralization is merely the heat of formation of one mole of liquid water from its ionic components.

$$H^{+}(aq) + OH(aq) \rightleftharpoons H_2O_{(\ell)} \quad \Delta Hn = -57.4\ kJ mol^{-1}$$

7. **Why it is necessary to mention the physical states of reactants and products in thermo chemical reaction?** (GRW. GII, 2017)(GRW. 2018)(DGK. GII, AJK. 2019)

Ans. It is true that all chemical reactions involves in change of energy of reactants and products, because all substance present in universe posses energy. It is also true that phase or physical state change of a substance involves in the change in energy. So, whenever we mention a chemical reaction in thermo chemistry, then it is essential to mention the physical states of reactants and products. That represents the conditions of reaction in term of pressure, volume etc. by which change in physical state of reactants and products is carried out.

8. **State first law of thermodynamics. Give its mathermatical formula.** (RWP. GI, MLN. GI, 2014) (MLN. GI, RWP. GI, BWP. GI, MLN. GII, 2017)(GRW. GII, MLN. GI, DGK. GII, 2019)

Ans. **First law of thermodynamics:** The first law of thermodynamics, also called the law of conservation of energy, states "that energy can neither be created nor destroyed, but can be change from one form to another."

As $\Delta E = q_v$.

According to the first law of thermodynamics

$$q = \Delta E + (-W)$$

Since $W = P\Delta V$

So, $q = \Delta E - P\Delta V$

If heat q is being supplied at constant volume, then there is no work done by the system.

Since, $\Delta V = 0$

Therefore $P\Delta V = 0$

$qv = \Delta E$

Hence the Increase in internal energy of a system is equal to the heat absorbed by the system at constant volume. Bomb calorimeter may be used to measure the q. All those reactions which involve only solids of liquids as reactants or products have a very small change of ΔV . It is so small that it can be ignored.

So $\Delta E = qv$

Hence, heat absorbed at constant volume is the internal energy change.

9. **State Hess's law of constant Heat summation.** (RWP. GI, 2014)(MLN. GI, 2015)(SGD. GII, 2019)

Ans. Hess's Law of constant Heat summation: Hess's Law of constant heat summation is defined as:-

"If a chemical change takes place by several different routes, the overall energy change is the same, regardless of the route by which the chemical change occurs, provided the initial and final conditions are the same. $\sum \Delta H(\text{cycle}) = 0$" (RWP. GI, 2016)

10. **Define Born-Haber cycle and Lattice energy.**

Ans. Born-Haber Cycle: Born-Haber Cycle can be stated as:

The sum of energy changes in the initial and final states of various processes occurring in a closed cycle is zero.

Lattice Energy: The lattice energy of an ionic crystal is the enthalpy of formation of one mole of the ionic compound from gaseous ions under standard conditions.

$$Na^{+}_{(g)} + C\ell^{-}_{(g)} \longrightarrow Na^{+}C\ell^{-}_{(s)} \quad \Delta H^{o}_{lat} = -787 kJmo\ell^{-1}$$

11. **Describe that burning of candle is a spontaneous process. Justify.**
(GRW. GI, 2014) (GRW. GII, LHR. GII, 2015)(GRW. GII, MLN. GII, DGK. GI, SGD. GI, 2017) (LHR. GII, DGK. GII, BWP. GI, 2018)(LHR. GI, 2019)

Ans. The burning of candle is a spontaneous process because spontaneous process needs energy to start with, but once it is started, than it proceeds on its own.

To burn a candle, a spark or temperature is required from out, but once it starts burning, there is no more energy required and candle burn spontaneously, Because heat evolved due to burning makes the reaction spontaneous.

12. **What is state function? Explain with example.**
(BWP. GI, MLN. GI, 2014)(RWP. GI, MLN. GII, GRW. GI, BWP. GI, 2015)(RWP. GI, AJK. GI, 2016) (SWL. GII, MLN. GI, SGD. GII, SWL. GI, FBD. GII, 2017)(MLN. GII, 2018)(LHR. GI & GII, RWP. 2019)

Ans. State Function: A state function is a macroscopic property of a system which has some definite values for initial and final states, and which is independent of the path adopted to bring about a change.

Examples: The examples of state function are:

(i) Pressure (P) **(ii)** volume(V) **(iii)** Internal energy(E)
(iv) Enthalpy (H) **(v)** Temperature (T)

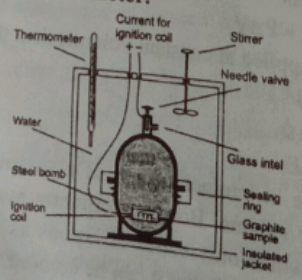
13. **Define standard enthalpy of atomization with an example.**
(DGK. GII, LHR. GI, 2015)(DGK. GI, 2016)(BWP. GI, & GII, 2018)(FBD. GII, 2019)

Ans. Standard enthalpy of Atomization: The standard enthalpy of atomization of an element is defined as the amount of heat absorbed when one mole of gaseous atoms is formed from the element under standard conditions.

Example: $\frac{1}{2}H_{2(g)} \longrightarrow H_{(g)} \quad \Delta H^{o}_{at} = 218 kJmo\ell^{-1}$

14. **Draw a labeled diagram of bomb calorimeter.**

Ans. Bomb Calorimeter: (RWP. GI, 2015)



15. ***Prove that $\Delta E = q_v$.***

Ans. According to first law of thermodynamics (FBD. 2018)(FBD. GI, MLN. GII, SWL. 2019)

$\Delta E = q + w \qquad w = p\Delta v$

$\Delta E = q + p\Delta v$

If volume $\Delta v = 0$ $\quad \Delta E = q + p(0) = qv.$

$\Delta E = qv.$

16. What is internal energy? What is effect of increase in internal energy on the system? (SWL, SGD. 2018)

Ans. Internal Energy: The energy stored in a substances in terms of it kinetics and potential energy but it virtue of its constituent particle is called its internal energy. When the temperature of system increase the kinetics and potential energy of atom and molecule in system increase. Thus the internal energy of system increase which mean enthalpy of the system increase.

17. Differentiate between Atomization energy and Lattice energy. (DGK. GI, 2018)

Ans. Atomization Energy: The heat required in breaking molecules into its compnents atoms is called atomization energy.

Lattice Energy: A measure of the energy contained in the crystal lattice of a compound equal to the energy that would be released if the component ions were brought together from infinity.

18. What is thermo-chemical equation? Give its two examples. (DGK. GII, 2018)

Ans. A thermo chemical equation is a balanced stoichemstric chemical equation that includes the enthalpy ΔH. In variable form

$A + B \longrightarrow C$

$\Delta H = (+)\ \#$

Such equation in which information about heat changes occur are called thermo chemical equation.

Usually its units of kJ.

1. $C_{(s)} + O_2 \longrightarrow CO_2 \qquad \Delta H = -393.5 kJ$
2. $C + 2O_2 \longrightarrow CO_4 \qquad \Delta H = +74.25 kJ$

19. Define Standard Enthalpy of Combustion and Standard Enthalpy of Solution. (BWP. GII, 2018)

Ans. Enthalpy of Combustion: The standard enthalpy of combustion of substance is amount of heat evolved when one male of the substance is completely burnt in excess of oxygen under standard condition. It is denoted by sH_c°

$$C_2H_5OH(\ell) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(\ell) \quad \Delta H_c^0 = -1368\,kJ\,mol^{-1}$$

Enthalpy of Solution: The standard enthalpy of solution is the amount of heat absorbed or evolved when one mole of substance is dissolved in so much solvent that further dilution results in no detectable heat change it is denoted by ΔH_{sol}°.

20. Define heat and work. (FBD. GI, SWL. GII, 2019)

Ans. Heat: "The quantity of energy that flows across the boundary of a system during a change in its state due to difference in temperature between the system and the surrounding."

Work: " The product of force and distance is called work." $\boxed{W = F \times S}$

21. Justify that heat of formation of compoun is the sum of all the other enthalpies. (SGD. GI, DGK. GI, 2019)

Ans. Heat of formation of compounds is the sum of all the offer enthalpies which is also described by.

Hess's Law as

$\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3$

It can be justified by enthalpy of formation of CO

Single Step process.

$C + O_2 \rightarrow CO_2 \qquad \Delta H = -393.7\ kJ/mol$

Two steps process.

$C+\frac{1}{2}O_2 \rightarrow CO \quad \Delta H\,(CO) = ?$

$C+\frac{1}{2}O_2 \rightarrow CO_2 \quad \Delta H_2\,(CO_2) = -283 kJ/mol$

According to Hess's law.

$\Delta H = \Delta H_1 + \Delta H_2$

$\Delta H_1 = \Delta H_2 + \Delta H$

$= -393 - (-283)$

$= -110$ KJ/mol.

So enthalpy of formation of CO = –110 KJ/mol.

ESSAY TYPE QUESTIONS

1. Define Enthalpy and Prove that $q_p = \Delta H$. (DGK. GII, MLN. GI, 2014)(MLN. GI&GII, 2015)(LHR. GI, DGK. GI, 2016)(RWP. GI, DGK. GI, 2017)
2. Explain standard Heat of neutralization. (AJK. GI, 2015)(GRW. GII, 2019)
3. What is enthalpy of a reaction? How is ΔH of reaction measured in laboratory by glass-calorimeter? (SGD. GI, 2017)
4. 10.16g of graphite is burnt in a bomb calorimeter and the temperature rise recorded is 3.87 K. Calculate the enthalpy of combustion of graphite, if the heat capacity of the calorimeter is 86.02 KJ K^{-1}. (GRW. GI, 2015)
5. State first law of thermodynamics. How does it explain that $q_p = \Delta H$. (RWP. GI, 2017)(LHR. GII, DGK. GI, BWP. GII, GRW, SWL. 2018)
6. What is first law of thermodynamics? Prove that $\Delta E = q_v$. (BWP. GI, 2014)(RWP. GI, DGK. GII, 2015)(BWP. GI, SGD. GI, 2017)(FBD. GI, BWP. GII, 2019)
7. Define Enthaply and derive Enthalpy change at constant pressure. (MLN. GII, 2017)
8. Explain the term internal energy of a system and also mention how the change in internal energy of a system can occur? (FBD. GI, 2014)
9. Explain standard enthalpy of combustion. (AJK. GI, 2015)
10. Define and explain Hess's law of constant heat summation with examples. (GRW. GI, DGK. GI, 2014)(GRW. GII, 2015)(MLN. GII, RWP. GI, BWP. GI, LHR. GII, 2016) (LHR. GI, RWP. GII, 2017)(LHR. GI, FBD. 2018)(LHR. GI, RWP. AJK. MLN. GI, 2019)
11. Define lattice energy and Bon-Haber cycle. How lattice energy is measured by Born-Haber cycle. Write equation of different enthalpy changes in the formation of NaCI from its elements. (SGD. GI, 2014)
12. Describe measurement of enthalpy of a reaction with bomb calorimeter. (RWP. 2018)(MLN. GII, SWL. 2019)
13. Define the following with one example. (DGK. GII, 2018)
    (i) System (ii) Surrounding (iii) State function (iv) Endothermic reaction
14. Define Enthalpy. How is it determined with help of Bomb's Calorimeter. (BWP. GI, 2018)(FBD. GII, SGD. GI, SGD. GII, DGK. GII, 2019)
15. Explain the following terms: (LHR. GII, 2019)
    (i) Standard heat of neutralization. (ii) Standard enthalpy of solution.
16. Derive the relationship between ΔH and ΔE, where H stands for enthalpy an E stands for internal energy. Which are two conditions when ΔH and ΔE becomes equal. (GRW. GI, 2019)

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CHAPTER 08

CHEMICAL EQUILIBRIUM

MULTIPLE CHOICE QUESTIONS (MCQ's)

1. **By adding $NH_4C\ell$ to NH_4OH solution. The ionization of NH_4OH:** (SGD. GI, 2014)(BWP. GI, 2015)
   (A) Increases (B) Remains same
   (C) Decreases (D) Increases 100 times

2. **An excess of aqueous silver nitrate is added to aqueous barium chloride and precipitate is removed by filtration. What are the main ions in the filtrate?** (AJK. GI, FBD. GI, 2015)(SGD. GI, DGK. GI, RWP. GI, DGK. GI, 2017)(LHR. GII, 2018)
   (A) Ag^+ and NO_3^- **(B) Ag^+ and Ba^{+2} and NO_3^-**
   (C) Ba^{+2} and NO_3^- only (D) Ba^{+2} and NO_3^- and $C\ell^-$

3. **In the presence of common ion, the ionization of an electrolyte will.** (RWP. GI, 2014)
   (A) Increase **(B) Decrease**
   (C) no affect (D) Moderate change

4. **Which statement about the following equilibrium is correct?** (SGD. GII, 2014) (RWP. GII, BWP. GI, 2017)(DGK. GII, 2019)

   $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} \quad \Delta H = -188.3 \text{ kJ mol}^{-1}$

   (A) The value of K_p falls with rise in temperature
   (B) The value of K_p falls with increasing pressure
   (C) Adding V_2O_5 catalyst increase the equilibrium yield of sulphur trioxide
   (D) The value of K_p is equal to K_c

5. **The pH of 10^{-3} mol dm^{-3} of an aqueous solution of H_2SO_4 is:** (LHR. GI, RWP. GI, BWP. GI, 2015)(LHR. GI, RWP. GI, BWP. GI, MLN. GII, AJK. GI, DGK. GI, 2016) (SGD. GI, MLN. GI, DGK. GII, FBD. GII, BWP. GI, AJK. GI, 2017)(DGK. GII, BWP. GII, AJK. 2018)
   (A) 3.0 **(B) 2.7** (C) 2.0 (D) 1.5

6. **The pH of 10^{-4} moles / dm^3 of Ba $(OH)_2$ is:** (SGD. GII, 2017)
   (A) 4.5 (B) 6.4 (C) 7.5 **(D) 10.3**

7. **The nature of milk is:** (FBD. GI, 2017)
   (A) Acidic **(B) Basic** (C) Neutral (D) Normal

8. **Sum of pKa and pKb is equal to:** (LHR. GII, 2017)
   (A) 7 (B) 9 (C) 11 **(D) 14**

9. **For which system does the equilibrium constant K_c has units of (concentration)^1?** (LHR. GI, 2014)(MLN. GII, DGK. GI, 2016)(BWP. GI, LHR. GI, 2017)(FBD. RWP. BWP. GII, 2018)
   (A) $3H_2 \rightleftharpoons 2NH_3$ (B) $H_2 + I_2 \rightleftharpoons 2HI$
   (C) $2NO_2 \rightleftharpoons N_2O_4$ (D) $2HF \rightleftharpoons H_2 + F_2$

10. **_____ was derived by C.M. guldberg and P. Waage in 1864.** (MLN. GI, 2017)
    (A) Law of Conservation of Mass **(B) Law of Mass Action**
    (C) Distribution Law (D) Law of Conservation of Energy

11. **The unit of Q_C for reaction $N_2 + O_2 \rightleftharpoons 2NO$ will be:** (LHR. GII, 2017)
    (A) mole / dm^3 (B) $mole^{-1}$ / dm^3 (C) $mole^{-2}/dm^{+6}$ **(D) No unit**

12. **Optimum pressure in Haber's process for synthesis of Ammonia is** (BWP. GII, 2017)
    (A) 100 - 150 atm **(B) 200 - 300 atm** (C) 350 - 450 atm (D) 500 - 600 atm

13. The pH of human blood is: (GRW. GI, 2017)(LHR. GI, 2018)
(A) 7.12 **(B) 7.35** (C) 7.56 (D) 8.0

14. pH of soft drinks at 25°C is about: (DGK. GI, 2017)
(A) 3.0 (B) 11.0 (C) 1.0 (D) 7.0

15. pH of pure water is: (GRW. GI, 2014)(FBD. GI, 2015)(AJK. 2015)
(A) 4.4 (B) 5.4 **(C) 7.0** (D) 8.0

16. The pH of the gastric juice is: (MLN. GI, 2016)
(A) 2.0 (B) 3.0 (C) 3.5 (D) 5.6

17. pH of bananas is: (SGD. GI, 2016)
(A) 2.1 **(B) 4.6** (C) 9.4 (D) 9.6

18. pOH of water is: (DGK. GI, 2019)
(A) 2.0 (B) 4.0 (C) 6.0 **(D) 7.0**

19. The ionization constant of pure water (K_w) at 25° C is: (MLN. GII, 2019)
(A) 1.8×10^{-16} mole dm^{-3} (B) 1.6×10^{-14} mole dm^{-3}
(C) 1.0×10^{-14} $mole^2$ dm^{-6} (D) 1.8×10^{-14} $mole^2$ dm^{-6}

20. Acid having Ka > 1 will be: (RWP. GI, 2014)
(A) Weak (B) very weak (C) Moderate **(D) strong**

21. Approximate pH of apple is : (LHR. GI, 2018)
(A) 2.7 **(B) 3.1** (C) 4.2 (D) 4.5

22. Rain water is : (LHR. GII, 2018)
(A) Slightly acidic **(B) Slightly basic** (C) Neutral (D) Highly basic

23. Optimum temperature for synthesis of ammonia by Haber Process is: (GRW. 2018)
(A) 370°C (B) 390°C **(C) 400°C** (D) 410°C

24. Which one affects the value of K_c? (FBD, MLN. GI, 2018)
(A) Concentration **(B) Temperature** (C) Pressure (D) Catalyst

25. The units for kw of H_2O are:- (MLN. GII, 2018)
(A) mol/dm^3 (B) mol^2dm^{-6} (C) $mol^{-2}dm^6$ (D) $mol^{-2}dm^{-3}$

26. The units of K_c for the reaction of ammonia synthesis are: (SWL. 2018)
(A) $moles^{-2}dm^6$ (B) $moles^{-1}dm^6$ (C) $moles^{-2}dm^3$ (D) $moles^{-2}dm^2$

27. The term pH was introduced by (SWL. 2018)
(A) Ilenderson (B) Millikan (C) Le-chattilier **(D) Sorenson**

28. When Kc value of a reaction is very small, the equilibrium position lies to: (DGK. GII, 2018)
(A) Left (B) Right
(C) May be left or right (D) Can not be predicted

29. The pH of Milk of Magnesia is: (BWP. GI, 2018)
(A) 10.5 (B) 3.5 (C) 8.5 (D) 11.1

30. The relationship between Kp and Kc is given by: (RWP. 2019)
(A) $Kc = Kp(P)^{\Delta n}$ (B) $Kc = Kp(\frac{P}{N})^{\Delta n}$ **(C)** $Kp = Kc(RT)^{\Delta n}$ (D) $Kp = Kc(RT)^{-\Delta n}$

SHORT ANSWER QUESTIONS

1. **Give the equations for calculating pH and pOH for acidic and basic buffers.**

Ans. We can calculate the "pH"of a basic buffer solution by using Henderson equation which can be derived as. (FBD. GII, 2017)

$$PH = Pka - \log$$

Similarly , we can use following equation in order to calculate the values "$_{P}OH$" of basic buffers.

$$POH = Pkb + \log$$

2. What is Henderson's equation and for which purpose it used. (AJK. 2019)

Ans. Hendersen's equation shows that two factors evidently govern the pH of buffer solution.

$$pH = pK_a - \log \frac{[acid]}{[salt]}$$

First is the pKa of the acid used and second is the ratio of the concentration of salt & the acid.best buffer is prepared by taking equal concentration of salt & acid. Hendersen's equestion guides us quantitatively to have the buffer solutions of good buffer capacity and to select the pair of compounds for this purpose.

3. Define pH and give the pH of milk and eggs. (RWP. GI, 2015)

Ans. pH: The negative logarithm of the H^+ ion concentration is called pH.

$$pH = -\log [H^+]$$

(a) pH of milk =6.5 **(b)** pH of eggs = 7.8

4. Is it true that value of Kw increases 75 times when temperature is increased from 0°C to 100°C? (DGK. GII, 2014)

Ans. yes it is true that value of Kw increases 75 times when temperature is increased from 0°C to 100°C.

5. Define pH and pKw. (RWP. GI, 2014)

Ans. pKw: The negative log of the dissociation constant (Kw) of water at any temperature is called pKw of water.

$$PKw = -\log Kw$$

pH: The negative logarithm of the H+ ion concentration is called pH.

$$pH = -\log [H^+]$$

6. Why the value of ionic product of water increases with the rise of temperature? (MLN. GI, 2014)

Ans. The value of ionic product of water (Kw) increases with the rise of temperature because the concentration of hydrogen ion $[H^+]$ and concentration of hydroxide ion $[OH^-]$ increases by increasing temperature. Hence ionic product of water (Kw) increases. The value of Kw approaches 7.5×10^{-14} at 100°C.

$$K_w = [H^+][OH^-]$$

7. How ammonia is synthesized by Haber's Process? Also give the optimum condition of reactions. (SGD. GI, 2014)

Ans. Synthesis of Ammonia by Haber's Process: The Haber process combines nitrogen from the air with hydrogen derived mainly from natural gas (methane) into ammonia. The reaction is reversible and the production of ammonia is exothermic.

Optimum conditions for the synthesis of Ammonia: The most suitable conditions to get maximum yield of ammonia are:

(i) Pressure between 200-300 atmospheres **(ii)** Temperature around 673K (400°C)

(iii) Pieces of iron crystals embedded in a fused mixture of MgO, $A\ell_2O_3$ and SiO_2 acting as catalysts.

8. What is the effect of change in pressure on $2SO_2+O_2 \rightleftharpoons 2SO_3$ reaction? (BWP. GI, 2014)

Ans. Effect of Pressure on SO_3 Formation: Formation of pressure on SO_3 is an exothermic reaction so it occurs at lower temperature. At low temperature Kp for the formation of SO_3

is large but equilibrium is reached very slowly.
In order to have a best yield of SO_3, with in a reasonable time, a mixture of SO_2 and O_2 at "latm" is passed over solid catalyst V_2O_5.

9. What conditions are required for the best possible yield of SO_3? (MLN. GI, 2014)

Ans. Optimum conditions for the synthesis of SO_3: In order to have a best yield of SO_3, within a reasonable time, a mixture of $SO_{2(g)}$ and $O_{2(g)}$ (air) at one atmospheric pressure is passed over a solid catalyst (V_2O_5) at 650°C. The equilibrium mixture is recycled at low temperature of 400-500°C. It increases the yield of $SO_{3(g)}$.

10. What is the effect of increase of temperature on the yield of the product for the reaction $SO_{2(g)} + O_{2(g)} \rightleftharpoons SO_{3(g)}$ +Heat. (MLN. GI, 2015)

Ans. Formation of SO_3 is an exothermic reaction, its mean that formation of SO_3 takes place at low temperature with evolution of heat.

$$SO_2 + O_2 \rightleftharpoons SO_3 \quad -194 kJmol^{-1}$$

So when temperature is increased then reaction will move in backward direction and yield of S03 will decreased.

11. Define reversible reaction with an example. (DGK. GI, 2014)(BWP. GI, 2015)

Ans. The reactions, which go in the forward and the backward direction simultaneously under the similar conditions, are called reversible reactions.

Examples:

(i) $N_2 + 3H_2 \overset{Fe/450°C}{\rightleftharpoons} 2NH_3$ (ii) $H_2 + I_2 \rightleftharpoons 2HI$

(iii) $PC\ell_5 \rightleftharpoons PC\ell_3 + C\ell_2$

12. Differentiate between reversible and Irreversible Reactions. Give examples.
(MLN. GII, 2015)(MLN. GII, 2016)(BWP. GII, FBD. GII, 2017)(MLN. GII, 2018)(LHR. GII, FBD. GII, 2019)

Ans. Difference between reversible and irreversible reactions:-

Reversible Reactions	Irreversible Reactions
(i) The reactions in which products formed are reconverted into reactants are known as reversible reactions	(i) The reactions in which products formed are not reconverted into reactants are known as irreversible reactions.
(ii) These reactions proceed in both directions.	(ii) These reactions proceed only in one direction.
(iii) These are represented by a pair of oppositely directed half headed arrows.	(iii) These reactions are represented by a full headed arrow.
Example: $N_2+3H_2 \overset{Fe/450°C}{\rightleftharpoons} 2NH_3$	**Example:** $2Na_{(s)} + 2H2O_{(\ell)} \longrightarrow 2NaOH_{(aq)}+H_{2(g)}$

13. How does a catalyst affect a reversible reaction?
(SGD. GII, SWL. GI, 2014)(DGK. GII, 2016) (RWP. GI, 2017)(LHR. GI, BWP. GII, 2018)

Ans. Effect of catalyst on equilibrium constant: In most of the reversible reaction the equilibrium is not always reached within a suitable short time. So, an appropriate catalyst is added. A catalyst does not affect the equilibrium position of the reaction. It increases the rates of both forward and backward reactions and this reduces the time to attain the state of equilibrium. Actually, a catalyst lowers the energy of activation of both forward and reverse steps by giving new path to the reaction.

14. What is effect of change of pressure on given reaction, $N_2 + 3H_2 \rightleftharpoons NH_3$ (FBD. GI, 2016)(SWL. GII, DGK. GI, 2017)

Ans. Increase the pressure will decrease the volume of the reaction vessel. Four moles of the

reactants combine to give two, moles of the products. High pressure will shift the equilibrium position to right to give more and more ammonia.

15. What are optimum conditions for the synthesis of NH_3? (FBD. GI, 2014)(BWP. GII, DGK. GI, 2017)(LHR. GI, DGK. GII, 2019)

Ans. Optimum conditions for the synthesis of Ammonia:
The most suitable conditions to get maximum yield of ammonia are:

(i) Pressure between 200-300 **(ii)** Temperature around 673K (400°C)

(iii) Pieces of iron crystals embedded in a fused mixture of MgO, $A\ell_2O_3$ and SiO_2 acting as catalysts.

16. Define Buffer solution and solubility Product. (BWP. GI, 2014)(LHR. GII, 2015)

Ans. Buffer Solutions: Those solutions which resist the change in pH, when a small amount of an acid or a base is added to it, are called buffer solutions.

Solubility Product: Solubility product is the product of the concentrations of ions raised to an exponent equal to the co-efficient of the balanced eauation.

17. Define solubility principle? Give example. (BWP. GI, 2017)

Ans. The principle of Solubility is defined as "the maximum quantity of a substance (solute) that can be completely dissolved in a given solvent at the equilibrium state of solution at content temperature".

18. What is solubility? What is solubility product expression of $PbC\ell_2$? (MLN. GI, DGK. GII, 2016)(FBD. GII, 2015)(BWP. GII, LHR. GI, 2017)(SGD. 2018)

Ans. Solubility: it is a chemical property or the ability substance or solute, to dissolve in a solvent,

Solubility product: The solubility product is the product of the concentrations of ions raised to an exponent equal to the co-efficient of the balanced equation.

Solubility Product Expression for $PbC\ell_2$:

$$PbC\ell_{2(s)} \rightleftharpoons PbC\ell_2(ac) \rightleftharpoons Pb^{2+}_{(a2)} + 2C\ell_{(a2)}$$

$$Kc = \frac{\left(Pb^{2+}_{(2c)}\right)\left(C\ell^{-}_{(ac)}\right)^2}{\left(PbC\ell_2\right)}, \qquad K_{sp} = \left(PB^{2+}_{ac}\right)\left(C\ell^{-}_{(ac)}\right)^2$$

19. What is the solubility product? Derive solubility product expression for Ag_2CrO_4. (FBD. GII, SGD. GII, 2017)

Ans. Solubility Product: The solubility product is the product of the concentrations of ions raised to an exponent equal to the co-efficient of the balanced equation.

$Ag_2CrO_4 \rightarrow 2Ag+ + CrO_4^{-2}$

No. of ions = 3

No. of cation = 2

No. of Anion = 1

Solubility = 8.7×5. –5gdm–l

$$K_{sp} = [Ag+]^2[CrO_4] = 2.6\times10^{-12}$$

20. How extent of a reversible chemical reaction can be indicated by equilibrium constant? (GRW. GI, 2014)(LHR. GI&GII, 2015)(FBD. GI, 2016)(BWP. GI, SGD. GI, LHR. GII, 2017)

Ans. The direction of chemical reaction at any particular time can be predicted by means of [products]/ [reactants] ratio, calculated before the reaction attains equilibrium. The value of [product] / [reactants] ratio leads to one of the following three possibilities.

(a) The ratio is less than K_c. This implies that more of the product is required to attain the equilibrium; therefore, the reaction will proceed in the forward direction.

(b) The ratio is greater than K_c. It means that the reverse reaction will occur to attain the equilibrium.

(c) When the ratio is equal to K_c, then the reaction is at equilibrium.

21. State Le-Chatelier's Principle and discusses the effect of change in concentration of a product on reversible reaction. (GRW. GI, DGK. GII, 2014)(LHR. GI, 2015)(DGK. GI, 2017)(AJK. 2018)(SGD. GII, 2019)

Ans. Le-Chatelier's Principle: Le-Chatelier's Principle states that if a stress is applied to a system at equilibrium, the system acts in such a way so as to nullify, as far as possible, the effect of that stress.

Effect of change in concentration: Addition of a substance among the reactant or the removed of a substance among the products at equilibrium stage disturbs the equilibrium position and reaction is shifted to forward direction.

Addition of a substance among the products or removal of a substance among the reactants will drive the equilibrium in backward direction.

Example: $PC\ell_5 \rightleftharpoons PC\ell_3 + C\ell_2$

If few moles of $PC\ell_5$ are added at equilibrium, the reaction is pushed to the forward direction. If $PC\ell_3$ or $C\ell_2$ or both are added from outside then reaction will move in backward direction.

22. How the change of temperature disturb both the equilibrium position and equilibrium constant? (RWP. GI, 2014)

Ans. Effect of change in temperature:

(a) Increase of Temperature: When the reversible reaction is exothermic then, increase in temperature will shift it to the backward direction, when the reversible reaction is endothermic then the increase of temperature will shift it to the forward direction.

(b) Decrease of Temperature: When the reversible reaction is exothermic then decrease in temperature will shift it to the forward direction. When the reversible reaction is endothermic then decrease of temperature will shift it to the backward directin.

23. Derive the units of Kc for the system. $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (DGK. GII, 2015)(RWP. GI, 2017)

Ans. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_3$

$$K_C = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{[\text{moles dm}^{-3}]^2}{[\text{moles dm}^{-3}][\text{moles dm}^{-3}]^3} = \text{moles}^{-2}\text{dm}^{+6}$$

In the expression of Kc, we have ignored the physical states for the sake of convenience.

24. State law of mass action.

(FBD. GI, 2014)(LHR. GII, 2015)(GRW. GII, LHR. GII, RWP. GI, DGK. GII, MLN. GII, 2017)(MLN. GI, SGD, DGK. GII, BWP. GI, 2018)(GRW. GI & GII, SWL. 2019)

Ans. Law of Mass: The law of mass action can be states as,

The rate at which the reaction proceeds is directly proportional to the product of active masses of the reactants.

25. Why units of equilibrium constants are mostly not mentioned? (GRW. GI, 2015)

Ans. Unit of equilibrium constants are mostly not mentioned because if the reaction has equal number of moles on the reactant and product sides. It is a usual practice that we do not write the units with Kp or Kc values.

Example:

$$CH_3COOH_{(aq)} + C_2H_5OH_{(aq)} \rightleftharpoons CH_3COOC_2H_{5(aq)} + H_2O_{(\ell)}$$

$$K_C = \frac{[CH_3COOC_2H_5][H_2O]}{[CH_3COOH][C_2H_5OH]} = \frac{[\text{moles dm}^{-3}][\text{moles dm}^{-3}]}{[\text{moles dm}^{-3}][\text{moles dm}^{-3}]} = \text{no units}$$

6. Calculate pH of 10^{-4} mol dm^{-3} of $Ba(OH)_2$. (DGK. GII, 2016)(RWP. GI, 2017)

ns. $Ba(OH)_2$ is also a strong electrolyte, and is dissociated 100% at very low concentrations of

10^{-4} mol.dm^{-3}.

$$Ba(OH)2 \_\_\_\_\_ Ba^{2+} + 2OH^-$$
$$10^{-4} \text{ moles dm}^{-3} \_\_\_\_\_ 0+0$$
$$0 \_\_\_\_\_ 10^{-4} + 2(10^{-4})\,t = \text{equilibrium}$$

Formula applied:

$$pOH = -\log [OH^-]$$

Putting the values

$$pOH = -\log 2\times10^{-4} = 3.69$$

Since $pH + pOH = 14$

Therefore, $pH = 14 - pOH = 10.31$.

27. Define PK a and PKb. (MLN. GI, SGD. GII, 2014)(DGK. GI, 2015)(GRW. GII, 2017)(AJK. 2018)

Ans. **PK_a:** It is the negative log of dissociation constant H of an acid. It gives quantitative measurement of strength of acid.

$$Pk_a = -\log K_a$$

PK_b: It is the negative log of dissociation constant of a base. It gives quantitative measurement of strength of base.

$$PK_b = -\log K_b$$

28. Prove $K_p = K_{c(RT)^{\Delta n}}$ (DGK. GI, 2017)

Ans. For the reaction:

$$aA(g) + bB(g) + ... \rightleftharpoons cC(g) + dD(g) + ...$$

The equilibrium constant based on partial pressures is

$$K_p = \frac{P_{Ce}^c P_{De}^d .....}{P_{Ae}^a P_{Be}^b .....}$$

From the ideal gas law: $P_{Ae}V = n_A RT$

Where,

n_A is the number of moles of A

R is the ideal gas constant = 0.0821 dm^3 atm/mol $\bullet$ K^{-1} mole^{-1}

T the absolute temperature in K

P is the pressure in atm

V the system volume in L

Similar expressions can be written for each gas phase component.

Rearranging gives

$$P_{Ae} = \frac{nA}{V}RT$$

But n_A/V is just the molar concentration = $[A]_e$ Substituting into the expression for Kp (for each gas phase component) gives

$$K_p = \frac{([C]_e RT)^c ([D]_e RT)^d ....}{([A]_e RT)^a ([B]_e RT)^b ....}$$

Collecting terms gives

$$K_p = \frac{[C]_e^c [D]_e^d ...}{[A]_e^a [B]_e^b ...} \times \frac{(RT)^c (RT)^d ...}{(RT)^a (RT)^b ...}$$

The left part of the fraction is Kc, so

$$K_p = K_c \times (RT)^{(c+d+...)-(a+b+...)}$$

The exponent in RT is the sum of the stoichiometric coefficients for the reactants subtracted from the sum of the stoichiometric coefficients for the products, defined as Δn.

$K_p = K_p \times (RT)\,\Delta n$

Because the derivation goes through the ideal gas law, the proper units for R in this case is dm³ atm K⁻¹ mole⁻¹ (i.e., R = 0.0821 L•atm/mol•K). (GRW. GII, LHR. GI & GII, 2017)

29. What is ionic product of water?

Ans. Pure water is a very poor conductor of electricity, in Equilibrium state its constant K_c is given as.

as. $H_2O + H_2O \rightleftharpoons H_3O^+ + OH$ and $H_2O \rightleftharpoons H^+ + OH$

Equilibrium constant Kc at 25°C is given as.

$$K_c = \frac{[H^+][OH]}{[H_2O]} = 1.8 \times 10^{-16} \text{ moles dm}^{-3}$$

If H_2O = 1000g = 55.5 moles, then Kc of H_2O is almost equal to another constant called K_w.

