Class XI Session 2023-24
Subject - Chemistry
Sample Question Paper - 3

Time Allowed: 3 hours **Maximum Marks: 70**

General Instructions:

1. There are 33 questions in this question paper with internal choice.
2. SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
3. SECTION B consists of 5 very short answer questions carrying 2 marks each.
4. SECTION C consists of 7 short answer questions carrying 3 marks each.
5. SECTION D consists of 2 case-based questions carrying 4 marks each.
6. SECTION E consists of 3 long answer questions carrying 5 marks each.
7. All questions are compulsory.
8. The use of log tables and calculators is not allowed

Section A

1. One _____ is the collection of 6.022×10^{23} atoms/molecules/ions. **[1]**

   a) mole b) gram

   c) kilogram d) candela

2. In the emission spectrum of hydrogen atom, the Balmer series falls in the **[1]**

   a) Ultraviolet region b) X - ray region

   c) Infra-red region d) Visible region

3. Calculate the heat and the work associated with a process in which 5.00 mol of gas expands reversibly at constant temperature $T = 298k$ from a pressure of 10.00 to 1.00 atm **[1]**

   a) 27.0 kJ, -28.5 kJ b) 28.5 kJ, -28.5 kJ

   c) 25.5 kJ, -28.5 kJ d) 30.5 kJ, -28.5 kJ

4. Charge on the electron was determined by **[1]**

   a) Electrical discharge carried out in the modified cathode ray tube b) x-ray tube experiments

   c) R.A. Millikan's oil drop experiment d) cathode ray discharge tube experiments

5. Entropy is a state function and measures **[1]**

   a) the degree of randomness or disorder in the system. b) the internal energy of the system.

   c) the degree of regularity or order in the d) the enthalpy of the system.

system.

6. Quantum mechanics is a theoretical science that deals with the study of the: **[1]**

a) motions of the microscopic objects that have only particle like properties

b) motions of the macroscopic objects that do not have both observable wave-like and particle like properties

c) motions of the microscopic objects that have both observable wave-like and particle-like properties

d) motions of the macroscopic objects that have only particle like properties

7. For ions composed of only one atom, the oxidation number is equal to the: **[1]**

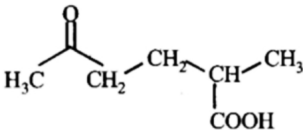
a) Always -1

b) Always +1

c) The sum of different oxidation states

d) Charge on the ion

8. The IUPAC name of the compound is: **[1]**



a) 2-Methyl-5-oxohexanoic acid

b) 2-Formyl-5-methylhexan-6-oic acid

c) 5-Methyl-2-oxohexan-6-oic acid

d) 5-Formyl-2-methylhexanoic acid

9. In Friedel-Crafts alkylation reaction, when benzene is treated with an alkyl halide in the presence of a catalyst, alkylbenzene is formed. The catalyst used is: **[1]**

a) Anhydrous aluminium chloride

b) Palladium

c) H_3PO_4

d) Silver

10. One of the following has ns^1 as its outermost electronic configuration: **[1]**

a) Lanthanoids

b) Transition elements

c) Alkali metals

d) Alkaline earth metals

11. Comment on the thermodynamic stability of NO(g), Given: **[1]**

$\frac{1}{2}N_2(g) + \frac{1}{2}O_2(g) \rightarrow NO(g)$; $\Delta_r H^0 = 90$ kJ mol^{-1}

$NO(g) + \frac{1}{2}O_2(g) \rightarrow NO_2(g)$; $\Delta_r H^0 = -74$ kJ mol^{-1}

a) NO(g) is unstable, but NO_2 (g) is formed

b) NO_2 (g) is unstable, but NO(g) is formed

c) NO_2 (g) is stable, but NO(g) is formed

d) NO(g) is stable, but NO_2 (g) is formed

12. Which branched chain isomer of the hydrocarbon with molecular mass 72u gives only one isomer of monosubstituted alkyl halide? **[1]**

a) Tertiary butyl chloride

b) Neohexane

c) Neopentane

d) Isohexane

13. **Assertion (A):** Neha noted that resonance provided by CH_3NO_2 be represented by the 2 lewis structures. **[1]**

Reason (R): The energy of the actual structure of the molecule is higher than the conical structure.

a) Both A and R are true and R is the correct

b) Both A and R are true but R is not the

explanation of A.

correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

14. **Assertion (A):** Addition of X_2 on alkene is anti-addition reaction. **[1]**

Reason (R): Addition of X_2 on alkene proceed by formation of cyclic halonium ion.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

