Class XI Session 2023-24
Subject - Chemistry
Sample Question Paper - 7

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. If 500 mL of a 5M solution is diluted to 1500 mL, what will be the molarity of the solution obtained? **[1]**

   a) 0.017 M b) 1.59 M

   c) 1.66 M d) 1.5 M

2. In the line spectrum of hydrogen, the lines described by the formula $\bar{v} = 109,677\left(\frac{1}{2^2} - \frac{1}{n^2}\right) \mathrm{cm}^{-1}$ where, n = interger, n $\geq$ 3 constitutes **[1]**

   a) Lyman series b) Paschen series

   c) Pfund series d) Balmer series

3. Which one is the correct unit for entropy? **[1]**

   a) JK^{-1} mol b) kJ mol

   c) JK^{-1} mol^{-1} d) KJ mol^{-1}

4. In an alpha scattering experiment, few alpha particles rebounded because **[1]**

   a) The mass of the atom is concentrated in the centre b) Positive charge of the atoms very little space

   c) All the positive charge and mass of the atom is concentrated in small volume d) Most of the space in the atom is occupied

5. Given $N_2(g) + 3H_2(g) \rightarrow NH_3(g)$; $\Delta_r H°$ = -92.4 kJ mol^{-1}. What is the standard enthalpy of formation of NH_3 gas? **[1]**

   a) -41.3 kJ mol^{-1} b) -46.2 kJ mol^{-1}

c) -56.5 kJ mol^{-1}

d) -36.9 kJ mol^{-1}

6. According to Pauli's exclusion principle: **[1]**

a) No two electrons in an atom can have the same set of four quantum numbers

b) Any two electrons in an atom can have the same spin numbers

c) Any two electrons in an atom can have the same set of four quantum numbers

d) All electrons in an atom can have the same spin numbers

7. The oxidation number of the carboxylic carbon atom in CH_3COOH is _____. **[1]**

a) +4

b) +2

c) + 1

d) +3

8. Which of the following elements in an organic compound cannot be detected by Lassaignes test? **[1]**

a) S

b) N

c) H

d) Cl

9. Which of the following reactions of methane represents its incomplete combustion? **[1]**

a) $CH_4 + 2O_2 \rightarrow CO_2(g) + 2H_2O(l)$

b) $CH_4 + O_2 \xrightarrow{Mo_2O_3} HCHO + H_2O$

c) $2CH_4(g) + O_2(g) \rightarrow 2CO(g) + 4H_2(g)$

d) $2CH_4 + O_2 \xrightarrow{Cu,523K,100atm} 2CH_3OH$

10. General outer electronic configuration of d-block elements is **[1]**

a) $(n - 1)d^{1-10}ns^3$

b) $(n + 1)d^{1-10}ns^{0-2}$

c) $(n - 1)d^{1-10}ns^{0-2}$

d) $(n - 1)d^0ns^{0-2}$

11. Calorimetry is an experimental technique or process of: **[1]**

a) measuring the energy changes associated with chemical or physical processes.

b) measuring the maximum pressure developed in a reaction.

c) measuring the amount of chemicals consumed.

d) measuring the amount of work done in a reaction.

12. An aqeous solution of compound A gives ethane on electrolysis. The compound A is .....? **[1]**

a) Sodium propionate

b) Sodium acetate

c) Sodium ethoxide

d) Ethyl acetate

13. **Assertion (A):** Pent-1-ene and pent-2-ene are position isomers. **[1]**

Reason (R): Position isomers differ in the position of a functional group or a substituent.

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.

14. **Assertion:** The addition of HBr on 2-butene gives two isomeric products. **[1]**

Reason: Addition of HBr on 2-butene follows Markovnikov's rule.

a) If both Assertion & Reason are true and the reason is the correct explanation of the

b) If both Assertion & Reason are true but the reason is not the correct explanation of the

assertion.

assertion.

c) If Assertion is true statement but Reason is false.

d) If both Assertion and Reason are false statements.