$K_c[H_2O] = [H^+][OH^-]$

$K_c = 1.8 \times 10^{-16} \times 55.5 = 1.01 \times 10^{-14} = [H^-][OH]$

This 1.01×10^{-14} is called KC of water of 25°C

Here K_c of water become equal to an other constant "K_w"

$$K_w [H^+][OH^-] = 10^{-14} \text{ at } 25°C$$

Where "K_w" is ionic product of H_2O and at 25°C, it values increases as the temperature increases and value of an acid H^+ and a base OH^- makes it neutral conductor of electricity.

$[H^+] = 10^{-7}$ moles dm^{-3} and $[OH] = 10^{-7}$ moles dm^{-3}

30. What is pH and pOH. (FBD. GI, SGD. GII, BWP. GI, 2014)(BWP. GI, 2014) (MLN. GI, DGK. GI, 2016)(BWP. GI, AJK. GI, FBD. GII, 2017)(SGD. GII, RWP. BWP. GI, BWP. GII, 2019)

Ans. pKw: The negative log of the dissociation constant (Kw) of water at any temperature is called pKw of water.

Whatever the concentrations of H^+ or OH^- are, in an aqueous solution the value of pKw is always equal to 14, at 25°C.

$$PK_w = -\log Kw$$

PH: The negative logarithm of the H+ ion concentration is called pH.

$$pH = -\log [H^+]$$

pOH: The negative log of OH^- ion concentration is called pOH.

$$pOH = -\log [OH^-]$$

31. How does a Buffer act? Explain with an example. (MLN. GI, 2015)(MLN. GII, 2018)(SGD. GI, 2019)

Ans. Le-Chatelier's principle and common ion effect can help us to understand the buffer action of the solutions.

Let us consider the buffer solution consisted of CH_3COOH and CH_3COONa. Both are dissociated in water. Sodium acetate being a very strong electrolyte as compared to acetic acid furnishes sufficient CH_3COO^- ion as compared to CH_3COOH.

$$CH_3COOH \rightleftharpoons CH_3COO^-_{(aq)} + H^+_{(aq)}$$

$$CH_3COONa \rightleftharpoons CH_3COO^-_{(aq)} + Na^+_{(aq)}$$

When a few drops of an acid, say HCI are added in this solution, the H^+ ions provided by HCI are taken up by CH_3COO^- (mostly obtained from CH_3COONa) so incoming protons are consumed and pH is retained.

When a few drops of a base say NaOH is added from outside, then the protons already present in the solution are consumed. To compensate to those protons, there happens a further dissociation of CH_3COOH and pH is retained.

32. Give two applications of Buffer solution.

Ans. Applications of Buffer solution: (DGK. GI, 2014)(MLN. GII, 2016)(LHR. GI, 2017)(BWP. GI, 2018)

(i) Many industrial processes such as electroplating, manufacture of leather, manufacture of photographical materials and the preparation of dyes require the use of buffers.

(ii) The pH of human blood is buffered at 7.4. This is maintained by a mixture of bicarbonates, phosphates and complex protein systems. For the normal range, the pH of blood is from 7.35 to 7.45. In case it decreases up to 7 or goes up to 8 deaths may occur.

(iii) Buffer solutions are extensively used by an analytical chemist.

(iv) Buffer tablets are available in the market which can be used to calibrate the pH meter.

(v) In bacteriological research, one uses the buffer solutions in culture media, because the growth of bacteria needs a definite pH.

33. Why do we need buffer solution? (AJK. GI, FBD. GI, 2015)

Ans. Sometimes we want to study a reaction under conditions that would suffer any associated change in the pH of the reaction mixture. So, by suitable choice of the solutes, a chemist can ensure that a solution will not experience more than a very small change in pH, even if a small amount of a strong acid or a strong base is added.

34. What is meant by Buffer Capacity? (DKG. GII, AJK. GI, 2015)(DGK. GII, 2018)(GRW. GII, 2019)

Ans. The buffer capacity of a solution is the capability of a buffer to resist the change of pH. It is measured quantitatively that how much extra acid or a base solution can be absorbed before the buffer is essentially destroyed.

The molarities of the two components of buffer solution determine the buffer capacity.

35. Give the effect of pressure on the following reversible reaction. $PC\ell_5 \rightleftharpoons PC\ell_3 + C\ell_2$ (MLN. GII, 2015)(MLN. GI, SGD. GII, 2017)

Ans. $PC\ell_{5(g)} \rightleftharpoons PC\ell_{3(g)} + C\ell_{2(g)}$

'a' moles 'o' moles 'o' moles $t = 0$ sec.

(a-x) moles 'x' moles 'x' moles $t = t_{eq}$

$$\left(\frac{a-x}{v}\right)\text{moles dm}^{-3} \rightleftharpoons \left(\frac{x}{v}\right)\text{moles dm}^{-3} + \left(\frac{x}{v}\right)\text{moles dm}^{-3}$$

Equilibrium constant expression:

Since $K_c = \dfrac{[PC\ell_3][C\ell_2]}{[PC\ell_5]}$

Putting the concentrations at equilibrium

$$K_c = \frac{\frac{x}{V}\cdot\frac{x}{V}}{\frac{(a-x)}{V}}$$

Simplifying the right hand side, we get

$$K_c = \frac{x^2}{V(a-x)}$$

36. Give the relationship of equilibrium constants K_c and K_p. (BWP. GI, MLN. GI, 2016)(LHR. GI, 2018)

Ans. Consider the following reversible reaction.

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

When concentrations are expressed in terms of partial pressure for gaseous reactants and products then.

Since

$$PV = nRT$$

$$PV = \frac{nRT}{V} \quad \text{(ii)} \quad \frac{n}{V} = C$$

Putting this value of "Pressure" from equation (ii) to equation (i) and rearranging.

$$K_p = \frac{(C_C RT.C_D RT)^{c+d}}{(C_A RT.C_B RT)^{a+b}}$$

$$K_p = \frac{(C_C.C_D)^{c+d}}{(C_A.C_B)^{a+b}} R^n T^n \Rightarrow K_p = K_c (RT)^{\Delta n}$$

$$\therefore \Delta n = o \Rightarrow K_p = K_c$$

$$\therefore \Delta n = -ve \Rightarrow k_p > K_c$$

$$\therefore \Delta N = +v \Rightarrow k_p < K_c$$

37. Prove that Pka + Pkb = 14 at 25°C. (GRW. GI, 2014)(GRW. GII, 2015)(RWP. 2018)(FBD. GI, 2019)

Ans. $HA + H_2O \rightleftharpoons H_3O^+ + A^-$

Now, $K_C = \frac{[H_3O^+][A^-]}{[H_2O][HA]}$ or $K_a = \frac{[H^+][A^-]}{[HA]}$

In case A^- is dissolved in water, the equation for hydrolysis of conjugate base A^- will be,

$$A^- + H_2O \rightleftharpoons HA + OH^-$$

So, its

$$K_b = \frac{[HA][OH]}{[A^-]}$$

Let us multiply two expressions for K_a and K_b

$$K_a \times K_b = \frac{[H^+][A^-]}{[HA]} \times \frac{[OH^-][HA]}{[A^-]}$$

$$K_a \times K_b = \frac{[H^+][A^-]}{[HA]} \times \frac{[OH^-][HA]}{[A^-]}$$

$$K_a \times K_b = K_w$$

The value of K_w is a constant at a given temperature, i.e 10^{-14} at 25°C.

Let us take the log of above equation:

$$\log(K_a \times K_b) = \log(K_w)$$

Or $\log K_a + \log K_b = \log K_w$

Multiply both sides by '–1'

$$-\log K_a - \log K_b = -\log K_w$$

Since,

$$pK_a = -\log K_a \text{ and } pK_b = -\log K_b$$

Or $pK_a + pK_b = pK_w$

Since $pK_w = 14$, at 25°C, hence pK_a and pK_b of conjugate acid base pair has a very simple relation with each other.?

$$pK_a + pK_b = 14 \text{ at } 25°C,$$

38. What is meant by common ion effect?

(BWP. GI, RWP. GII, SWL. GII, 2017)(SGD. 2018)(GRW. GI, 2019) (RWP. GI, 2014)(FBD. GI, 2015)

Ans. Common Ion effect: The suppression of ionization of a weak electrolyte by adding a common ion from outside is called common ion Effect.

Example: The dissociation of a weak acid H_2S in water can be suppressed by the addition

of stronger acid $HC\ell$. H^+ is a common ion. H_2S becomes less dissociated in acidic solution. In this way low concentration of S^{-2} ion is developed.

$$H^2S \rightleftharpoons 2H^+ + 2H^+(aq) + S^{-2}(aq)$$

This low concentration of S^{-2} ions helps to do the precipitation of radicals of second group basic radicals during salt analysis.

$$HC\ell(aq) \rightleftharpoons H^+(aq) + C\ell_{(aq)}$$

39. Why do the rate of forward reaction slow down when a reversible reaction approaches the equilibrium stage? (LHR. GII. 2018)

Ans. The rate of forward reaction slow down when a reversible reaction approaches to equilibrium stage is that all reaction cease at equilibrium so that the system become stationary. The forward and reverse reaction are take place simultaneously at exactly the same rate.

40. Prove by equations that what happens when Na_2CrO_4 is added to saturated solution of $PbCrO_4$? (LHR. GII. 2018)

Ans. The presence of a common ion decreases the solubility of a slightly soluble ionic compounds. In order to explain it, consider a saturated solution of $PbCrO_4$, which is a sparingly soluble in ionic salt.

$PbCrO_4\,(aq) \rightleftharpoons Pb^{2+}\,(aq) + CrO_4^{2-}\,(aq)$

Now add Na_2CrO_4 which is a soluble salt. CrO_4^{2-} is the common ion. It combines with pb^{2+} to form more insoluble $PbCrO_4$. So equilibrium is shifted to the left to keep K_{sp} constant.

41. Define Lowry Bronsted concept of acids and bases. (LHR. GII, MLN. GI, SGD. 2018)

Ans. **Acid:** A substance that donate a proton H^+ to another substance is called lowry Bronsted acid.

Base: A base is a substance that accept the proton.

42. What is the formula to calculate the percentage ionization of weak acid? (LHR. GII. 2018)

Ans. The formula to calculate the percentage of weak acid is:

$$Ka = \frac{[H_3O^+]\{A^-]}{[HA]}$$

43. What effect will be observed when we change pressure, on the production of NH_3 and SO_3 by following reactions: (GRW. 2018)

(a) $N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$ **(b) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3\,(g)$**

Ans. $N_2 + 3H_2 \rightleftharpoons 2NH_3$

So high pressure, low temperature and continual removal of ammonia will give the maximum yield of ammonia. The effect of the rise of temperature on the value of K_c. The optimum conditions to get maximum yield of ammonia. The percent yield of ammonia vs temperature (°C) at five different operating pressures. At very high pressure and low temperature the yield of NH_3 is high but the rate of formation is low.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

High pressure tends to increases yield of SO_3 however, instead using high pressure the concentration of O_2 is increased to increase the yield of SO_3 help to understand the effect of yield of SO_3.

44. What will be the nature of solution having pH equal to 12? (GRW. 2018)

Ans. The value of pH varies form 0 – 14. A solution having pH value in between 0 – 7 are acidic in nature while a solution having pH value 7 – 14 is basic in nature. The mentioned solution has pH = 12 so it is basic in nature.

45. What happens to the acidic and basic properties of aqueous solutions when pH varies from zero to 14? (FBD. 2018)

Ans. When the pH ranges from 1 to 6 it will be acidic in nature while on the range or of 8 to 14 it will be basic when the pH is 7 it will be neutral.

46. Prepare acidic and basic buffers with one example in each case. (FBD. 2018)

Ans. Acidic Buffers: By mixing a weak acid and its salt with a stronger base. Such solutions give acidic buffers with pH less than 7. Mixture of acetic acid and sodium acetate in one of the best example of such a buffer.

Basic Buffer: By mixing a weak base and its salt with a stronger acid. Such solutions will give basic buffers with pH more than 7. Mixture of NH_4OH and $NH_4C\ell$ is one of the best example of such a basic buffer.

47. What will be the effect of increase of pressure and temperature on the following reaction? (FBD. 2018)

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -92.46kJ$$

Ans. Increase the pressure to decrease the volume of the reaction vessel. Four moles of the rectant combine to give two moles of the product. High pressure will shift the equilibium position to right to give more and more ammonia.

Decreasing the temperature will shift it to the forword direction according to Le-chatelier's principle.

48. Why do we need buffers in daily life? (FBD. GI, 2017)(MLN. GI, DGK. GI, 2018)

Ans. Sometimes we want to study a reaction under conditions that would suffer any associated change in the pH of the reaction mixture. So, by suitable choice of the solutes, a chemist can ensure that a solution will not experience more than a very small change in pH, even if a small amount of a strong acid or a strong base is added.

49. Define Solubility Product Constant (K_{SP}) (MLN. GI, 2018)

Ans. Solubility Product Constant: The equilibrium expresses the degree to which the solid is soluble in water the equilibrium constant is called a solubility product constan or simple it is solubility product constant and is denoted by Ksp.

50. What is buffer solution? Give types of buffer solution with their composition. (RWP. 2018)

Ans. A buffer solution is one which resists changes in pH when small quantities of an acid or an alkali are added to it.

Buffer solution can be prepared by the following two ways.

1. Bymixing a weak acid and salt of it with a strong base.

Example:

(i) $CH_3COOH + CH_3COONa$ (ii) $H_3PO_4 + NaH_2PO_4$

(iii) $H_2CO_3 + NaHCO_3$

They give buffers having pH value less than seven.

2. By mixing a weak base and salt of it with a strong acid.

Example: They give basic buffers having pH values more than seven.

51. Define solubility product along with its one application. (DGK. GI, 2018)

Ans. The solubility product is the product of the concentration of ion raised to an exponent equal to co-efficient of balanced equation.

For this purpose we need the formula of the compound and Ksp value. Then the unknown molar solubility is calculated and the concentration of the ions is determined.

The relationship between the Ksp values and the solubility of some sparingly soluble compounds.

52. Write effect of change in pressure on following reaction at equilibrium state (DGK. GI, 2018)

$$N_{2(S)}+3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

Ans. $N_2 + 3H_2 \rightleftharpoons 2NH_3$ Increase the pressure to decrease the volume of the reaction vessel. Four moles of the reactants combine to give two moles of the products. High pressure will shift the equilibrium position to right to give more and more ammonia.

53. What is ionization constant of acids (SWL, DGK. GII, 2018)

Ans. Acid and Bases when dissolved in water may or may not completely dissociated. Many acids are weak electrolytes to ionize to an extent which less than 100%. The value of Kc called dissocation constant of acid.

54. Define pH of a Solution. Give its mathematical formula. (BWP. GII, 2018)

Ans. **pH:** The negative logarithm of hydrogen ion concentration present is the solution is called as pH of the solution.

Mathematical Formual: $pH = -\log [H^+]$

55. What are Basic Buffers? How are they prepared? (BWP. GII, 2018)(SWL. 2019)

Ans. Basic buffers having pH values more than 7. They can be prepared by combining weak base and salt of it with a strong acid.

e.g. $NH_4OH + NH_4C\ell$ give us a basic buffer solution.

56. Discuss the effect of common ion on the solubility of sparingly soluble salt with one example. (DGK. GI, 2019)

Ans. The solubility of a partially soluble electrolyte is decreased by the addition of a more soluble electrolyte having common ion. For example precipitation of $KClO_3$.

$$KC\ell O_3 \rightleftharpoons K^+ + C\ell O_3^-$$

$$KC\ell \rightleftharpoons K^+ + C\ell^-$$

57. Why Solubility of Glucose in water in increased by increasing the temperature? (BWP. GI, 2019)

Ans. When glucose is dissolved in water it show endothermic, heat of solution. Solute molecules seprate from each other to dissolve in solvent. This process required energy. So when temperature is increased solubility increase.

58. Explain the effect of change in temperature on K_w. (BWP. GII, 2019)

Ans. K_w is called ionic product of water or dissociation constant of water. The value of K_w increases almost 75 times when temperature is increased from 0°C to 100°C. Anyhow, the increase in K_w is not regular.

ESSAY TYPE QUESTIONS

1. Calculate the pH of a buffer pollution in which 0.11 molar CH_3COONa and 0.09 molar acetic acid solutions are present Ka for acetic acid is 1.85×10^{-5}. (DGK. GII, 2016)

2. The following reaction was allowed to reach the state of equilibrium. $2A_{(aq)} \rightleftharpoons C_{(aq)}$. The initial amounts of the reactants in one dm^3 of solution were 0.50 mole of A and 0.60 mole of B. At equilibrium, the amounts were 0.20 moles of A and 0.45 moles of B and 0.15 mole of C. Calculate the equilibrium constant Kc. (BWP. GI, 2014)

3. Calculate the percentage ionization of acetic acid in a solution in which 0.1 moles of it has been dissolved per dm^3 of the solution. $K_a = 1.85 \times 10^{-5}$. (SGD. GII, 2017)(GRW. GII, FBD. GI, AJK. 201

4. Calculate the pH of buffer solution in which 0.11 molar $H_3CCOONa$ and 0.0 molar acetic acid solutions are present Ka for $H_3CCOONa$ is 1.85×10^{-5}. (SWL. GI, MLN. GI, GRW. GII, 2014)(BWP. GI, RWP. GI, 2015)(FBD. GI, 2016)(SGD. GI, BWP. GI, 201

5. $N_{2(g)}$ and $H_{2(g)}$ combine to give $NH_{3(g)}$. The value of Kc in this reaction at 500C° i 6.0×10^{-2} calculate the value of Kp for this reaction. (RWP. GI, GRW. GI, 2014)(AJK. GII, 2017)(RWP. 2018)(FBD. GII, MLN. GI, & GII, SWL. 201

6. $Ca(OH)_2$ is a sparingly soluble compound. Its solubility product i 6.5×10^{-6}. Calculate the solubility of $Ca(OH)_2$. (Atomic mass: Ca = 40). (LHR. GII, 2015)(LHR. GII, DGK. GI, 201 (RWP. GII, BWP. GI, DGK. GI, 2017)(LHR. GI & GII, GRW. GI, 201

7. The Solubility product of Ag_2CrO_4 in water is 2.6 x 102 at 25°C, calculate th solubility of the compound. (MLN. GI, 2016)(LHR. GI, 201

8. Benzoic acid, C_6H_5COOH, is a weak mono basic acid (Ka = 6.4×10^{-5} mol dm^{-3}). What is the pH of a solution containing 7.2 g of sodium benzoate (C_6H_5COONa) in one dm^3 of 0.02 mol dm^{-3} benzoic acid? (Atomic masses Na: 23, C: 12) (SGD. GII, 2014)(DGK. GI, LHR. GI, 2015)(MLN. GII, BWP. GI, 2016)(DGK. GII, 201

9. What is common ion effect? How is this effect used in salt analysis, give two examples? (LHR. GII, SWL, AJK. 2018)

10. How can you predict the followings with the help of equilibrium constant (K_C) of reversible reaction:
    (i) Direction of a reaction (ii) Extent of a reaction (GRW, BWP. GI, 2018)

11. Define law of mass action. Derive equilibrium constant expression for a given reversible reaction: $aA + bB \rightleftharpoons cC + dD$ (FBD, SGD. 2018)

12. Explain Lowry Bronsted Acid and Base concept. Explain giving examples. (MLN. GI, 2018)

13. What are buffer solutions ? Derive Henderson's equation for finding pH of a buffer. (DGK. GII, 2018)

14. Define pH and pOH. Mow are they related with pKw? (BWP. GII, 2018)

CHAPTER 09

SOLUTIONS

MULTIPLE CHOICE QUESTIONS (MCQ's)

1. **Relative lowering of vapour pressure is equal to:** (LHR. GII, 2017)
   [A] Mole fraction of solute (B) Mole fraction of solvent
   (C) Molarity (D) Molality

2. **Which of the following solutions has the highest boiling point?** (BWP. GI, 2017)(MLN. GI, & GII, 2019)
   [A] 5.85% solution of sodium chloride (B) 18.0% solution of glucose
   (C) 6.0% solution of urea (D) All have the same boiling point

3. **Melting of ice can be lowered by the use of:** (RWP. GI, 2014)
   (A) $LiC\ell$ (B) $BeC\ell_2$ [C] $NaC\ell$ (D) $AgC\ell$

4. **18 g glucose is dissolved in 90g of water. The relative lowering of%vapour pressure is equal to:** (MLN. GI, 2014)(FBD. GI, 2015)(LHR. GI, AJK. GI, FBD. GI, 2016)(MLN. GI, LHR. GI, 2017) (GRW, MLN. GI, DGK. GI, 2018)(LHR. GI, MLN. GI, SGD. GII, 2019)
   (A) $\frac{1}{5}$ (B) 5.1 [C] $\frac{1}{51}$ (D) 6

5. **Azeotropic mixture of two liquids boils at a lower temperature than either of them, when:** (FBD. GII, SGD. GI, 2019)
   (A) it is saturated
   [B] it shows positive deviation from Raoult's law
   (C) it shows negative deviation from Raoult's law
   (D) it is metastable

6. **Ideal solutions obey:** (LHR. GI, 2018)
   (A) Henry's law (B) Avogadro's law [C] Raoult's law (D) Smith's law

7. **The number of moles of hydrogen atoms in 92g alcohol (C_2H_5OH) are:** (FBD. 2018)
   (A) 5 moles (B) 6 moles (C) 10 moles [D] 12 moles

8. **One molar solution of glucose ($C_6H_{12}O_6$) contains the amount of solute in $500cm^3$ solution:** (FBD. 2018)
   (A) 180g [B] 90g (C) 45g (D) 270g

9. **When ionic product of a solution is greater than the solubility product at a particular temperature then the solution is said to be:-** (MLN. GI, 2018)
   (A) Unsaturated [B] Saturated (C) Very dilute (D) Super saturated

10. **A solution of glucose is 10% the volume to which 1 gm/mole of it dissqlved will be:** (SWL. 2018)
    (A) $1dm^3$ (B) $200Cm^3$ [C] $1.8\ dm^3$ (D) $900Cm^3$

11. **Which one of the following is an ideal solution.** (SGD. 2018)
    (A) C_2H_5-OH and H_2O (B) C_6H_6 and $CC\ell_4$
    (C) $CHC\ell_3$ and $(CH_3)_2CO$ [D] None of these

12. **The Number of Moles of Solute per kg of Solvent is called:** (BWP. GI, 2018)
    [A] Molality (B) Molarity (C) Mole Fraction (D) Normality

13. **The salt dissolved in water forms a solution of pH greater than 7:** (LHR. GI, DGK. GI, 2019)
    (A) $NaC\ell$ [B] Na_2CO_3 (C) $CuSO_4$ (D) $NH4C\ell$

(LHR. GII, 2015)

14. **Liquids which are practically immiscible:**
[A] $H_2O + C_6H_6$ (B) $H_2O + C_2H_5 - OH$
(C) $H_2O + HCl$ (D) $H_2O + CH_3 - O - CH_3$

(AJK. 2015)

15. **Which one of the following is not a colligative property:**
(A) Lowering of vapour pressure (B) Elevation of B.P
(C) Depression of Freezing point [D] Boiling point of soution

16. **In Azeotropic mixture showing positive deviation from Raoult's law, the volume of the mixture is:**
[A] slightly more than the total volume of the components
(B) slightly less than the total volume of the components
(C) equal to the total volume of the components
(D) none of these

17. **Two solutions of NaCℓ and KCℓ are prepared separately by dissolving same moles of them in the fixed amount of solvent. Which of the following statements is true for these solutions?**
(A) KCℓ solution will have higher boiling point than NaCℓ solution
(B) Both the solution have different boiling point
[C] KCℓ and NaCℓ solutions possess same vapour pressure
(D) KCℓ solution possesses lower freezing point than NaCℓ solution

SHORT ANSWER QUESTIONS

1. **Aqueous solution of CH_3COONa is basic why?** (SWL. GI, 2014)(FBD. GI, 2015)(GRW. GI, 2019)

Ans. Aqueous solution of CH_3COONa is basic in a nature because the acetate ion is hydrolyzed in water to give CH_3COOH and OH^- becomes free. Na^+ is not hydrolyzed, i.e.

$$CH_3COONa + H_2O \rightleftharpoons CH_3COOH + Na^+ + OH^-$$

2. **Why the aqueous solution of $NH_4C\ell$ is acidic?**
(GRW. GII, 2014)(GRW. GII, 2015)(SWL. GII, BWP. GII, 2017)(SGD. GII, 2019)

Ans. Aqueous solution of $NH_4C\ell$ is acidic in nature because Ammonium Chloride ($NH_4C\ell$) is a salt of a strong acid ($HC\ell$) and a weak base (NH_4OH). Hence, in an aqueous solution, it shows acidic properties. When mixed with water, it gets hydrolyzed as follows.

$$NH_4C\ell + H_2O \rightarrow NH_4OH + HC\ell$$

The salt and the strong acid ($HC\ell$) get ionized while the weak base (NH_4OH) remains unionized.

$$NH_4^+ + C\ell^- + H_2O \rightarrow NH_4OH + H^+ + C\ell^-$$

Cancelling the $C\ell^-$ ions from both sides.

$$NH_4^+ + H_2O \rightarrow NH_4OH + H^+$$

The H^+ ions left in the solution gives the solution it's acidic properties.

3. **Define cryoscopy constant with an example.** (DGK. GII, 2015)(AJK. GI, 2016) (DGK. GII, 2017)

Ans. Cryoscopic constant (Molar Freezing point constant):

Cryoscopy constant is the depression of freezing point of one molal solution of a non-volatile, non-electrolyte solute in a volatile solvent.

It is also known as molal freezing point constant.

It is denoted by K_f.

Examples:

Solvent	Normal F.P. (°C)	Molal F.P. constant K_r (°C / molal)
Acetic acid	16.6	3.90
Water	0.00	1.86

4. Boiling points of the solvents increase due to the presence of solutes. Justify it. (AJK. GI, 2015)(FBD. GII, RWP. GII, 2017)

Ans. The presence of non-volatile solutes increases the boiling point of solvent because whenever a solvent is heated, its vapour pressure rises. When the vapour pressure becomes equal to the external pressure then the solvent boils. The addition of a non-volatile solute lowers the vapour pressure therefore, the temperature at which the solution will boil is increased.

5. Give two applications of Colligative properties. (SGD. GI, 2014)(DGK. GII, 2019)

Ans. Applications of Colligative properties:

(i) We can determine the molecular mass with the help of colligative properties.

(ii) Colligative properties also contributed to the development of solution theory.

(iii) The most important application of this phenomenon is the use of antifreeze (e.g ethylene glycol) in the radiater of automobile.

(iv) Freezing mixture preparation is another application.

6. What is solubility principle? (BWP. GI, 2017)

Ans. "The principle of Solubility is defined as" the maximum quantity of a substance (solute) that can be completely dissolved in a given solvent at the equilibrium state of solution at constant temperature".

7. What is solubility carve? Name its two types. (DGK. GI, 2016)(LHR. GI, 2019)

Ans. Solubility carve: A graphical representation between temperature and solubility of the solution is called solubility curves.

Types of Solubility Curve:

(i) Continuous solubility curves. **(ii)** Discontinuous solubility curves.

8. What are continuous solubility curve? Give an example also. (MLN. GII, 2015)

Ans. Continuous solubility curve is a gradual increase or decrease of the solubility of a substance with change of temperature, and then it is continuous solubility curve.

Example: **(i)** $KC\ell O_3$ **(ii)** $K_2Cr_2O_7$ **(iii)** $Pb(NO_3)_3$ **(iv)** $CaC\ell_2$

9. Give two examples of Liquid, liquid solutions. (DGK. GI, 2014)

Ans. Liquid- Liquid solutions:

The liquids which are mix up with each other in all proportions and give homogeneous mixture, forming liquid-liquid solutions:

Examples:

(i) Water and alcohol are completely miscible with each other.

(ii) Alcohol and ether are completely miscible with each other.

(iii) Benzene and toluene are also completely miscible with each other.

10. Define Raoult's Law. Give one of its mathematical forms. (MLN. GI, 2016)(BWP. GI&GII, 2017)(BWP. GII, 2018)(FBD. GI, MLN. GI, 2019

Ans. Raoult's Law:

The vapour pressure of the solution is directly proportional to the mole fraction of th solvent.

Mathematical forms. pX1

$$p = p^\circ X_1 \quad \text{_____(1)}$$

Where,

p = vapour pressure of solution

p° = vapour pressure of pure solvent

X_1 = mole fraction of solvent

In order to deduce the second definition of Raoult's law, we proceed as follows.

Since, $X_1 + X_2 = 1$ (X_1 is mole fraction of solute)

So, $X_1 = 1 - X_2$

Putting this value of Xi in equation (1)

$p = P^\circ(1-x_2)$

$p = p^\circ - p^\circ x_2$

$p^\circ - P = P^\circ x_2$

As $p^\circ - p = \Delta p$ (Δp is lowering of vapour pressure)

So $\Delta p = p^\circ x_2$

$\Delta p \propto x_2$

"Raoult law can also stated as the lowering of vapour pressure of a solvent is directly proportional to the mole fraction of solute.

$\frac{\Delta p}{p^\circ} = x_2 \left(\frac{\Delta p}{p} \text{is the relative lowering of vapour pressure} \right)$

11. Non-ideal solutions do not obey the Raoult's law. (SGD. GII, 2017)

Ans. Non-ideal solutions do not obey Raoult's law because they have differences in their molecular structures i.e size, shape and intermolecular forces and due to there differences, the lowering of upper pressure does not remaining in accordances with Raoult's law.

12. One molal solution of urea, in water is dilute as compared to one molar solution of urea, but the number of particles of the solute is same. Justify it.

(DGK. GII, MLN. GI, BWP. GI, 2014)(DGK. GI, LHR. GII, 2015)(LHR. GII, FBD. GI, BWP. GI, 2016) (LHR. GII, GRW. GII, FBD. GI, MLN. GI, RWP. BWP. GI, 2019)

Ans. In one molal urea solution, 1 mole urea is present in 1000g of water. In one molar urea solution, 60g (1 mole) urea is present in 1000 cm^3 of solution.

In first case volume of solution (60 g urea + 1000g H_2O) is greater than 1000 cm^3 of molar solution. Therefore one molal solution is dilute than one molar solution.

13. Differentiate between ideal and non-ideal solution.

(LHR. GI, 2014)(MLN. GII, 2016)(SGD. GI, 2017)(GRW, BWP. GI, 2018)(GRW. GI, SGD. GII, BWP. GI, 2019)

Ans.

Ideal Solution	Non-Ideal Solution
(i) The forces of attraction between the molecules of different components are same as when they were in the pure state.	(i) The forces of attractions between the molecules of different components are different from the situation when they were in the pure state.
(ii) The sum of volumes of individual components is equal to the volume of solutions. $V_1 + V_2 = V_{solution}$	(ii) The sum of volumes of individual component is not equal to the volume of solution. $V_1 + V_2 \neq V_{solution}$
(iii) There is no enthalpy change (ΔH) during the formation of solution. $(\Delta H) = 0$	(iii) There is an enthalpy change during the formation of solution. $\Delta H \neq 0$
(iv) The solutions obey the Raoult's Law.	(iv) The solutions do not obey the Raoult's law.

14. $Na_2SO_4.10H_2O$ shows discontinuous solubility curve. Give reason. (SGD. GI, 2014)

Ans. $Na_2SO_4\ 10H_2O$ shows discontinuous solubility curve because this curve is the combination of two or more solubility curves. At the break a new solid phase appears and another solubility curve of that new phase begins. It is the number of molecules of water crystallization which changes and Hence solubility chanqes.

15. What is discontinuous solubility curve? Give one example.
(BWP. GI, GRW. GI, 2015) (MLN. GII, 2017)

Ans. Discontinuous solubility curve show sudden changes of direction are called discontinuous solubility curves.

Examples: The most important substance which show discontinuous solubility curves are:

(i) $Na_2SO_4.10H_2O$ (ii) $CaC\ell_26H_2O$ (iii) NH_4NO_3

16. $NaC\ell$ lowers the melting point of ice. Give reason.
(SGD. GII, 2014)(DGK. GI, LHR. GI, MLN. GII, 2015)(BWP. GI, 2016)(LHR. GI, AJK. GII, FBD. GII, 2017)

Ans. $NaC\ell$ and KNO_3 are electrolytes and are sufficiently soluble in water. They double the number of particles after dissociation in water. In this way they, can manage to decrease the freezing point of water to a greater extent as compared to a non-electrolyte.

17. In summer the antifreeze solutions protect liquid of the radiator from boiling over. Justify it.
(MLN. GI, 2014)(LHR. GI, 2015)(AJK. GII, MLN. GII, 2017)

Ans. Water boils at 100°C. It is used in the radiators to decrease the temperature of the working engine. If we add some suitable solutes which increase the boiling point of water, above 100°C, then easy boiling over of water is avoided. Actually such solutes also decrease the freeginy point of solutions as well.

18. Define upper consulate temperature with example.
(SGD. GII, 2014)(MLN. GI, RWP. GI, LHR. GI, 2015)(GRW. GII, 2017)

Ans. Critical solution temperature:

The temperature at which two conjugate solution merge into one another is called critical solution temperature or upper consulate temperature.

Example: 65.9 °C is the critical solution temperature of water phenol system.

19. Cane sugar cannot be dissolved in benzene. Give reason. (GRW. GI, 2014)(SWL. GII, 2017)

Ans. Sugar cane cannot be dissolved in benzene, because sugar is soluble only in polar covalent compounds like water while benzyne is not a polar compound, hence cane sugar does not dissolve in benzene according to rule like dissolve like.

20. Many solutions do not behave ideally. Give reason. (GRW. GI, 2014)

Ans. Many solutions do not behave ideally. They show deviations from Raoult's Law due to differences in their molecular structures i.e. size shape and intermolecular forces. Formation of such solutions is accompanied by changes in volume and enthalpy. The vapour pressure deviations may be positive or negative in such solutions.

21. Make difference between continuous and discontinuous solubility curves. (FBD. GI, 2014)

Ans. Difference between continuous and discontinuous solubility curves:

Continuous Solubility Curve	Discontinuous Solubility Curve
(i) Continuous solubility curves don't show sharp breaks anywhere.	(i) Discontinuous solubility curve show sudden change of solubility's.
(ii) These curves are not combination of two or more solubility curves.	(ii) These curves are combination of two or more solubility curves.