15. **Assertion (A):** The spectrum of He^+ is expected to be similar to that of hydrogen. **[1]**

Reason (R): He^+ is also an one-electron system.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

16. **Assertion (A):** The empirical mass of ethene is half of its molecular mass. **[1]**

Reason (R): The empirical formula represents the simplest whole number ratio of various atoms present in a compound.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

Section B

17. The ionization constant of HF, HCOOH and HCN at 298 K are is $6.8 \times 10^{-4}, 1.8 \times 10^{-4}$ and 4.8×10^{-9} respectively. Calculate the ionization constant of the corresponding conjugate base. **[2]**

18. Describe the main features of Mendeleev's periodic table. **[2]**

19. Calculate the number of moles in the following masses **[2]**

i. 1.46 metric ton of Al (1 metric ton = 10^3 kg)

ii. 7.9 mg of Ca

20. How will you prepare isobutane? **[2]**

OR

Write structural formulae of the following compounds.

i. 3, 4, 4, 5-tetramethylheptane

ii. 2, 5-dimethylhexane

21. The unpaired electrons in Al and Si are present in 3p orbital. Which electrons were experience more effective nuclear charge from the nucleus? **[2]**

Section C

22. Explain why CO_3^{2-} ion cannot be represented by a single Lewis structure. How can it be best represented? **[3]**

23. **Answer:** **[3]**

(i) Define Heat capacity. **[1]**

(ii) At what temperature entropy of a substance is zero? **[1]**

(iii) The difference between C_P and C_V can be derived using the empirical relation H = U + pV. Calculate **[1]**

the difference between C_P and C_V for 10 moles of an ideal gas.

24. When 1 g of liquid naphthalene ($C_{10}H_8$) solidifies, 149 J of heat is evolved. Calculate the heat of fusion of naphthalene. **[3]**

25. Balance the following equations by oxidation number method: **[3]**

i. $CuO + NH_3 \rightarrow Cu + N_2 + H_2O$

ii. $K_2 MnO_4 + H_2O \rightarrow MnO_2 + KMnO_4 + KOH$

26. A photon of wavelength 4×10^{-7} m strikes on the metal surface, the work function of metal being 2.13 eV. Calculate **[3]**

i. the energy of the photon (eV),

ii. the kinetic energy of emission,

iii. the velocity of the photoelectron. (1 eV = 1.6020×10^{-19} J).

27. The first (IE) and second (IER) ionization enthalpy: (KJ mol^{-1}) of three elements A, B and C are given below: **[3]**

	A	**B**	**C**
IE_1	403	549	1142
IE_2	2640	1060	2080

Identify the element which is likely to be

i. a non-metal

ii. an alkali metal

iii. an alkaline earth metal

28. What volume of oxygen at STP is required to effect complete combustion of 200 cm^3 of acetylene and what would be the volume of carbon dioxide formed? **[3]**

Section D

29. **Read the text carefully and answer the questions:** **[4]**

The existing large number of organic compounds and their ever-increasing numbers has made it necessary to classify them on the basis of their structures. Organic compounds are broadly classified as open-chain compounds which are also called aliphatic compounds. Aliphatic compounds further classified as homocyclic and heterocyclic compounds. Aromatic compounds are special types of compounds. Alicyclic compounds, aromatic compounds may also have heteroatom in the ring. Such compounds are called heterocyclic aromatic compounds. Organic compounds can also be classified on the basis of functional groups, into families or homologous series. The members of a homologous series can be represented by general molecular formula and the successive members differ from each other in a molecular formula by a $–CH_2$ unit.

(i) The successive members of a homologous series differ by which mass of amu?

OR

Is tetrahydrofuran is aromatic compounds?

(ii) Does Pyridine, pyrrole, thiophene are all heteroaromatic compounds

(iii) Difference between heterocyclic and homocyclic compound.

30. **Read the text carefully and answer the questions:** **[4]**

The ionic character of metallic halides tends toward covalent nature as per Fajan's rule. Such covalent halides behave as non-metal in their higher oxidation states. The property to hydrolyse to give oxy-acids of the element

and corresponding hydro halogen acid for most non-metallic elements proceeds exceptionally in the way, keeping oxidation number of element and halide sam in oxo-acids.

Non-polar halides are immiscible in water, as they do not show hydrolysis, but halides of some elements with empty d-orbital undergo hydrolysis. Stability of halides of the higher state is governed by the inert-pair effect.

(i) How does halide undergo hydrolysis to give oxy-acids of underlined element PCl_3?

(ii) Out of NCl_3 and BCl_3 undergoes hydrolysis to form oxy-acids? Write the chemical reaction for the correct answer.