15. **Assertion (A):** Half-filled and fully-filled degenerate orbitals are more stable. **[1]**

Reason (R): Extra stability is only due to the symmetry of degenerate orbitals.

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):** 1.34×10^{-3} and 1.23 both have three significant figures. **[1]**

Reason (R): Numbers other than zero are all significant.

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. Hydrolysis of sucrose gives, **[2]**

Sucrose + $H_2O \rightleftharpoons$ Glucose + Fructose

Equilibrium constant K_c for the reaction is 2×10^{13} at 300K. Calculate $\Delta G^{\ominus}$ at 300K.

18. Why is ionization enthalpy of nitrogen greater than that of oxygen? **[2]**

19. The cost of table salt (NaCI) and table sugar ($C_{12}H_{22}O_{11}$) is Rs. 2 per kg and Rs. 6 per kg, respectively. **[2]**

Calculate their costs per mol.

20. What is Lindlar's catalyst? Give its use. **[2]**

OR

Write the chemical equation for combustion reaction of the following hydrocarbons:

i. Butane

ii. Pentene

21. Find out atomic number, mass number, number of electron and neutron in an element ${}^{40}_{20}X$? **[2]**

Section C

22. Write the important conditions required for the linear combination of atomic orbitals to form molecular orbitals. **[3]**

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

(i) Define enthalpy. **[1]**

(ii) At 1 atm, will the $\Delta_f H^{\circ}$ be zero for CI_2 (g) and Br_2 (g)? Explain. **[1]**

(iii) Predict the change in internal energy for an isolated system at constant volume. **[1]**

24. For oxidation of iron, **[3]**

$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$

entropy change is – 549.4 JK^{-1} mol^{-1} at 298 K. Inspite of negative entropy change of this reaction, why is the reaction spontaneous?

($\Delta_r H^{\ominus}$ for this reaction is -1648×10^3 J mol^{-1})

25. Write three illustrations to justify the following statement- **[3]**

"Whenever a reaction between an oxidizing agent and a reducing agent is carried out, a compound of

i. lower oxidation state is formed if the reducing agent is in excess and,

ii. higher oxidation state is formed if oxidizing agent is in excess."

26. The mass of an electron is 9.1×10^{-31} kg. If its kinetic energy is 3.0×10^{-25} J, calculate its wavelength. **[3]**

27. Discuss the various factors on which ionization enthalpy depends. **[3]**

28. The density of water at room temperature is 1.0g / mL. **[3]**

How many molecules are there in a drop of water if its volume is 0.05 mL?

Section D

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

Chromatography is an important technique extensively used to separate mixtures into their components, purify compounds and also test the purity of compounds. Based on the principle involved, chromatography is classified into different categories. Two of these are Adsorption chromatography and Partition chromatography. Two main types of chromatographic techniques are based on the principle of differential adsorption column chromatography, and thin-layer chromatography. Adsorption chromatography is based on the fact that different compounds are adsorbed on an adsorbent to different degrees. Column chromatography involves the separation of a mixture over a column of adsorbent (stationary phase) packed in a glass tube. Thin-layer chromatography (TLC) is another type of adsorption chromatography, which involves the separation of substances of a mixture over a thin layer of an adsorbent coated on a glass plate. Partition chromatography is based on the continuous differential partitioning of components of a mixture between stationary and mobile phases.

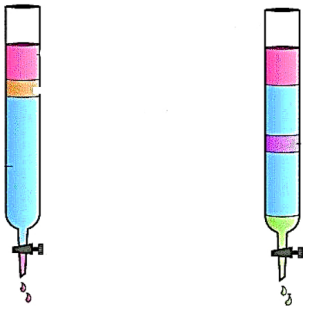
(i) Which adsorbent is used in adsorption chromatography?

OR

How do you visualize colourless compounds after separation in Paper Chromatography?

(ii) Why paper chromatography is a type of partition chromatography?

(iii) Which chromatography is shown in following image?