(iii) In this, there is no sharp breaks.	(iii) At the break a new solid phase appears and another solubility curve of that new phase begins.
Examples: $KC\ell O_3$, $K_2Cr_2O_7$, $CaC\ell_2$	**Examples:** $Na_2SO_4.10H_2O$, $CaC\ell_2.6H_2O$

22. 100 g of 98% H_2SO_2 has a volume of 54.34 cm^3 of H_2SO_4. (Density = 1.84 g cm^{-3}) (DGK. GI, 2018)

Ans. $$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{Since, volume} = \frac{\text{mass}}{\text{density}}$$

Putting the values:

$$\text{volume} = \frac{100\,\text{g}}{1.84\,\text{g cm}^{-3}} = 54.3\text{cm}^3$$

It means that the 98% H_2SO_4 having total mass of 100 g has a volume of 54.34 cm^3.

23. Define ebullioscopic constant with an example.

(GRW. GI, 2014)(GRW. GII, 2015)(AJK. GI, BWP. GI, 2016)

Ans. Ebullioscopic constant:

Ebullioscopic constant is the elevation of the boiling point for one molal solution of a non-volatile, non-electrolyte solute in a volatile solvent.

It is also known as molal boiling point constant.

It is denoted by K_b.

Example: Ebullioscopic constant of water $=H_2O$ Kb = 0.52 °C

24. What is the difference between Zeotropic and Azeotropic solutions?

(MLN. GII, 2017)(LHR. GI, 2018)(AJK. 2019)

Ans.

Zeotrophic solutions	Azeotrophic solutions
Such solutions or mixtures, which distil with a change in composition, are called zerotroppic solutions or mixtures. Example: Methyl alcohol-water solution can be separated into pure components by distillation.	Those solutions or mixtures, which have a constant boiling point and they distil over without changing their composition at any temperature like a Pure chemical compound, are called azeotropic solutions. Example: $HC\ell$ forms an azeotropic mixture with water

25. Define Azeotropic mixtures with example. (DGK. GI&GII, 2014)(GRW. GII, FBD. GI, 2017)

Ans. Azeotropic mixtures:

Azeotropic mixtures are those which boil at constant temperature and distil over without change in composition at any temperature like a pure chemical compound.

Example:

(i) Azeotropic with maximum boiling point, with Negative Deviation:

A	B	Azeotrope Boiling point (°C)	Weight % of A in Azeotrope
Water	$HC\ell$	108.5	79.76
Chloroform	Acetone	64.7	80.00

(ii) Azeotropic with minimum boiling points and positive deviation.

A	B	Azeotrope Boiling point (°C)	Weight % of A in Azeotrope
Water	Ethanol	78.15	4.4
$CC\ell_4$	CH_3OH	55.7	79.4

26. Relative lowering of vapour pressure is independent of the temperature. (FBD. GII, SWL. 2019)

Ans. The relative lowering of vapour pressure and mole fraction of solute are related as:

$$\frac{Dp}{p^\circ} X_2 - \frac{n_2}{n_1 + n_2}$$

(i) Vapour pressure and lowering of va, our pressure depend upon temperature. So, when the temperature of a solution is increased both the factors ΔP and P° increase in such a way that the ratio remains the same.

(ii) Another reason is that the moles of a substance do not depend upon temperature. So relative lowering of vapour pressure is independent of temperature.

27. Colligative properties are obeyed when the solute is non-electrolyte, and also when the solutions are dilute.

Ans. The properties which depend upon number of solute partical and not upon their nature are called colligative pr perties.

- Solute is an el.ctrolyte, it will decompose into ions. So number of particals will increase. Thus colligative properties will changed.
- In concentrated solution more solute is present this may cause association of molecules and number of solute molecules may change. Therefore Raoult's law is not obeyed. Hence colligative properties are only obeyed when solute is non electrolyte and solution is dilute.

28. Define upper consulate temperature. Give two examples. (LHR. GII, 2018)(DGK. GI, 2019)

Ans. Upper consulate temperature: It is the critical temperature above the component of a mixture are miscible in all proportions. The word upper indicate that is on upper bond to temperature range partially miscibility or certain composition only.

e.g. At 79°C these substance are miscible in all proportion above 19.°C but not at lower temperature.

29. Define colligative properties. Why are they so called? (GRW. 2018)(DGK. GII, 2019)

Ans. Colligative properties are called so because these depend upon the number of solute particles in definite amount of solvent and independent on the nature of solute. For example lowering of vapour pressure of water, caused by the addition of 6 g of urea, 18 g of glucose and 34.2 g of sucrose is same although the solute particles are of different nature but their numbers are same.

30. What is meant by conjugate solutions? (FBD. 2018)

Ans. Conjugate Solution: A mixture of two partially miscible liquid. A homogenous mixture of two or more substances frequently a liquid solution.

31. Define critical solution temperature or upper consulate temperature. (MLN. GII, 2018)

Ans. Critical Solution Temperature: The temperature at which complete miscibility is reached as the temperature is raised or in some cases lowered used two liquid that are partially miscible under ordinary condition called also consulate temperature.

Upper Consulate Temperature:
It is the critical temperature above which the conponent of mixture are miscible in all proportions.

32. **Justify that the total volume of solution by mixing 100cm of H_2O with 100 cm of alcohol may not be equal to 200 cm^3.** (DGK. GII, 2018)

Ans. Because the intermolecular forces of attraction between alcohol and water molecules are not the same as the intermolecular attractive force between alcohol molecules or between water molecules. Hence the total volume of solution by mixing 100cm^3 of alcohol with 100cm^3 of water will not equal to 200cm^3 the total volume of solution will be greater than 200cm^3 because the forces of attraction between alcohol and water molecules are weaker than those between alcohol molecules or between water molecules.

33. **Define colligative properties, name important colligative properties.** (GRW. GI, 2015)(AJK. 2018)

Ans. **Colligative Properties:** The colligative properties are those properties of solution that depend on the number of solute and solvent molecules or ion.

Important Colligative Properties:
Colligative properties of solution are:

- ☆ Lowering of vapour pressure.
- ☆ Elevation of boiling point
- ☆ Depression of freezing point
- ☆ Osmotic pressure

34. **Define Heat of solution. Give example.** (GRW. GI, 2019)

Ans. The quantity of heat energy, that is absorbed or released when a substance forms solution is called heat of solution.

Example: Heat of solution for NaCl is 4.98 $kJmol^{-1}$

ESSAY TYPE QUESTIONS

1. **Explain Positive and Negative deviations of Non-ideal solution.** (DGK. GI, MLN. GI, 2016)
2. **Define solubility and differentiate between continuous solubility and discontinuous solubility curves.** (GRW. GI, 2015)
3. **What is solubility? Explain solubility curves.** (FBD. GI, 2015)
4. **Write comprehensive note on Raoult's Law.** (GRW. GI, 2014)(MLN. GI, GRW. GII, 2015)
5. **How Raoult's law can be defined in three different ways? Also give their mathematical expression.** (RWP. GI, 2014)(BWP. GI, DGK. GII, 2015)(BWP. GI, LHR. GII, SGD. GI, RWP. GII, 2017)(AJK. 2019)
6. **State different form of Roault's Law. How this law can help us to understand the ideality of a solution.** (LHR. GII, 2016)(BWP. GII, 2017)
7. **Give graphical explanation for elevation of boiling point of a solution.** (RWP. GI, 2015)(GRW. GI, 2019)
8. **Describe one method to determine the boiling point of elevation of solutes.** (LHR. GI&GII, 2015)(DGK. GII, 2017)
9. **Describe Landsberger's method for the measurement of boiling point elevation.** (DGK. GII, 2014)(MLN. GII, 2016)(SWL. GII, DGK. GII, 2017)(BWP. GII, 2019)
10. **How depression in freezing point is measured by Beckmann's Apparatus.** (SGD. GII, 2017)(MLN. GII, SGD. GII, 2019)
11. **Differentiate between Ideal and Non-ideal solutions.** (DGK. GII, 2016)(AJK. GII, 2017)(LHR. GII, 2019)

12. What are Colligative properties? Why are they called so? (SWL. GI, 2014)(RWP. GI, 2017)
13. Define colligative Properties. How molecular mass of solute is determined by lowering in vapour pressure? (MLN. GI, 2014)
14. Explain Lowering of Vapour Pressure by adding a Non volatile, Non electrolyte solute in a solvent. (MLN. GII, 2017)(GRW. GII, FBD. GII, 2019)
15. What are Azeotropic mixtures? Explain with the help of graph. (DGK. GI, MLN. GI, 2014)(AJK. GI, 2015)
16. Define non-ideal solution and explain positive deviation with the help of graph. (SGD. GI, 2014)(MLN. GII, 2015)
17. What are azeotropic mixtures? Discuss positive deviation from Raoults Law. (RWP. GI, 2016)
18. The freezing point of pure camphor is 178.4 °C. Find the freezing point of a solution containing 2.0 g of a non-volatile compound, having molecular mass 140, in 40g of camphor. The molar freezing point constant of camphor is 37.7 °C kg mol^{-1}. (LHR. GI, SGD, AJK. 2018)
19. The boiling point of water is 99.725 °C. To a sample of 600g of water are added 24.0 g of a solute having molecular mass of 58g mol^{-1}, to form a solution. Calculate the boiling point of the solution. (LHR. GII, 2018)
20. The boiling point of a solution containing 0.2g of a substance 'A' in 20.0 g of ether (molar mass= 74) is 0.17 K higher than that of pure ether. Calculate the molar mass of 'A'. Molal boiling point constant of ether is 2.16 K. (GRW, MLN. GI, 2018)
21. 3g of a non-volatile, non-electrolyte solute 'X' are dissolved in 50gm of ether (molar mass=74) at 293K. The vapour pressure of ether falls from 442 torr to 426 torr. Under these conditions calculate molar mass of solute 'X' (FBD. 2018)
22. Hydrochloric acid available in the laboratory is 36% (w/w). The density of HCl solution is 1.19gcm^{-3}. Determine the Molarity of HCl solution. (SWL. 2018)
23. Discuss Raoult's law for the solution in which both components are volatile. (RWP. 2018)
24. The vapour pressure of water at 30°C is 28.4 torr. Calculate the vapour pressure of a solution containing 70 g of cane sugar ($C_{12}H_{22}O_{11}$) in 1000 g of water at same temperature. Also, calculate the lowering of vapour pressure. (DGK. GII, 2018)
25. Pure Benzene has Vapour Pressure of 122.0 torr at 32°C. When 20 g of a non-volatile solute were dissolved in 300 g of Benzene, a vapour pressure of 120 torr was observed. Calculate the Molecular Mass of the solute. The Molecular Mass of Benzene being 78.1. (BWP. GII, 2018)
26. Write note on (SWL. 2019)
    (i) Hydration (ii) Hydrates
27. Explain the effect of temperature on Phenol-Water System. (SGD. GI, 2019)
28. Derive Handerson's equation for acidic and basic buffer. (RWP. 2019)

CHAPTER 10

ELECTROCHEMISTRY

MULTIPLE CHOICE QUESTIONS (MCQ's)

1. If the salt bridge is not used between two half cells, then the voltage: (DGK. GII, GRW. GI, 2014)(LHR. GII, DGK. GI, BWP. GI, DGK. GII, MLN. GI, 2016) (SGD. GI, 2017)(GRW. 2018)(FBD. GI, MLN. GI, DGK. GI, BWP. GII, 2019)
(A) decrease rapidly (B) decrease slowly (C) does not change **(D) drops to zero**

2. Stronger the oxidizing agent, greater is the: (LHR. GI, BWP. GI, GRW. GI, 2014)(AJK. GI, FBD. GI, 2016)(RWP. GI&GII, DGK. GI, 2017) (LHR. GII, DGK. GI, 2018)(GRW. GI, & GII, RWP. BWP. GI, 2019)
(A) oxidation potential **(B) reduction potential**
(C) redox potential (D) emf of cell

3. The reduction potential of Zn is: (AJK. GI, 2017)
(A) +0.76V (B) –0.34V (C) +0.34V (D) –0.75V

4. A single lead cell provides volts: (SGD. GII, 2017)
(A) 2 (B) 4 (C) 6 (D) 8

5. In H_2SO_4, the oxidation number of "S" is: (LHR. GI, 2014)
(A) +2 **(B) +6** (C) +8 (D) +4

6. The oxidation number of $C\ell$ in $HC\ell O_4$ is: (LHR. GII, 2014)
(A) +2 (B) +3 (C) +5 **(D) +7**

7. Oxidation number of Cl in a $Ca(C\ell O_3)_2$ is: (FBD. GI, 2014)
(A) -1 **(B) +5** (C) +3 (D) +1

8. Oxidation number of Cr in a K_2CrO_4 is: (SWL. GII, 2017)
(A) +2 (B) +4 **(C) +6** (D) +8

9. The cathodic reaction in the electrolysis of dil. H_2SO_4 with Fe electrodes is: (LHR. GI, MLN. GI, BWP. GI, 2014)(MLN. GII, AJK. GI, 2016)(LHR. GI, BWP. GI, FBD. GII, 2017)
(A) reduction (B) oxidation
(C) both oxidation and reduction (D) neither oxidation nor reduction

10. The voltage of Nickel Cadmium cell is: (LHR. GI&GII, 2017)
(A) 1 V (B) 1.2 V **(C) 1.4 V** (D) 1.6 V

11. Oxidation number of phosphorus in the compound (HPO_3) is: (RWP. GI, 2014)
(A) +3 (B) +4 **(C) +5** (D) +6

12. The oxidation number of O atom in OF_2 is: (SGD. GII, 2014)(RWP. GI, 2016)(LHR. GI, 2019)
(A) –2 **(B) +2** (C) –1 (D) +1

13. Oxidation number of chromium in Cr_2O_3 is: (LHR. GI, 2018)
(A) +1 (B) +2 **(C) +3** (D) +4

14. The oxidation state of oxygen in KO_2 is: (FBD. 2018)
(A) -1 (B) -2 **(C) $\frac{-1}{2}$** (D) + 2

15. Standard Hydrogen Electrode (SHE) is made of (SGD. 2018)
(A) Ag foil (B) Au foil (C) Cu foil **(D) Pt foil**

16. Stronger is the oxidizing agent, greater is the: (RWP. 2018)
(A) Oxidation potential (B) Reduction potential
(C) Redox potential (D) E.M.F of the cell

17. Oxidation number of 'Cl' in $Ca(ClO_3)_2$ is. (AJK. 2018)
(A) +3 (B) + 5 (C) +1 (D) - 1

18. The oxidation state of Mn in $KMnO_4$ is: (LHR. GII, 2019)
(A) + 7 (B) + 6 (C) + 2 (D) + 5

19. Oxidation number of Cr is $K_2Cr_2O_7$ is: (FBD. GII, 2019)
(A) + 2 (B) + 3 (C) + 6 (D) + 7

20. The standard electrode potential (in volt) of SHE is taken as: (DGK. GII, 2019)
(A) 0.00 (B) 1.00 (C) 10.0 (D) 100

SHORT ANSWER QUESTIONS

1. **Differentiate between primary and secondary cell giving one example each.**
(DGK. GI, RWP. GII, 2017)(SGD. DGK. GII, 2018)(MLN. GI, 2019)

Ans.

Primary Cell	Secondary Cell
A primary cell is a cell or battery that cannot recharge. Primary cells can only be used one time.	A secondary cell is not rechargeable battery. Secondary cells can be reused again
The electrochemical reaction occurring in the cell is not reversible. **Examples:** dry cell, alkaline battery, mercury and silver battery etc.	The electrochemical reaction occurring in the cell is reversible. **Examples:** car battery, fuel cell, lead-acid battery, Ni-Cd- battery etc.

2. **Define electrolytic cell and voltaic cell.** (FBD. GII, 2017)

Ans. **Electrolytic Cell:** "A type of chemical cell, in which, the flow of electric energy from an external source causes a redox reaction to occur". In other words, In electrolytic cell non-spontaneous reversible reaction take place that requires electrical energy to occur.

Voltaic cell: If a voltaic cell is an electrochemical cell that uses a chemical reaction to produce electrical energy. The anode is an electrode where oxidation occurs. The cathode is an electrode where reduction occurs.

3. **Write down the equations for electrode processes in the electrolysis of fused $PbC\ell_2$.**

Ans. **Electrolysis of fused $PbC\ell_2$:** (DGK. GI, 2014)

Reaction At cathode: The positive ions move towards cathode, which supplies electrons to positive ions and they are reduced. For example, in case of molten $PbC\ell_2$, reaction at cathode will be as under:

$$Pb^{2+}_{(\ell)} + 2e^- \longrightarrow Pb^{\circ}_{(s)} \quad \text{(reduction)}$$

Reaction at Anode: Negative ions travel towards anode. Anode picks up electron from anions and hence they are oxidized.

$$C\ell^-_{(\ell)} \longrightarrow C\ell^{\circ}_{(g)} + \ell e^-$$

Two $C\ell$ atoms combine to form $C\ell_{2(g)}$.

$$C\ell_{(g)} + C\ell_{(g)} \longrightarrow C\ell_{2(g)}$$

4. **What is meant by electromotive force (emf) of cell?** (BWP. GI, 2016)(GRW. GI, 2017)

Ans. **Electromotive force:** The force that causes the flow of electrons from one electrode to another electrode is called e.m.f of the cell.

Under standard conditions, it is called standard e.m.f of the cell and is denoted by E°.

Electromotive Force of A cell: The flow of electrons takes place in the half reactions of an electrochemical cell. This flow occurs in a specific direction. The voltage of the cell is given by the voltmeter and is called electromotive force of the cell (E°cell).

$$E^\circ_{cell} = E^\circ_{anode} + E^\circ_{cathode}$$
$$E^\circ_{cell} = E^\circ_{(ox.pot)} + E^\circ_{(red.pot)}$$
$$E^\circ_{cell} = E^\circ_{(red)cathode} - E^\circ_{(ox)anode}$$

5. How relative chemical reactivity of metals is studied with the help of electrochemical series. (SWL. GII, 2017)

Ans. When elements are arranged in the order of their standard, electrode potentials on the hydrogen scale, the resulting list is known as electrochemical series.This series tell us the electrode potentials of metals given in the mode of reduction. It has been observed that Greater the value of standard reduction potential (SHE) of a metal, smaller is its tendency to lose electrons to change into a positive ion and hence lower will be its reactivity.

Example: metals like Li, Na, K and Rb are highly reactive where as Coinage metals, Cu, Ag, and Au are the least reactive because they have positive reduction potentials.

6. Na^+ and K^+ can displace hydrogen from acids but Pt, pd and Cu cannot explain. (DGK. GII, FBD. GI, 2015)(AJK. FBD. GI, 2016)(SGD. GI, 2017)(MLN. GI, BWP. GII, 2018)

Ans. The metals like Pt, pd and Cu have sufficiently high positive value of reduction potentials, therefore they cannot liberate hydrogen from acids. On the other hand, Na and K are close to top of the electrochemical series and have very low reduction potentials and can liberate hydrogen.

7. Calculate the oxidation state of underlined element.

(a) $H_3\underline{P}O_3$ (b) $(Ca(\underline{Cl}O_3)_2$ (MLN. GI, 2015)(RWP. GI, SWL. GII, 2017)

Ans. Oxidation number: The apparent charge positive or negative or zero on an atom of an element in a molecule or an ion is called oxidation number or oxidation state.

(a) $H_3\underline{P}O_3$

Let the oxidation number of P = x
Oxidation number of H = +1
Oxidation number of 0 = –2

By applying formula:

$$3(O.N.\text{ of } H) + (O.N \text{ of } P) + 3\,(O.N \text{ of } O) = 0$$
$$3\,(+1) + (x) + 3(-2) = 0$$
$$3 + x - 6 = 0$$
$$x - 3 = 0$$
$$x = +3$$

(b) $Ca(\underline{C}\ell O_3)_2$

Let the oxidation number of $C\ell$ = x
Oxidation number of Ca = +2
Oxidation number of O = – 2

By applying formula:

$$(O.N.\text{ of } Ca) + 2(O.N \text{ of } C\ell) + 2\times3(0.N.\text{ of } O) = 0$$
$$(+2) + 2\,(x) + 6\,(-2) = 0$$
$$2 + 2x - 12 = 0$$
$$2x - 10 = 0$$
$$2x = +10$$
$$x = +5$$

8. Calculate the oxidation number of underlined element of compound HNO_3. (FBD. GI, 2014)

Ans. Oxidation number of Nitrogen in HNO_3.

Let the oxidation number of N = x

Oxidation number of H = +1
Oxidation number of O = -2

By applying formula:

(O.N. of H)+(O.N of X)+3(O.N of O) = 0
(+1) + (x) + 3 (-2) = 0
1 + (x) - 6 = 0 x - 5 = 0
x = +5
x = +4

9. Define oxidation state with two examples. (LHR. GII, 2017)(MLN. GI, 2019)

Ans. Oxidation Number (Oxidation State):
It is the apparent charge on an atom of an element in a molecule or an ion is called oxidation number or oxidation state. It may be positive or negative or zero.
Examples: Oxidation number of elements in free state is zero $H_2^0, Na^0, K^0, Mg^0, O_2^0$ etc.

10. Write two rules for assigning oxidation number. (GRW. GI, 2015)

Ans. Rules for assigning oxidation number:
(i) Elements in Free State have zero oxidation number.
$H_2^0, Na^0, K^0, Mg^0, O_2^0$
(ii) In case of simple ions of elements of the same group, the oxidation number will have same sign and same charge.
Examples: Ions of I-A group → +1
Ions of II-A group → +2
Ions of III-A group → +3

11. The oxidation state of oxygen is +2 in OF_2. Justify it. (AJK. GI, 2015)(DGK. GI, 2018)

Ans. Fluorine predominantly exhibits -1 oxidation state in almost all its compounds. In OF_2, its oxidation number is -1. Using this, we will calculate the oxidation state of oxygen in OF_2. The overall charge in this compound is zero. So when we calculate the charge on oxygen in OF_2, it comes out to be +2. The oxidation state of OF_2 can be calculated as follows:
Let the oxidation number of oxygen be Z. As there is no overall charge on the molecule, therefore we have $z + 2(-1) = 0$
This gives $z = 2$
Thus the charge on oxygen in OF_2 is +2.

12. Mention the function of salt bridge.
(RWP.GI, DGK. GI, GRW. GI, MLN. GI, BWP. GI, 2014)(GRW. GII, 2015)
(MLN. GII, DGK. GII, LHR. GI, 2016)(SGD. GI, 2017)(LHR. GII, 2018)(LHR. GII, GRW. GI, 2019)

Ans. Function of Salt Bridge: Salt bridge has two major functions which are as follow:
(i) It connects the solutions in two half cells and completes the cell circuit.
(ii) It maintains the electrical neutrality by the diffusion of ions through it.
(iii) It prevents direct mixing of two solutions because by direct mixing of two solutions the half cells are destroyed.
(iv) It prevents any net charge accumulation is either solution because it allows excess ions to diffuse from one solution to other solution.

13. What is salt bridge? How it maintains electrical neutrality in the half cell solution.
(DGK. GII, 2014)(DGK. GI, MLN. GI, RWP. GI, 2015)(MLN. GI, 2016)(MLN. GI, SGD. GII, RWP. GII, 2017)

Ans. Salt bridge is a U-shaped glass tube having a saturated solution of some strong electrolyte like $KC\ell$, K_2SO_4 or KNO_3. It prevents the physical contact between the two electrolytic solutions. At the time of electronic current in the outer circuit negative ions moves from cathode compartment to anodic compartment. In this way, the solutions of both half cells remain neutral.

14. What is electrolysis? Give example. (LHR. GII, 2015)

Ans. Electrolysis: The process of decomposing a substance usually in solution or in molten state by the passage of an electric current is called electrolysis.

Example: Electrolysis of fused $NaC\ell$ in Nelson's cell to produce sodium metal..

15. Write the importance of standard hydrogen electrode, (SHE). (FBD. GI, 2014)

Ans. Importance of standard hydrogen electrode, (SHE):- (LHR. GI, MLN. GII, 2017)(AJK. 2018)

Importance of standard hydrogen electrode is as follows:

- **SHE act as both anode and cathode:**

(i) SHE is used as reference electrode to determine the reduction potential of different electrodes.

(ii) SHE is used as a reference potential of 0 volts and serves as a medium for any cell potential calculation.

(iii) SHE is used as a standard electrode.

16. SHE acts as an anode when connected with copper (Cu) electrode but as cathode with Zinc (Zn) electrode. Why?
(BWP. GI, 2014)(MLN. GII, 2016)(RWP. GII, FBD. GII, RWP. GII, AJK. GII, DGK. GII, 2017)
(DGK. GI, BWP. GI, 2018)(BWP. GI, 2019)

Ans. The electrodes above SHE in electrochemical series have negative reduction potential and positive oxidation potential. They have greater tendency to deliver the electrons to SHE.

$Zn \longrightarrow Zn^{+2} + 2e^-$ (oxidation at anode)

$2H^+ + 2e^- \longrightarrow H_2$ (reduction at cathode)

The electrodes below SHE in electrochemical series have negative oxidation potential. They accept the electrons from SHE.

$Cu^{+2} + 2e^- \longrightarrow Cu^\circ$ (reduction at cathode)

$H_2 \longrightarrow 2H^+ + 2e^-$ (oxidation at anode)

17. Find out the oxidation state of Cr in
(i) $K_2Cr_2O_7$ (ii) K_2CrO_4 (iii) Cr_2O_3
(RWP. GI, 2014)(LHR. GI, 2015)(DGK. GII, SWL. GI, 2017)
(DGK. GII, RWP. GI, 2015)(MLN. GI, BWP. GI, 2016)(LHR. GI, RWP. 2019)

Ans. Oxidation number of Chromium in $CrC\ell_3$:

(i) $CrC\ell_3$

Let the oxidation number of Cr = x

Oxidation number of $C\ell = -1$

By applying formula:

$$(O.N.\ of\ Cr) + 3\ (O.N\ of\ C\ell) = 0$$
$$x + 3\ (-1) = 0$$
$$x - 3 = 0$$
$$x = 3$$

(ii) Oxidation Number of Chromium in K_2CrO_4:

Let the oxidation number of Cr = x

Oxidation number of K = +1

Oxidation number of O = –2

By applying formula:

$$2(O.N.\ of\ K) + (O.N\ of\ Cr) + 4\ (O.N\ of\ O) = 0$$
$$2\ (+1) + (x) + 4\ (-2) = 0$$
$$2 + x - 8 = 0$$
$$x - 6 = 0$$
$$x = 6$$

(iii) Cr_2O_3

Let the oxidation number of C r = x

Oxidation number of O = – 2

By applying formula:

2(O.N. of Cr) + 3(O.N of O) = 0

2(x) + 3 (–2) = 0

2x – 6 = 0

2x = 6

x = 3

18. Determine the oxidation number of Phosphorus in H_3PO_4.

Ans. Oxidation number of Phosphorus in H_3PO_4: (MLN. GII, 2015)(LHR. GI, 2016)(BWP. GI, 2017)

Let the oxidation number of P = x

Oxidation number of H = + 1

Oxidation number of O = –2

By applying formula:

3 (O.N. of H) + (O.N of P) + 4(O.N of O) = 0

3 (+1) + (x) + 4 (-2) = 0

3 + x-8 = 0

x - 5 = 0

19. Calculate oxidation number of S in H_2SO_4. (LHR. GI, 2017)

Ans. H_2SO_4.

Let the oxidation number of S = x

Oxidation number of H = + 1

Oxidation number of O = –2

By applying formula:

2(O.N. of H) + (O.N of S) + 4(O.N of O) = 0

2 (+1) + (x) + 4 (–2) = 0

2 + x – 8 = 0

x–6 = 0

20. Calculate oxidation number of Mn in (i) $KMnO_4$ (ii) K_2MnO_4 (iii) Na_2MnO_4

(SGD. GII, SWL. GII, DGK. GII, GRW. GII, BWP. GI, 2014)
(LHR. GII, BWP. GI, GRW. GII, 2015)(BWP. GI, 2016)(BWP. GII, 2017)

Ans. (i) Oxidation number of Mn in $KMnO_4$:

Since KMn04 is neutral molecule, therefore (oxidation number of K) + (oxidation number of Mn) + 4 (oxidation number of 0) = Zero

Let

Oxidation number of Mn = X

Oxidation niimhpr nf K = +1

Oxidation niimhor nf O = –2

substituting these values in the above equation, we get:

(+l) + x + 4(–2) = 0

l+ x–8 = 0

x –7 = 0

x = +7

So Mn has +7 oxidation number in $KMnO_4$.

(ii) Oxidation number of Mn in K_2MnO_4.

Let the oxidation number of Mn = x

Oxidation number of K = +1

Oxidation number of O = -2

By applying formula:

$$2(\text{O.N. of K})+(\text{O.N. of Mn}) + 4\,(\text{O.N. of O}) = 0$$
$$2(+1) + (X) + 4(-2) = 0$$
$$2 + x - 8 = 0$$
$$x - 6 = 0$$
$$x = \boxed{6}$$

(iii) Oxidation number of Mn in Na_2MnO_4

Let the oxidation number of Mn = x

Oxidation number of Na = +1

Oxidation number of O = –2

By applying formula:

$$2\,(\text{O.N. of Na}) + (\text{O.N of x}) + 4\,(\text{O.N. of O}) = 0$$
$$2\,(+1) + (x) + 4(-2) = 0$$
$$2 + (x) - 8 = 0$$
$$x - 6 = 0$$
$$x = +6$$

21. Calculate oxidation number of sulphur in SO_4^{2}. (FBD. GI, 2015)(LHR. GII, 2016)(MLN. GI, 2017)

Ans. The equation for this molecule is

(Oxidation number of S)+4 (Oxidation number of O) = –2

Let:

Oxidation number of S = x

Oxidation number of O = -2

By putting these value in above equation,

$$(x) + 4(-2) = -2$$
$$x - 8 = -2$$
$$x = -2 + 8 = \boxed{+6}$$

So sulphur in SO_4^{2} has +6 oxidation numbers.

22. Differentiate between electrolytic cell and galvanic cell.

Ans. (DGK. GII, 2014)(SWL, DGK. GI, 2018)(GRW. GII, FBD. GII, SGD. GII, AJK. 2019)

Electrolytic Cell	Galvanic Cell
(i) The device in which electric energy is converted into chemical energy is called electrolytic cell.	(i) The device in which chemical energy is converted into electric energy is called galvanic cell.
(ii) In this cell current is used to drive a chemical reaction.	(ii) In this cell current is produced as a result of chemical reaction.
(iii) Non-spontaneous oxidation reduction reactions take place.	(iii) Spontaneous oxidation-reduction reactions take place.
(iv) In this cell, electrolysis takes place.	(iv) In this cell electric conduction takes place.
Examples: Down's cell, Nelson's cell	**Examples:** Daniel's cell, fuel cell.

23. Voltaic cell is reversible cell state. (LHR. GI, 2015)(DGK. GII, 2018)

Ans. Voltaic cell as a reversible cell:

The voltaic cell can be changed into reversible cell. This is done by replacing the circuit of voltaic cell with a source of electricity which opposes the voltaic cell. The reactions occurring at electrodes can be reversed. Then the external source of electricity will push the electrons in the opposite direction and supplies energy to the cell. In this way, a reverse non-spontaneous reaction takes place. This is known as a reversible cell.

Reversed Reactions:

At cathode: $Zn^{2+}_{(aq)} + 2e^- \longrightarrow Zn_{(s)}$ (reduction)

At anode: $Cu_{(s)} \longrightarrow Cu^{2+}_{(aq)} + 2e^-$ (oxidation)

Overall reaction: $Zn^{2+}_{(aq)} + Cu_{(s)} \longrightarrow Zn_{(s)} + Cu^{2+}_{(aq)}$

In the reversed cell, oxidation takes place at copper electrode while reduction occurs at zinc electrode (cathode has changed to anode and vice versa). The cell will work as an electrolytic cell instead of voltaic or galvanic cell.

24. What is meant by standard hydrogen electrode (SHE)?
(RWP. GI, 2015)(DGK. GII, 2016)(AJK. GI, LHR. GII, SWL. GI, 2017)(FBD. GI, 2019)

Ans. Standard hydrogen electrode (SHE):

The standard hydrogen electrode is the standard measurement of electrode potential for the thermodynamic scale of redox potentials.

25. Define oxidizing agent and reducing agent. (RWP. GII, 2017)

Ans. Oxidizing Agent: "A species having greater tendency of to gain elections or accept electrons while reduction with greater value of standard reduction potential and act as an oxidizing agent".

Examples: The series like F" $C\ell_2$, Br_2, etc is example of strong oxidizing agents with a large positive value of standard reduction potentials.

Reducing Agent: "A species having lesser tendency to gain elections or accept electrons while reduction with lesser value of standard reduction potential and act as an reducing agent"

Examples: The series like like Li, K, Ca, Na etc is example of strong reducing agents have large negative values becose they lie above SHE

26. Give any two applications of electrochemical series. (MLN. GII, 2019)

Ans. Two applications of electrochemical series:

(i) Prediction of the feasibiltiy of a chemical reactions.

(ii) It is used to calculate the voltage or Electromotive force (emf) of cells.

27. Calculate the oxidation numbers of the elements underlined in the following compounds: (LHR. GI, 2018)

(i) K_2MnO_4 **(ii) $Ca(C\ell O_3)_2$**

Ans. (i) K_2MnO_4: O.N of Mn = x

O.N of each O atom = –2

O.N of each Ka atom = + 1

Sum of O.N of atoms = 2 (+1) + x + 4 (–2)

= 2 + x – 6

= x – 6

x – 6 = 0

x = +6

(ii) $Ca(C\ell O_3)_2$: O.N of Ca atom = + 2
O.N of $C\ell$ = x
O.N of O atom = –2
Sum of O.N of O atoms = + 2 (+1) + x –2 (6)
x = + 2 – 12
x = 12 + 2
x = 14

28. What is oxidation number? Calculate oxidation number of Mn in $KMnO_4$. (FBD. 2018)(GRW. GI, 2019)

Ans. Oxidation Number: It is the apparent charge on an atom of an element in a molecule or an ion. It may be positive or negative or zero are called oxidation number.

Oxidation Number of Mn in $KMnO_4$:
Oxidation no. of K = +1
Oxidation No. of O = –2
Oxidation No. of Mn = x
By putting values
+ 1 + x + 4(–2) = 0
+ 1 + x –8 = 0
– 7 + x = 0
x = 7
Oxidation No. of Mn = 7.

29. How does a salt bridge maintain the electrical neutrality in a galvanic cell? (FBD, AJK. 2018)

Ans. The salt bridge is used to connect two half cells. For example reaction between Zn-Cu. In this Zn continuously loosing electron which increase positive charge.

$Zn \longrightarrow Zn^{2+} + 2e^-$
$Cu^{2+} + 2e^- \longrightarrow Cu$

Accumulation of positive charges on Zn and negative on Cu stop the reaction. Salt bridge prevents the accumulation of charges in either bearer. Thus salt bridge will move the ions to maintain neutrality.