(iii) Out of $PbCl_4$, PbF_4, PbI_4 and $PbBr_4$ which one doesn't exist?

OR

Non-Polar halides are immiscible in water. Why?

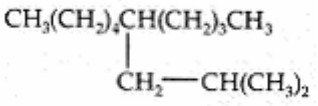
Section E

31. **Attempt any five of the following:** **[5]**

(i) Which type of isomerism is exhibited by but-1-yne and but-2-yne? **[1]**

(ii) Write the IUPAC name:  **[1]**

(iii) Write IUPAC name of following: **[1]**



(iv) Draw the New man's projection formula of the staggered form of 1,2-dichloroethane. **[1]**

(v) What happens to equilibrium constant when temperature increases for a reaction? **[1]**

(vi) What happens when benzene is treated with acetyl chloride in presence of $AlCl_3$? **[1]**

(vii) What is electrophile in sulphonation? **[1]**

32. The first ionization constant of H_2S is 9.1×10^{-8}. Calculate the concentration of HS^- ions in its 0.1 M solution and how will this concentration be affected if the solution is 0.1 M in HCl also? If the second dissociation constant of H_2S is 1.2×10^{-13}, calculate the concentration of S^{2-} under both conditions. **[5]**

OR

At certain temperature and under a pressure of 4 atm, PCl_5 is 10% dissociated.

Calculate the pressure at which PCl_5 will be 20% dissociated temperature remaining constant.

33. **Answer:** **[5]**

(i) i. Which of the following represents the correct IUPAC name for the compounds concerned? **[2.5]**

a. 2, 2-Dimethylpentane or 2-Dimethylpentane

b. 2, 4, 7-Trimethyloctane or 2, 5, 7-Trimethyloctane

c. 2-Chloro-4-methylpentane or 4-Chloro-2-methylpentane

d. But-3-yn-1-ol or But-4-ol-1-yne.

ii. What are electrophiles? Explain electrophile substitution reaction with the help of example. **[2.5]**

OR

i. Write the IUPAC names of the compounds (i)-(iv) from their structures **[2.5]**

i. $CH_3 - CH_2 - \underset{\underset{OH}{|}}{CH} - CH_2 - CH_2 - \underset{\underset{CH_3}{|}}{CH} - CH_2 - CH_3$

ii. $CH_3 - CH_2 - \overset{\overset{O}{\|}}{C} - CH_2 - \overset{\overset{O}{\|}}{C} - CH_3$

iii. $CH_3 - \overset{O}{\overset{\|}{C}} - CH_2 - CH_2 - CH_2 - COOH$

iv. CH ≡ C - CH = CH - CH ≡ CH_2

ii. Give condensed and bond line structural formulas and identify the functional groups present, if any, for: **[2.5]**

a. 2, 2, 4-Trimethylpentane

b. 2-Hydroxy-1, 2, 3-propanetricarboxylic acid

c. Hexanedial?

Solution

Section A

1. **(a)** mole
   Explanation: mole

2. **(d)** Visible region
   Explanation: The spectral lines obtained as a result of transition of electrons from higher energy levels to the second energy level of a hydrogen atom give rise to Balmer Series which is in the visible region of electromagnetic spectrum.

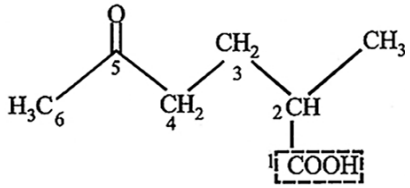
3. **(b)** 28.5 kJ, -28.5 kJ
   Explanation: At constant T, $\frac{P_1}{P_2} = \frac{10atm}{1atm} = 10$; n = 5 mol, T = 298K
   Thus, work $w = -2.303nRT\log\frac{P_1}{P_2} = -2.303 \times 5 \times 8.314 \times 298 \times \log 10 = -2.85 \times 10^4 J = -28.5kJ$
   Here, heat $\Delta U = 0; \Rightarrow q = -w = +28.5kJ$

4. **(c)** R.A. Millikan's oil drop experiment
   Explanation: In 1909, Robert Millikan and Harvey Fletcher conducted the oil drop experiment to determine the charge of an electron. They suspended tiny charged droplets of oil between two metal electrodes by balancing downward gravitational force with upward drag and electric forces.
   The experiment helped earn Millikan a Nobel prize in 1923

5. **(a)** the degree of randomness or disorder in the system.
   Explanation: Entropy is a state function and it measures the degree of randomness or disorder of a system. It is denoted by 'S'.