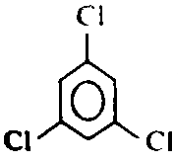
30. **Read the text carefully and answer the questions:** **[4]**

Covalent molecules formed by heteroatoms bound to have some ionic character. The ionic character is due to shifting of the electron pair towards A or B in the molecule AB. Hence, atoms acquire small and equal charge but opposite in sign. Such a bond which has some ionic character is described as a polar covalent bond. Polar covalent molecules can exhibit a dipole moment. The dipole moment is equal to the product of charge separation, q and the bond length, d for the bond. The unit of dipole moment is Debye. One Debye is equal to 10^{-18} esu cm.

The dipole moment is a vector quantity. It has both magnitude and direction. Hence, the dipole moment of molecules depends upon the relative orientation of the bond dipole, but not the polarity of bonds alone. The symmetrical structure shows a zero dipole moment. Thus, a dipole moment help to predict the geometry of the molecules. Dipole moment values can be used to distinguish between cis- and trans-isomers; ortho-, meta- and para-forms of a substance, etc. The percentage of ionic character of a bond can be calculated by the application

of the following formula:

% ionic character = $\frac{\text{Experimental value dipole moment}}{\text{Theoretical value of dipole moment}} \times 100$

(i) Out of  and  which compounds have zero dipole moments?

(ii) A diatomic molecule has a dipole moment of 1.2D. If the bond length is 1.0×10^{-8}cm, what fraction of charge does exist on each atom?

(iii) The dipole moment of NF_3 is very much less that of NH_3. Why?

OR

A covalent molecule, x-y, is found to have a dipole moment of 1.5×10^{-29} cm and a bond length 150 pm. What will be the percentage of ionic character of the bond?

Section E

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

(i) Which conformation of ethane is more stable? **[1]**

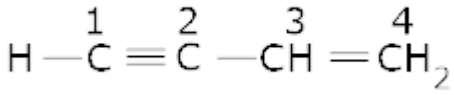
(ii) The intermediate carbocation formed in the reactions of HI, HBr and HCl with propene is the same and the bond energy of HCl, HBr and HI is 430.5 kJ mol^{-1}, 363.7 kJ mol^{-1} and 296.8 kJ mol^{-1} respectively. What will be the order of reactivity of these halogen acids? **[1]**

(iii) Convert methane into ethane. **[1]**

(iv) What happens when 2-bromobutane is being treated with KOH (alcoholic)? **[1]**

(v) If Qc < Kc, when we continuously remove the product, what would be the direction of the reaction? **[1]**

(vi) Name the type of hybridization in C (2) and C (3) in the following molecule **[1]**



(vii) Convert 1-bromopropane to 2-bromopropane. **[1]**

32. 13.8g of N_2O_4 was placed in a 1L reaction vessel at 400K and allowed to attain equilibrium **[5]**

$N_2O_4\ (g) \rightleftharpoons 2NO_2\ (g)$

The total pressure at equilibrium was found to be 9.15 bar. Calculate K_c, K_p and partial pressure at equilibrium.

OR

The ionization constant of HF is 3.2×10^{-4}. Calculate the degree of dissociation of HF in its 0.02 M solution. Calculate the concentration of all species present (H_3O^+, F^- and HF) in the solution and its pH.

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

(i) i. Expand each of the following condensed formulas into their complete structural formulas. **[2.5]**

a. $CH_3CH_2COCH_2CH_3$

b. $CH_3CH{=}CH(CH_2)_3CH$

ii. Why does SO_3 act as an electrophile? **[2.5]**

OR

i. What are electrophiles and nucleophiles? Explain with examples. **[2.5]**

ii. Ammonia produced when 0.75g of a substance was kjeldahlized, neutralized 30cm^3 of 0.25 N H_2SO_4. Calculate the percentage of nitrogen in the compound. **[2.5]**

Solution

Section A

1.

(c) 1.66 M

Explanation: For dilution, the molarity equation is:

$M_1V_1 = M_2V_2$

$M_2 = \frac{M_1V_1}{V_2} = \frac{500 \times 5}{1500}$ =1.66 M

2.

(d) Balmer series

Explanation: Balmer series

3.