30. Define Oxidation and Oxidation Number. (MLN. GII, 2018)

Ans. Oxidation: oxidation is a loss of electron.

$$Zn_{(s)} \longrightarrow Zn + 2 + 2e^-$$
(loss of e^-)

Oxidation Number: It is apparent charge on an atom of an element in a molecule or an ion. It may be positive or negative or zero.

31. Calculate oxidation number of 'Cr' in (a) $CrC\ell_2$ (b) $K_2Cr_2O_2$ (SGD. 2018)(DGK. GII, AJK. 2019)

Ans. (a) $CrC\ell_2$:
Let oxidation number of Cr = x
oxidation number of K = +1
oxidation no. of O = –2
applying formula
2(ON of K) + (ON of Cr) + 4(ON of O) = O
2(+1) + x + 4(–2) = O
2 + x –8 = O
2 + x –8 = O
x = 8 – 2
6

(b) $K_2Cr_2O_2$:

2(O.N of K) + (O.N of Cr) + 2(O.N of O)

2(+1) + (x) + 2(4)

2 + x + –4

x = 4 + 2

x + 6

32. Define oxidation number and calculate oxidation number of chromium in K_2CrO_4. (RWP. 2018)

Ans. Oxidation number: The apparent charge on atom of an element in a compound or radical is called.

Oxidation number: It may be positive, negative or zero.

Example: $K^+ = +1$

Oxidation number of Cr in K_2CrO_4

2(oxidation no of k) + O.N of Cr) + 4(Or No of O) = 0

2 (+1) + (x) + 4(–2) = 0

(+2) + oxidation number of Cr = –8

Oxidation number of Cr = +6

33. The standard oxidation potentia l of Zn is + 0.76 v and its reduction potential is -0.76 v. Why? (DGK. GI, BWP. GII, 2018)

Ans. The tendency of substance to accept electrons is called its reduction potential and lose of electron is called oxidation potential. Both oxidation and reduction potential values of an element have same value but with opposite sign.

$Zn^{+2} + 2e^- \longrightarrow Zn \quad -0.76\ V$ (Reduction potential)

$Zn \longrightarrow Ze^{+2} \quad +0.76\ V$ (Oxidation potential)

34. What are secondary cells? Write name of any two such cells. (LHR. GII, 2019)

Ans. Those cells which can be Recharged are called Secondary Cells.

Examples: **(i)** Lead – Acid Battery **(ii)** Ni – Cd battery

35. Define electrode potential. (LHR. GII, 2019)

Ans. The potential set up when an electrode is in contact with one molar solution of its own ions at 298k is called standard electrode potential. It is denoted by $E°$.

36. How is voltaic cell represented? (FBD. GI, 2019)

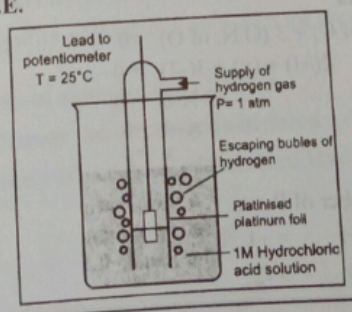
Ans. A voltaic or galvanic cell consists of two half-cells that are electrically connected. Each half cell is a function of the total cell in which a half reaction takes place. The left half -cell exists of a strip of zinc metal dipped in 1 M solution of $ZnSO_4$. The right half-cell is a copper metal that dips into 1M $CuSO_4$ solution.

37. Why water is a weak electrolyte? (MLN. GII, 2019)

Ans. Water is considered to be a weak electrolyte. Only a small fraction of the H_2O molecules in water dissociate to form H^+ and OH^- ion. Therefore it is weak electrolyte.

38. Draw the diagram of S.H.E. (MLN. GII, 2019)

Ans.



39. Calculate the oxidation numbers of the elements underlined in the following compounds.

(i) $Ca(\underline{C}\ell O_3)_2$

Let the oxidation number of C ℓ = x
Oxidation number of Ca = +2
Odixation number of O = –2
By applying formula:

$$(O.N. \text{ of } Ca) + 2(O.N \text{ of } C\ell) + 2 \times 3(O.N. \text{ of } O) = 0$$
$$(+2) + 2(x) + 6(-2) = 0$$
$$2 + 2x - 12 = 0$$
$$2x - 10 = 0$$
$$2x = +10$$
$$x = +5$$

(ii) Na_3PO_4

Let the oxidation number of P = x
Oxidation number of Na = +1
Oxidation number of 0 = -2
By applying formula

$$3(O.N. \text{ of } Na) + (O.N. \text{ of } P) + 4(O.N. \text{ of } O) = 0$$
$$3(+1) + (x) + 4(-2) = 0$$
$$3 + X - 8 = 0$$
$$x - 5 = 0$$
$$x = 5$$

(iii) $Cr_2(SO_4)_3$

Let the oxidation number of S = x
Oxidation number of Cr = +3
Oxidation number of 0 = -2
By applying formula

$$2(O.N. \text{ of } Cr) + 3(O.N.. \text{ of } S) + 3x4\ (O.N. \text{ of } 0) = 0$$
$$2(+3) + 3(x) + 12(-2) = 0$$
$$6 + 3x - 24 = 0$$
$$3x = 18$$
$$x = 6$$

(iv) Na_2CO_3

Let the oxidation number of C = x
Oxidation number of Na = +1
Oxidation number of O = -2
By applying formula

$$2(O.N. \text{ of } Na) + (O.N. \text{ of } C) + 3\ (O.N. \text{ of } O) = 0$$
$$2(+1) + (x) + 3(-2) = 0$$
$$2 + X - 6 = 0$$
$$x - 4 = 0$$
$$x = 4$$

(v) HPO_3

Let the oxidation number of P = x
Oxidation number of H = +1
Oxidation number of 0 = -2

By applying formula

$$(O.N. \text{ of } H) + (O.N. \text{ of } P) + 3\,(O.N. \text{ of } 0) = 0$$
$$(+1) + (x) + 3(-2) = 0$$
$$1 + x - 6 = 0$$
$$x - 5 = 0$$
$$x = 5$$

ESSAY TYPE QUESTIONS

1. Define standard hydrogen electrode (SHE). How it is used to meas potential of copper?
(DGK. GII, 2014)(LHR. GI, 2016)(AJK. GII, SG
2. Describe the construction and working of standard hydrogen elect
(RWP. GI, 2014)(DGK. GI
3. Describe the electrolysis of molten sodium chloride and a concent sodium chloride.
(SGD. GI, 2014)(LHR. GII, 2015)(FBD. GI, 2016)(DGK. GII, 2017)(DGK. G
4. Describe fuel cells? Give their uses. (RWP. GII, LHR
5. What is voltaic cell? Explain with one example.
(MLN. GI, 2014)(MLN. GII, 2017)(
6. Describe a galvanic cell, explaining the functions of electrodes an
(SWL.
7. State rules for assigning oxidation number of elements with exan
(D
8. Balance the following equation by oxidation number method.

$$Cu + HNO_3 \longrightarrow Cu(NO_3)_2 + NO_2 + H_2O$$

9. Define electrolysis. Explain the electrolysis of very dilute solutio
(SGD. GII, 2017
10. What is galvanic cell? Give composition and working of galvani
(BWP. GI, 2014)(RWP
11. Write comprehensive note on lead accumulator with its recharging.
(FBD. GI, 2014)(FBD. GI, DGK. GI, 2015)(BWP. GI
12. Define electrochemical series and give any two applications of
(LHR. GI, MLN. GI, BWP. GII, 2018)(LHR. GII, GRW. G
13. Give explanation of electrolysis of fused sodium chloride.
14. Describe Zn - Cu Galvanic Cell and explain the function of sal
15. Describe four uses of electrolysis process in industries.
16. Write the rules for assigning oxidation number to an element
17. Describe the Electrolysis of aqueous salt of KNO_3.
18. What is electrolysis? Discuss the electrolysis of fused salt PbB
19. Describe the construction and working of standard Hydrogen

CHAPTER 11

REACTION KINETICS

MULTIPLE CHOICE QUESTIONS (MCQ's)

1. If the rate equation of a reaction $2A + B \longrightarrow$ products is, rate $=K[A]^2[B]$, and A is present in large excess, then order of reaction is: (DGK. GI, 2014)(DGK. GI, 2015)(RWP. GI & GII, LHR. GII, 2017)(DGK. GI, 2018)(MLN. GI, SWL. BWP. GII, 2019)
[A] 1 (B) 2 (C) 3 (D) none of these

2. The order of decomposition of Nitrogen Pentoxide $2N_2O_5 \longrightarrow 2N_2O_4 + O_2$ is: (FBD. GI, 2016)
[A] First-order (B) Second-order (C) Third-order (D) Zero-order

3. The rate of reaction: (LHR. GI, MLN. GI, BWP. GI, AJK. GI, 2014)(GRW. GII, LHR. GI, BWP. GI, 2017)(BWP. GII 2018)(RWP. AJK. 2019)
(A) increases as the reaction proceeds
[B] Decrease as the reaction proceeds
(C) remains the same as the reaction proceeds
(D) may decrease or increase as the reaction proceeds

4. With increase in 10°C temperature, the rate of reaction doubles. This increase in rate of reaction is due to: (DGK. GI, FBD. GII, 2017)(SGD. GI, 2019)
(A) Decrease in activation energy of reaction
(B) Decrease in the number of collisions between reactant molecules
(C) Increase in activation energy of reactants
[D] Increase in the number of effective collisions

5. The unit of rate constant is the same as that of the rate of reaction is: (LHR. GI, GRW. GI, GRW. GII, DGK. GI, 2014)(BWP. GI, 2015)(DGK. GI, AJK. GI, BWP. GI, 2016)(RWP. 2018)(LHR. GI, FBD. GI, MLN. GII, SGD. GII, BWP. GI, 2019)
(A) First order reaction (B) Second order reaction
[C] Zero-order reaction (D) Third order reaction

6. Unit of Rate Constant is the same as the rate of reaction is: (BWP. GII, 2017)
[A] Zero Order Reaction (B) 1st Order Reaction
(C) 2nd Order Reaction (D) 3rd Order Reaction

7. In zero order reaction, the rate is independent of: (FBD. GI, 2015)(BWP. GI, MLN. GI, MLN. GII, 2016)(SWL. GII, 2017)(LHR. GII, GRW. GI, DGK. GI, 2019)
(A) Temperature of reaction [B] Concentration of reactants
(C) Concentration of products (D) None of these

8. Half-life period for U_{92}^{235} is: (DGK. GI, 2015)
[A] 710 million years (B) 720 million years
(C) 810 million years (C) 820 million years

9. Hydrolysis of tertiary butyl bromide is: (GRW. 2018)
(A) zero order reaction (B) first order reaction
[C] pseudo first order reaction (D) second order reaction

10. The order of reaction for the reaction $2N_2O_5 \rightarrow 2N_2O_4 + O_2$ is: (FBD. 2018)
(A) Zero order [B] First order (C) Second order (D) Third order

11. Half life of a second order reaction is inversely proportional to:- (MLN. GI, 2018)
[A] Initial concentration of reactants (B) Final concentration of reactants
(C) Initial concentration of products (D) Final concentration of products

12. The order of reaction for the reaction $NO + O_3 \longrightarrow NO_2 + O_2$ is (SGD. 2018)
(A) Two (B) Three [C] One (D) Zero

13. Hydrolysis of Tertiary butyl bromide has order of reaction (DGK. GII, 2018)
[A] First (B) Pseudo first (C) Second (D) Third

SHORT ANSWER QUESTIONS

1. **What do you mean by activation energy?** (FBD. GI, MLN. GI, 2016)(BWP. GII, 2017)

Ans. **Activation energy:** The minimum amount of energy required for an effective collision is called activation energy. Energy of activation of a reaction provides a valuable information about the way a reaction takes place and thus to understand the reaction.

2. **Differentiate between Average and Instantaneous Rate.** (BWP. GI, 2019)

Ans.

Average Rate	Instantaneous Rate
(i) The rate at any one instant during the interval is called the instantaneous Rate.	(i) The rate of reaction between two specific time intervals is called average rate.
(ii) Instantaneous Rate $= \frac{dx}{dt}$	(ii) Average rate. $= \frac{\Delta x}{\Delta t}$

3. **50% of a hypothetical first order reaction completes in one hour.** (BWP. GI, 2016)

Ans. The time required to convert 50% of reactants into product is called half life of reaction. Let us suppose a first order reaction whose half life is one hour. In first hour 50% reaction will complete. In second hour 50% of remaining reaction (25%) will complete. In third hour 50% of the remaining reaction (12.5%) will complete. This after 3 hour 87.5% reaction will complete.

Hence we can say th at first 50% reaction completes in one hour and remaining 50% needs more than one hour f or completion.

4. **Define with example seconed order Reaction.** (LHR. GII, 2016)

Ans. A reaction is said to be second order reaction if the rate of the reaction is proportional to the product of the concentration of two species of the reactants whose concentrations alter during the course of the chemical reaction.

$$A + B \longrightarrow \text{Products.}$$

Example:

(i) Decomposition of HI in the gas phase.

$$2HI \longrightarrow H_2 + I_2$$

Rate of reaction = $k[HI]^2$.

(ii) Decomposition of ozone.

$$2O_3 \longrightarrow 3O_2$$

Rate of reaction = $k[O_3]^2$

5. **The order of reaction may be in fractions. Justify with the help of an example.** (MLN. GI, 2015)

Ans. The order of a reaction is usually positive integer or a zero, but it can also be in fraction or can have a negative value.

Consider the formation of carbon tetrachloride from chloroform.

$$CHC\ell_{3(\ell)} + C\ell_{2(g)} \longrightarrow CC\ell_{4(\ell)} + HC\ell_{(g)}$$

$$\text{Rate} = k[CHC\ell_3][C\ell_2]^{1/2}$$

The sum of exponents will be $1 + 1/2 = 1.5$.

So, the order of this reaction is 1.5.

6. **The radioactive decay is always a first order reaction. Justify.** (LHR. GII, 2016) (SGD. GII, RWP. GI, FBD. GII, 2017)(LHR. GII, 2018)(LHR. GI, 2019)

Ans. Radioactive decay have a single species at a moment, whose nucleus is being broken up without the help of any external agency. So, only one reactant is present and it follows the first order mechanism.

7. **Rate of reaction decreases with the passage of time explains.** (BWP. GI, 2014)

Ans. According to law of mass action, the rate of a reaction is directly proportional to the active masses of reactants. Since the active masses decrease with the passage of time, so the forward rate decreases with the passage of time.

8. Differentiate between Average and instantaneous rate of reaction.
(DGK. GII, SGD. GII, 2014)(RWP. GI, 2015)(DGK. GI, 2016)(SWL. GII, MLN. GI, SGD. GI, DGK. GI, 2017)

Ans.

Average rate	Instantaneous rate
(i) Average reaction rate is the rate of a reaction time between two specific interval, of time.	(i) The instantaneous rate is the rate of reaction at a specific time.
(ii) Average rate is the rate over a given period of time.	(ii) Instantaneous rate is at a specific given moment.
(iii) At the end of the interval the average rate becomes higher than the instantaneous rate.	(iii) At first, the instantaneous rate is higher than the average rate.

9. What is specific rate constant or velocity constant?
(DGK. GI, 2015)(DGK. GII, RWP. GI, 2017)(DGK. GII, 2018)(FBD. GII, 2019)

Ans. Specific rate constant: The rate constant of a reaction is the rate when the concentrations of reactants are unity.

10. What is meant by order of reaction? Give an example.
(DGK. GI, 2015)(DGK. GII, RWP. GI, 2017)

Ans. Order of reaction: The order of reaction is given by the sum of all the exponents to which the concentrations in the rate equation are raised.

$$aA + bB \longrightarrow cC + dD$$

$$\text{Rate of reaction} = k[A]^a[B]^b$$

The exponent 'a' or 'b' gives the order of reaction with respect to the individual reactant. Thus the reaction is of order 'a' with respect to A and of order of b with respect to B. the overall order of reaction is (a+b).

Example: Oxidation of nitric oxide with ozone has been shown to be first order with respect to NO and first order with respect O_3. The sum of the individual orders gives the overall order of reaction as two.

$$NO_{(g)} + O_{3(g)} \longrightarrow NO_{2(g)} + O_{2(g)}$$

$$\text{Rate} = k[NO][O_3]$$

11. Justify that rate of reaction depends upon surface area given one example.
(MLN. GII, 2015)(DGK. GII, LHR. GI&GII, BWP. GI, 2016)
(MLN. GI, LHR. GI, FBD. GII, 2017)(BWP. GI, 2018)(FBD. GI, 2019)

Ans. Whenever the surface area of the reactant is increased, the reaction rates enhance. The reason is that the atoms and molecules of the reactants find the greater chances to touch each other.

Example: $CaCO_3$ in the powder from reacts with dil. H_2SO_4 more efficiently then big pieces of $CaCO_3$.

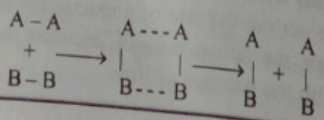
12. What is effect of light on the rate of reaction?
(SWL. GI, 2014)(SWL. GII, 2016)

Ans. Effect of light on reaction rate: Light is consisted of photons. Photons have energies. When photons of proper frequency become available to the reactant, sometimes the reaction rates are enhanced.

Examples: (a) The combination CH_4 and $C\ell_2$ requires light.
(b) Light plays a vital role in photosynthesis.

13. What do you mean by Activation Complex of a reaction?
(DGK. GI, 2016)(BWP. GII, 2017)

Ans. Activation Complex: Activation Complex is an unstable combination of all the atoms involved in the reaction for which the energy is maximum. It is a short lived species and decomposes into the Products immediately. It has a transient existence that is why it is also called as transition state.



14. State the rate of reaction Give its units.
(DGK. GI, 2014)(GRW. GI, 2015)(LHR. GII, MLN. GII, RWP. GI 2016)(BWP. GI&GII, RWP. GII, 2017)

Ans. Rate of reaction: The change in concentration of a reactant or a product per unit time is called the rate of reaction. Let the change in concentration be denoted by Δc and the change in time by Δt.
then:

$$\text{Rate of reaction} = \frac{\text{change in concentration}}{\text{time period of change}}$$

$$\text{Rate of reaction} = \frac{\Delta C}{\Delta t}$$

The symbol Δ (delta) means "the change in."

Units of Reaction Rates: When the concentration is expressed in moles dm^3 and the time in seconds, then the rate is in moles $dm^{-3}\ s^{-1}$.

In case of gaseous reactions, the concentration is measured in partial pressures, so the rates are expressed in atm s^{-1}.

15. The unit of rate constant of a second order reaction is $dm^3\ mol^{-1}s^{-1}$, but the unit of rate of reaction is mole $dm^{-3}s^{-1}$ justify. (MLN. GI, 2014)

Ans. The rate of reaction is the rate of change of concentration with respect to time.
Since,

$$\frac{\Delta C}{\Delta t} = \frac{\text{mole}\,dm^{-3}}{s} = \text{moles}\,dm^{-3}s^{-1}$$

$$\text{Rate} = k[A][B]$$

$$k = \frac{\text{Rate}}{[A][B]} = \frac{\text{moles}\,dm^{-3}s^{-1}}{\text{mole}\,dm^{-3}\,\text{mole}\,dm^{-3}}$$

$k = dm^3\ mol^{-1}\ s^{-1}$

16. What is pseudo first order reaction? Give one example.
(MLN. GII, GRW. GI, LHR. GI, RWP. GII, 2017)(BWP. GI, 2017)(AJK. 2018)(MLN. GI, 2019)

Ans. Pseudo First Order Reaction: "A pseudo first order reaction is a reaction that is truely appeared to be second order reaction in nature but is approximated as first order reaction on close analysis under special circumstances". In other words such reaction occurs when one of the reactant in biochemical reaction is in larger excess.

Example: Following equation is an example of Pseudo first order reaction in which reaction is dependent on the concentrations of both A and B but one of the components is present in large excess and thus its concentration hardly changes as the reaction proceeds.

$$A + B \longrightarrow C + D$$

17. What is meant by half-life period? Give one example.
(LHR. GII, RWP. GI, FBD. GI, AJK. GI, 2015)(SWL. GII, LHR. GII, GRW. GII, 2017)

Ans. Half life period: The half life period of a reaction is the time required to convert 50% of the reactants into products, e.g.

The half life period for the decomposition of N_2O_5 at 45°C is 24 minutes.

Half life determines order of reaction:

Let we have initial concentrations a_1, and a_2 and their half life period are t_1 and t_2.

$$t_1 \alpha \frac{1}{a_1^{n-1}} \quad \text{(i)}$$

$$t_2 \alpha \frac{1}{a_2^{n-1}} \quad \text{(ii)}$$

Dividing equation (i) and (ii)

$$\frac{t_1}{t_2} = \left[\frac{a_2}{a_1}\right]^{n-1}$$

Taking log on both sides

$$\log \frac{t_1}{t_2} = (n-1)\log\left[\frac{a_2}{a_1}\right]$$

Rearranging

$$n = 1 + \frac{\log\left[\frac{t_1}{t_2}\right]}{\log\left[\frac{a_2}{a_1}\right]}$$

18. How rate of reaction is determined by electrical conductivity method? (GRW. GII, 2017)

Ans. Rate of Reaction By Electrical Conductivity Method:
The rate of a reaction involving ions can be studied by electrical conductivity method, the conductivity of such a solution depends upon the rate of change of concentration of the reacting ions or the ions formed during the reaction. The conductivity will be proportional to the rate of change in the concentration of such ions.

19. What is Zero-order reaction? Give one example. (FBD. GI, 2016)(DGK. GI, 2017)(RWP. 2019)

Ans. Zero-order: The chemical reaction, whose rate is independent of concentration of reactant, is called zero order reaction.

Examples:

(i) Decomposition of ammonia by using tungsten.

$$2NH_3 \xrightarrow{\text{Tungsten}} N_2 + 3H_2$$

(ii) The thermal decomposition of HI on gold surface.

$$2HI \xrightarrow{\text{Gold}} H_2 + I_2$$

All catalytical reactions are zero order.

20. How the rates of reaction depend upon the nature of reactants? (DGK. GII, 2015)

Ans. The rate of reaction depends upon the nature of substances because the physical and chemical properties of the substances are largely controlled by the arrangement of electrons in the outermost orbital and their behaviour can be guessed.

Example:

Elements of I-A group of the Periodic Table have one electron in the s-orbital as outermost. They react with water more swiftly than the elements of II-A.

21. Differentiate between overall reaction and rate determining step with example. (BWP. GI, 2014)

Ans.

Overall Reaction	Rate Determining Step
(i) It is the sum of several steps involved in the chemical reaction.	(i) It is slowest step among the several steps involved in the chemical reaction.
(ii) It does not determine the rate of reaction.	(ii) It determines the rate of reaction.
Examples: The overall reaction for production of NO_2 takes place as given below: $NO_2 + NO_2 \longrightarrow NO_{3(g)} + NO_{(g)}$ $NO_{3(g)} + CO_{(g)} \longrightarrow NO_{2(g)} + CO_{2(g)}$	**Examples:** In the following steps of chemical reaction, first step is the slowest. $NO_2 + NO_2 \xrightarrow{\text{slow}} NO_{3(g)} + NO_{(g)}$ $NO_{3(g)} + CO_{(g)} \xrightarrow{\text{Fast}} NO_{2(g)} + CO_{2(g)}$

22. How concentration of reactants affects the rate of reaction? (DGK. GII, 2015)

Ans. Increase in the concentration of the reactants will result in the corresponding increase in the reaction rate, while decrease in the concentrations will have a reverse effect. For example combustion that occurs slowly in air (21% oxygen will occur more rapidly in pure oxygen.

23. Define specific rate constant. Give equation to support your answer. (LHR. GI, 2018)

Ans. It state that the rate of reaction is proportional to the active mass of the reactants to the product of active mass if more then one reactant are involved in chemical reaction.

$aA + bB \longrightarrow cC + dD$

Rate of reaction $= K [A]^a [B]^b$

$[A] = 1\ moldm^{-3}$ $[B] = 1\ moldin^{-3}$ Rate of reation $= K[1]^c [1]^b$

24. How are enthalpy changes of reaction and energy of activation of reaction distinguished? (LHR. GII, 2018)

Ans.

Enthalpy changes of reaction	Energy of Activation
The enthalpy charge occur when the certain number of moles of reactants as indicated by the balanced chemical equation react together completely to give the products under standard conditions. It is symbolized as ΔH.	The amount of energy required by reactants to start the reaction is called energy of activation.

25. The sum of the co-efficients of a balanced chemical equation is not necessarily important to give the order of reaction. Give reasons in support of your answer. (GRW. 2018)

Ans. There are many reactions in which the coefficient of overall balanced equation don't become the powers in the rate expression in the reaction. In such reaction there are more than one steps. The coefficients of that slowest step determines the order of reaction.

26. Define half life period of a reaction. Give one example. (FBD. 2018)

Ans. Half life period: half life period of a reaction is the time required to convert 50% of the reactants into products,

Example: The half life period for the decomposition of N_2O_5 at 45°C is 24 minutes.

27. What is Zero order reaction? Give one example. (SGD. 2018)

Ans. Zero Order Reaction: Zero order reaction that has a rate that is independent of concentration of the reactants.

e.g. photochemical reactions.

28. How can half life be used to determine order of reaction? (RWP, BWP. GI, 2018)(MLN. GII, 2019)

Ans. Half life period: half life period of a reaction is the time required to convert 50% of the reactants into products, e.g.

The half life period for the decomposition of N_2O_5 at 45C° is 24 minutes.

Half life determines order of reaction:

Let we have initial concentrations a_1, and a_2 and their half life period are t_1 and t_2.

$$t_1 \alpha \frac{1}{a_1^{n-1}} \quad \text{(i)}$$

$$t_2 \alpha \frac{1}{a_2^{n-1}} \quad \text{(ii)}$$

Dividing equation (i) & (ii)

$$\frac{t_1}{t_2} = \left[\frac{a_2}{a_1}\right]^{n-1}$$

Taking log on both sides

$$\log \frac{t_1}{t_2} = (n-1) \log \left[\frac{a_2}{a_1}\right]$$

Rearranging

$$n = 1 + \frac{\log\left[\frac{t_1}{t_2}\right]}{\log\left[\frac{a_2}{a_1}\right]}$$

(DGK. GI, 2018)

29. What is rate-determining step?

Ans. If a reaction occurs in several steps, one of the steps is the slowest. The rate of this step determines the overall rate of reaction. This slowest step is called the rate determining step. (AJK. 2018)

30. What is the difference between rate constant and specific rate constant?

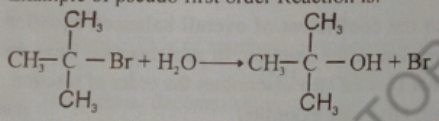
Ans. **Rate constant:** It is the rate of reaction when the concentrations of the reactants are unity.

Speific Rate Constant: It states that the rate of reaction is proportional to the active mass of the reactant or to the product of active masses of reactants if more than one reactants are involved in a chemical reaction.

31. Define order of reaction. Give an example of pseudo first order reaction. (GRW. GI, 2019)

Ans. **Order of Reaction:** "It is sum of all the exponents of concentrations involved in the rate equation.

Example of pseudo first order Reaction is:



$$\text{Rate} = K\left[(CH_3)_3CBr\right]$$

32. How radioactive $^{66}_{29}Cu$ is converted into $^{66}_{30}Zn$. Give equation. (GRW. GII, 2019)

Ans. The radioactive $^{66}_{29}Cu$ is converted into $^{66}_{30}Zn$

$$^{65}_{29}Cu + {}^{1}_{0}n \longrightarrow {}^{66}_{29}Cu + h\nu \quad (\nu \text{ radiations})$$

$$^{66}_{29}Cu \longrightarrow {}^{66}_{30}Zn + {}^{0}_{1}e$$

33. Differentiate between order of reaction and rate of reaction. (GRW. GII, 2019)

Ans.

Order of reaction	Rate of Reaction
(i) It is the sum of all the exponents of concentration involved in the rate of equation.	(i) It is the change in concentration of reactant or product per unit time.
(ii) e.g $aA+bB \rightarrow cC+dD$ $R = K[A]^a[B]^b$	(ii) $\text{Rate} = \frac{dx}{df}$

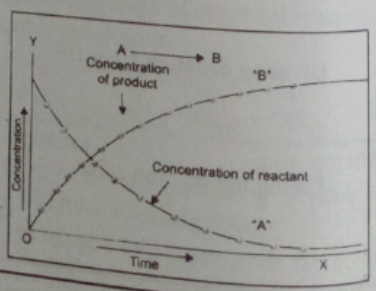
34. Define the terms: (i) Promotor (ii) Auto catalyst (GRW. GII, SGD. GII, 2019)

Ans. **(i) Promotor:** Such a substance which promotes the activity of a catalyst is called promoter or activation. It is also called "Catalyst for a Catalyst".

(ii) Auto Catalyst: In some of the reactions, a product formed acts as catalyst. This phenomena is called auto-catalyst.

35. Rate of reaction is an ever changing parameter. Give reason. (FBD. GI, 2019)

Ans. Rate of reaction never remain constant during different time intervals. Initially rate of reactions is high but decrease with passage of time. Which is shown by diagram. It means that the rate of reaction is changing every moment.



36. Define average and instantaneous rate of reaction. (FBD. GII, 2019)

Ans. The rate at any one instant during a specific interval of time is called instantaneous rate of reaction."

The rate of reaction between two specific intervals of time is called average rate of reaction.

37 Differentiate between chemical kinetics and chemical equilibrium.

Ans.

Chemical Kinetics	Chemical Equilibrium
(i) It is the study of rates and mechanism of reaction	(i) It is state at which rate of forward reaction is equal to the rate of reverse reaction.
(ii) It is related to rate of reaction whether it is forward reverse.	(ii) It is related to the state of reaction when rates of forward and reverse reactions become equal.
(iii) Kinetic study of the reaction is possible whether it is reversible or irreversible.	(iii) The state of chemical equilibrium is possible only if reaction is reversible.
(iv) Chemical kinetics belongs to the path or mechanism of reaction.	(iv) The state of chemical equrbrium belongs to the rates of forward and reverse reactions.
(v) Chemical kinetics is concerned with rate of reaction and the factors affecting reaction rate.	(v) It depends upon the state of equilibrium and the factors affecting upon it.

ESSAY TYPE QUESTIONS

1. **How does the Arrhenius equation help us to calculate the energy of activation of a reaction?** (GRW. GI, DGK. GI & GII, 2014)(GRW. GII, 2015)(DGK. GII, 2016) (MLN. GII, BWP. GII, 2018)(LHR. GI, MLN. GI, RWP. 2019)

2. **Define the order of a reaction and give one example of first, second and third order of a reaction.** (RWP. GI, GRW. GI, 2014)(GRW. GII, 2015)(DGK. GII, 2017)(LHR. GII, 2018)

3. **Explain effect of temperature on rate of reaction by Arrhenius equation.** (FBD. GI, 2014)(DGK. GI, 2015)(LHR. GII, 2019)

4. **Explain velocity constant of a reaction. What will be effect of temperature on velocity constant?** (DGK. GI, 2018)

5. **Give names of different types of methods for determining order of a reaction and explain half-life method.** (DGK. GII, 2018)

6. **What do you mean by rate determining step of a chemical reaction. Explain it with following example.** $NO_2(g) + CO(g) \longrightarrow NO(g) + CO_2(g)$ (AJK. 2018)
Define order of a chemical reaction. How does half-life method can be used for its measurement. (SGD. GII, 2019)

7. **Define half-life period. How is half-life method used to determine the order of reaction?**

ACCORDING TO THE
ACCELERATED LEARNING PROGRAMME (ALP)
OF EDUCATION DEPARTMENT

Smart Syllabus

ANNUAL PAPERS

TAKEN FROM PREVIOUS QUESTIONS OF ANNUAL PAPERS 2014 - 2019 OF ALL SECONDARY BOARDS

LAHORE	GUJRANWALA
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SARGODHA	BAHAWALPUR
D.G. KHAN	AZAD JAMMU & KASHMIR

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Paper No.01 CHEMISTRY Annual Paper 2014-2019

Roll No. _____ (To be filled in by the candidate)

Maximum Marks: 17 **(OBJECTIVE TYPE)** Time Allowed: 20 Minutes

NOTE: You have four choices for each objective type question as A, B, C and D. The choice which you think is correct, fill that circle in front of that question number. Use marker or pen to fill the circles. Cutting or filling two or more circles will result in zero mark in that question.