6. **(c)** motions of the microscopic objects that have both observable wave-like and particle-like properties
   Explanation: Quantum mechanics, science dealing with the behaviour of matter and light on the atomic and subatomic scale. It attempts to describe and account for the properties of molecules and atoms and their constituents—electrons, protons, neutrons, and other more esoteric particles such as quarks and gluons.

7. **(d)** Charge on the ion
   Explanation: By definition, the **oxidation number** of an atom is the charge that an atom would have if the compound was composed of ions. The oxidation number of simple ions is equal to the charge on the ion. The oxidation number of sodium in the Na^+ ion is +1, for example, and the oxidation number of chlorine in the Cl^- ion is -1.

8. **(a)** 2-Methyl-5-oxohexanoic acid
   Explanation: 

   IUPAC NAME
   2-Methyl-5-oxohexanoic acid

9. **(a)** Anhydrous aluminium chloride
   Explanation: The acid chloride or anhydride reacts with anhydrous aluminium chloride to form the acylium ion which serves as an electrophile which then attacks the benzene ring to give alkylbenzene.

10. **(c)** Alkali metals

Explanation: The elements of Group 1 (alkali metals) which have ns^1 outermost electronic configuration belong to the s-Block Elements.

11. **(a)** NO(g) is unstable, but NO_2 (g) is formed

Explanation: NO(g) is unstable because the formation of NO is endothermic, but NO_2(g) is formed because its formation is exothermic. Therefore, unstable NO(g) converts into stable NO_2(g).

12. **(c)** Neopentane

Explanation: $(CH_3)_3CCH_3 + HX(X=Cl,Br,I) \rightarrow (CH_3)_3CCH_2X$

Hence a monosubstituted derivative is formed.

13. **(c)** A is true but R is false.

Explanation: The resonance provided by CH_3NO_2 can be represented by the 2 lewis structures. The two N-O bond CH_3NO_2 are of the same length.

14. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation: Both A and R are true and R is the correct explanation of A.

15. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation: All species like He^+, Li^{2+}, Be^{3+} having one electron are expected to have similar spectrum as that of hydrogen.

16. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation: Molecular formula = n × (empirical formula)

$n = \frac{Molecular mass}{Empirial formula mass}$

Empirical formula of ethene = CH_2

The empirical formula mass of ethene = 14 amu

$= \frac{1}{2}$ × molecular mass of ethene.

Empirical formula shows that ethene has (C : H) 1 : 2

Section B

17. If K_a is the ioniation constant of weak acis (HA) and K_b is the ionization constant of its conjugate (A^-), then K_a . K_b = K_w ;

Where, K_w = ionic product of water at 25° C (298K) =10^{-14} .

Therefore, K_a and K_b can be calculated by using above formula as follows:

For F-, $K_b = K_w/K_a = 10^{-14}/(6.8 \times 10^{-4}) = 1.47 \times 10^{-11} \simeq 1.5 \times 10^{-11}$.

For $HCCO^-$, $K_b = 10^{-14}/(1.8 \times 10^{-4}) = 5.6 \times 10^{-11}$

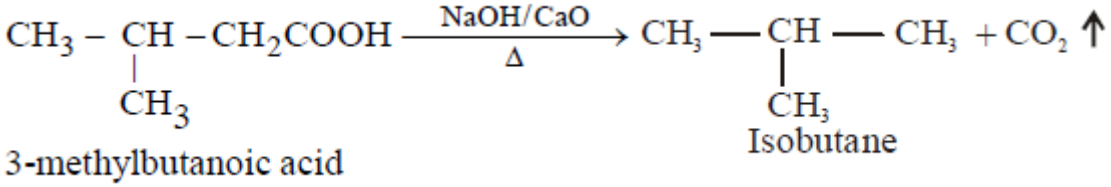
For CN^-, $K_b = 10^{-14}/(4.8 \times 10^{-9}) = 2.08 \times 10^{-6}$

18. i. In Mendeleev table, the elements were arranged in vertical columns, and horizontal rows. The vertical columns were called groups and the horizontal rows were called periods.
    ii. There were in all eight groups. Group I to VIII. The group numbers were indicated by Roman numerals. Group VIII occupy three triads of the elements each i.e. in all nine elements.
    iii. There were seven periods to accommodate more elements the period 4, 5, 6 and 7 were divided into two halves. The first half of the elements were placed in the upper left corner and the second half in the lower right corner of each box.