(c) JK^{-1} mol^{-1}

Explanation: As $\triangle S = \frac{q_{rev}}{T}$

It is an extensive entropy, therefore, the SI unit of entropy change is Joule K^{-1} mol^{-1}.

4.

(b) Positive charge of the atoms very little space

Explanation: Positive charge of the atoms very little space

5.

(b) -46.2 kJ mol^{-1}

Explanation: Given, $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$; $\Delta_r H° = –92.4$ kJ mol^{-1}.

Chemical reaction for the enthalpy of formation of NH_3 (g) is as follows:

$\frac{1}{2}N_2\ (g)\ + \frac{3}{2}H_2(g)\ \rightarrow NH_3(g)$

Therefore, $\Delta_f H^\circ = \frac{-92.4}{2} =$ - 46.2 kJ/mol

6. **(a)** No two electrons in an atom can have the same set of four quantum numbers

Explanation: The Pauli Exclusion Principle states that, in an atom or molecule, no two electrons can have the same four electronic quantum numbers. As an orbital can contain a maximum of only two electrons, the two electrons must have opposing spins.

7.

(d) +3

Explanation: In CH_3COOH the carbon on the right will lose all the electrons it contributes to the bonds with oxygen because oxygen is more electronegative than carbon.

As a result, the right carbon will have oxidation of +3.

8.

(c) H

Explanation: H

9.

(c) $2CH_4(g) + O_2(g) \rightarrow 2CO(g) + 4H_2(g)$

Explanation: CH_4 on complete combustion gets completely oxidized to form (CO_2 + H_2O), as per the following equation;

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

The given reaction,

$2CH_4 + O_2 \rightarrow 2CO + 4H_2$

$or, CH_4 + \frac{1}{2}O_2 \rightarrow CO + 2H_2$

represents incomplete combustion, because stoichiometrically,

i. for complete combustion 2 moles of O_2 per mole of CH_4 is required, while the only $\frac{1}{2}$ mole of O_2 per mole of CH_4 is taken to carry out its complete oxidation or combustion.

ii. $O_2(g)$is the limiting reagent for the reaction.

Thus, one mole of methane is burnt in a limited supply of oxygen, resulting in the formation of one mole of CO(g).

i. CO(g)could have been further oxidized to form $CO_2(g)$ as the final product of combustion.

$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

Hence, the given equation represents incomplete combustion of methane.

10.

(c) $(n - 1)d^{1-10}ns^{0-2}$

Explanation: d-block elements are elements of group 3 to 12 in the centre of the periodic table. So, general outer electronic configuration = $(n - 1)d^{1-10}ns^{0-2}$.

11. **(a)** measuring the energy changes associated with chemical or physical processes.

Explanation: Calorimetry is an experimental technique or process of measuring the heat of chemical reactions or physical changes as well as heat capacity.

12.

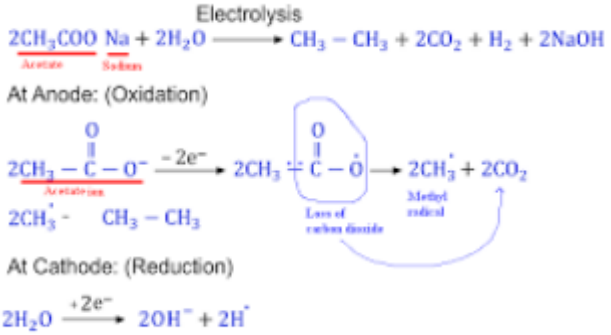
(b) Sodium acetate

Explanation:

This is an example of Kolbe's electrolysis method. The reaction is:

$2CH_3COONa + 2H_2O \overset{electrolysis}{\longrightarrow} CH_3.CH_3 + 2NaOH + H_2 + 2CO_2$

The step-wise redox reactions occuring in the electrolytic cell are depicted as under



$2H^- \rightarrow H_2$

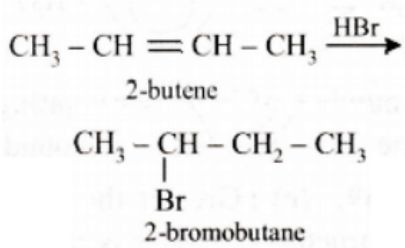
13. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation: When two or more compounds differ in the position of substituent functional group on the carbon skeleton, they are called position isomers and this phenomenon is termed as position isomerism. Pent-2-ene and pent-1-ene are position isomers because they differ in the position of a double bond.