Q1. 17

1. **The largest number of molecules are present:**

(GRW. FBD. LHR. 2014)(AJK. DGK. GII, FBD. 2016)(RWP. GI, MLN. GII, FBD. LHR. GII, 2017)
(GRW. 2018)(LHR. GI & GII, FBD. GI, MLN. GI, SGD. GI, 2019)

(A) 3.6 g of H_2O (B) 4.8 g of C_2H_5OH
(C) 2.8 g of CO (D) 5.4 g of N_2O_5

2. **27 g of Al will react completely with how much mass of O_2, to produce Al_2O_3.**

(LHR. GII, DGK. GII, 2015)(MLN. GII, RWP. 2016)(RWP. GII, GRW. GI, SGD. GI, MLN. GI, 2017)
(LHR, DGK. GI, BWP. GII, AJK. 2018)(GRW. GI, MLN. GII, RWP. BWP. 2019)

(A) 8 g of oxygen (B) 16 g of oxygen
(C) 32 g of oxygen (D) 24 g of oxygen

3. **Solvent extraction method is particularly useful technique for separation when the product to be separated is:**

(LHR. 2014)(MLN. GI, DGK. GII, LHR. GI & GII, 2016)
(AJK. GII, 2017)(BWP. GII, 2018)(LHR. GI, SGD. GI, RWP. 2019)

(A) Non-volatile or thermally unstable (B) Volatile or thermally stable
(C) Non-volatile or thermally stable (D) Volatile or thermally unstable

4. **Partial pressure of oxygen in the air is:**

(DGK. GII, 2014)(SGD. GII, 2017)(LHR. GII, 2018)

(A) 156 torr (B) 157 torr
(C) 158 torr (D) 159 torr

5. **Formula used for the conversion of °F into °C is:** (RWP. 2014)

(A) $°F = \frac{9}{5}(°C) + 32$ (B) $°C = \frac{5}{9}[°F - 32]$
(C) $°F = \frac{5}{9}(°C) + 32$ (D) $°C = \frac{9}{5}[°F - 32)$

6. **The boiling point of water at Muree Hills:**

(DGK. GI, 2016)(GRW. 2018)

(A) 90°C (B) 98°C
(C) 100°C (D) 120°C

7. **Crystal of diamond is:** (SGD. GII, 2017)(DGK. GI, 2019)

(A) Ionic (B) Covalent
(C) Molecular (D) Metallic

8. When fast neutron carries nuclear reaction with nitrogen it ejects particles: (RWP. GI, 2014)

(A) α (B) β
(C) γ (D) δ

9. The velocity of photon is: (SGD. GI, MLN. GII, RWP. GII, 2017)(GRW, RWP, BWP. GI, 2018)(LHR. GII, 2019)

(A) independent of its wavelength (B) depends on its wavelength
(C) equal to square of its amplitude (D) depends on its source

10. The carbon atom in C_2H_4 is: (SGD. GII, 2017)

(A) sp^3-hybridized (B) sp^2-hybridized
(C) sp-hybridized (D) dsp^2-hybridized

11. In ethyne molecule the number and nature of bonds are:- (MLN. GI, 2018)

(A) One sigma two pi (B) Two sigma one pi
(C) Three sigma two pi (D) Two sigma two pi

12. The change in heat energy of a chemical reaction at constant temperature and pressure is called: (DGK. GI, 2016)(MLN. GI, BWP. GI, 2017)(RWP, AJK. 2018)(MLN. GI, BWP. GI, 2019)

(A) enthalpy change (B) bond energy
(C) heat of sublimation (D) internal energy change

13. For which system does the equilibrium constant K_c has units of (concentration)^1? (LHR. GI, 2014)(MLN. GII, DGK. GI, 2016)(BWP. GI, LHR. GI, 2017)

(A) $3H_2 \rightleftharpoons 2NH_3$ (B) $H_2 + I_2 \rightleftharpoons 2HI$
(C) $2NO_2 \rightleftharpoons N_2O_4$ (D) $2HF \rightleftharpoons H_2+F_2$

14. An aqueous solution of ethanol in water has vapour pressure: (SGD. GI, SWL. GI, 2014)(DGK. GI, 2017)

(A) equal to that of water (B) equal to that of ethanol
(C) more than that of water (D) less than that of water

15. Liquids which are practically immiscible: (LHR. GII, 2019)

(A) $H_2O + C_6H_6$ (B) $H_2O + C_2H_5 - OH$
(C) $H_2O + HCl$ (D) $H_2O + CH_3 - O - CH_3$

16. Stronger the oxidizing agent, greater is the (LHR. GI, BWP. GI, GRW. GI, 2014)(AJK. GI, FBD. GI, 2016)(RWP. GI&GII, DGK. GI, 2017) (LHR. GII, DGK. GI, 2018)(GRW. GI, & GII, RWP. BWP. GI, 2019)

(A) oxidation potential (B) reduction potential
(C) redox potential (D) emf of cell

17 With increase in 10°C temperature, the rate of reaction doubles. This increase in rate of reaction is due to: (DGK. GI, FBD. GII, 2017)(SGD. GI, 2019)

(A) Decrease in activation energy of reaction
(B) Decrease in the number of collisions between reactant molecules
(C) Increase in activation energy of reactants
(D) Increase in the number of effective collisions

Annual Paper 2014 - 2019

Roll No. _____ (To be filled in by the candidate)

Maximum Marks: 68 **(SUBJECTIVE TYPE)** Time Allowed: 2.40 Hours

SECTION - I

Q2. Write short answers to any EIGHT (8) questions: 8×2=16

(i) Define Avogadro's number. How does it relate to the masses of chemical substances?
(GRW. GI, 2015)(BWP. GII, 2018)(MLN. GII, DGK. GI, 2019)

(ii) 23 g of sodium and 238 g of uranium have equal number of atoms in them.
(MLN. GI, 2014)(LHR. GI, RWP. GII, 2017)(SWL. 2018)(MLN. GII, 2019)

(iii) Write down only steps to determine Limiting Reactant. (BWP. GI, 2018)

(iv) What is R_f value? Why it has no units?
(MLN. GI, 2016)(GRW. GII, MLN. GI, AJK. 2017)(FBD. 2018)(SGD. GI, 2019)

(v) What is sublimation? Give examples of substances which show sublimation.
(RWP. GI, SWL. DGK. GI, 2014)(GRW. GI, LHR. GI & GII, DGK. GII, BWP. 2015)(BWP. GI, RWP. GII, 2017)

(vi) Define Avogadro's law with two suitable examples.
(DGK. GII, LHR. GI, 2016)(GRW. GII, DGK. GI, 2017)(FBD, BWP. GII, 2018)

(vii) Write down two characteristics of plasma.
(RWP. GI, 2014)(AJK. 2015)(BWP. GI, 2017)(LHR. GII, GRW, 2018)(LHR. GI, SWL. 2019)

(viii) Explain the process of Respiration obeys Daltons Law of partial pressure.
(SGD. GII, 2014)

(ix) Some of the postulates of KMT are faulty. Justify.
(GRW. GII, 2014)(LHR. GI, GRW. GII, RWP. 2015)(BWP. GI & GII, 2017)(GRW. GII, 2019)

(x) Give two applications of Colligative properties. (SGD. GI, 2014)(DGK. GII, 2019)

(xi) What is solubility carve? Name its two types. (DGK. GI, 2016)(LHR. GI, 2019)

(xii) Define colligative properties. Why are they so called? (GRW. 2018)(DGK. GII, 2019)

Q3. Write short answers to any EIGHT (8) questions: 8×2=16

(i) Write a note on the factors affecting the London forces. (BWP. GI, 2017)

(ii) Describe cleaning action of soaps and detergents on the basis of H-bonding.
(LHR. GI, 2017)(SGD. GI, 2019)

(iii) Why water is liquid at room temperature but H_2S and H_2Se are gases, comment?
(GRW. G1, 2015)(DGK. GII, 2016)(MLN. GII, LHR. GII, 2017)

(iv) How liquid crystals act as temperature sensor? (FBD. GI, 2019)

(v) Cathode rays are material particles explain with reason.
(GRW. GI, 2014)(AJK. GRW. GII, 2015)(LHR. GI, DGK. GI, 2016)(DGK. GI, 2018)

(vi) How the wave nature of electron was verified experimentally?
(GRW. GII, 2014)(AJK. 2015)(MLN. GI, SWL. 2019)

(vii) Differentiate between orbit and orbital. (DGK. GII, 2018)(SWL. 2019)

(viii) Sodium chloride and Cesium Flouride have the same geometry, comment on it.
(GRW. GII, 2019)

(ix) What are optimum conditions for the synthesis of NH_3?
(FBD. GI, 2014)(BWP. GII, DGK. GI, 2017)(LHR. GI, DGK. GII, 2019)

(x) How does a Buffer act? Explain with an example. (MLN. GI, 2015)(MLN. GII, 2018)(SGD. GI, 2019)

(xi) The radioactive decay is always a first order reaction. Justify.
(LHR. GII, 2016) (SGD. GII, RWP. GI, FBD. GII, 2017)(LHR. GII, 2018)(LHR. GI, 2019)

(xii) What is pseudo first order reaction? Give one example.
(MLN. GII, GRW. GI, LHR. GI, RWP. GII, 2017)(BWP. GI, 2017)(AJK. 2018)(MLN. GI, 2019)

Q4. Write short answers to any SIX (6) questions: 6×2=12

(i) Why liquids are less common then solids and gases? (SWL. GII, 2017)

(ii) Ionization energy is index to the metallic character. Why? (SGD. GI, 2014)(BWP. GII, 2017)(BWP. GII, 2019)

(iii) Both NH_3 and BF_3 are tetra atomic but different geometries. Why. (RWP. GII, 2017)(DGK. GII, 2018)

(iv) 75.4 pm is compromise distance between the bonded hydrogen atoms. Justify. (LHR. GII, 2018)(FBD. GII, 2019)

(v) Define standard enthalpy of combustion. Give one example. (FBD. GI, 2014)(MLN. GI, RWP. GI, 2016)(BWP. GI, DGK. GII, RWP. GI, 2017)

(vi) State Hess's law of constant Heat summation. (RWP. GI, 2014)(MLN. GI, 2015)(SGD. GII, 2019)

(vii) Differentiate between primary and secondary cell giving one example each. (DGK. GI, RWP. GII, 2017)(SGD, DGK. GII, 2018)(MLN. GI, 2019)

(viii) Na^+ and K^+ can displace hydrogen from acids but Pt, pd and Cu cannot explain. (DGK. GII, FBD. GI, 2015)(AJK. FBD. GI, 2016)(SGD. GI, 2017)(MLN. GI, BWP. GII, 2018)

(ix) Write two rules for assigning oxidation number. (GRW. GI, 2015)

SECTION - II

Note: Attempt any THREE questions. 3×8=24

Q5. (a) Write down various steps to calculate the empirical formula of a compound. 4 (MLN. GI, 2014)(GRW. GII, SGD. GII, 2019)

(b) What is meant by the term hydrogen bonding? How does hydrogen bonding explain, the properties of proteins. 4 (RWP. GI, MLN. GI, 2016)(SGD. GI, 2017)

Q6. (a) Prove general gas equation (PV = nRT). 4 (DGK. GI, 2015)

(b) Describe Millikan's oil drop method for the measurement of charge on an electron. 4 (DGK. GI, SWL. 2014)(MLN. GII, BWP. 2015)(LHR. GI, MLN. GI, 2016) (SWL, MLN. GI & GII, RWP. 2018)(FBD. GI, AJK. 2019)

Q7. (a) Give the main postulates of VSEPR theory, Illustrate with the explanation of the structure of one molecule. 4 (DGK. GI & GII, SWL. GRW. GI & GII, 2014)(RWP. 2015)(LHR. GII, 2016) (SWL. GII, FBD. GI, MLN. GI, BWP. GI, LHR. GI & GII, 2017)(SGD. 2018)(GRW. GII, SGD. GI, 2019)

(b) What is first law of thermodynamics? Prove that $\Delta E = q_v$. 4 (BWP. GI, 2014)(RWP. GI, DGK. GII, 2015)(BWP. GI, SGD. GI, 2017)(FBD. GI, BWP. GII, 2019)

Q8. (a) How can you predict the followings with the help of equilibrium constant (K_C) of reversible reaction: 4

(i) Direction of a reaction (ii) Extent of a reaction (GRW, BWP. GI, 2018)

(b) How does the Arrhenius equation help us to calculate the energy of activation of a reaction? 4 (MLN. GII, BWP. GII,)(LHR. GI, MLN. GI, RWP. 2019)

Q9. (a) How Raoult's law can be defined in three different ways? Also give their mathematical expression. 4 (RWP. GI, 2014)(BWP. GI, DGK. GII, 2015)(BWP. GI, LHR. GII, SGD. GI, RWP. GII, 2017)(AJK. 2019)

(b) Describe the electrolysis of molten sodium chloride and a concentrated solution of sodium chloride. 4 (SGD. GI, 2014)(LHR. GII, 2015)(FBD. GI, 2016)(DGK. GII, 2017)(DGK. GII, 2018)(SGD. GI, 2019)

Paper No.02 CHEMISTRY Annual Paper 2014-2019

Roll No. _____ (To be filled in by the candidate)

Maximum Marks: 17 **(OBJECTIVE TYPE)** Time Allowed: 20 Minutes

NOTE: You have four choices for each objective type question as A, B, C and D. The choice which you think is correct, fill that circle in front of that question number. Use marker or pen to fill the circles. Cutting or filling two or more circles will result in zero mark in that question.

Q1. 17

1. **Nickel has isotopes:** (DGK. GII, 2017)

(A) 3 (B) 5

(C) 6 (D) 11

2. **The mass of two moles of electrons is:** (BWP. LHR. SWL. 2014)

(A) 1.10 mg (B) 1.008 mg

(C) 0.184 mg (D) 1.673 mg

3. **Which one is not example of a sublimate?** (DGK. G1, 2015)

(A) Ammonium chloride (B) Iodine

(C) NaCℓ (D) Benzoic acid

4. **If absolute temperature of the gas is doubled and the pressure is reduced to one half the volume of the gas will:**

(SGD. GII, 2014)(MLN. GII, LHR. GI, 2017)(DGK. GI, AJK. 2018)(GRW. GI, 2019)

(A) Remains uncharged (B) Increase four times

(C) Reduce to $\frac{1}{4}$ (D) be doubled

5. **Volume occupied by one mole of gas at standard temperature and pressure is:** (DGK. GI, 2019)

(A) 54 dm^3 (B) 22.414 dm^3

(C) 2.24 dm^3 (D) 2.4 dm^3

6. **Dipole-induced dipole forces are also called:-** (MLN. GI, DGK. GI, 2018)

(A) Dipole-dipole forces (B) Ion-dipole forces

(C) Debye forces (D) London dispersion forces

7. **Which of the halogen halides has the highest percentage of ionic character:**

(GRW. GI, FBD. GI, MLN. GI, SGD. GI, RWP. DGK. GII, BWP. GII, AJK. 2019)

(A) HCℓ (B) HBr

(C) HF (D) HI

8. The e/m value for the positive rays in maximum for the gas. (BWP. 2015)(AJK. 2018)

(A) Hydrogen (B) Helium

(C) oxygen (D) Nitrogen

9. Orbitals having same energy are called:
(RWP. GI, 2014)(LHR. GI, BWP. 2015)(FBD. GI, 2016)(BWP. GI, LHR. GI, SGD. GII, DGK. GI, 2017)
(GRW. GII, FBD. GI, SGD. GI, & GII, DGK. GI, AJK. 2019)

(A) hybrid orbitals (B) valence orbitals

(C) degenerate orbitals (D) d-orbitals

10. The bond angle in NH_3 molecule is: (BWP. GRW. GI, 2014)(DGK. GII, 2016)

(A) 109.5° (B) 107.5°

(C) 104.5° (D) 108°

11. The tendency of an atom to attract shared pair of electron towards itself is called its: (SGD. GII, 2014)

(A) Ionization energy (B) Electron Affinity

(C) Electronegativity (D) Dipole moment

12. For the reaction $NaOH + HC\ell \longrightarrow NaC\ell + H_2O$ the change in enthalpy is called:
(GRW. GI, SWL. GI, 2014)(DGK. GII, 2016)(BWP. GII, MLN. GII, LHR. GII, BWP. GII, 2017)
(SWL, GRW, DGK, BWP, GI, 2018)(SGD. GII, 2019)

(A) heat of reaction (B) heat of formation

(C) heat of Neutralization (D) heat of combustion

13. pH of pure water is: (GRW. GI, 2014)(FBD. GI, 2015)(AJK. 2019)

(A) 4.4 (B) 5.4

(C) 7.0 (D) 8.0

14. The number of moles of solute per kg of solvent is called: (BWP. GI, 2018)

(A) Molality (B) Molarity

(C) Mole Fraction (D) Normality

15. Ideal solutions obey: (LHR. GI, 2018)

(A) Henry's law (B) Avogadro's law

(C) Raoult's law (D) Smith's law

16. The standard electrode potential (in volt) of SHE is taken as: (DGK. GII, 2019)

(A) 0.00 (B) 1.00

(C) 10.0 (D) 100

17. In zero order reaction, the rate is independent of:
(FBD. GI, SGD. GII, BWP. GI, GRW. GII, 2014)(FBD. GI, 2015)(BWP. GI, MLN. GI, MLN. GII, 2016)
(SWL. GII, 2017)(LHR. GII, GRW. GI, & GII, DGK. GI, & GII, 2019)

(A) Temperature of reaction (B) Concentration of reactants

(C) Concentration of products (D) None of these

Annual Paper 2014 - 2019

Roll No. _____ (To be filled in by the candidate)

Maximum Marks: 68 **(SUBJECTIVE TYPE)** Time Allowed: 2.40 Hours

SECTION - I

Q2. Write short answers to any EIGHT (8) questions: 8×2=16

(i) What are isotopes? Why they have same chemical but different physical properties. (LHR. GII, 2015)(DGK. GI, 2016)(AJK. GII, 2017)(LHR. GII, 2019)

(ii) Differentiate between actual yield and theoretical yield. (RWP. FBD. GI, DGK. GII, 2015)(DGK. GII, BWP. GII, 2017)(DGK. GI, 2018)

(iii) Why do the isotopes have same chemical but different physical properties? (MLN. GI, 2019)

(iv) Define Sublimation and Chromatography. (BWP. GII, 2017)(DGK. GII, 2018)

(v) Define chromatography. Give its two uses. (DGK. GI, FBD. GI, 2016)(AJK. GII, BWP. GI, 2017)(BWP. GI, 2018)(DGK. GII, FBD. GI, 2019)

(vi) Write down four postulates of kinetic molecular theory of gases responsible for the deviation of gases from ideal behaviour. (BWP. GII, 2017)(SWL. DGK. GI, 2018)

(vii) Derive Boyle's Law from Kinetic molecular theory of gases. (SGD. GII, RWP. GI, 2017)(DGK. GI, 2018)(GRW. GII, MLN. GII, 2019)

(viii) Convert 37°C into °F scale. (SWL. GII, 2017)(AJK. 2018)

(ix) Where do natural plasma and artificial plasma exist? (LHR. GI, 2018)

(x) Define cryoscopy constant with an example. (DGK. GII, 2015)(AJK. GI, 2016) (DGK. GII, 2017)

(xi) $NaC\ell$ lowers the melting point of ice. Give reason. (SGD. GII, 2014)(DGK. GI, LHR. GI, MLN. GII, 2015)(BWP. GI, 2016)(LHR. GI, AJK. GII, FBD. GII, 2017)

(xii) Why is aqueous solution of $CuSO_4$ acidic in nature? (FBD. GI, 2019)

Q3. Write short answers to any EIGHT (8) questions: 8×2=16

(i) What is the role of Hydrogen bonding in biological compounds? (BWP. GII, 2017)

(ii) What are dipole-dipole forces of attraction? Explain with an example. (LHR. MLN. GII, 2015)(FBD. GI, 2016)

(iii) Explain the term 'Anisotropy' with an example. (SWL. 2018)

(iv) Boiling needs a constant supply of heat. Justify. (BWP. GI, 2019)

(v) Calculate mass of an electron when $^{e}/_{m} = 1.758 \times 10^{11}$ C. kg^{-1}. (LHR. BWP. 2015)(RWP. 2016)(FBD. GII, 2017)(FBD. GII, MLN. GI, 2019)

(vi) State Heisenberg uncertainty Principle and give its mathematical form. (SWL. MLN. GI, 2014)(DGK. GI, LHR. GII, RWP. 2015)(LHR. GI, 2016)(MLN. GI & GII, 2018)(SWL. AJK. 2019)

(vii) How will you prove that Cathode Rays travel in Straight Line? (BWP. GI, 2017)(FBD. GI, 2019)

(viii) Differentiate between frequency and wave number. (SGD. 2018)

(ix) State Le-Chatelier's Principle and discusses the effect of change in concentration of a product on reversible reaction. (GRW. GI, DGK. GII, 2014)(LHR. GI, 2015)(DGK. GI, 2017)(AJK. 2018)(SGD. GII, 2019)

(x) Give two applications of Buffer solution. (DGK. GI, 2014)(MLN. GII, 2016)(LHR. GI, 2017)(BWP. GI, 2018)

(xi) What do you mean by activation energy? (FBD. GI, MLN. GI, 2016)(BWP. GII, 2017)

(xii) The unit of rate constant of a second order reaction is $dm^3\ mol^{-1}s^{-1}$, but the unit of rate of reaction is mole $dm^{-3}s^{-1}$ justify. (MLN. GI, 2014)

Q4. Write short answers to any SIX (6) questions: 6×2=12

(i) What is co-ordinate covalent bond? Give one example.
(SGD. GI, 2014)(DGK. GII, MLN. GII, 2015) (MLN. GI, AJK. BWP. 2016)
(BWP. GII, SWL. GII, DGK. GII, RWP. GI, 2017)(AJK. 2018)(SGD. GI, DGK. GII, 2019)

(ii) Helium is diamagnetic in nature Justify. (SWL. GII, 2017)(BWP. GII, 2018)

(iii) Why Pi (π) bonds are more diffused than sigma bonds?
(GRW. GI & GII, BWP. 2014)(MLN. GII, GRW. GII, 2015)(MLN. GI, RWP. 2016)
(LHR. GII, 2017)(SWL. 2018)(MLN. GII, 2019)

(iv) How Sigma and pi bonds are fomed? (DGK. GI, 2017)(GRW. GII, 2019)

(v) Define the terms standard enthalpy of neutralization and standard enthalpy of atomization.
(SGD. GII, 2017)(MLN. GII, SGD. GII, BWP. GI, 2019)

(vi) Differentiate between Atomization energy and Lattice energy. (DGK. GI, 2018)

(vii) The oxidation state of oxygen is +2 in OF_2. Justify it. (AJK. GI, 2015)(DGK. GI, 2018)

(viii) What is electrolysis? Give example. (LHR. GII, 2015)

(ix) Voltaic cell is reversible cell state. (LHR. GI, 2015)(DGK. GII, 2018)

SECTION - II

Note: Attempt any THREE questions. 3×8=24

Q5. (a) A well known ideal gas is enclosed in a container having volume 500 cm^3 at S.T.P. Its mass comes out to be 0.72g. What is the molar mass of this gas. 4
(AJK. MLN. GII, 2016)(MLN. GI, AJK. GII, DGK. GI, 2017)(SWL, BWP. GII, 2018)

(b) What is effect of external Pressure on boiling point of a substance? Give example. 4
(DGK. GI, 2016)

Q6. (a) What is graham's Law of diffusion? Also qive its experimental verification. 4
(RWP. AJK. 2015)(DGK. GII, RWP. MLN. GII, FBD. GI, 2016)(BWP. GII, DGK. GII, LHR. GI, 2017)
(GRW, DGK. GII, AJK. 2018)(RWP. 2019)

(b) Explain Rutherford's model of atom. 4
(RWP. 2014)(MLN. GI, 2015)(LHR. GII, 2017)

Q7. (a) Briefly explain shapes of NH_3 and H_2O molecule according to hybridization theory. 4
(DGK. GI, 2015)(AJK. GII, 2017)

(b) State first law of thermodynamics. How does it explain that $q_p = \Delta H$. 4
(RWP. GI, 2017)(LHR. GII, DGK. GI, BWP. GII, GRW, SWL. 2018)

Q8. (a) $Ca(OH)_2$ is a sparingly soluble compound. Its solubility product is 6.5×10^{-6}. Calculate the solubility of $Ca(OH)_2$. (Atomic mass: Ca = 40). 4
(LHR. GII, 2015)(LHR. GII, DGK. GI, 2016)(RWP. GII, BWP. GI, DGK. GI, 2017)(LHR. GI, & GII, GRW. GI, 2019)

(b) Explain velocity constant of a reaction. What will be effect of temperature on velocity constant? 4
(DGK. GI, 2018)

Q9. (a) Discuss differences between ideal solution and non-ideal solutions. 4
(DGK. GI, 2015)(LHR. GII, 2019)

(b) State rules for assigning oxidation number of elements with examples. 4
(DGK. GI, 2014)

Paper No.03 CHEMISTRY Annual Paper 2014-2019

Roll No. _____ (To be filled in by the candidate)

Maximum Marks: 17 **(OBJECTIVE TYPE)** Time Allowed: 20 Minutes

NOTE: You have four choices for each objective type question as A, B, C and D. The choice which you think is correct, fill that circle in front of that question number. Use marker or pen to fill the circles. Cutting or filling two or more circles will result in zero mark in that question.

Q1. 17

1. **A limiting reactant is the one which:** (GRW. 2017)
   (A) Gives maximum amount of the product
   (B) Gives minimum amount of the required product
   (C) is taken in lesser quantity in grams as compared to other reactants
   (D) Is taken in lesser quantity in volume as compared to the other reactants

2. **Bromine has isotopes:** (SGD. GII, 2017)
   (A) 8 (B) 6
   (C) 4 (D) 2

3. **Solvent extraction is an equilibrium process and is Controlled by:**
   (SGD. SWL. BWP. MLN. GI, GRW. GI & GII, 2014)(LHR. GI, AJK. RWP. FBD. GI, BWP. 2015)
   (MLN. GII, DGK. GI, AJK. BWP. 2016)(FBD. DGK. GII, RWP. GII, LHR. GII, BWP. GI, 2017)
   (GRW. GII, DGK. GII, BWP. GI, 2018)(GRW. GI & GII, MLN. GII, SWL. BWP. GI, 2019)
   (A) Law of mass action (B) The amount of solvent used
   (C) Distribution law (D) The amount of Solute

4. **Equal masses of methane and oxygen are mixed in an empty container at 25°C. The fraction of total pressure exerted by oxygen is:**
   (FBD. DGK, 2014)(LHR. GII, 2017)(LHR. GI, DGK. GII, 2018)
   (A) $\frac{1}{3}$ (B) $\frac{8}{9}$
   (C) $\frac{1}{9}$ (D) $\frac{16}{17}$

5. **The temperature of natural plasma is about:** (DGK. GI, 2017)
   (A) 20000 °C (B) 10000 °C
   (C) 5000 °C (D) 1000 °C

6. **Which one of the following is in liquid state at room temperature?** (SWL. 2018)
   (A) Methane (B) Ethane
   (C) Hexane (D) Propane

7. **Hydrogen bonding is maximum in:** (LHR. GII, 2019)
   (A) HI (B) HBr
   (C) HCℓ (D) H_2O

8. **The nature of positive rays depends on:** (SWL. 2014)(MLN. GI, 2016)(RWP. GI, 2017)(RWP. 2018)(GRW. GI, MLN. GII, RWP. 2019)
   (A) the nature of electrode (B) the nature of discharge tube
   (C) the nature of residual gas (D) all of the above

9. **Positive rays were discovered by:** (AJK. 2017)
   (A) J.J Thomson (B) Goldstein
   (C) William Crookes (D) Ruther ford

10. **The bond order of N_2 molecule is:** (SGD. GII, 2014)(MLN. GII, AJK. GII, 2017)(SGD. 2018)(MLN. GII, 2019)
    (A) 1 (B) 2
    (C) 3 (D) 4

11. **The amount of energy released by absorbing an electron in the valence shell of an atom is:** (DGK. GII, 2018)
    (A) Ionization energy (B) Electron affinity
    (C) Electro negativity (D) Bond energy

12. **The net heat change in a chemical reaction is same whether it is brought about in two or more different ways in one or several steps. It is known as:** (DGK. GI, 2014)(LHR. GI, 2016)(SGD. GI, 2019)
    (A) Henry's law (B) Hess's law
    (C) Joule's principle (D) Law of conservation of energy

13. **pH of bananas is:** (SGD. GI, 2014)
    (A) 2.1 (B) 4.6
    (C) 9.4 (D) 9.6

14. **Relative lowering of vapour pressure is equal to:** (LHR. GII, 2017)
    (A) Mole fraction of solute (B) Mole fraction of solvent
    (C) Molarity (D) Molality

15. **A solution of glucose is 10% the volume to which 1 gm/mole of it dissqlved will be:** (SWL. 2018)
    (A) $1dm^3$ (B) $200Cm^3$
    (C) $1.8\ dm^3$ (D) $900Cm^3$

16. **The cathodic reaction in the electrolysis of dil. H_2SO_4 with Fe electrodes is:** (LHR. GI, MLN. GI, BWP. GI, 2014)(MLN. GII, AJK. GI, 2016)(LHR. GI, BWP. GI, FBD. GII, 2017)
    (A) reduction (B) oxidation
    (C) both oxidation and reduction (D) neither oxidation nor reduction

17. **Hydrolysis of tertiary butyl bromide is** (GRW. 2018)
    (A) zero order reaction (B) first order reaction
    (C) pseudo first order reaction (D) second order reaction

Annual Paper 2014 - 2019

Roll No. _____ (To be filled in by the candidate)

Maximum Marks: 68 (SUBJECTIVE TYPE) Time Allowed: 2.40 Hours

SECTION - I

Q2. Write short answers to any EIGHT (8) questions: 8×2=16

(i) No individual Neon (Ne) atom in the sample of the element has a mass of 20.18 amu why? (SGD. GI, 2014)(MLN. GI, DGK. GII, 2015)(BWP. GII, SGD. GII, MLN. GII, GRW. GII, 2017)

(ii) Two grams of H_2, 16 g of CH_4 and 44 g of CO_2 occupy separately the volumes of 22.414 dm^3, although the sizes and masses of molecules of three gases are very different from each other. (LHR. GI, 2017)(LHR. GII, 2018)

(iii) 2g H_2, 16g CH_4, 44g CO_2 occupy same volume. Why? (FBD. GII, 2019)

(iv) What is solvent extraction technique? Give an example also. (GRW. GI, RWP. 2015)(LHR. GI, BWP. GI, 2017)(BWP. GII, MLN. GI, 2019)

(v) Mention only steps involved in complete quantitative determination. (BWP. GI, 2018)

(vi) Why deep sea divers take oxygen mixed with an inert gas, Like (He)? (DGK. GI, 2014)(RWP. 2015)(DGK. GI, 2017)

(vii) Calculate the value of gas constant "R" in SI units. (BWP. SGD. GI & GII, GRW. GI & GII, 2014)(DGK. GRW. GII, MLN. GII, 2015) (MLN. GII, LHR. GI, 2016)(FBD. GII, DGK. GII, MLN. GII, SGD. GI & GII, 2017)(LHR. GII, FBD. 2018) (LHR. GI & GII, GRW. GI, FBD. GI, MLN. GI, SGD. GII, BWP. GI, BWP. GI, 2019)

(viii) Why pilots feel uncomfortable breathing in unpressurised cabin? (SGD. GII, 2017)(MLN. GII, SWL. 2018)

(ix) Describe two causes of deviation of real gas from ideal behaviour. (DGK. GI, 2019)

(x) Boiling points of the solvents increase due to the presence of solutes. Justify it. (AJK. GI, 2015)(FBD. GII, RWP. GII, 2017)

(xi) In summer the antifreeze solutions protect liquid of the radiator from boiling over. Justify it. (MLN. GI, 2014)(LHR. GI, 2015)(AJK. GII, MLN. GII, 2017)

(xii) Define colligative properties, name important colligative properties. (GRW. GI, 2015)(AJK. 2018)

Q3. Write short answers to any EIGHT (8) questions: 8×2=16

(i) What are dipole-dipole forces? How they effect thermodynamic properties of substances. (DGK. GI, 2017)(GRW. GI, FBD. GII, 2019)

(ii) Iodine dissolves readily in teterachloromethane. (SWL. GII, SGD. GII, 2017)

(iii) What is the relationship between polymorphism and allotropy? (LHR. GI, 2015)(SGD. GII, BWP. GI, 2017)

(iv) Define amporphous solids and give two examples. (DGK. GII, 2019)

(v) How positive rays are produced in discharge tube? (DGK. GI, 2014)(DGK. GII, AJK. 2015)(DGK. GI, 2018)

(vi) Narrate Properties of Cathode rays. (RWP. DGK. GII, 2016)(LHR. GI, MLN. GII, 2017)

(vii) Give two defects of Rutherford's atomic model. (FBD, AJK. 2018)(LHR. GI, FBD. GI, FBD. GII, SGD. GII, DGK. GI, 2019)

(viii) Write down four properties of Neutron. ((BWP. 2014)(AJK. 2018)(DGK. GI, 2019)

(ix) How does a catalyst affect a reversible reaction? (SGD. GII, SWL. GI, 2014)(DGK. GII, 2016) (RWP. GI, 2017)(LHR. GI, BWP. GII, 2018)

(x) Prove by equations that what happens when Na_2CrO_4 is added to saturated solution of $PbCrO_4$? (LHR. GII, 2018)

(xi) What is meant by order of reaction? Give an example. (DGK. GI, 2015)(DGK. GII, RWP. GI, 2019)

(xii) Differentiate between Average and Instantaneous Rate. (BWP. GI, 2019)

6×2=12

Q4. Write short answers to any SIX (6) questions:

(i) Why CO is polar and CO_2 is non-polar? (GRW. GI, 2014)(GRW. GII, 2015)

(ii) How the nature of a chemical bond is predicted with the help of electronegativity values of two bonded atoms? (FBD. GI, 2014)(LHR. GI, 2019)

(iii) Why the radius of an atom cannot be determined precisely? (GRW. GII, 2014)(RWP. 2015)(BWP. 2016)(RWP. GII, 2017)(BWP. GI, 2018)(SWL. DGK. GI, 2019)

(iv) Electronegativity difference between the bonded atoms is an index to the polar nature of covalent bond, justify. (GRW. 2018)(SGD. GI, BWP. GII, 2019)

(v) The enthalpy of neutralization of all the strong acids and strong bases has the same value. Justify. (GRW. GII, DGK. GI, 2014)(LHR. GII, MLN. GI, DGK. GI, 2018)

(vi) Define Standard Enthalpy of Combustion and Standard Enthalpy of Solution. (BWP. GII, 2018)

(vii) How relative chemical reactivity of metals is studied with the help of electrochemical series. (SWL. GII, 2017)

(viii) Calculate oxidation number of 'Cr' in (a) $CrC\ell_2$ (b) $K_2Cr_2O_2$ (SGD. 2018)(DGK. GII, AJK. 2019)

(ix) Write the function of salt bridge in Galvanic cell. (GRW. GI, 2019)

SECTION - II

Note: Attempt any THREE questions. 3×8=24

Q5. (a) What is difference between actual yield and theoretical yield? Why actual yield is less than the theoretical yield? 4

(FBD. GI, 2014)(BWP. GI, MLN. GII, RWP. GII, 2019)

(b) Define liquid crystals; write down three uses of liquid crystals. 4

(DGK. GII, 2018)(GRW. GII, 2019)

Q6. (a) What is Joule Thomson effect and describe Linde's method of liquefaction of gases? 4

(SWL. 2014)(MLN. GII, 2015)(AJK. 2016)(AJK. GII, 2017)(BWP. GI, 2018)

(b) How are positive rays produced in discharge tube? Give properties of these rays. 4

(GRW. GII, 2014)(GRW. GII, 2015)

Q7. (a) Define electron affinity. Give its trend in the periodic table. Also mention abnormal behaviour of electron affinity in different groups. 4

(GRW. 2018)(MLN. GI, 2019)

(b) Describe measurement of enthalpy of a reaction with bomb calorimeter. 4

(RWP. 2018)(MLN. GII, SWL. 2019)

Q8. (a) What is Le-Chatelier's Principle? Discuss effect of concentration on an equilibrium system. 4

(GRW. GII, 2015)(LHR. GI, MLN. GII, DGK. GI, 2018)

(b) Define order of a chemical reaction. How does half-life method can be used for its measurement. 4

(SGD. GII, 2019)

Q9. (a) Explain Lowering of Vapour Pressure by adding a Non volatile, Non electrolyte solute in a solvent. 4

(MLN. GII, 2017)(GRW. GII, FBD. GII, 2019)

(b) Define electrochemical series and give any two applications of it. 4

(LHR. GI, MLN. GI, BWP. GII, 2018)(LHR. GII, GRW. GI, SGD. GII, BWP. GI, 2019)

Paper No.04 CHEMISTRY Annual Paper 2014-2019

Roll No. _____ (To be filled in by the candidate)

Maximum Marks: 17 **(OBJECTIVE TYPE)** Time Allowed: 20 Minutes

NOTE: You have four choices for each objective type question as A, B, C and D. The choice which you think is correct, fill that circle in front of that question number. Use marker or pen to fill the circles. Cutting or filling two or more circles will result in zero mark in that question.