19. We know that , Number of moles of a substance = $\frac{Mass\ of\ substance}{Molar\ Mass\ of\ substance}$

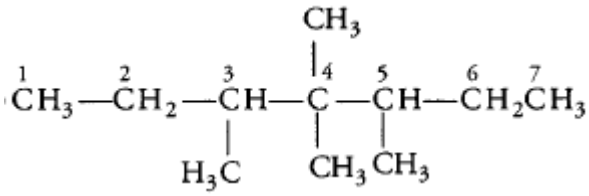
    i. 1.46 metric ton of Al = 1.46× 10^3 × 10^3 g of Al = 1.46 × 10^6 g
    Atomic mass of Al = 27 g/mol
    Number of moles of Al = $\frac{\text{mass of Al}}{\text{atomic mass}} = \frac{1.46\times10^6}{27}$ = 5.41 × 10^4 mol
    ii. 7.9 mg of Ca = 7.9×10^{-3}g of Ca
    Atomic mass of Ca = 40.1 g/mol
    Number of moles of Ca = $\frac{\text{mass of Ca}}{\text{atomic mass}} = \frac{7.9\times10^{-3}}{40.1}$ = 1.97 × 10^{-4} mol

20. 3-methylbutanoic acid on decarboxylation in the presence of with sodalime (a mixture of NaOH and CaO) at 630 K gives Isobutane.

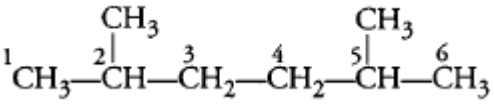


OR

i. Structural formula of 3, 4, 4, 5-tetra methyl heptane is:



ii. Structural formula of 2, 5-dimethyl hexane is:



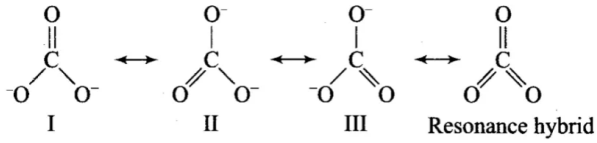
21. Configuration of the two elements are :

Al (Z = 13): $[Ne]^{10}3s^2 3p^1; Si(Z = 14) : [Ne]^{10}3s^2 3p^2$

The unpaired electrons in silicon (Si) will experience more effective nuclear charge because the atomic number of the element Si is more than that of Al.

Section C

22. A single Lewis structure of CO_3^{2-} ion is inadequate for the representation of all the properties of this ion. It can be represented as a resonance hybrid of the following structures:



If it were represented only by one structure, there should be two types of bonds, i.e., C = O double bond, and C-O single bonds but actually, all bonds are found to be identical with the same bond length and same bond strength.

23. Answer:

(i) **Heat capacity:** The quantity of heat needed to raise the temperature of one mole of substance by one degree Celsius is known as heat capacity of that substance.

(ii) The **Third Law of Thermodynamics** states, "The entropy of a perfect crystal is zero when the temperature of the crystal is equal to **absolute zero (0 K).**

(iii) Given that, C_v = heat capacity at constant volume,

C_p = heat capacity at constant pressure Difference between C_p and C_v is equal to a gas constant (R).

$\therefore C_p - C_v = nR$ (where, n = no. of moles)

$= 10 \times 8.314 = 83.14$ J

24. Molecular mass of naphthalene $= 128 g\ mol^{-1}$

Solidification reaction:

$C_{10}H_8(l) \longrightarrow C_{10}H_8(s)$

According to the question, heat evolved when 1 g of naphthalene solidifies $= 149\ J$

Heat evolved when 128 g of naphthalene solidifies $= 149 \times 128 = 19072\ J$

$\Delta_{fus} H^{\ominus} = -19072$ J

Fusion reaction:

$C_{10}H_8(s) \longrightarrow C_{10}H_8(l)$

This reaction is the reverse of the solidification.

$\therefore \Delta_{fus} H^{\circ} = +19072$ J

25. To balance a chemical redox reaction. first of all, find the oxidized and reduced species by identifying their oxidation number and then balance them according to their loss and gain of electron individually.

i. Skeleton of equation

$$\overset{+2}{Cu}O + \overset{-3}{N}H_3 \rightarrow \overset{0}{Cu} + \overset{0}{\underset{2}{N}} + H_2\overset{-2}{O}$$

The oxidation number of Cu decreases from +2 to 0 and oxidation number (O.N.) of N-atom increases from –3 to 0.
In order to balance the increase of O.N. with a decrease of O.N., there should be three atoms of copper and two atoms of nitrogen. Hence balancing hydrogen and oxygen atoms we have,
$3\ CuO + 2\ NH_3 \rightarrow 3Cu + N_2 + 3H_2O$

ii. Writing K_2MnO_4 twice Oxidation number of Mn, we have the skeleton of the equation

$$K_2\overset{+6}{Mn}O_4 + H_2O \rightarrow \overset{+4}{Mn}O_2 + K\overset{+7}{Mn}O_4 + KOH$$

The oxidation number of Mn in 1 mole K_2MnO_4 decreases from +6 to +4 (MnO_2) and in the other 1 mole increases from +6 to +7 ($KMnO_4$) i.e. 1 mole gains two electrons while the other loses 1 electron.