14.

(d) If both Assertion and Reason are false statements.

Explanation: Addition of HBr on 2 -butene gives only one product, 2 -bromobutane.



As 2 -butene is a symmetrical alkene, it does not follow Markownikoff's rule.

15.

(c) A is true but R is false.

Explanation: It is an universal rule that symmetry has uniform distribution of energy hence maximum stability. Other cause for half filled and fully filled subshells is maximum possible numbers of exchange energies.

16.

(c) A is true but R is false.

Explanation: For a number written in scientific notation, all digits are significant. All the zeros to the right of the decimal point are significant.

Section B

17. $\Delta G^{\ominus}$ = – RTlnK_c

$\Delta G^{\ominus}$ = – 8.314J $mol^{-1}K^{-1} \times$ 300K $\times$ ln(2×10^{13})

$\Delta G^{\ominus}$ = – 7.64 $\times$ 10^4 J mol^{-1}

18. The electronic configuration of Nitrogen is $1s^2$ $2s^2$ $2p^3$ and that of Oxygen is $1s^2$ $2s^2$ $2p^4$. Nitrogen has half filled p-orbitals which is a very stable configuration. Oxygen will readily loose its extra electron to attain the nitrogen-like configuration. Hence, oxygen will have a lower ionization enthalpy than nitrogen.

19. The molar mass of NaCI = 58.5 g

Molar mass of Sugar($C_{12}H_{22}O_{11}$) = 342 g

Given 1000 g of NaCl cost = Rs 2

So the cost of 58.5 g of NaCI i.e., per mol = $\frac{2}{1000} \times 58.5 = Rs.0.117$

Given 1000 g of $C_{12}H_{22}O_{11}$ (Sugar) cost = Rs 6

So the cost of 342 g of $C_{12}H_{22}O_{11}$ (Sugar) i.e., per mol = $\frac{6}{1000} \times 342 = Rs.2.05$

20. $\mathrm{pd/BaSO_4}$ is known as Lindlar's catalyst. It is used in the conversion of alkynes to alkenes with the help of H_2 .

OR

i. $\underset{\text{Butane}}{C_4H_{10}(g)} + \frac{13}{2}O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g)$

ii. $\underset{\text{Pentene}}{C_5H_{10}(g)} + \frac{15}{2}O_2(g) \rightarrow 5CO_2(g) + 5H_2O(g)$

21. The mass no. of X is 40.

The atomic no. of X is 20.

No. of neutrons = A– Z = 40 – 20 = 20

No. of proton = Atomic number = 20

No. of electron = No. of protons for a neutral element = 20

Section C

22. (i) The combining atomic orbitals should have comparable energies. For example, 1s orbital of one atom can combine with a 1s atomic orbital of another atom, 2s can combine with 2s.

(ii) The combining atomic orbitals must have proper orientations. So that they are able to overlap to a considerable extent.

(iii) The extent of overlapping should be large.

23. Answer:

(i) **Enthalpy:** The total heat content of the system is known as enthalpy.

(ii) At 1 atm, $\Delta_f H^\circ$ for CI_2 (g) will be zero.

At 1 atm, $\Delta_f H^\circ$ for Br_2 (g) will not be zero because liquid bromine is in elementary state and not in gaseous state.

(iii) For an isolated system at constant volume, there is no transfer of energy in the form of heat or work.