Q1. 17

1. The volume occupied by 16 g of CH_4 at STP. (AJK. 2017)

(A) 224.14 dm^3 (B) 22.4 dm^3

(C) 1.12 dm^3 (D) 2.24 dm^3

2. Tin has isotopes: (DGK. GI, 2014)(BWP. 2015)

(A) 9 (B) 10

(C) 11 (D) 12

3. The comparative rates at which the solutes move in paper chromatography, depends on: (LHR. FBD. GRW. 2014)(RWP. FBD. GI, AJK. LHR. GI, 2016)(SGD. GI, LHR. GI, RWP. GI, 2017) (GRW, FBD, SGD, RWP. 2018)(FBD. GI, & GII, MLN. GI, SGD. GII, BWP. GII, 2019)

(A) The size of paper used (B) Their R_f values solutes

(C) Temperature of the experiment (D) Size of the chromate graphic tank

4. The number of molecules in one dm^3 of water is close to: (BWP. 2014)(AJK. LHR. GI, DGK. GI, BWP. 2016)(BWP. GII, SGD. GII, 2017)(SGD. GII, AJK. GI, 2019)

(A) $\frac{6.02}{22.4}\times10^{23}$ (B) $\frac{12.04}{22.4}\times10^{23}$

(C) $\frac{18}{22.4}\times10^{23}$ (D) $55.6\times6.02\times10^{23}$

5. Pressure remaining constant at which temperature the volume of a gas will become twice of water it is at 0°C: (MLN. GI, 2017)(BWP. GII, AJK. 2018) (GRW. GI, & GII, FBD. GI, SWL. SGD. GI, & GII, RWP. BWP. GI, 2019)

(A) 546° C (B) 200° C

(C) 546 K (D) 273 K

6. Which of the given has Hydrogen Bonding: (BWP. GII, 2017)

(A) CH_4 (B) $CC\ell_4$

(C) NH_3 (D) $NaC\ell$

7. If $a \neq b \neq c$ and $\alpha = \gamma = 90° \beta \neq 90°$ then crystal system is: (DGK. GI, 2014)

(A) Monoclinic (B) Diclinic

(C) Triclinic (D) Polyclinic

8. Lyman series lies in spectral region:

(A) Infrared (B) ultra violet

(C) Visible (D) none of these

9. De-Broglie equation is represented by:

(A) $\lambda = \frac{\lambda}{mv}$ (B) $mv = \frac{h}{\lambda}$

(C) $mv = \frac{\lambda}{h\nu}$ (D) $\lambda = \frac{h}{mv}$

10. The number of bonds in nitrogen molecule is:

(A) One sigma and one Pi (B) One sigma and two

(C) Three sigma only (D) Two sigma

11. Which compound does not obey the octet rule?

(A) NH_3 (B) BCl_3

(C) H_2O (D) CH_4

12. Calorie is equivalent to:

(A) 0.4184 J (B) 4.184 J

(C) 4.184 J (D) 418.4 J

13. The pH of 10^{-2} mol dm^{-3} of an aqueous solution of H_2SO_4 is:

(A) 3.0 (B) 2.7

(C) 2.0 (D) 1.5

14. When ionic product of a solution is greater than the solubility product at a particular temperature then the solution is said to be:-

(A) Unsaturated (B) Saturated

(C) Very dilute (D) Super saturated

15. The salt dissolved in water forms a solution of pH greater than 7:

(A) $NaCl$ (B) Na_2CO_3

(C) $CuSO_4$ (D) NH_4Cl

16. If the salt bridge is not used between two half cells, then the voltage:

(A) decrease rapidly (B) decrease slowly

(C) does not change (D) drops to zero

17. The rate of reaction _____ as the reaction proceeds.

(A) Increases (B) Decreases

(C) Remains the same (D) May decrease or Increase

Annual Paper 2014 - 2019

Roll No. _____ (To be filled in by the candidate)

Maximum Marks: 68 **(SUBJECTIVE TYPE)** Time Allowed: 2.40 Hours

SECTION - I

Q2. Write short answers to any EIGHT (8) questions: 8×2=16

(i) Define Isotope. Give an example. (AJK. 2016)

(ii) Many chemical reactions taking place in our surrounding involve the limiting reactants. Explain with examples. (BWP. 2014)(FBD. GII, 2015)(LHR. GI, FBD. 2018)(BWP. GII. 2019)

(iii) Give the reason to explain that actual yield is less than the theoretical yield. (DGK. GII, SWL. BWP. 2014)(AJK. LHR. GI, 2015)(FBD. GI, 2016)(SGD. GII, SGD. GI, RWP. GI. 2017) (MLN. GI, BWP. GII. 2018)(DGK. GII. 2019)

(iv) What is difference between qualitative analysis and quantitative analysis? (LHR. GI, 2015)(SWL. GII, BWP. GI, 2017)(LHR. GI, 2018)

(v) Write down the uses of chromatography. (DGK. GII, 2014)(MLN. GI, DGK. GII, 2015)(SGD. GI, 2017)(SWL. SGD. BWP. GI, 2018)

(vi) Why water vapours do not behave ideally at 273K? (FBD. GI, GRW. GI, 2015)(DGK. 2016)(GRW. GII. DGK. GI, 2017)(GRW. 2018)(SGD. GI, 2019)

(vii) Derive Charles's law by kinetic equation of gases. (DGK. GII, 2014)(RWP. 2015)(LHR. GI. BWP. GII. 2017)(RWP. 2019)

(viii) Apply Datton's Law of partial pressure to determine the partial pressure of a dry gas? (MLN. GI, 2016)(DGK. GII, 2018)

(ix) −273. 15°C is known to be the lowest temperature of an ideal gas. Give reason. (SWL. 2019)

(x) One molar solution of urea, in water is dilute as compared to one molar solution of urea, but the number of particles of the solute is same. Justify it. (DGK. GII, MLN. GI, BWP. GI, 2014)(DGK. GI, LHR. GII, 2015)(LHR. GII, FBD. GI, BWP. GI, 2016) (LHR. GII, GRW. GII, FBD. GI, MLN. GI, RWP. BWP. GI, 2019)

(xi) What is discontinuous solubility curve? Give one examples. (BWP. GI, GRW. GI, 2015) (MLN. GII, 2017)

(xii) Give general principle of liquefaction of gasses. (FBD. GII, 2019)

Q3. Write short answers to any EIGHT (8) questions: 8×2=16

(i) Define transition temperature and give two examples. (SWL. 2014)(MLN. RWP. 2015)(FBD. GI, RWP. LHR. GI, DGK. GII, 2016)(MLN. GI, BWP. GI, 2018)

(ii) What do you mean by cleavage and cleavage planes? (RWP. 2015)(DGK. GII, 2016)(LHR. GII, 2017)

(iii) Lower alcohols are soluble in water but hydrocarbons are insoluble. Give reason. (DGK. GI, 2014)(AJK. 2015)(LHR. GI, 2018)(SWL. 2019)

(iv) Cleavage of crystals is itself anisotropic behaviour, explain. (MLN. GI, BWP. 2014)(AJK. 2015)(AJK. GI, 2018)

(v) Why is it necessary to decrease the pressure in discharge tube to get cathode rays? (AJK. 2014)(DGK. GII, 2017)(GRW, FBD. 2018)(GRW. GII, MLN. GII, SGD. GI, BWP. GI, BWP. GII, 2019)

(vi) Differentiate between fast neutron and slow neutron. (RWP. 2016)(GRW. GII, 2017)(BWP. GI, 2019)

(vii) Give two defects in Bohr's atomic model. (MLN. GII, 2018)(LHR. GII, MLN. GII, 2019)

(viii) Justify that the distance gaps between different orbits go on increasing from the lower to the higher orbits. (GRW. GI, 2019)

(ix) How extent of a reversible chemical reaction can be indicated by equilibrium constant? (GRW. GI, 2014)(LHR. GI&GII, 2015)(FBD. GI, 2016)(BWP. GI, SGD. GI, LHR. GII, 2017)

(x) Why do we need buffers in daily life? (FBD. GI, 2017)(MLN. GI, DCK. GI, 2018)

(xi) What is specific rate Constant or Velocity Constant. (SGD. 2018)

(xii) Define average and instantaneous rate of reaction. (FBD. GII, 2019)

Q4. Write short answers to any SIX (6) questions: 6×2=12

(i) Write down two postulates of VSEPR theory. (DGK. GI, 2016)(MLN. GII, 2019)

(ii) Why ionization energy (IE) values are decreased from top to bottom in a group? (SWL. 2014)(LHR. GII, 2016)(LHR. GI, MLN. GI, BWP. GI, LHR. GII, 2017)

(iii) Define electronegativity and give its trend in periodic table. (MLN. GI, 2014)(BWP. RWP. 2015)(LHR. GII, 2016)(RWP. GI, 2017)(DGK. GII, 2018)

(iv) How bond length is effected by change of hybridization state? (MLN. GII, 2018)

(v) What is standard enthalpy of solution? Give one example. (MLN. GII, 2016)(LHR. GI, 2018)(SGD. GI, 2014)(FBD. GI, 2015)

(vi) Describe that burning of candle is a spontaneous process. Justify. (GRW. GI, 2014)(GRW. GII, LHR. GII, 2015)(GRW. GII, MLN. GII, DGK. GI, SGD. GI, 2017) (LHR. GII, DGK. GII, BWP. GI, 2018)(LHR. GI, 2019)

(vii) Define oxidizing agent and reducing agent. (RWP. GII, 2017)

(viii) What are secondary cells? Write name of any two such cells. (LHR. GII, 2019)

(ix) Give any two applications of electrochemical series. (MLN. GII, 2019)

SECTION - II

Note: Attempt any THREE questions. 3×8=24

Q5. (a) Write a note on Limiting reactant. Explain it giving at least two examples. 4
(GRW. GI, DGK. GII, SWL. GII, BWP. GII, 2019)

(b) Define boiling point and how does it is effected by external pressure? Explain briefly. 4
(MLN. GI, 2018)

Q6. (a) What is ideal gas constant "R"? Calculate its value in different units? 4
(MLN. 2015)(BWP. 2016) (SGD. GI, 2017)

(b) Describe J.J. Thomson's experiment for determining e/m value of electron. 4
(DGK. GI, BWP. 2016)(MLN. GI, DGK. GII, 2017)(LHR. GI, 2018)(SGD. GII, DGK. GII, 2019)

Q7. (a) Explain Postulates of Molecular orbital theory. 4
(DGK. GII, 2016)(MLN. GI, DGK. GI, 2017)(GRW. GI, 2019)

(b) Define Enthalpy. How is it determined with help of Bomb's Calorimeter. 4
(BWP. GI, 2018)(FBD. GII, SGD. GI, SGD. GII, DGK. GII, 2019)

Q8. (a) Calculate the pH of buffer solution in which 0.11 molar $H_3CCOONa$ and 0.09 molar acetic acid solutions are present Ka for $H_3CCOONa$ is 1.85×10^{-5}. 4
(SWL. GI, MLN. GI, GRW. GII, 2014)(BWP. GI, RWP. GI, 2015)(FBD. GI, 2016)(SGD. GI, BWP. GI, 2019)

(b) Explain effect of temperature on rate of reaction by Arrhenius equation. 4
(FBD. GI, 2014)(DGK. GI, 2015)(LHR. GII, 2019)

Q9. (a) How depression in freezing point is measured by Beckmann's Apparatus. 4
(SGD. GII, 2017)(MLN. GII, SGD. GII, 2019)

(b) What is voltaic cell? Explain with one example. 4
(MLN. GI, 2014)(MLN. GII, 2017)(FBD. GI, MLN. GI, 2019)

Paper No.05

CHEMISTRY

Annual Paper 2014-2019

Roll No. _____ (To be filled in by the candidate)

Maximum Marks: 17 **(OBJECTIVE TYPE)** Time Allowed: 20 Minutes

NOTE: You have four choices for each objective type question as A, B, C and D. The choice which you think is correct, fill that circle in front of that question number. Use marker or pen to fill the circles. Cutting or filling two or more circles will result in zero mark in that question.

Q1. 17

1. **Isotopes differ in:** (MLN. DGK. GII, 2016)(BWP. 2018)
   (A) Properties which depend upon mass
   (B) Arrangement of electrons in orbitals
   (C) Chemical properties
   (D) The extent to which they may be affected in

2. **Cadmium has isotopes:** (SWL. DGK. GI, MLN. GI 2017)(SGD. 2018)
   (A) 3 (B) 4
   (C) 5 (D) 9

3. **Chromatography in which the stationary phase is a solid is classified as:** (MLN. GI, 2017)
   (A) Partition chromatography (B) Gas Chromatography
   (C) Adsorption Chromatography (D) Thin layer Chromatography

4. **The molar volume of CO_2 is maximum at:**
   (GRW. DGK. 2014)(BWP. GI, RWP. GI & GII, 2017)(FBD, BWP. GI, AJK. 2018)
   (LHR. GII, GRW. GII, FBD. GI & GII, MLN. GII, SWL. BWP. GII, 2019)
   (A) STP (0°C and 1 atm) (B) 127°C and 1 atm
   (C) 0°C and 2 atm (D) 273°C and 2 atm

5. **The partial pressure of oxygen in lungs is:** (FBD. GI, 2014)(LHR. GII, 2017)
   (A) 760 torr (B) 320 torr
   (C) 159 torr (D) 116 torr

6. **Acetone and chloroform are soluble in each other due to:**
   (BWP. GRW. SGD. 2014)(BWP. FBD. AJK. RWP. MTN. GII, 2016)(FBD. GII, 2017)
   (SGD, AJK. 2018)(FBD. GI, MLN. GII, BWP. GI, & GII, DGK. GI, 2019)
   (A) Intermolecular hydrogen bonding (B) Dipole-dipole interaction
   (C) Instantaneous dipoles (D) all of the above

7. **London dispersion forces are the only forces present among the:**
   (LHR. GRW. 2014)(DGK. GII, MLN. GII, 2016)(BWP. GI, 2017)(MLN. GII, RWP. 2019)
   (A) Molecules of water in liquid state
   (B) Atoms of helium in gaseous state at high temperature
   (C) Molecules of solid iodine
   (D) Molecules of hydrogen chloride gas

8. Which equation correctly presents the Heisenberg's uncertainty principle? (SGD. GI, 2014)

(A) $\Delta X.\Delta\rho = \frac{h}{4\pi}$ (B) $\Delta X.\Delta\rho > \frac{h}{4\pi}$

(C) $\Delta X.\Delta\rho \geq \frac{h}{4\pi}$ (D) $\Delta X.\Delta\rho \leq \frac{h}{4\pi}$

9. The charge on proton is: (FBD, 2018)

(A) $1.6022\times10^{-11}C$ (B) $1.6022\times10^{11}C$

(C) $1.6022\times10^{-19}C$ (D) $1.6022\times10^{19}C$

10. Which of the following species has unpaired electrons in anti bonding molecular orbitals? (AJK. 2015)(LHR. GII, RWP. 2016)(RWP. GI, & GII, FBD. GII, 2017)(BWP. GII, 2018) (GRW. GII, FBD. GII, SWL. SGD. GII, DGK. GI, BWP. GI, AJK. 2019)

(A) O_2 (B) $N^{2-}{}_2$

(C) B_2 (D) F_2

11. The type of hybridization in $BeC\ell_2$ is : (LHR. GII, 2019)

(A) sp^3 (B) sp^2

(C) sp (D) dsp^2

12. For the given process the heat changes at constant pressure (q_p) and constant volume (q_v) are related to each other as: (LHR. GII, MLN. GI, BWP. GII, 2018)(MLN. GII, SWL. BWP. GII, AJK. 2019)

(A) $q_p = q_v$ (B) $q_p < q_v$

(C) $q_p > q_v$ (D) $q_p = q_v / 2$

13. Which one affects the value of K_c? (FBD, MLN. GI, 2018)

(A) Concentration (B) Temperature

(C) Pressure (D) Catalyst

14. 18 g glucose is dissolved in 90g of water. The relative lowering of%vapour pressure is equal to: (MLN. GI, 2014)(FBD. GI, 2015)(LHR. GI, AJK. GI, FBD. GI, 2016)(MLN. GI, LHR. GI, 2017) (GRW, MLN. GI, DGK. GI, 2018)(LHR. GI, MLN. GI, SGD. GII, 2019)

(A) $\frac{1}{5}$ (B) 5.1

(C) $\frac{1}{5.1}$ (D) 6

15. The number of moles of hydrogen atoms in 92g alcohol (C_2H_5OH) are: (FBD. 2018)

(A) 5 moles (B) 6 moles

(C) 10 moles (D) 12 moles

16. If salt bridge is not used between two half cells then the voltage. (GRW. 2018)(FBD. GI, MLN. GI, DGK. GI, BWP. GII, 2019)

(A) decreases rapidly (B) decreases slowly

(C) does not change (D) drops to zero

17. The unit of rate constant is the same as that of the rate of reaction is: (LHR. GI, GRW. GI, SWL. GI, DGK. GI, 2014)(BWP. GI, 2015)(DGK. GI, AJK. GI, BWP. GI, 2016) (RWP. 2018)(LHR. GI, FBD. GI, MLN. GII, SGD. GII, BWP. GI, 2019)

(A) First order reaction (B) Second order reaction

(C) Zero-order reaction (D) Third order reaction

Annual Paper 2014 - 2019

Roll No. _____ (To be filled in by the candidate)

Maximum Marks: 68 **(SUBJECTIVE TYPE)** Time Allowed: 2.40 Hours

SECTION - I

Q2. Write short answers to any EIGHT (8) questions: 8×2=16

(i) One mole of H_2O has two moles of bonds, three moles of atoms, ten moles of electrons and twenty eight moles of the total fundamental particles present in it. (LHR. GII, BWP. 2016)(GRW. 2018)

(ii) Law of Conservation of mass has to be obeyed during stoichiometric calculations. Give reason. (LHR. GI, 2014)(RWP, DGK. 2018)(DGK. GII. 2019)

(iii) Define Stoichiometry and give two assumptions for stoichiometric calculations. (GRW. GI & GII, 2014)(LHR. GII, DGK. GI, BWP. 2015)(RWP. MLN. GII, DGK. GI, DGK. GII, 2016) (MLN. GI & GII, 2017)(MLN. GI, 2019)

(iv) Define extraction. (LHR. GII, 2019)

(v) Differentiate between adsorption and partition chromatography. (GRW. GI, & GII, MLN. GII, 2019)

(vi) Define absolute zero. What is its value? (DGK. GII, MLN. GI, 2014)(FBD. GI, 2015) (FBD. GI, LHR. GII, 2016)(LHR. GII, DGK. GI, 2017)(FBD. GI, SGD. GI, DGK. GI, 2019)

(vii) What is plasma? How it is formed? (FBD-GI, DGK. GII, MLN. GI, 2014)(LHR. GI, 2015)(MLN. GI, BWP. 2016)(GRW. GI, BWP. GI, 2019)

(viii) Why pilots feel uncomfortable breathing at higher altitude? (DGK. GII, 2019)

(ix) Why normal air cannot be used for breathing by sea divers? (DGK. GI, 2014)(SGD. GII, AJK. 2017)

(x) Why the aqueous solution of $NH_4C\ell$ is acidic? (GRW. GII, 2014)(GRW. GII, 2015)(SWL. GII, BWP. GII, 2017)(SGD. GII, 2019)

(xi) Define upper consulate temperature with example. (SGD. GII, 2014)(MLN. GI, RWP. GI, LHR. GI, 2015)(GRW. GII, 2017)

(xii) Aqueous solution of CH_3COONa is basic why? (SWL. GI, 2014)(FBD. GI, 2015)(GRW. GI, 2019)

Q3. Write short answers to any EIGHT (8) questions: 8×2=16

(i) Differentiate between isomorphism and polymorphis. (SGD. GII, 2014)(BWP. GI, 2016)(RWP. GII, LHR. GI, MLN. GI, & GII, 2017)(LHR. GI, 2018)(LHR. GII, 2019)

(ii) Define Polymorphims and Anisotorpy. Give one example of each. (DGK. GII, AJK. GRW. GI, 2015)(MLN. GII, 2016)(SWL. GII, BWP. GI, 2017)(SGD. 2018)(MLN. GI, 2019)

(iii) Ionic crystals do not conduct electricity in the solid state. Why? (MLN. GI, 2014) (DGK. GII, 2015)(MLN. GI, 2016)(SWL. GII, MLN. GI, RWP. GII, 2017)(SWL, DGK. GI, 2018)(DGK. GI, 2019)

(iv) Define Polarizibility. How it affects London dispersion forces? (MLN. GII, FBD. GII, 2019)

(v) Write two postulates of Bohr's atomic model. (MLN. GI, 2014)(LHR. GI, MLN. GI, BWP. GI, 2017)

(vi) Describe behavior of cathode rays in magnetic field. (DGK. GII, 2014)(BWP. GI, 2017)

(vii) Write down any two postulate of Plank's quantum theory. (LHR. GII, 2018)(LHR. GII, 2019)

(viii) Explain atomic spectrum with one example. (DGK. GI, 2019)

(ix) State law of mass action. (FBD. GI, 2014)(LHR. GII, 2015) (GRW. GII, LHR. GII, RWP. GI, DGK. GII, MLN. GII, 2017) (MLN. GI, SGD, DGK. GII, BWP. GI, 2018)(GRW. GI & GII, SWL. 2019)

(x) What is meant by Buffer Capacity? (DKG. GII, AJK. GI, 2015)(DGK. GII, 2018)(GRW. GII, 2019)

(xi) Justify that rate of reaction depends upon surface area given one example also. (MLN. GII, 2015)(DGK. GII, LHR. GI&GII, BWP. GI, 2016) (MLN. GI, LHR. GI, FBD. GII, 2017)(BWP. GI, 2018)(FBD. GI, 2019)

(xii) What do you mean by Activation Complex of a reaction? (DGK. GI, 2016)(BWP. GII, 2017)

6×2=12

Q4. Write short answers to any SIX (6) questions:

(i) Ionization energy is index to the metallic character. Why? (SGD. GI, 2014)(BWP. GII, 2017)(BWP. GII, 2019)

(ii) Why molecular orbital theory is superior to that of VSEPR and VB theories? (SGD. GII, DGK. GII, 2014)(FBD. GI, 2015)(MLN. GII, DGK. GI, 2016)(FBD. GI, SGD. GII, BWP. GI, 2019)

(iii) Why sigma bond is stronger than Pi bond? (FBD. GI, SGD. GI, BWP. 2014)(MLN. GII, 2016)(GRW. GII, LHR. GI, 2017)(RWP. 2019)

(iv) Define Electronegativity and Electron Affinity of an Atom. (BWP. GI, 2018)(GRW. GII, AJK. 2019)

(v) Why it is necessary to mention the physical states of reactants and products in thermo chemical reaction? (GRW. GII, 2017)(GRW. 2018)(DGK. GII, AJK. 2019)

(vi) Define standard enthalpy of atomization with an example. (DGK. GII, LHR. GI, 2015)(DGK. GI, 2016)(BWP. GI, & GII, 2018)(FBD. GII, 2019)

(vii) Mention the function of salt bridge. (RWP.GI, DGK. GI, GRW. GI & GII, MLN. GI, BWP. GI, 2014)(GRW. GII, 2015) (BWP. GI, MLN. GII, LHR. GI, DGK. GI & GII, 2016)(SGD. GI, 2017)(LHR. GII, 2018)(LHR. GII, 2019)

(viii) Calculate oxidation number of sulphur in SO_4^{2}. (FBD. GI, 2015)(LHR. GII, 2016)(MLN. GI, 2017)

(ix) What is Anodized Aluminium? Give its advantages. (RWP. GI, 2017)(MLN. GI, BWP. GI, 2018)(LHR. GI, 2019)

SECTION - II

Note: Attempt any THREE questions. 3×8=24

Q5. (a) Define stoichiometry. Give its assumptions. Mention two important laws which help to perform the stoichiometric calculation. 4 (DGK. GI, 2019)

(b) Write a note on three factors affecting the London Forces. 4 (BWP. GI, 2017)

Q6. (a) What is Kinetic molecular theory of gases? Give its postulates. 4 (SGD. GI, 2014)(LHR. GII, 2016)(MLN. GI, 2017)(SWL. 2018)

(b) Give the different postulates of Bohr's atomic model. 4 (GRW. GI, 2014)(GRW. GI, RWP. FBD. GI, DGK. GI, 2015)(RWP. AJK. FBD. GI, 2016) (RWP. GI & GII, LHR. GI, AJK. GII, DGK. GI, 2017)(DGK. GI, BWP. GII, 2019)

Q7. (a) What is bond order? Why bond formation is not possible between two He atoms. 4 (SWL. GII, 2014)(SGD. GI, 2016)(DGK. GI, MLN. GI, LHR. GII, 2017)

(b) Define and explain Hess's law of constant heat summation with examples. 4 (GRW. GI, DGK. GI, 2014)(GRW. GII, 2015)(MLN. GII, RWP. GI, BWP. GI, LHR. GII, 2016) (LHR. GI, RWP. GII, 2017)(LHR. GI, FBD. 2018)

Q8. (a) The Solubility product of Ag_2CrO_4 in water is 2.6 x 102 at 25°C, calculate the solubility of the compound. 4

(b) Define the order of a reaction and give one example of first, second and third order of a reaction. (MLN. GI, 2016)(LHR. GI, 2017) 4 (RWP. GI, GRW. GI, 2014)(GRW. GII, 2015)(DGK. GII, 2017)(LHR. GII, 2018)

Q9. (a) Describe Landsberger's method for the measurement of boiling point elevation. 4 (DGK. GII, 2014)(MLN. GII, 2016)(SWL. GII, DGK. GII, 2017)(BWP. GII, 2019)

(b) What is galvanic cell? Give composition and working of galvanic cell. 4 (BWP. GI, 2014)(RWP. GI, 2015)(DGK. GI, 2019)

Answers

Paper No. 1

– Objective –

Q.1: Multiple choice questions.

1. 3.6 g of H_2O
2. 24 g of oxygen
3. Volatile or thermally unstable
4. 159 torr
5. $°C = \frac{5}{9}[°F - 32]$
6. 98°C
7. Molecular
8. α
9. independent of its wavelength
10. sp^2-hybridized
11. One sigma two pi
12. enthalpy change
13. $2NO_2 \longrightarrow N_2O_4$
14. more than that of water
15. $H_2O + C_6H_6$
16. reduction potential
17. Increase in the number of effective collisions

– Subjective –

Section I

Q.2: Short answer questions.

(i) Define Avogadro's number. How does it relate to the masses of chemical substances?

Ans. Avogadro's number: Avogadro's number is the number of atoms, molecules or ions in one gram atom of an element, one gram mole of a compound or one gram ion of ionic substance. Avogadro's number is denoted by NA.

Relationship between Avogadro's number and masses of chemical substances:

There are three useful relationships:

(ii) 23 g of sodium and 238 g of uranium have equal number of atoms in them.

Ans. 23 g is atomic mass of Na, 238 g is atomic mass of U. As mass taken in gram is 1 mole of the substance. Both are one mole each, so both have 6.02×10^{23} atoms in them individually.

(iii) Write down only steps to determine Limiting Reactant.

Ans. To identify a limiting reactant the following steps are performed:

1. Calculate the number of moles from given amount of reactant.
2. Find out the number of moles of product with the help of a balanced chemical equation.
3. Identify the reactant which produces the least amount of product as limiting reactant.

(iv) What is R_f value? Why it has no units?

Ans. Retardation Factor (R_f): A component of a mixture may be identified by a specific retardation factor called R_f value. It is related to the partition coefficient by the following relationship.

Formula:

$$R_f = \frac{\text{Distance travelled by a component from the original spot}}{\text{Distance travelled by a component from the original spot}}$$

R_f has no units because it is ratio between component travelled distance from the original spot and solvent travelled distance from the original spot.

(v) What is sublimation? Give examples of substances which show sublimation.

Ans. Sublimation: Sublimation is a process in which a solid, when heated vaporizes directly without passing through the liquid phase and these vapours can be condensed to form the solid again.Sublime substances can be purified by this technique.

Substances Purified by sublimation: Following substances are purified by sublimation:

1. Ammonium chloride 2. Iodine 3. Naphthalene 4. Benzoic acid

(vi) Define Avogadro's law with two suitable examples.

Ans. Avogadro's law: According to this law, "equal volumes of all the ideal gases at the same temperature and pressure contain equal number of molecules".

Examples:

(a) $2.016\ g\ H_2 = 1\ mol\ of\ H_2 = 22.414\ dm^3\ of\ H_2$
$= 6.02 \times 10^{23}$ molecules of H_2

(b) $16\ g\ CH_4 = 1\ mol\ CH_2 = 22.414\ dm^3\ of\ CH_4$
$= 6.02 \times 10^{23}$ molecules of CH_4

(vii) Write down two characteristics of plasma.

Ans. Characteristics of plasma.

1. Plasma must have sufficient number of charged particles so as a whole; it exhibits a collective response to electric and magnetic fields. The motions of the particles in the plasma generate magnetic fields and electric currents from within plasma density. It refers to the density of the charged particles. This complex set of interactions makes plasmas a unique, fascinating, and complex state of matter.
2. Although plasma includes electrons and ions and conducts electricity, it is macroscopically neutral. In measurable quantities the number of electrons and ions are equal.

(viii) Explain the process of Respiration obeys Daltons Law of partial pressure.

Ans. The process of respiration obeys Dalton's Law of partial pressure because respiration process depends upon the partial pressure difference, when animal inhale air then oxygen moves into lungs as the partial pressure of oxygen in the air is 159 torr, while the partial pressure of oxygen in the lungs 116 torr. CO_2 moves out in the opposite direction as its partial pressure is more in the lungs than that in air.

(ix) Some of the postulates of KMT are faulty. Justify.

Ans. (a) According to KMT there are no forces of attraction between the gas molecules but it has been observed that molecules of gases have forces of attraction when they are pressurized.

(b) Actual volume of the gas molecules is negligible as compared to the occupied volume gas. This is also true under normal temperature and pressure but under highly compressed state the actual volume no longer remains negligible. Hence at high P and low T gases behave non-ideally.

(x) Give two applications of Colligative properties.

Ans. Applications of Colligative properties:

1. We can determine the molecular mass with the help of colligative properties.
2. Colligative properties also contributed to the development of solution theory.
3. The most important application of this phenomenon is the use of antifreeze (e.g ethylene glycol) in the radiater of automobile.
4. Freezing mixture preparation is another application.

(xi) What is solubility carve? Name its two types.

Ans. Solubility carve: A graphical representation between temperature and solubility of the solution is called solubility curves.

Types of Solubility Curve:

1. Continuous solubility curves. 2. Discontinuous solubility curves.

(xii) **Define colligative properties. Why are they so called?**

Ans. Colligative properties are called so because these depend upon the number of solute particles in definite amount of solvent and independent on the nature of solute. For example lowering of vapour pressure of water, caused by the addition of 6 g of urea, 18 g of glucose and 34.2 g of sucrose is same although the solute particles are of different nature but their numbers are same.

Q.3: Short answer questions.

(i) **Write a note on the factors affecting the London forces.**

Ans. London forces or Instantaneous dipole-induced dipole forces are weaker as compared to dipole-dipole intractions. The strength of London forces depends upon the following two factors:

(i) Size of electronic cloud: As the electronic cloud of atom or molecules increases, the London depression forces are more prominent.

(ii) Number of atoms in molecules: As the number of atoms in non-polar molecules increases, as polarizability of the molecules increases, so, London forces becomes stronger.

(ii) **Describe cleaning action of soaps and detergents on the basis of H-bonding.**

Ans. Soaps and detergents perform the cleansing action because the polar part of their molecules are water soluble due to hydrogen-bonding and the non-polar parts remain outside water, because they are alkyl or benzyl portions and are insoluble in water.

(iii) **Why water is liquid at room temperature but H_2S and H_2Se are gases, comment?**

Ans. Water is liquid at room temperature which is due to the presence of strong hydrogen bonding among water molecules. On the other hand, H_2S and H_2Se are gases at room temperature which is due to the presence of weak dipole-dipole forces among H_2S and H_2Se molecules.

(iv) **How liquid crystals act as temperature sensor?**

Ans. Like solid crystals, liquid crystals can diffract light when one of the wave lengths of white light is reflected, from a liquid crystal it appears coloured. As the temperature changes, the distance between the layers of the molecules of liquid crystal change. Therefore the colour of reflected light charges accordingly. Thus liquid crystals can be used as temperature sensors.

(v) **Cathode rays are material particles explain with reason.**

Ans. Cathode rays are material particles because these rays can derive a small paddle wheel placed in this path. This shows that these rays possess momentum and it is inferred that cathode rays are not rays but material particles having a definite mass and velocity.

(vi) **How the wave nature of electron was verified experimentally?**

Ans. Experimental Verification of wave nature of electron by Davisson and Germer:

In 1927, two American scientists, Davisson and Germer did an experiment to verify the wave nature of moving electron. Electrons were produced from heated tungsten filament and accelerated by applying the potential difference through charged plates. Davisson and Germer proved that the accelerated electrons undergo diffraction, like waves, when they fall on a nickel crystal. In this way, the wave nature of electron got verified.

(vii) **Differentiate between orbit and orbital.**

Ans.

Orbit	Orbital
1. It is a definite circular path at a definite distance from the nucleus in which the electron moves.	1. It is a space around the nucleus within which the probability of finding an electron with a certain energy is maxiumum.

2. An orbit shows an exact position of an electron in an atom.	2. Orbital does not specify the exact position of an electron in an atom.
3. Orbit shows a certainty about the position and movement of an electron.	3. According to uncertainty principle, one is not sure about the position and movement of an electron in an orbital.
4. Orbit gives us the idea about the planer motion of electron.	4. Orbital gives the three dimensional motion of an electron.
5. The maximum number of electrons in an orbit are given by $2n^2$.	5. An orbital cannot accommodate more than 2 electrons.

(viii) Sodium chloride and Cesium Flouride have the same geometry, comment on it.

Ans. In case of NaCl, $6Cl^-$ ions are present around Na^+ ion while in case of CsCl, $8Cl^-$ ions are present around the Cs^+ ion. Coordination number of an Ion depends upon the radius ratio of cation to anion r^+/r^-. The radius ratio of Cs^+ ion is greater than Na^+ ion, Therefore its coordination Number is high. So they have different structure.

(ix) What are optimum conditions for the synthesis of NH_3?

Ans. Optimum conditions for the synthesis of Ammonia: The most suitable conditions to get maximum yield of ammonia are:

1. Pressure between 200-300
2. Temperature around 673K (400°C)
3. Pieces of iron crystals embedded in a fused mixture of MgO, $A\ell_2O_3$ and SiO_2 acting as catalysts.

(x) How does a Buffer act? Explain with an example.

Ans. Le-Chatelier's principle and common ion effect can help us to understand the buffer action of the solutions.