In order to balance the Oxidation number of Mn, 1 mol. K_2MnO_4 and $KMnO_4$ are multiplied by 2. Hence

$K_2MnO_4 + 2K_2MnO_4 + H_2O \rightarrow MnO_2 + 2KMnO_4 + KOH$

In order to balance the number of K and H atoms, KOH is multiplied by 4 and H_2O by 2.

$3K_2MnO_4 + 2H_2O \rightarrow MnO_2 + 2KMnO_4 + 4KOH$

26. i. The energy of the photon

Energy (E) = $\frac{hc}{\lambda} = \frac{(6.626\times10^{-34}\text{Js})\times(3\times10^{8}\text{ms}^{-1})}{(4\times10^{-7}\text{m})}$ = 4.97 × 10^{-19}

= $\frac{(1\text{eV})}{(1.602\times10^{-19}\text{J})}$ × (4.97 × 10^{-19} J) = 3.1 eV

ii. The kinetic energy of emission

Kinetic energy of emission = E - work function (i.e. kinetic energy of emitted electron)

= (3.1 - 2.13) = 0.97 eV

iii. Velocity of photoelectron

KE of emission = $\frac{1}{2}mv^2$ = 0.97 eV

= 0.97 ×1.602 ×10^{-19} J = 0.97 ×1.602 ×10^{-19} kg m^2 s^{-2}

or $v^2 = \frac{2\times0.97\times1.602\times10^{-19}(\text{kgm}^2\text{s}^{-2})}{(9.1\times10^{-31}\text{kg})}$ = 0.34 × 10^{12} m^2s^{-2}

or v = (0.34 × 10^{12} m^2 s^{-2})$^{1/2}$ = 0.583 ×10^6 ms^{-1} = 5.83 ×10^5 ms^{-1}

27. i. C is non-metal

ii. A is alkali metal

iii. B is alkaline earth metal

28. The combustion of acetylene is given by balanced chemical equation :

$$\underset{2\times22400cm^3}{\underset{2mol}{2C_2H_2}} + \underset{5\times22400cm^3}{\underset{5mol}{5O_2}} \rightarrow 4CO_2 + \underset{4\times224400cm^3}{\underset{4mol}{2H_2O}}$$

It is clear from the equation that, at S.T.P.

2 × 22400 cm^3 of acetylene require O_2 for complete combustion = 5 × 22400 cm^3

200 cm^3 of acetylene will require O_2 for complete combustion $= \frac{5\times22400}{2\times22400} \times 200 = 500\text{cm}^2$

Further 2 × 22400 cm^3 of acetylene produce = 4 × 224000 cm^3 of carbon dioxide (CO_2).

∴ 200 cm^3 of acetylene will produce = $\frac{4\times22400}{2\times22400} \times 200 = 400\text{cm}^3$ of carbon dioxide (CO_2).

Section D

29. **Read the text carefully and answer the questions:**

The existing large number of organic compounds and their ever-increasing numbers has made it necessary to classify them on the basis of their structures. Organic compounds are broadly classified as open-chain compounds which are also called aliphatic compounds. Aliphatic compounds further classified as homocyclic and heterocyclic compounds. Aromatic compounds are special types of compounds. Alicyclic compounds, aromatic compounds may also have heteroatom in the ring. Such compounds are called heterocyclic aromatic compounds. Organic compounds can also be classified on the basis of functional groups, into families or homologous series. The members of a homologous series can be represented by general molecular formula and the successive members differ from each other in a molecular formula by a $–CH_2$ unit.

(i) The successive members of a homologous series are differ by a $-CH_2$ group. The molecular mass of a $-CH_2$ group is 14 amu. Hence, each successive homologue of a homologous series differ by a mass of 14 amu.

OR

Tetrahydrofuran is non-aromatic, due to absence of conjugation in π electrons, and it does not follow Huckel's rule.