So, $\Delta U = q + W$

$\Rightarrow \Delta U = 0 + 0$

$\Rightarrow \Delta U = 0$

24. One decides the spontaneity of a reaction by considering ΔS_{total} (ΔS_{sys} + ΔS_{surr}). For calculating ΔS_{surr}, we have to consider the heat absorbed by the surroundings which is equal to $-\Delta_r H^{\ominus}$. At temperature T, entropy change of the surroundings is $\Delta S_{\text{surr}} = -\frac{\Delta_r H^{\ominus}}{T}$ (at constant pressure)

$= -\frac{\left(-1648\times10^3 \text{Jmol}^{-1}\right)}{298\text{K}}$

= 5530 $JK^{-1}mol^{-1}$

Thus, total entropy change for this reaction

$\Delta_r S_{\text{total}}$ = 5530 JK^{-1} mol^{-1} + (-549.4 JK^{-1} mol^{-1})

= 4980.6 JK^{-1} mol^{-1}

This shows that the above reaction is spontaneous.

25. i. Reaction of carbon with oxygen in which C is a reducing agent while O_2 is an oxidizing agent.

a. Reaction of Carbon with oxygen: If excess of carbon is burnt in a limited supply of O_2, CO is formed in which the oxidation state of C is +2.

$2C^{o}(s) + O_2 \longrightarrow 2C^{+2}O_{(g)}$

(excess)

b. If, however, excess of O_2 is used, the initially formed CO gets oxidized to CO_2 in which oxidation state of C is + 4.

$$\underset{(Excess)}{2C(s)}\ O_2(g) \longrightarrow 2\overset{+2}{C}O(g);\ C(s) + \underset{(Excess)}{O_2(g)}\ + \overset{+4}{C}O_2(g)$$

ii. Reaction of phosphorus with chlorine:

In the reaction of Phophorus with chlorine, P_4 is a reducing agent while Cl_2 is an oxidizing agent.

a. when excess of P_4 is used, PCl_3 is formed in which the oxidation state of P is +3.

$P^{0}_{4}(s) + 6\ Cl_2\ (g) \longrightarrow 4P^{3+} + Cl_3$

b. If, however, excess of Cl_2 is used, the initially formed PCl_3 reacts further to form PCl_5 in which the oxidation state of P is +5

$P^{0}_{4}\ (s) + 6Cl_2\ (g) \longrightarrow 4P^{+3}\ Cl_3$

$P^{0}_{4}\ (s) + 10Cl_2 \longrightarrow 4\ P^{+5}\ Cl_5$

iii. Reaction of sodium with oxygen:

Na is a reducing agent while O_2 is an oxidizing agent.

a. When excess of Na is used, sodium oxide is formed in which the oxidation state of O is -2.

$4Na(s) + O_2(g) \longrightarrow 2\ Na_2O^{-2}$

b. If, however, excess of O_2 is used, Na_2O_2 is formed in which the oxidation state of O is -1 which is greater than -2.

$$\underset{(Excess)}{4Na(s)} + O_2(g) \longrightarrow \overset{-2}{Na_2O}(g);\ 2Na(s) + \underset{(Excess)}{2O_2(g)} \longrightarrow \overset{-1}{Na_2O_2}(s)$$

26. Step I.

Calculation of the velocity of an electron

Kinetic energy = 1/2 mv^2 = 3.0 $\times 10^{-25}$ J = 3.0 $\times$ 10^{-25} kg m^2s^{-2}

$v^2 = \frac{2\times K.E}{m} = \frac{2\times(3.0\times10^{-25}\text{kg m}^2\text{s}^{-2})}{(9.1\times10^{-31}\text{kg})}$ = 65.9 $\times$ 10^4 m^2s^{-1}

v = (65.9 $\times 10^4$ m^2s^{-2})$^{1/2}$ = 8.12 $\times$ 10^2 ms^{-1}

Step II.

Calculation of wavelength of the electron

According to de Broglie's equation,

$\lambda = \frac{h}{mv} = \frac{(6.626\times10^{-34}\text{kgm}^2\text{s}^{-1})}{(9.1\times10^{-31}\text{kg})\times(8.12\times10^2\text{ms}^{-1})}$

= 0.08967 $\times$ 10^{-5} m = 8967 $\times$ 10^{-10} m = 8967 $\mathring{A}$ ($\because$ 1 $\mathring{A}$ = 10^{-10} m)

27. i. **Atomic size.** With the increase in the atomic size, the number of electron shells increases. Therefore, the force that binds the electrons with the nucleus decreases. Thus the ionization enthalpy decreases with increase in atomic size.

ii. **Nuclear charge.** As the magnitude of the positive charge on the nucleus of an atom increases, the attraction with the electrons also increases. Therefore, the ionization enthalpy increases with the increase in the magnitude of the nuclear charge.

iii. **Screening or shielding effect.** Greater the magnitude of the screening effect less will be the value of ionization enthalpy or potential.