Let us consider the buffer solution consisted of CH_3COOH and CH_3COONa. Both are dissociated in water. Sodium acetate being a very strong electrolyte as compared to acetic acid furnishes sufficient CH_3COO^- ion as compared to CH_3COOH.

$$CH_3COOH \rightleftharpoons CH_3COO^-_{(aq)} + H^+_{(aq)}$$

$$CH_3COONa \rightleftharpoons CH_3COO^-_{(aq)} + Na^+_{(aq)}$$

When a few drops of an acid, say HCl are added in this solution, the H^+ ions provided by HCl are taken up by CH_3COO^- (mostly obtained from CH_3COONa) so incoming protons are consumed and pH is retained.

When a few drops of a base say NaOH is added from outside, then the protons already present in the solution are consumed. To compensate to those protons, there happens a further dissociation of CH_3COOH and pH is retained.

(xi) The radioactive decay is always a first order reaction. Justify.

Ans. Radioactive decay have a single species at a moment, whose nucleus is being broken up without the help of any external agency. So, only one reactant is present and it follows the first order mechanism.

(xii) What is pseudo first order reaction? Give one example.

Ans. Pseudo First Order Reaction:

"A pseudo first order reaction is a reaction that is truely appeared to be second order reaction in nature but is approximated as first order reaction on close analysis under special circumstances". In other words such reaction occurs when one of the reactant in biochemical reaction is in larger excess.

Example: Following equation is an example of Pseudo first order reaction in which

reaction is dependent on the concentrations of both A and B but one of the components is present in large excess and thus its concentration hardly changes as the reaction proceeds.

$$A + B \longrightarrow C + D$$

Q.4: Short answer questions.

(i) Why liquids are less common then solids and gases?

Ans. On Earth, all substances in which molecules held together by dipole-dipole forces are solid at S.T.P, while the molecules of substances those held together by weaker London forces are liquids or gasses, such as oils or noble gasses. Thus majority of substances have dipole-dipole interactions and they are mostly solids, where as in comparison to dipole-dipole interaction , London forces are weaker so it only requires a very little energy to change phase; that is why, most occurring substance on the earth then solids are liquid and noble gases due to non-polar and weak inter molecular forces then solids.

(ii) Ionization energy is index to the metallic character. Why?

Ans. Ionization energy is an index to the metallic character. The elements having low ionization energies are metals and those having high ionization energies are non- metals. Those with intermediate values are mostly metalloids.

(iii) Both NH_3 and BF_3 are tetra atomic but different geometries. Why.

Ans. In NH_3 the central Nitrogen atom undergoes sp_3 hybridization and there is one lone pair on Nitrogen atom. Similarly, there exists repulsion force between lone pair and bond pair of electrons in NH_3 molecule because of which it acquires pyramidal shape. Where as in BF_3 the central atom Boron undergoes sp_3 hybridization and has no lone pair of electrons. Thus three Fluorine atoms will occupy three corners of triangular planar structure of BF_3.

(iv) 75.4 pm is compromise distance between the bonded hydrogen atoms. Justify.

Ans. When atom approach each other for bond formation forces of attraction and repulsion Simultaneously act when they reached at a certain distance. The force of attraction are maximum and PE is maximum then this distance is called compromise distance.

(v) Define standard enthalpy of combustion. Give one example.

Ans. Standard enthalpy of combustion: The standard enthalpy of combustion of a substance is the amount of heat evolved when one mole of a substance is completely burnt in excess of oxygen under standard conditions. It is denoted by ($\Delta H°c$)

Example: $C_2H_5OH_{(\ell)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O(\ell) \quad \Delta H_c^\circ = -1368 kJmol^{-}$

(vi) State Hess's law of constant Heat summation.

Ans. Hess's Law of constant Heat summation: Hess's Law of constant heat summation is defined as:-

"If a chemical change takes place by several different routes, the overall energy change is the same, regardless of the route by which the chemical change occurs, provided the initial and final conditions are the same. $\sum \Delta H(\text{cycle}) = o$"

(vii) Differentiate between primary and secondary cell giving one example each.

Ans.

Primary Cell	Secondary Cell
A primary cell is a cell or battery that cannot recharge. Primary cells can only be used one time.	A secondary cell is not rechargeable battery. Secondary cells can be reused again
The electrochemical reaction occurring in the cell is not reversible. **Examples:** dry cell, alkaline battery, mercury and silver battery etc.	The electrochemical reaction occurring in the cell is reversible. **Examples:** car battery, fuel cell, lead-acid battery, Ni-Cd- battery etc.

(viii) Na^+ and K^+ can displace hydrogen from acids but Pt, pd and Cu cannot explain.

Ans. The metals like Pt, pd and Cu have sufficiently high positive value of reduction potentials, therefore they cannot liberate hydrogen from acids. On the other hand, Na and K are close to top of the electrochemical series and have very low reduction potentials and can liberate hydrogen.

(ix) Write two rules for assigning oxidation number.

Ans. Rules for assigning oxidation number:

(i) Elements in Free State have zero oxidation number.

$$H_2^0, Na^0, K^0, Mg^0, O_2^0$$

(ii) In case of simple ions of elements of the same group, the oxidation number will have same sign and same charge.

Examples: Ions of I-A group → +1

Ions of II-A group → +2

Ions of III-A group → +3

Section II

Note: Attempt any THREE questions.

Q5. (a) Write down various steps to calculate the empirical formula of a compound.

(b) What is meant by the term hydrogen bonding? How does hydroqen bonding explain, the properties of proteins.

Q6. (a) Prove general gas equation (PV = nRT).

(b) Describe Millikan's oil drop method for the measurement of charge on an electron.

Q7. (a) Give the main postulates of VSEPR theory, Illustrate with the explanation of the structure of one molecule.

(b) What is first law of thermodynamics? Prove that $\Delta E = q_v$.

Q8. (a) How can you predict the followings with the help of equilibrium constant (K_C) of reversible reaction:

(i) Direction of a reaction (ii) Extent of a reaction

(b) How does the Arrhenius equation help us to calculate the energy of activation of a reaction?

Q9. (a) How Raoult's law can be defined in three different ways? Also give their mathematical expression.

(b) Describe the electrolysis of molten sodium chloride and a concentrated solution of sodium chloride.

Paper No. 2

– Objective –

Q.1: Multiple choice questions.

1. 5	2. 1.10 mg	3. NaCl
4. Increase four times	5. 22.414 dm^3	6. Debye forces
7. HF	8. Hydrogen	9. degenerate orbitals
10. 107.5°	11. Electronegativity	12. heat of Neutralization
13. 7.0	14. Molality	15. Raoult's law
16. 0.00	17. Concentration of reactants	

– Subjective –

Section I

Q.2: Short answer questions.

(i) What are isotopes? Why they have same chemical but different physical properties.

Ans. Isotopes: The atoms of the same element having different masses but same atomic numbers. Such atoms of an element are called Isotopes.

Properties of Isotopes: They have similar chemical properties because isotopes of an element have the same number of electrons as an atom of that element. The electron arrangement is the same owing to same chemical properties. However they have different numbers of neutrons, which affects the mass number. Mass number determines the physical properties such as boiling point melting and density etc.

(ii) Differentiate between actual yield and theoretical yield.

Ans. Difference between actual yield and theoretical yield.

Actual yield	Theoretical yield
(i) It is the amount of product which is actually obtained in chemical reaction	(i) It is the amount of product which is calculated from balanced chemical equation.
(ii) It is also known as experimental yield.	(ii) It is also known as calculated or expected yield.
(iii) It is mostly in fewer amounts as compared to the theoretical yield.	(iii) It is always greater than actual yield.
(iv) It is obtained by weighing the purified and dried product obtained as a result of chemical reaction.	(iv) This is maximum yield of product that can be produced in a chemically redaction

(iii) Why do the isotopes have same chemical but different physical properties?

Ans. Isotopes of an element have same chemical properties and same position in the periodic table, but due to different atomic masses have different physical properties.

(iv) Define Sublimation and Chromatography.

Ans. Sublimation: It is a process in which a solid, when heated, vapourizes directly without passing through the liquid phase"

Chromatography: It is an analytical technique used for the separation of a mixture due to different distribution of substance between stationary and mobile phase.

(v) Define chromatography. Give its two uses.

Ans. Chromatography: Chromatography is a technique which is used primarily for the separation of a sample of mixture. It involves the distribution of a solute between a stationary phase and a mobile phase.

Uses of Chromatography:

1. It is used to obtain pure compounds from mixtures.
2. Chromatography is used for quality control in the food industry, by separating and analyzing additives, vitamins, preservatives, proteins, and amino acids.

(vi) Write down four postulates of kinetic molecular theory of gases responsible for the deviation of gases from ideal behaviour.

Ans. Following are the some postulates of the kinetic molecular theory of gases:

1. Every gas consists of a large number of very small particles called molecules. Gases like He, Ne, Ar have monoatomic molecules.

2. The molecules of a gas move colliding among themselves and with the walls of the container and change their directions.
3. The pressure exerted by a gas is due to the collisions of its molecules with the walls of a container. The collisions among the molecules are perfectly elastic.
4. The molecules of a gas are widely separated from one another and there are sufficient empty spaces among them.

(vii) Derive Boyle's Law from Kinetic molecular theory of gases.

Ans. According to one of the postulates of kinetic theory of gases, the kinetic energy is direct proportional to the absolute temperature of the gas. Therefore, The kinetic energy of molecule is

$$\frac{1}{2}mNC^{-2}$$

So, $\frac{1}{3}mN^{-}C^{2} \propto T$

$$\frac{1}{2}mN^{-}C^{2} = KT \quad \text{____ (1)}$$

Where K is the proportionality constant. According to the Kinetic equation if gases

$$PV = \frac{1}{3}mN^{-}C^{2}$$

Multiplying and dividing by 2 on right hand side

$$PV = \frac{2}{3}\left(\frac{1}{2}mN^{-}C^{2}\right) \quad \text{____ (2)}$$

Putting equation (1) into equation (2)

$$PV = \frac{2}{3}kT \quad \text{____ (3)}$$

If the temperature (T) is constant then right hand side of equation (3) will be equal to $\frac{2}{3}$ KT is constant. Let that constant be K'.

So, $PV = k'$ (which is Boyle's law)

Hence, at constant temperature and number of moles, the product PV is a constant quantity.

(viii) Convert 37°C into °F scale.

Ans. we know that

$$F = \frac{9}{5}(C) + 32$$

So, by putting the values.

$°F = 9/5 \times 37 + 32$

$°F = 1.8 \times 37 + 32$

$°F = 66.6 + 32 = 98.6$

$°F = 98.6$

(ix) Where do natural plasma and artificial plasma exist?

Ans. Artificial plasma can be created by ionization of a gas. As in neon signs. Plasma at low temperatures is hard to maintain because outside a vacuum low temperature plasma reacts rapidly with any molecule it encounters. This aspect makes this material, both very useful and hard to use.

Natural plasma exists only at very high temperatures, or low temperature vacuums. Natural plasma does not breakdown or react rapidly, but is extremely hot (over 20,000°C minimum). Its energy is so high that it vaporizes any material it touches.

(x) Define cryoscopy constant with an example.

Ans. Cryoscopic constant (Molar Freezing point constant),

Cryoscopy constant is the depression of freezing point of one molal solution of a non-volatile, non-electrolyte solute in a volatile solvent.

It is also known as molal freezing point constant.

It is denoted by K_f.

Examples:

Solvent	Normal F.P. (°C)	Molal F.P. constant K_f (°C / molal)
Acetic acid	16.6	3.90
Water	0.00	1.86

(xi) NaCℓ lowers the melting point of ice. Give reason.

Ans. NaCℓ and KNO_3 are electrolytes and are sufficiently soluble in water. They double the number of particles after dissociation in water. In this way they, can manage to decrease the freezing point of water to a greater extent as compared to a non-electrolyte.

(xii) Why is aqueous solution of $CuSO_4$ acidic in nature?

Ans. When $CuSO_4$ is dissolved in water it produce H_2SO_4 which is an acid, so aqueous solution of $CuSO_4$ is acidic in nature as show by reaction.

$$CuSO_4 + H_2O \longrightarrow Cu(OH)_2 + H_2SO_4$$

Q.3: Short answer questions.

(i) What is the role of Hydrogen bonding in biological compounds?

Ans. Role of Hydrogen Bonding in Biological Compounds:

Hydrogen bonding exists in the molecules of living system. Proteins are the important part of living organisms and its basic component amino acids shows hydrogen bonding. Similarly, Fibers found in the hair, silk and muscles consist of long chains of amino acids which coiled and spiral with one another to form a helix. Each spiral linked together by hydrogen bonds. The food materials like carbohydrates include glucose, fructose and sucrose. They all have -OH groups in them which are responsible for hydrogen bonding in them.

(ii) What are dipole-dipole forces of attraction? Explain with an example.

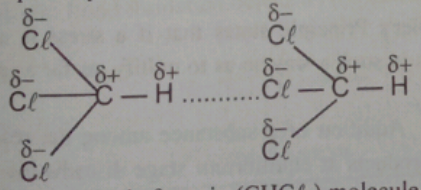
Ans. Dipole-dipole Forces of attraction: Dipole-dipole forces are electrostatic forces of attraction in which the positive end of one molecule attracts the negative end of the other molecule.

The strength of these forces depends upon the electronegativity difference between the bonded atoms and the distance between the molecules. Greater the strength of these forces, greater is the values of thermodynamic parameters like melting points, boiling points, heats of vaporization and heats of sublimation.

Example:

1. $\overset{\delta+}{H}-\overset{\delta-}{C\ell}\cdots\cdots\overset{\delta+}{H}-\overset{\delta-}{C\ell}\cdots\cdots\overset{\delta+}{H}-\overset{\delta-}{C\ell}$

   Dipole-dipole forces in HCl molecule

2. 

   Dipole-dipole force in ($CHC\ell_3$) molecule.

(iii) Explain the term 'Anisotropy' with an example.

Ans. Anisotropy: Some of the crystals show variations in physical properties depending upon the direction such properties are called anisotropic properties and phenomenon is reffred to as anisotropy for e.g. electrical conductivity of graphite greater in one direction then in another.

(iv) Boiling needs a constant supply of heat. Justify.

Ans. Boiling needs a constant supply of heat. When a liquid is heated continuously its kinetic energy increases and temperature is also increased low energy molecules left behind. As a result temperature of the liquid in the earhenmic decrease so boiling needs constant supply of heat.

(v) Calculate mass of an electron when e/m =1.758 × 10^{11} C. kg^{-1}.

Ans. The value of charge on electron is 1.602×10^{-19} coulombs while e/m is 1.758×10^{11} coulombs kg^{-1}. So,

$$\frac{e}{m}=\frac{1.6022\times10^{-19}\text{ coulombs}}{\text{Mass of electron}}=1.7588\times10^{11}\text{ coulombs kg}^{-1}$$

$$\text{Mass of electron}=\frac{1.6022\times10^{-19}\text{ C}}{1.7588\times10^{11}\text{ C kg}^{-1}}$$

$$\text{Mass of electron} = 9.1095\times10^{-31}\text{kg}$$

(vi) State Heisenberg uncertainty Principle and give its mathematical form.

Ans. Heisenberg uncertainity principle: It is difficult to determine the position as well as the momentum of the electron simultaneously.

Mathematical expression: If the ΔX represents the uncertainty of position and ΔP represents the uncertainly in the measurement of momentum of an electron, then.

$$\Delta X.\Delta P \geq \frac{h}{4\pi}$$

This relationship is called uncertainty principle.

(vii) How will you prove that Cathode Rays travel in Straight Line?

Ans. Systematic investigations of scientists showed that "Unless disturbed by any magnetic or electric field, cathode rays always keep travelling in a straight line by following the law of inertia", until they hit the anode on the opposite side of the vacuum tube, because cathode rays are basically electrons travel in straight lines and tend to travel the shortest distance from cathode to anode in straight line when electric field or magnetic field applied between the anode and cathode is approximately uniform.

(viii) Differentiate between frequency and wave number.

Ans. Frequency: the number of waves passing through a point per second is called frequency (u) it unit are hertz (Hz).

Wave Number: The number of waves per unit length is called wave number of and is reciprocal of wave length. The wave number is expressed (m-1) or per meter.

(ix) State Le-Chatelier's Principle and discusses the effect of change in concentration of a product on reversible reaction.

Ans. Le-Chatelier's Principle: Le-Chatelier's Principle states that if a stress is applied to a system at equilibrium, the system acts in such a way so as to nullify, as far as possible, the effect of that stress.

Effect of change in concentration: Addition of a substance among the reactant or the removed of a substance among the products at equilibrium stage disturbs the equilibrium position and reaction is shifted to forward direction.

Addition of a substance among the products or removal of a substance among the reactants will drive the equilibrium in backward direction.

Example: $PC\ell_5 \rightleftharpoons PC\ell_3 + C\ell_2$

If few moles of $PC\ell_5$ are added at equilibrium, the reaction is pushed to the forward direction. If $PC\ell_3$ or $C\ell_2$ or both are added from outside then reaction will move in backward direction.

(x) Give two applications of Buffer solution.

Ans. Applications of Buffer solution:

1. Many industrial processes such as electroplating, manufacture of leather, manufacture of photographical materials and the preparation of dyes require the use of buffers.
2. The pH of human blood is buffered at 7.4. This is maintained by a mixture of bicarbonates, phosphates and complex protein systems. For the normal range, the pH of blood is from 7.35 to 7.45. In case it decreases up to 7 or goes up to 8 deaths may occur.
3. Buffer solutions are extensively used by an analytical chemist.
4. Buffer tablets are available in the market which can be used to calibrate the pH meter.
5. In bacteriological research, one uses the buffer solutions in culture media, because the growth of bacteria needs a definite pH.

(xi) What do you mean by activation energy?

Ans. Activation energy: The minimum amount of energy required for an effective collision is called activation energy. Energy of activation of a reaction provides a valuable information about the way a reaction takes place and thus to understand the reaction.

(xii) The unit of rate constant of a second order reaction is $dm^3\ mol^{-1}s^{-1}$, but the unit of rate of reaction is mole $dm^{-3}s^{-1}$ justify.

Ans. The rate of reaction is the rate of change of concentration with respect to time.

Since,

$$\frac{\Delta C}{\Delta t} = \frac{\text{mole dm}^{-3}}{\text{s}} = \text{moles dm}^{-3}\text{s}^{-1}$$

$$\text{Rate} = k[A][B]$$

$$k = \frac{\text{Rate}}{[A][B]} = \frac{\text{moles dm}^{-3}\text{s}^{-1}}{\text{mole dm}^{-3}\,\text{mole dm}^{-3}}$$

$$k = \text{dm}^3\ \text{mol}^{-1}\ \text{s}^{-1}$$

Q.4: Short answer questions.

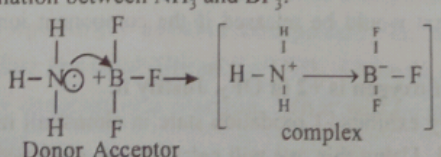
(i) What is co-ordinate covalent bond? Give one example.

Ans. Co-ordinate covalent Bond: A co-ordinate covalent bond is formed between two atoms when the shared pair of electrons is donated by one of the bonded atoms.

The atom, ion or molecule which donates an electron pair is called donor and that which accepts a pair of electrons is called acceptor. The bond formed between donor and acceptor species is called co-ordinate covalent bond.

It is represented by an arrow ($\rightarrow$) pointing from donor to acceptor.

Example: Bond formation between NH_3 and BF_3.



Donor Acceptor complex

(ii) Helium is diamagnetic in nature Justify.

Ans. Helium is diamagnetic in nature because its valence shell is totally filled and of helium gas have no need for bond with another atom. It is a noble gas that's why it is a diamagnetic in nature.

(iii) Why Pi (π) bonds are more diffused than sigma bonds?

Ans. π–bonds are more diffused than sigma bonds because σ bond is formed by head to head overlap of two half-filled atomic orbitals. The electronic cloud density is symmetrical along the bond axis. The electronic cloud density of π–bond is not symmetrical along the bond axis. So, π–bond is more diffused.

(iv) How Sigma and pi bonds are fomed?

Ans. Formation of Sigma and pi bonds: Sigma bonds are the strongest type of covalent bonds those are formed by direct overlapping or end-to end over lapping or head-to-head overlapping between two adjacent orbitals of atoms. Electrons from the outer most shell of each atom combine to form an electron pair creating the sigma bond & electron density exist in between two nuclei of shared atoms. Similarly, pi (π) bonds (a type of weak covalent bonds) are formed by sideways or lateral overlapping half filled orbitals of two adjacent atoms. In pi (π) bonds, electron density is present above and below the joining line of nuclei of both adjacent atoms.

(v) Define the terms standard enthalpy of neutralization and standard enthalpy of atomization.

Ans. Standard Enthalpy of Neutralization: (ΔHn):

The standard enthalpy of neutralization is the amount of heat evolved when one mole of hydrogen ions H^+ form an acid and react with one mole of hydroxide ions OH^- from a base to form one mole of water.

Example: The standard enthalpy of neutralization of sodium hydroxide by hydrochloric acid is -57.4 kJ $mo\ell^{-1}$.

A strong acid $HC\ell$ and a strong base, NaOH, ionize completely in dilute solutions as follows.

$$HC\ell\,(aq) \longrightarrow H^{+"}(aq) + C^{-}\ell\,(aq)$$

$$NaOH\,(aq) \longrightarrow "Na^{+}\,(aq) + OH^{-}(aq)$$

Standard enthalpy of atomization: "The amount of heat absorbed when one mole of gaseous atoms is formed from the element under standard conditions, is called standard enthalpy of atomization of that element." It is denoted by "ΔHato"

Example: the standard enthalpy of atomization of hydrogen is = 218kJ $mo\ell^{-1}$. Various methods use for the determination of enthalpies of atomization of elements.

(vi) Differentiate between Atomization energy and Lattice energy.

Ans. Atomization Energy: The heat required in breaking molecules into its compnents atoms is called atomization energy.

Lattice Energy: A measure of the energy contained in the crystal lattice of a compound equal to the energy that would be released if the component ions were brought together from infinity.

(vii) The oxidation state of oxygen is +2 in OF_2. Justify it.

Ans. Fluorine predominantly exhibits -1 oxidation state in almost all its compounds. In OF_2, its oxidation number is -1. Using this, we will calculate the oxidation state of oxygen in OF_2.

The overall charge in this compound is zero. So when we calculate the charge on oxygen in OF_2, it comes out to be +2. The oxidation state of OF_2 can be calculated as follows:

Let the oxidation number of oxygen be Z. As there is no overall charge on the molecule, therefore we have $z + 2(-1) = 0$

This gives $z = 2$

Thus the charge on oxygen in OF_2 is +2.

(viii) What is electrolysis? Give example.

Ans. Electrolysis: The process of decomposing a substance usually in solution or in molten state by the passage of an electric current is called electrolysis.

Example: Electrolysis of fused NaCℓ in Nelson's cell to produce sodium metal..

(ix) Voltaic cell is reversible cell state.

Ans. Voltaic cell as a reversible cell:

The voltaic cell can be changed into reversible cell. This is done by replacing the circuit of voltaic cell with a source of electricity which opposes the voltaic cell. The reactions occurring at electrodes can be reversed. Then the external source of electricity will push the electrons in the opposite direction and supplies energy to the cell. In this way, a reverse non-spontaneous reaction takes place. This is known as a reversible cell.

Reversed Reactions:

At cathode: $Zn^{2+}_{(aq)} + 2e^- \longrightarrow Zn_{(s)}$ (reduction)

At anode: $Cu_{(s)} \longrightarrow Cu^{2+}_{(aq)} + 2e^-$ (oxidation)

Overall reaction: $Zn^{2+}_{(aq)} + Cu_{(s)} \longrightarrow Zn_{(s)} + Cu^{2+}_{(aq)}$

In the reversed cell, oxidation takes place at copper electrode while reduction occurs at zinc electrode (cathode has changed to anode and vice versa). The cell will work as an electrolytic cell instead of voltaic or galvanic cell.

Section II

Note: Attempt any THREE questions.

Q5. (a) **A well known ideal gas is enclosed in a container having volume 500 cm^3 at S.T.P. Its mass comes out to be 0.72g. What is the molar mass of this gas.**

(b) **What is effect of external Pressure on boiling point of a substance? Give example.**

Q6. (a) **What is graham's Law of diffusion? Also qive its experimental verification.**

(b) **Explain Rutherford's model of atom.**

Q7. (a) **Briefly explain shapes of NH_3 and H_2O molecule according to hybridization theory.**

(b) **State first law of thermodynamics. How does it explain that $q_p = \Delta H$.**

Q8. (a) **$Ca(OH)_2$ is a sparingly soluble compound. Its solubility product is 6.5×10^{-6}.Calculate the solubility of $Ca(OH)_2$. (Atomic mass: Ca = 40).**

(b) **Explain velocity constant of a reaction. What will be effect of temperature on velocity constant?**

Q9. (a) **Discuss differences between ideal solution and non-ideal solutions.**

(b) **State rules for assigning oxidation number of elements with examples.**

Paper No. 3

– Objective –

Q.1 Multiple choice questions.

1. Gives minimum amount of the required product
2. 2
3. Distribution law
4. $\frac{1}{3}$
5. 20000 °C
6. Ethane
7. H_2O
8. the nature of residual gas
9. Goldstein
10. 3
11. Electron affinity
12. Hess's law
13. 4.6
14. Mole fraction of solute
15. 1.8 dm^3
16. reduction
17. pseudo first order reaction

– Subjective –

Section I

Q.2 Short answer questions.

(i) No individual Neon (Ne) atom in the sample of the element has a mass of 20.18 amu why?

Ans. Neon has three isotopes of atomic masses 20,21 and 22 with relative abundances as 90.92%, 0.26% and 8.82%. The relative atomic mass of neon, comes out to be 20.18 a.m.u. So 20.18 a.m.u. is the average atomic mass of all the three isotopes and there is no atom of Ne with this atomic mass.

$$\text{At.mass of Ne} = \frac{(20\times 90.92)+(21\times 0.26)+(22\times 8.82)}{100} = 20.18 \text{ amu}$$

(ii) Two grams of H_2, 16 g of CH_4 and 44 g of CO_2 occupy separately the volumes of 22.414 dm^3, although the sizes and masses of molecules of three gases are very different from each other.

Ans. One mole of an ideal gas at S.T.P occupies a volume of 22.414 dm^3. Size and masses of molecules of different gases do not affect the volume. Normally it is known that in the gaseous state, the distance between the molecules is 300 times greater than their diameter. Therefore two grams of H_2, 16g of CH_4 and 44g of CO_2 (1 mole of each gas) separately occupy a volume of 22.4 dm^3. This is called molar volume (V_m).

(iii) 2g H_2, 16g CH_4, 44g CO_2 occupy same volume. Why?

Ans. 2g of H_2 = 1mole = 6.02×10^{23} molecule = 22.44dm^3 volume at STP

16 g of CH_4 = 6.02×10^{23} molecule = 22.414dm^3 volume at STP

44 g of CO_2 = 1 mole = 6.02×10^{23}molecule = 22.414 dm^3 volume at STP

According to Avagadro law equal number of molecules of all gas occupy same volume at same temperature and presure. Since H_2, CH_4, CO_2 have same number of molecules that is why these occupy same volume.

(iv) What is solvent extraction technique? Give an example also.

Ans. Solvent Extraction: Solvent extraction is a technique in which a solute can be separated from a solution by shaking the solution with a solvent in which the solute is more soluble and the added solvent does not mix with the solution.

Example: In a typical organic synthesis, the aqueous solution containing the organic product is shaken up with ether in a separating funnel and allowed to separate. The inorganic impurities remain in aqueous phase whereas the organic compound goes to the ether layer. The ether layer is separated and the organic product is obtained by evaporating the ether.

(v) Mention only steps involved in complete quantitative determination.

Ans. A complete quantitative determination generally consists of four major steps:

1. Obtaining a sample for analysis.
2. Separation of the desired constituent.
3. Measurement, and calculation of results.
4. Drawing conclusion from the analysis.

(vi) Why deep sea divers take oxygen mixed with an inert gas, Like (He)?

Ans. Deep sea divers take oxygen mixed with an inert gas like He to adjust the pressure of oxygen according to the requirement. Actually, in sea after every 100 ft. depth, the diver experiences approximately 3 atm pressure, so normal air cannot be breathed in depth of sea. Moreover, the pressure of N_2 increases in depth of sea and it diffuses in the blood.

(vii) Calculate the value of gas constant "R" in SI units.

Ans. By using SI units of pressure, volume and temperature in the general gas equation, the value of "R" is calculated as follows:

The SI units of pressure are Nm^{-2} and of volume are m^3. By using Avogadro's principle.

1 atm = 760 torr = 101325 Nm^{-2}

$1m^3$ = 1000 dm^3

n = 1 mole

T = 273.16 K

P = 1 atm = 101325 Nm^{-2}

V = 22.414 dm^3 = 0.0022414 m^3

Putting these values, along with units.

$$R = \frac{PV}{nT} = \frac{101325 Nm^{-2} \times 0.022414 m^3}{1 mol \times 273.16 K}$$

$R = 8.3143\ NmK^{-1}\ mol^{-1}$

$= 8.3143\ JK^{-1}\ mol^{-1}$ (1Nm = 1J)

(viii) Why pilots feel uncomfortable breathing in unpressurised cabin?

Ans. At higher altitudes, the pilots feel uncomfortable breathing in cabin because the partial pressure of oxygen in the un-pressurized cabin is low around 150 torr, which is less then 159 torr that is necessary pressure required to human beings to breath comfortabley.

(ix) Describe two causes of deviation of real gas from ideal behaviour.

Ans. Real gas show non ideal behavior due to two assumptions of Kinetic molecular theory.

1. The molecules of a gas have no face of attraction for each other.
2. The actual volume of molecules of a gas is negligible as compared to the volume of the gas.

(x) Boiling points of the solvents increase due to the presence of solutes. Justify it.

Ans. The presence of non-volatile solutes increases the boiling point of solvent because whenever a solvent is heated, its vapour pressure rises. When the vapour pressure becomes equal to the external pressure then the solvent boils. The addition of a non-volatile solute lowers the vapour pressure therefore, the temperature at which the solution will boil is increased.

(xi) In summer the antifreeze solutions protect liquid of the radiator from boiling over. Justify it.

Ans. Water boils at 100°C. It is used in the radiators to decrease the temperature of the working engine. If we add some suitable solutes which increase the boiling point of water, above 100°C, then easy boiling over of water is avoided. Actually such solutes also decrease the freeginy point of solutions as well.

(xii) Define colligative properties, name important colligative properties. (GRW. GI, 2015)(AJK. 2018)

Ans. Colligative Properties: The colligative properties are those properties of solution that depend on the number of solute and solvent molecules or ion.

Important Colligative Properties: Colligative properties of solution are:

- ☆ Lowering of vapour pressure.
- ☆ Elevation of boiling point
- ☆ Depression of freezing point
- ☆ Osmotic pressure

Q.3: Short answer questions.

(i) What are dipole-dipole forces? How they effect thermodynamic properties of substances.

Ans. Dipole-dipole forces are attractive forces which exist between the positive end of one polar molecule and the negative end of another polar molecule.

These forces affect on many thermodynamic properties of substances in different ways.

For example:

1. Melting and Boiling Points: Stronger the dipole dipole forces higher will be the melting and boiling points.

2. Viscosity: Stronger the dipole dipole forces higher will be the viscosity.

3. Surface Tension: Stronger the dipole-dipole forces higher will be the surface tension.

4. Vapour Pressure: Stronger the dipole-dipole forces lower will be the vapour pressure.

It means that thermodynamics properties of substance like viscosity, melting and boiling points etc; are a measure of how strong the Dipole-dipole forces are exist between individual atoms or molecules of substance.

(ii) Iodine dissolves readily in teterachloromethane.

Ans. "Like dissolves the like". I_2 is a non-polar substance having molecular crystals. $CC\ell_4$ is also non-polar solvent. So Iodine dissolves in $CC\ell_4$.

(iii) What is the relationship between polymorphism and allotropy?

Ans. Relationship between polymorphism and Allotropy: Both polymorphism and allotropy are related to existence of a substance in more than one crystalline forms. But polymorphism is existence of a compound in more than one forms while allotropy is existence of an element in more than one crystalline forms.

(iv) Define amporphous solids and give two examples.

Ans. Amorphous solids substances are those whose constituent atoms, ions, or molecules do not possess a regular orderly arrangement.

Examples: Glass, plastic.

(v) How positive rays are produced in discharge tube?

Ans. These positive rays are produced, when high speed cathode rays (electrons) collide with the molecules of a gas enclosed in the discharge tube. They knock out electrons from the gas molecules and positive ions are produced, which start moving towards the cathode.

$$M + e \longrightarrow M^{+} + 2e^{-}$$

(vi) Narrate Properties of Cathode rays.

Ans. Properties of Cathode Rays:

1. Cathode rays can ionize gases.
2. They can cause a chemical change, because they have a reducing effect.
3. Cathode rays can pass through a thin metal foil like aluminium or gold foil.
4. The e/m value of cathode rays shows that they are simply electrons.

(vii) Give two defects of Rutherford's atomic model.

Ans. Following are the defects in Rutherford's atomic model:

1. The outer electrons could not stationary.
2. The behaviour of electrons remains unexplained in the atom.

(viii) Write down four properties of Neutron.

Ans. Properties of Neutron:

1. Neutrons cannot ionize gases.
2. Neutrons are highly penetrating particles.
3. They can expel high speed protons from paraffin, water, paper and cellulose.
4. When neutrons travel with an energy 1.2 Mev (Mega electron volt), they are called fast neutrons but with energy below lev are called slow neutrons. Slow neutrons are usually more effective than fast ones for the fission purposes.

(ix) How does a catalyst affect a reversible reaction?

Ans. Effect of catalyst on equilibrium constant: In most of the reversible reaction the equilibrium is not always reached within a suitable short time. So, an appropriate catalyst is added. A catalyst does not affect the equilibrium position of the reaction. It increases the rates of both forward and backward reactions and this reduces the time to attain the state of equilibrium. Actually, a catalyst lowers the energy of activation of both forward and reverse steps by giving new path to the reaction.

(x) Prove by equations that what happens when Na_2CrO_4 is added to saturated solution of $PbCrO_4$?

Ans. The presence of a common ion decreases the solubility of a slightly soluble ionic compounds. In order to explain it, consider a saturated solution of $PbCrO_4$, which is a sparingly soluble in ionic salt.

$$PbCrO_4\,(aq) \rightleftharpoons Pb^{2+}\,(aq) + CrO_4^{2-}\,(aq)$$

Now add Na_2CrO_4 which is a soluble salt. CrO_4^{2-} is the common ion. It combines with pb^{2+} to form more insoluble $PbCrO_4$. So equilibrium is shifted to the left to keep K_{sp} constant.

(xi) What is meant by order of reaction? Give an example.