(ii) Heterocyclic compounds are a major class of organic compounds characterized by the fact that some or all of the atoms in their molecules are joined in rings containing at least one atom of an element other than carbon and follow Huckels rule, the most common heterocycles are those having five or six-membered rings and containing hetero members of Nitrogen, oxygen, sulphur. Pyridine, pyrrole, thiophene are all heteroaromatic compounds

(iii) A cyclic compound in which the ring includes at least one atom of an element different from the rest is called heterocyclic compound. A homocyclic compound is a cyclic compound in which all the ring atoms are the same.

30. **Read the text carefully and answer the questions:**

The ionic character of metallic halides tends toward covalent nature as per Fajan's rule. Such covalent halides behave as non-metal in their higher oxidation states. The property to hydrolyse to give oxy-acids of the element and corresponding hydro halogen acid for most non-metallic elements proceeds exceptionally in the way, keeping oxidation number of element and halide sam in oxo-acids.

Non-polar halides are immiscible in water, as they do not show hydrolysis, but halides of some elements with empty d-orbital undergo hydrolysis. Stability of halides of the higher state is governed by the inert-pair effect.

(i) $PCl_3 + 3H_2O \rightarrow H_3PO_3 + 3HCl$

(ii) BCl_3 undergoes hydrolysis to form oxy-acids. The chemical reaction is as follows:

$BCl_3 + 3H_2O \rightarrow H_3BO_3 + 3HCl$

(iii) PBI_4 doesn't exist because Pb^{4+} is strong oxidant, where as I^- is strong reductant.

OR

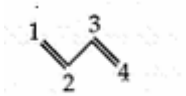
The non-polar halides are immiscible in water because it doesn't show hydrolysis but halides of some element with empty d-orbital undergo hydrolysis.

Section E

31. Attempt any five of the following:

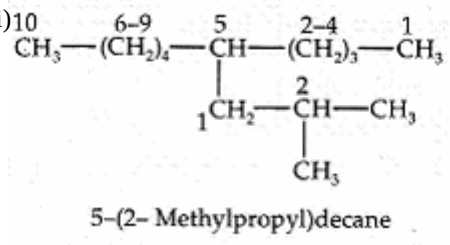
(i) Position isomerism.

(ii)



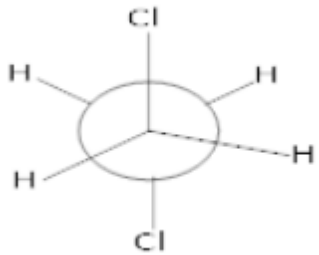
Buta–1,3–diene

(iii)



5–(2– Methylpropyl)decane

(iv) New man's projection formula of staggered form of 1,2-dichloroethane:



(v) Equilibrium constants gets changed if we change the temperature of the system.

- For Exothermic reactions, if the temperature is increased, the equilibrium will shift to favour the reaction which will decrease the temperature and the exothermic reaction is favoured.
- For Endothermic reactions, if the temperature is increased, the equilibrium will shift to favour the reaction which will reduce the temperature and the endothermic reaction is favoured.

(vi) Acetophenone is formed.

(vii) SO_3

32. To calculate $[HS^-]$

	$H_2S \rightleftharpoons$	H^+ +	HS^-
Initial	0.1 M		
After disso.	0.1 – x ≃ 0.1	x	x

$k_A = \frac{x/x}{0.1} = 9.1 \times 10^{-8}$ or $x^2 = 9.1 \times 10^{-9}$ or $x = 9.54 \times 10^{-5}$

In presence of 0.1 M HCl, suppose H_2S dissociated is y. Then at equilibrium,

$[H_2S] = 0.1 - y \simeq 0.1,\ [H^+] = 0.1 + y \simeq 0.1, [HS^-] = yM$

$K_a = \frac{0.1 \times y}{0.1} = 9.1 \times 10^{-8}$ (given) or $y = 9.1 \times 10^{-8} M$

To calculate $[S^{2-}]$

$$H_2S \overset{K_{a_1}}{\rightleftharpoons} H^+ + HS^- \ ; \ HS^- \overset{K_{a_2}}{\rightleftharpoons} H^+ + S^{2-}$$

For the overall reaction,

$H_2S \rightleftharpoons 2H^+ + S^{2-}$

$K_a = K_{a_1} \times K_{a_2} = 9.1 \times 10^{-8} \times 1.2 \times 10^{-13} = 1.092 \times 10^{-20}$

$K_a = \frac{[H^+]^2[S^{2-}]}{[H_2S]}$

In the absence of 0.1 MHCl, $[H^+] = 2[S^{2-}]$

Hence, if $[S^{2-}] = x, [H^+] = 2x$

$\therefore \frac{(2x)^2 x}{0.1} = 1.092 \times 10^{-20}$ or $4x^3 = 1.092 \times 10^{-21} = 273 \times 10^{-24}$