28. Number of moles in a drop of water:-

Volume of a drop of water = 0.05 mL

Mass of a drop of water

= (Volume $\times$ density)

= (0.05 mL) × (1.0 g/mL)

= 0.05 g

Gram molecular mass of water

(H_2O) = 2×1 + 16

= 18 g

∴ 18g of water = 1 mol

& 0.05 g of water

= $\frac{1\,mol}{(18\,g)} \times (0.05)$ g

= 0.0028 mol

No. of molecules present:-

1 mole of water contains number of molecules

= 6.022×10^{23}

0.0028 mole of water contain molecules

= $6.022 \times 10^{23} \times 0.0028 = 1.68 \times 10^{21}$ molecules.

= 1.68×10^{21} molecules

Thus, a drop of water with its volume equal to 0.05 mL would contain 1.68×10^{21} molecules

Section D

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

Chromatography is an important technique extensively used to separate mixtures into their components, purify compounds and also test the purity of compounds. Based on the principle involved, chromatography is classified into different categories. Two of these are Adsorption chromatography and Partition chromatography. Two main types of chromatographic techniques are based on the principle of differential adsorption column chromatography, and thin-layer chromatography. Adsorption chromatography is based on the fact that different compounds are adsorbed on an adsorbent to different degrees. Column chromatography involves the separation of a mixture over a column of adsorbent (stationary phase) packed in a glass tube. Thin-layer chromatography (TLC) is another type of adsorption chromatography, which involves the separation of substances of a mixture over a thin layer of an adsorbent coated on a glass plate. Partition chromatography is based on the continuous differential partitioning of components of a mixture between stationary and mobile phases.

(i) In column chromatography adsorbent is silica gel or alumina while in paper chromatography adsorbent is cellulose.

OR

In paper chromatography the spots of the separated colourless components may be observed either under ultra-violet light or by the use of an appropriate spraying agent.

(ii) Partition chromatography is based on continuous differential partitioning of components of a mixture between stationary and mobile phases as doner in paper chromatography.

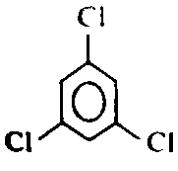
(iii) Column chromatography.

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

Covalent molecules formed by heteroatoms bound to have some ionic character. The ionic character is due to shifting of the electron pair towards A or B in the molecule AB. Hence, atoms acquire small and equal charge but opposite in sign. Such a bond which has some ionic character is described as a polar covalent bond. Polar covalent molecules can exhibit a dipole moment. The dipole moment is equal to the product of charge separation, q and the bond length, d for the bond. The unit of dipole moment is Debye. One Debye is equal to 10^{-18} esu cm.

The dipole moment is a vector quantity. It has both magnitude and direction. Hence, the dipole moment of molecules depends upon the relative orientation of the bond dipole, but not the polarity of bonds alone. The symmetrical structure shows a zero dipole moment. Thus, a dipole moment help to predict the geometry of the molecules. Dipole moment values can be used to distinguish between cis- and trans-isomers; ortho-, meta- and para-forms of a substance, etc. The percentage of ionic character of a bond can be calculated by the application of the following formula:

% ionic character = $\frac{\text{Experimental value dipole moment}}{\text{Theoretical value of dipole moment}} \times 100$

(i) Both the molecules have zero dipole moments since both  and  shows symmetrical structure.

(ii) Fraction of electronic charge = $\frac{1.2\times10^{-10}}{4.8\times10^{-10}} = 0.25$

(iii) Because of different direction of moment of N-H and N-F bonds.