Ans. Order of reaction: The order of reaction is given by the sum of all the exponents to which the concentrations in the rate equation are raised.

$$aA + bB \longrightarrow cC + dD$$

$$\text{Rate of reaction} = k[A]^a\,[B]^b$$

The exponent 'a' or 'b' gives the order of reaction with respect to the individual reactant. Thus the reaction is of order 'a' with respect to A and of order of b with respect to B. the overall order of reaction is (a+b).

Example:

Oxidation of nitric oxide with ozone has been shown to be first order with respect to NO and first order with respect O_3. The sum of the individual orders gives the overall order of reaction as two.

$$NO_{(g)} + O_{3(g)} \longrightarrow NO_{2(g)} + O_{2(g)}$$

$$\text{Rate} = k[NO][O_3]$$

(xii) Differentiate between Average and Instantaneous Rate.

Ans.

Average Rate	Instantaneous Rate
(i) The rate at any one instant during the interval is called the instantaneous Rate.	(i) The rate of reaction between two specific time intervals is called average rate.
(ii) Instantaneous Rate $= \frac{dx}{dt}$	(ii) Average rate. $= \frac{\Delta x}{\Delta t}$

Q.4: Short answer questions.

(i) Why CO is polar and CO_2 is non-polar?

Ans. CO_2 has two polar carbon oxygen bonds, but the molecule is non-polar because CO_2 has linear structure and the centre of the two negative charges is at the same place as the centre of the positive charge the carbon atom. i.e.

$$\overset{\delta^-}{O}=\overset{\delta^+}{C}=\overset{\delta^-}{O}$$

centre of positive and negative charge

Where as CO is polar because it has polar carbon- oxygen bonds i.e

$$\overset{\delta^+}{C}=\overset{\delta^-}{C}:$$

(ii) How the nature of a chemical bond is predicted with the help of electronegativity values of two bonded atoms?

Ans. The difference in the electronegativity values of the bonded atoms is an index to the polar nature of the covalent bond. When the difference is zero, the bond between the two atoms is non-polar. Thus, all the bonds which are formed between similar atoms are non-polar in character, while those formed between different elements are mostly polar. Elements of widely different electro negativities form ionic bonds. A difference of 1.7 units shows roughly equal contributions of ionic and covalent bonds.

(iii) Why the radius of an atom cannot be determined precisely?

Ans. The radius of an atom cannot be determined precisely due to the following reasons.

1. There is no sharp boundary of an atom. The probability of finding an electron never becomes exactly zero even at large distances from the nucleus.
2. The electronic probability distribution is affected by neighboring atoms. For this reason, the size of an atom may change from one compound to another.

(iv) Electronegativity difference between the bonded atoms is an index to the polar nature of covalent bond, justify.

Ans. In a molecule the difference of electronegativity of bonded atom is considered an index of bond nature. It the difference of electro negativity is greater than 1.7 the bond will be ionic. If the difference of electronegativity is zero between two bonded atom the bond will be non polar.

(v) The enthalpy of neutralization of all the strong acids and strong bases has the same value. Justify.

Ans. The enthalpy of neutralization of all the strong acids and strong bases has the same value because when these solution are mixed together during the process of neutralization, the only change that actually occurs in the formation of water molecules leaving the sodium ions and the chloride ions as free ions in solution. Thus, the enthalpy of neutralization is merely the heat of formation of one mole of liquid water from its ionic components.

$$H^+(aq) + OH(aq) \rightleftharpoons H_2O_{(\ell)} \quad \Delta Hn = -57.4\ kJmo\ell^{-1}$$

(vi) Define Standard Enthalpy of Combustion and Standard Enthalpy of Solution.

Ans. Enthalpy of Combustion: The standard enthalpy of combustion of substance is amount of heat evolved when one male of the substance is completely burnt in excess of oxygen under standard condition. It is denoted by sH_c°

$$C_2H_5OH(\ell) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(\ell) \quad \Delta H_c^\circ = -1368\,kJ\,mol^{-1}$$

Enthalpy of Solution: The standard enthalpy of solution is the amount of heat absorbed or evolved when one mole of substance is dissolved in so much solvent that further dilution results in no detectable heat change it is denoted by ΔH_{sol}°.

(vii) How relative chemical reactivity of metals is studied with the help of electrochemical series.

Ans. When elements are arranged in the order of their standard, electrode potentials on the hydrogen scale, the resulting list is known as electrochemical series.This series tell us the electrode potentials of metals given in the mode of reduction. It has been observed that Greater the value of standard reduction potential (SHE) of a metal, smaller is its tendency to lose electrons to change into a positive ion and hence lower will be its reactivity.

Example: metals like Li, Na, K and Rb are highly reactive where as Coinage metals, Cu, Ag, and Au are the least reactive because they have positive reduction potentials.

(viii) Calculate oxidation number of 'Cr' in (a) $CrC\ell_2$ (b) $K_2Cr_2O_2$

Ans. (a) $CrC\ell_2$:

Let oxidation number of Cr = x
oxidation number of K = +1
oxidation no. of O = –2

applying formula

2(ON of K) + (ON of Cr) + 4(ON of O) = O
2(+1) + x + 4(–2) = O
2 + x –8 = O
2 + x –8 = O
x = 8 – 2
x = 6

(b) $K_2Cr_2O_2$:

2(O.N of K) + (O.N of Cr) + 2(O.N of O)
2(+1) + (x) + 2(4)
2 + x + –4
x = 4 + 2
x + 6

(ix) Write the function of salt bridge in Galvanic cell.

Ans. The purpose of the salt bridge is to prevent any net charge accumulation in either beaker by allowing negative ions to leave the right beaker, diffuse through the bridge and enter the left beaker.

Section II

Note: Attempt any THREE questions.

Q5. (a) What is difference between actual yield and theoretical yield? Why actual yield is less than the theoretical yield?

(b) Define liquid crystals; write down three uses of liquid crystals.

Q6. (a) What is Joule Thomson effect and describe Linde's method of liquefaction of gases?

(b) How are positive rays produced in discharge tube? Give properties of these rays.

Q7. (a) Define electron affinity. Give its trend in the periodic table. Also mention abnormal behaviour of electron affinity in different groups.

(b) Describe measurement of enthalpy of a reaction with bomb calorimeter.

Q8. (a) What is Le-Chatelier's Principle? Discuss effect of concentration on an equilibrium system.

(b) Define order of a chemical reaction. How does half-life method can be used for its measurement.

Q9. (a) Explain Lowering of Vapour Pressure by adding a Non volatile, Non electrolyte solute in a solvent.

(b) Define electrochemical series and give any two applications of it.

Paper No. 4

– Objective –

Q.1: Multiple choice questions.

1. 22.4 dm^3 2. 11 3. Their R_f values solutes
4. $55.6 \times 6.02 \times 10^{23}$ 5. 546 K 6. NH_3
7. Monoclinic 8. ultra violet 9. $\lambda = \frac{h}{mv}$
10. One sigma and two pi 11. $BC\ell_3$ 12. 4.184 J
13. 2.7 14. Saturated 15. Na_2CO_3
16. drops to zero 17. Decreases

– Subjective –

Section I

Q.2: Short answer questions.

(i) Define Isotope. Give an example.

Ans. Isotope: The atoms of the same element having different masses but same atomic numbers. Such atoms of an element are called Isotopes.

Examples: (i) Hydrogen: H^1, H^2, H^3 **(ii) Oxygen:** O^{16}, O^{17}, O^{18} **(iii) Carbon:** C^{12}, C^{13}

(ii) Many chemical reactions taking place in our surrounding involve the limiting reactants. Explain with examples.

Ans. Many chemical reactions taking place in our surrounding involve the limiting reactants. Some examples are as follows:

Example 1: In a chemical reaction, a large quantity of oxygen makes the things to burn rapidly. As oxygen used in excess is left behind, when reaction is completed sothe other reagent is consumed completely and the reactant which is consumed earlier is known as limiting reactant.

Example 2: A person who has caught fire is enveloped with a blanket to stop supply of oxygen. Stopping oxygen makes it a limiting reactant.

(iii) Give the reason to explain that actual yield is less than the theoretical yield.

Ans. Following are the reason due to which actual yield is always less than theoretical yield:

1. Mechanical loss of product during
   (a) Filtration (b) Separation by distillation (c) Separation by separating funnels
   (d) Washing (e) Drying (f) Crystallization etc.
2. Reactions are reversible
3. Side reactions take place which reduce the amount of required product.

(iv) What is difference between qualitative analysis and quantitative analysis?

Ans. Difference between qualitative and quantitative analysis:

Qualitative Analysis	Quantitative Analysis
In qualitative analysis, the chemist is concerned with the detection or identification of the elements present in a compound.	In quantitative analysis, the relative amounts of the elements are determined.

(v) Write down the uses of chromatography.

Ans. Uses of chromatography: The techniques of chromatography are very useful in organic synthesis for:

1. Separation, isolation and purification of the products.
2. It is very important in qualitative and quantitative analysis.
3. It is very important for determination of the purity of a substance.

(vi) Why water vapours do not behave ideally at 273K?

Ans. When water vapours are present at 273 K (0°C), there are sufficient forces of attractions among its molecules. Due to this reason water vapours behave non-ideally at 273K.

(vii) Derive Charles's law by kinetic equation of gases.

Ans. Charles's Law: Charles's Law is a quantitative relationship between temperature and volume of a gas.

According to this law: "The volume of the given mass of a gas is directly proportional to the absolute temperature when the pressure is kept constant.

Mathematically: $V \propto T$ (When pressure and number of moles are constan)

$V = KT$

$\frac{V}{T} = K$

(viii) Apply Datton's Law of partial pressure to determine the partial pressure of a dry gas?

Ans. Some gases are collected over water in the laboratory. The gas during collection gathers water vapours and becomes moist. The pressure exerted by this moist gas is, therefore, the sum of the partial pressures of the dry gas and that of water vapours. The partial pressure exerted by the water vapours is called aqueous tension.

$P_{moist} = P_{dry} + P_{w.vap}$

$P_{moist} = P_{dry}$ + aqueous tension

$P_{dry} = P_{moist}$ – aqueous tension

(ix) –273. 15°C is known to be the lowest temperature of an ideal gas. Give reason.

Ans. The temperature (–273.16°C) is the lowest possible temperature, which would have been achieved if the substance remains in the gaseous state. Actually all the gases are converted into liquid above this temperature which shows that this temperature can not be attained for a real Gas.

(x) One molal solution of urea, in water is dilute as compared to one molar solution of urea, but the number of particles of the solute is same. Justify it.

Ans. In one molal urea solution, 1 mole urea is present in 1000g of water. In one molar urea solution, 60g (1 mole) urea is present in 1000 cm^3 of solution.

In first case volume of solution (60 g urea + 1000g H_2O) is greater than 1000 cm^3 of molar solution. Therefore one molal solution is dilute than one molar solution.

(xi) What is discontinuous solubility curve? Give one example.

Ans. Discontinuous solubility curve show sudden changes of direction are called discontinuous solubility curves.

Examples: The most important substance which show discontinuous solubility curves are:

(i) $Na_2SO_4.10H_2O$ **(ii)** $CaC\ell_26H_2O$ **(iii)** NH_4NO_3

(xii) Give general principle of liquefaction of gasses.

Ans. General Principle of liquifaction:

The conversion of a gas into liquid requires high pressure and low temperature. High pressure brings the molecules of a gas close to each other. Low temperature deprives the molecules from Kinetic energy and attractive forces starts dominating.

Q.3 Short answer questions.

(i) Define transition temperature and give two examples.

Ans. Transition temperature: Transition temperature is that temperature at which two crystalline forms of the same substance can co-exist in equilibrium with each other. At this temperature, one crystalline form of a substance changes to another. Above and below this temperature, only one form exists.

Example: Grey tin (cubic) $\xrightleftharpoons{13.2°C}$ White tin (tetragonal)

(ii) What do you mean by cleavage and cleavage planes?

Ans. Cleavage: Cleavage is the tendency of crystalline materials to split along definite crystallographic structural planes.

Cleavage Planes: Whenever the crystalline solids are broken, they do so along definite planes which are called the cleavage planes and they are inclined to one another at a particular angle for a given crystalline solid.

(iii) Lower alcohols are soluble in water but hydrocarbons are insoluble. Give reason.

Ans. Ethyl alcohol (C_2H_5OH) can dissolve in water because both can form hydrogen bonds with each other.

But hydrocarbons are not soluble in water at all, because they are non-polar compounds and there are no chances of hydrogen bonding between water and hydrocarbon molecules.

(iv) Cleavage of crystals is itself anisotropic behaviour, explain.

Ans. Cleavage is anisotropic behaviour: Cleavage is anisotropic property because when crystalline solids are broken they do so along definite planes. It means that cleavage depends upon direction. It proves that cleavage is itself anisotropic.

(v) Why is it necessary to decrease the pressure in discharge tube to get cathode rays?

Ans. At high pressure, there is over-crowding of gas molecules in the discharge tube. Under this condition, cathode rays fail to pass through due to hindrance. However, when pressure is reduced the molecules are less crowded and there is less hindrance for the free movement of cathode rays.

(vi) Differentiate between fast neutron and slow neutron.

Ans. Difference between fast neutron and slow neutron:

Fast neutron	Slow Neutron
When Neutrons travel with an energy 1.2 Mev, they are called Fast Neutrons.	When Neutrons travel with an energy 1 ev, they are called slow Neutrons.

(vii) Give two defects in Bohr's atomic model.

Ans. Defects in Bohr's Atomic Model:

1. Bohr's theory can successfully explain the origin of the spectrum of H-atom and the like He^{+1}, Li^{+2} and Be^{+3}, etc there are all one electron system. But this theory is not able to explain the spectrum of multi electron or poly electron system like He, Li and Be ect.
2. Bohr suggested circular orbits of electron around the nucleus of hydrogen atom but researches have shown that the motion of electron is not a single plane but takes places in three space. Actually the atomic model is flat.

(viii) Justify that the distance gaps between different orbits go on increasing from the lower to the higher orbits.

Ans. The distance between the orbits goes on increasing as we move from 1st orbit to higher. Because the force of attraction between nucleus and electrons decreases as we move towards higher orbits.

(ix) **How extent of a reversible chemical reaction can be indicated by equilibrium constant?**

Ans. The direction of chemical reaction at any particular time can be predicted by means of [products]/ [reactants] ratio, calculated before the reaction attains equilibrium. The value of [product] / [reactants] ratio leads to one of the following three possibilities.

(a) The ratio is less than K_c. This implies that more of the product is required to attain the equilibrium; therefore, the reaction will proceed in the forward direction.

(b) The ratio is greater than K_c. It means that the reverse reaction will occur to attain the equilibrium.

(c) When the ratio is equal to K_c. then the reaction is at equilibrium.

(x) **Why do we need buffers in daily life?**

Ans. Sometimes we want to study a reaction under conditions that would suffer any associated change in the pH of the reaction mixture. So, by suitable choice of the solutes, a chemist can ensure that a solution will not experience more than a very small change in pH, even if a small amount of a strong acid or a strong base is added.

(xi) **What is specific rate Constant or Velocity Constant.**

Ans. It state that the rate of reaction is proportional is the active mass of the reactant or to the product of active masses if more than are reactant are involved in chemical reaction.

(xii) **Define average and instantaneous rate of reaction.**

Ans. The rate at any one instant during a specific interval of time is called instantaneous rate of reaction."

The rate of reaction between two specific intervals of time is called average rate of reaction.

Q.4: Short answer questions.

(i) **Write down two postulates of VSEPR theory.**

Ans. Postulates of VSEPR Theory:

1. Both the lone pairs as well as the bond pairs participate in determining the geometry of the molecules.
2. The electron paris are arranged around the central polyvalent atom so as to remain at a maximum distance apart to avoid repulsions.

(ii) **Why ionization energy (IE) values are decreased from top to bottom in a group?**

Ans. Ionization energy decreases down the group in spite of the increase in proton number or nuclear charge. This is due to the successive addition of electronic shells as a result of which the valance electrons are placed at a large distance from the nucleus. As the force of attraction between the nucleus and the outer electron decreases with the increase in distance, the electron can be removed more easily or with less energy. Moreover, the force of attraction also decreases due to increasing shielding effect of the intervening electrons.

(iii) **Define electronegativity and give its trend in periodic table.**

Ans. Electronegativity: The tendency of an atom to attract shared pair of electrons towards itself is called electronegativity.

Variation of Electronegativity in Periodic table:

In groups: Electronegativity decreases from top to bottom in a group. This is due to the successive increase in the number of electronic shells. The addition of extra shells in larger atoms screens the shared pair from the nucleus and the pair is less attracted by the element in the combined state.

In Periods: Electronegativity values increase from left to right in the periods due to decrease in atomic size.

(iv) How bond length is effected by change of hybridization state?

Ans. Moreover, hybridization scheme involved, also explains the sortening of bonds due to the predominant participation of s-orbitals. Since, the 2s-orbital of carbon has smaller mean radius than the 2p-orbitals, It would be expected that greater the s character in the hybrid orbitals used, the shorter will be the bond distance. Thus, the C-C bond lengths are 154, 133, and 120 pm for ethane, ethane and ethyne, respectively where s orbital contribution increases from sp^3 to sp. Further, p- bonding also reduce the internuclear bond distance.

(v) What is standard enthalpy of solution? Give one example.

Ans. Standard Enthalpy of solution ($\Delta H°_{sol}$): The standard enthalpy of solution is the amount of heat absorbed or evolved when one mole of a substance is dissolved in so much solvent that further dilution results in no detectable heat change.

Example: Enthalpy of (ΔH°sol) of ammonium chloride is + 16.2 $kJmo\ell^{-1}$ and that of sodium carbonate is –25.0 $kJmo\ell^{-1}$.

(vi) Describe that burning of candle is a spontaneous process. Justify.

Ans. The burning of candle is a spontaneous process because spontaneous process needs energy to start with, but once it is started, than it proceeds on its own.

To burn a candle, a spark or temperature is required from out, but once it starts burning, there is no more energy required and candle burn spontaneously, Because heat evolved due to burning makes the reaction spontaneous.

(vii) Define oxidizing agent and reducing agent.

Ans. Oxidizing Agent:

"A species having greater tendency of to gain elections or accept electrons while reduction with greater value of standard reduction potential and act as an oxidizing agent".

Examples: The series like F^- $C\ell_2$, Br_2, etc is example of strong oxidizing agents with a large positive value of standard reduction potentials.

Reducing Agent:

"A species having lesser tendency to gain elections or accept electrons while reduction with lesser value of standard reduction potential and act as an reducing agent"

Examples: The series like like Li, K, Ca, Na etc is example of strong reducing agents have large negative values becose they lie above SHE

(viii) What are secondary cells? Write name of any two such cells.

Ans. Those cells which can be Recharged are called Secondary Cells.

Examples: **(i)** Lead – Acid Battery **(ii)** Ni – Cd battery

(ix) Give any two applications of electrochemical series.

Ans. Two applications of series are.

1. Prediction of the feasibiltiy of a chemical reactions.
2. It is used to calculate the voltage or Electromotive force (emf) of cells.

Section II

Note: Attempt any THREE questions.

Q5. (a) Write a note on Limiting reactant. Explain it giving at least two examples.

(b) Define boiling point and how does it is effected by external pressure? Explain briefly.

Q6. (a) What is ideal gas constant "R"? Calculate its value in different units?

(b) Describe J.J. Thomson's experiment for determining e/m value of electron.

Q7. (a) Explain Postulates of Molecular orbital theory.

(b) Define Enthalpy. How is it determined with help of Bomb's Calorimeter.

Q8. (a) Calculate the pH of buffer solution in which 0.11 molar $H_3CCOONa$ and 0.09 molar acetic acid solutions are present Ka for $H_3CCOONa$ is 1.85×10^{-5}.

(b) Explain effect of temperature on rate of reaction by Arrhenius equation.

Q9. (a) How depression in freezing point is measured by Beckmann's Apparatus.

(b) What is voltaic cell? Explain with one example.

Paper No. 5

– Objective –

Q.1: Multiple choice questions.

1. Properties which depend upon mass
2. 9
3. Adsorption Chromatography
4. 127°C and 1 atm
5. 116 torr
6. Intermolecular hydrogen bonding
7. Molecules of solid iodine
8. $\Delta X.\Delta p \geq \frac{h}{4\pi}$
9. $1.6022 \times 10^{-19}C$
10. $N^{2-}{}_2$
11. $\hat{I}$
12. $q_p > q_v$
13. Temperature
14. $\frac{1}{51}$
15. 12 moles
16. drops to zero
17. Zero-order reaction

– Subjective –

Section I

Q.2: Short answer questions.

(i) One mole of H_2O has two moles of bonds, three moles of atoms, ten moles of electrons and twenty eight moles of the total fundamental particles present in it.

Ans. The molecule of H–O–H has two bonds in it. Therefore, one mole of H_2O contains two moles of bonds and three moles of atoms. Similarly, there are eight electrons in oxygen and one electron in each of the two H atoms. One molecule of H_2O has 10 electrons. So one mole of water contains 10 moles of electrons. There are 28 moles of all fundamental particles in one mole of water 10 moles of electrons, 10 moles of protons, 8 moles of neutrons.

(ii) Law of Conservation of mass has to be obeyed during stoichiometric calculations. Give reason.

Ans. Stoichiometric calculation obeys law of conservation of mass:
Stoichiometric calculations are those in which balanced chemical equation is used.Balanced chemical equation means that mass of reactant and product are same. This means that law of conservation of mass has to be obeyed. Otherwise no calculation is correct.

(iii) Define Stoichiometry and give two assumptions for stoichiometric calculations.

Ans. Stoichiometry: Stoichiometry is the branch of chemistry which tells us the quantitative relationship between reactants and products in a balanced chemical equation.

Assumptions for Stoichiometry:
To perform stoichiometric calculations following assumptions are necessary:

1. All the reactants are completely converted into the products.
2. No side reaction occurs.

(iv) Define extraction.

Ans. This method is used to separate the products of organic synthesis from water. In a typica organic synthesis, the aqueous solution containing the organic product is shaken up with ether in a separating funnel and allowed to separate. The inorganic impurities remain in

aqueous phase, where as the organic compound goes to the ether layer. The ether layer is separated and organic product is obtained by evaporating the ether.

(v) Differentiate between adsorption and partition chromatography.

Ans.

Adsorption Chromatography	Partition Chromatography
Chromatography in which stationary phase is solid is called adsorption chromatography. e.g Column Chromatography.	Chromatography in which stationary phase is liquid is called partition chromatography. e.g Paper chromatography.

(vi) Define absolute zero. What is its value?

Ans. Absolute Zero: The temperature of –273.16°C at which the volume of a gas theoretically becomes zero is called absolute zero.

It is taken as zero on the Kelvin scale of temperature.

(vii) What is plasma? How it is formed?

Ans. Plasma: Plasma is an ionized gas mixture, consisting of ions, electrons and neutral atoms. It means that plasma is a distinct state of matter containing a significant number of electrically charged particles a number sufficient to affect its electrical properties and behaviour.

Formation of Plasma: Plasma can be created by heating a gas or subjecting it to a strong electromagnetic field applied with a laser or microwave generator. This decreases or increases the number of electrons, creating positive or negative charged particles called ions,and is accompanied by the dissociation of molecular bonds, if present.

(viii) Why pilots feel uncomfortable breathing at higher altitude?

Ans. At higher altitudes, the pilot feels uncomfortable breathing because the partial pressure of oxygen in the un- pressurized cabin is low, as compared to 159 torr, where one feels comfortable breathing.

(ix) Why normal air cannot be used for breathing by sea divers?

Ans. Normal air cannot be used by sea diver in diver tank for breathing in depth of sea, because in sea after every 100m depth diver experiences approximately 3 atm pressures and it diffuse in the blood.

(x) Why the aqueous solution of $NH_4C\ell$ is acidic?

Ans. Aqueous solution of $NH_4C\ell$ is acidic in nature because Ammonium Chloride ($NH_4C\ell$) is a salt of a strong acid ($HC\ell$) and a weak base (NH_4OH). Hence, in an aqueous solution, it shows acidic properties. When mixed with water, it gets hydrolyzed as follows.

$$NH_4C\ell + H_2O \rightarrow NH_4OH + HC\ell$$

The salt and the strong acid ($HC\ell$) get ionized while the weak base (NH_4OH) remains unionized.

$$NH_4^+ + C\ell^- + H_2O \rightarrow NH_4OH + H^+ + C\ell^-$$

Cancelling the $C\ell^-$ ions from both sides.

$$NH_4^+ + H_2O \rightarrow NH_4OH + H^+$$

The H^+ ions left in the solution gives the solution it's acidic properties.

(xi) Define upper consulate temperature with example.

Ans. Critical solution temperature:

The temperature at which two conjugate solution merge into one another is called critical solution temperature or upper consulate temperature.

Example: 65.9 °C is the critical solution temperature of water phenol system.

(xii) Aqueous solution of CH_3COONa is basic why?

Ans. Aqueous solution of CH_3COONa is basic in a nature because the acetate ion is hydrolyzed

in water to give CH_3COOH and OH^- becomes free. Na^+ is not hydrolyzed, i.e.

$$CH_3COONa + H_2O \rightleftharpoons CH_3COOH + Na^+ + OH^-$$

Q.3: Short answer questions.

(i) Differentiate between isomorphism and polymorphis.

Ans. Difference between Isomorphism and polymorphism:

Isomorphism	Polymorphism
1. Isomorphism is the phenomenon is which two different substances exist in the same crystalline form.	1. Polymorphism is the phenomenon in which a compound exists in more than one crystalline form.
2. These different substances are called isomorphs of each other.	2. These crystalline forms are called polymorphs of each other.
3. Their physical and chemical properties are different from each other.	3. Polymorphs have same chemical properties, but they differ in the physical properties.
4. Isomorphic substances crystallize together in all proportions in homogenous mixtures, e.g. $NaNO_3$,KNO_3 (rhombohedral)	4. Polymorphic substances do not form homogeneous mixtures, e.g. $CaCO_3$ (Trigonal and orthorhombic)

(ii) Define Polymorphims and Anisotorpy. Give one example of each.

Ans. Polymorphism: Polymorphism is a phenomenon is which a compound exists in more than one crystalline forms and these crystalline forms are called polymorphs of each other.

Example:

Element	Crystalline forms
Sulphur, S	Rhombic, monoclinic
Carbon, C	Cubic (diamond), hexagonal (graphite)

Anisotropy: Anisotropy is the phenomenon is which some of the crystals show variation in their physical properties that depends upon the direction. Such properties are called anisotropic properties.

Example: Electrical conductivity of graphite is greater parallel rather than perpendicular to the layers.

(iii) Ionic crystals do not conduct electricity in the solid state. Why?

Ans. Ionic crystals do not conduct electricity: In ionic crystals or ionic solids are tightly packed in a three dimensional way. They don't have translator motion. So they don't become responsible for carrying of current. Ionic crystals conduct electricity when they are in solution or in the molten state. In both cases ions become free.

(iv) Define Polarizibility. How it affects London dispersion forces?

Ans. Polarizability is the quantitative measurement of the extent to which the electronic cloud can be polarized or distorted. The increased distortion of electronic cloud create stronger London forces and hence the boiling points also increased down the group.

(v) Write two postulates of Bohr's atomic model.

Ans. Postulates of Bohr's Atomic Model: The main postulates of Bohr's theory are;

1. Electron revolves in one of the circular orbits outside the nucleus. Each orbit has a fixed energy and a quantum number is assigned to it.
2. Electron present in a particular orbit neither emits nor absorbs energy while moving in

the same fixed orbits. The energy is emitted or absorbed only when an electron jumps from one orbit to another.

(vi) Describe behavior of cathode rays in magnetic field.

Ans. When cathode rays are passed through the magnetic field, they bend perpendicular to the joining line of two poles. This is due to the negative charge. Anyhow, positively charged particles will bend in opposite direction to that of electrons in the magnetic field.

(vii) Write down any two postulate of Plank's quantum theory.

Ans. Postulate of Planck's Theory:

Energy is not emitted or absorbed continuously rather it is emitted absorbed in a discontinuous manner and in the form of wave pakect in case of light. The quantum of energy associated is called photon.

The amount of energy is associated with quantum of radiation is proportional to the frequency (v) of the radiation.

(viii) Explain atomic spectrum with one example.

Ans. When an element or its compound is volatilized on a flame and the light emitted is seen through a spectrometer, we see distinct lines separated by dark space. This type of spectrum is called line spectrum or atomic spectrum. For example, line spectrum of sodium contains two yellow coloured lines separated by a definite distance.

(ix) State law of mass action.

Ans. Law of Mass: The law of mass action can be states as,

The rate at which the reaction proceeds is directly proportional to the product of active masses of the reactants.

(x) What is meant by Buffer Capacity?

Ans. The buffer capacity of a solution is the capability of a buffer to resist the change of pH. It is measured quantitatively that how much extra acid or a base solution can be absorbed before the buffer is essentially destroyed.

The molarities of the two components of buffer solution determine the buffer capacity.

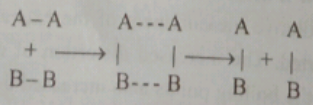
(xi) Justify that rate of reaction depends upon surface area given one example also.

Ans. Whenever the surface area of the reactant is increased, the reaction rates enhance. The reason is that the atoms and molecules of the reactants find the greater chances to touch each other.

Example: $CaCO_3$ in the powder from reacts with dil. H_2SO_4 more efficiently then big pieces of $CaCO_3$.

(xii) What do you mean by Activation Complex of a reaction?

Ans. Activation Complex: Activation Complex is an unstable combination of all the atoms involved in the reaction for which the energy is maximum. It is a short lived species and decomposes into the Products immediately. It has a transient existence that is why it is also called as transition state.



Q.4: Short answer questions.

(i) Ionization energy is index to the metallic character. Why?

Ans. Ionization energy is an index to the metallic character. The elements having low ionization energies are metals and those having high ionization energies are non- metals. Those with intermediate values are mostly metalloids.

(ii) Why molecular orbital theory is superior to that of VSEPR and VB theories?

Ans. MOT is superior to VBT and VSEPR:

- Molecular orbital theory is superior to VBT because MOT tells us the reason for no bond between noble gases.
- It also tells us about the paramagnetic and diamagnetic nature of the substance but VBT and VSEPR theories not give such answers.

(iii) Why sigma bond is stronger than Pi bond?

Ans. Sigma bond is stronger than pi-bond because bond strength of sigma bond is greater due to greater overlapping of orbitals than bond strength of pi-bond.

(iv) Define Electronegativity and Electron Affinity of an Atom.

Ans. Electronegativity: The tendency of an atom to attract a shared electron pair toward itself is called electronegativity.

Electron Affinity: The electron affinity of a atom is the energy released when on electron add to empty or partially filled orbital of an isolated gaseous atom in valence energy level to form an anion having a unit negative charge.

(v) Why it is necessary to mention the physical states of reactants and products in thermo chemical reaction?

Ans. It is true that all chemical reactions involves in change of energy of reactants and products, because all substance present in universe posses energy. It is also true that phase or physical state change of a substance involves in the change in energy. So, whenever we mention a chemical reaction in thermo chemistry, then it is essential to mention the physical states of reactants and products. That represents the conditions of reaction in term of pressure, volume etc. by which change in physical state of reactants and products is carried out.

(vi) Define standard enthalpy of atomization with an example.

Ans. Standard enthalpy of Atomization:

The standard enthalpy of atomization of an element is defined as the amount of heat absorbed when one mole of gaseous atoms is formed from the element under standard conditions.

Example: $\frac{1}{2}H_{2(g)} \longrightarrow H_{(g)} \qquad \Delta H^{o}_{at} = 218 kJmol^{-1}$

(vii) Mention the function of salt bridge.

Ans. Function of Salt Bridge:

Salt bridge has two major functions which are as follow:

1. It connects the solutions in two half cells and completes the cell circuit.
2. It maintains the electrical neutrality by the diffusion of ions through it.
3. It prevents direct mixing of two solutions because by direct mixing of two solutions the half cells are destroyed.
4. It prevents any net charge accumulation is either solution because it allows excess ions to diffuse from one solution to other solution.

(viii) Calculate oxidation number of sulphur in SO_4^{2}.

Ans. Calculate oxidation number of sulphur in SO_4^{2}:

The equation for this molecule is

(Oxidation number of S)+4 (Oxidation number of O) = –2

Let:

Oxidation number of S = x

Oxidation number of O =-2

By putting these value in above equation,

(x) + 4(-2) =-2

x -8 . = -2

x =-2 + 8 = +6

So sulphur in SO_4^{2} has +6 oxidation numbers.

(ix) What is Anodized Aluminium? Give its advantages.

Ans. Anodized aluminium is an electrochemical process in which an oxide layer is chemically built on the surface of metal. This oxide layer act as insulator and can dyed in a wide variety of color.

Advantages:

1. It gives aluminium a deeper, richer metallic appearance than is possible with organic coatings.
2. Anodizing aluminium cannot peal, chip, flake or blister.
3. The coating is actually part of the metal.

Section II

Note: Attempt any THREE questions.

Q5. (a) Define stoichiometry. Give its assumptions. Mention two important laws which help to perform the stoichiometric calculation.

(b) Write a note on three factors affecting the London Forces.

Q6. (a) What is Kinetic molecular theory of gases? Give its postulates.

(b) Give the different postulates of Bohr's atomic model.

Q7. (a) What is bond order? Why bond formation is not possible between two He atoms.

(b) Define and explain Hess's law of constant heat summation with examples.

Q8. (a) The Solubility product of Ag_2CrO_4 in water is 2.6 x 102 at 25°C, calculate the solubility of the compound.

(b) Define the order of a reaction and give one example of first, second and third order of a reaction.

Q9. (a) Describe Landsberger's method for the measurement of boiling point elevation.

(b) What is galvanic cell? Give composition and working of galvanic cell.

ANSWER SHEET

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SMART PAPERS

Informative Note

Knowledge is power and **HAMDARD KUTAB KHANA** is always working for the spread of knowledge, owing to its close co-operation with Education Department. It has always been an honour of **HAMDARD KUTAB KHANA** that it gives its readers awareness about the latest updates of Education Department. It also provides the helping reading material according to the new syllabus.

Unfortunately, the process of education is interrupted this year just because of the Pandemic (Covid-19). After viewing the crucial circumstances, Education Department has introduced the **Smart Syllabus** for all the classes according to the **Accelerated Learning Programme (ALP)**, this year. So that the students would be able to conduct the next annual examination 2021.

Now, **HAMDARD KUTAB KHANA** has published the Up to Date papers according to the **Smart Syllabus**, consisted of chapterwise Board Questions and annual papers for the convenience of the students.

Hopefully, these papers will be beneficial for the students of intermediate to prepare the next annual examination and get success in the board papers.

It is hoped that our this effort of providing you complete help and guidance will be admired by all of you and this effort shall also receive the same prominent place in the hearts of the learned teachers and students.

Thanks.

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