3 log x = log 273 - 24 = 2.4362 - 24

log x = 0.8127 - 8 = 8.8127

or x = Antilog $\bar{8}.8127 = 273 \times 10^{-24} = 6.497 \times 10 = 6.5 \times 10^{-8} M$

In presence of 0.1 M HCl, suppose $[S^{2-}]$ = y, then

$[H_2S] = 0.1 - y \simeq 0.1M, [H^+] = 0.1 + y \simeq 0.1M$

$K_a = \frac{(0.1)^2 \times y}{0.1} = 1.09 \times 10^{-20}$ or $y = 1.09 \times 10^{-19} M$

OR

Calculation of K_p

$PCl_5(g) \rightleftharpoons$	$PCl_3(g)$ +	Cl_2 (g)
1	0	0
(1 – α)	α	α

Total no. of moles in the equilibrium mixture = $1 - \alpha + \alpha + \alpha$

$= (1 + \alpha)$ mol.

Let the total pressure of equilibrium mixture = p atm

Partial pressure of PCl_5

${}_pPCl_5 = \frac{1-\alpha}{1+\alpha} \times p\ atm$

Partial pressure of $PCl_3 = \frac{\alpha}{1+\alpha} \times\ atm$

Partial pressure of Cl_2

${}_pCl_2 = \frac{\alpha}{(1+\alpha)} \times p\ atm$

$K_p = \frac{{}_pPCl_3 \times PCl_2}{{}_pPCl_5}$

$= \frac{\left(\frac{\alpha}{1+\alpha} p\ atm\right) \times \left(\frac{\alpha}{1+\alpha} p\ atm\right)}{\frac{1-\alpha}{1+\alpha} p\ atm}$

$= \frac{\alpha^2 p}{1-\alpha^2} atm$

P = 4 atm

and $\alpha = 10\% = \frac{10}{100} = 0.1$

$K_p = \frac{(0.1) \times (0.1) \times (4\ atm)}{(1-(0.1)^2}$

$= \frac{0.04}{0.99} = 0.04\ atm$

Calculation of P under new condition

$\alpha = 0.2$

K_p = 0.04 atm

$K_p = \frac{\alpha^2 p}{1-\alpha^2}$ or $P = \frac{K_p(1-\alpha^2)}{\alpha^2}$

$= \frac{(0.04\ atm)(1-(0.2)^2)}{(0.2)^2}$

$= \frac{0.04\ atm \times 0.96}{0.04} = 0.96\ atm$

33. Answer:

(i) i. a. 2, 2-Demethylpentane

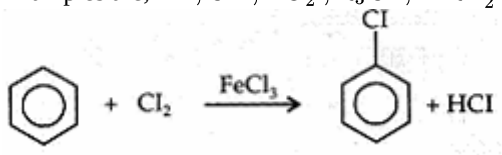
b. 2, 4,7-Trimethyloctane. For two alkyl groups on the same carbon its locant is repeated twice, 2, 4, 7-locant set is lower than 2, 5, 7.

c. 2-Chloro-4-methylpentane. Alphabetical order of substituents.

d. But-3-yn-1-ol. Lower locant for the principal functional group, i.e., alcohol.

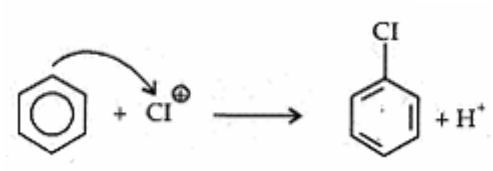
ii. A reagent which can accept an electron pair in a reaction is called an electrophile.

Examples are, $H^+, Cl^+, NO_2^+, R_3C^+,$ $RN_2^{\oplus}$



Mechanism:

$Cl_2 + FeCl_3 \longrightarrow FeCl_4^{\ominus} + Cl^{\oplus}$



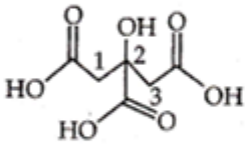
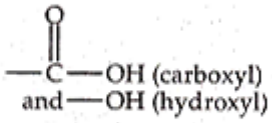
OR

i. i. 6-methyl octan-3-ol,

ii. Hexane-2,4-dione,

iii. 5-oxohexanoic acid,

iv. Hexa-1, 3-dien-5-yne

Condensed formula	Bond line formula	Functional group/s
(a) $(CH_3)_3CCH_2CH(CH_3)_2$		—
ii. (b) $HOOCCH_2C(OH)(COOH)CH_2COOH$		
(c) $OHC(CH_2)_4CHO$