OR

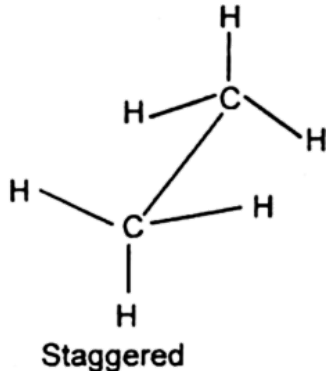
% ionic character = $\frac{1.5\times10^{-29}}{2.4\times10^{-29}} \times 100 = 62.5$

Section E

31. Attempt any five of the following:

(i) Staggered conformation of ethane is more stable.

Structure:



Staggered

(ii) The bond dissociation enthalpy decreases in the order HCl > HBr > Hl, the order of reactivity of these halogen acids is in the reverse order i.e., Hl > HBr > HCl.

(iii) Conversion of methane into ethane:

Step 1:

$$CH_4 \xrightarrow[\text{UV light}]{Cl_2} CH_3Cl$$

Step 2:

$$2\,CH_3Cl \xrightarrow[\text{Dry ether}]{2\,Na} \underset{\text{Ethane}}{CH_3—CH_3}$$

(iv) When 2-bromobutane is treated with KOH(alcoholic), But-2-ene is formed.

$$\underset{\text{2-bromobutane}}{CH_3—\underset{\displaystyle Br}{\underset{|}{CH}}—CH_2—CH_3} + KOH(alc.) \longrightarrow \underset{\text{But-2-ene}}{CH_3—CH=CH—CH_3} + KBr + H_2O$$

(v) Continuous removal of a product maintains Qc at a value less than Kc and reaction continues to move in the forward direction.

(vi) At, C(2) two σ and two π - bonds are present. Therefore, C(2) is sp-hybridized and at C(3) three σ and one π -bond are present. Therefore, (C3) is sp^2 hybridized.

(vii) We can convert 1-Bromopropne into 2-Bromopropane in two steps. In the first step, the dehydrohalogenation of 1-bromo propane with alcoholic KOH gives propene which on reacting with HBr gives 2-bromo propane due to Markovnikov's rule for addition.

$$\underset{\text{1-bromopropane}}{CH_3CH_2CH_2Br} \xrightarrow{KOH\ (alc.)} \underset{\text{Propene}}{CH_3—CH=CH_2} \xrightarrow{HBr} \underset{\text{2-bromopropane}}{CH_3—\underset{\displaystyle Br}{\underset{|}{CH}}—CH_3}$$

32. We know pV = nRT

Total volume (V) = 1 L

Molecular mass of N_2O_4 = 92 g

Number of moles = 13.8g/92 g = 0.15 of the gas (n)

Gas constant (R) = 0.083 bar L $mol^{-1}K^{-1}$

Temperature (T) = 400 K

pV = nRT

p × 1L = 0.15 mol × 0.083 bar L $mol^{-1}K^{-1}$ × 400 K

p = 4.98 bar

$N_2O_4 \rightleftharpoons 2NO_2$

Initial pressure: 4.98 bar 0

At equilibrium: (4.98 – x) bar 2x bar

Hence,

P_{total} at equilibrium = $P_{N_2O_4} + P_{NO_2}$

9.15 = (4.98 – x) + 2x

9.15 = 4.98 + x

x = 9.15 – 4.98 = 4.17 bar

Partial pressures at equilibrium are,

$P_{N_2O_4}$ = 4.98 – 4.17 = 0.81bar

P_{NO_2} = 2x = 2 × 4.17 = 8.34 bar

Kp = $(p_{NO_2})^2/p_{N_2O_4}$

= $(8.34)^2/0.81$ = 85.87

$K_p = K_c (RT)^{\Delta n}$

85.87 = Kc $(0.083 \times 400)^1$

K_c = 2.586 = 2.6

OR

The following proton transfer reactions are possible:

i. $HF + H_2O \rightleftharpoons H_3O^+ + F^-$ $K_a = 3.2 \times 10^{-4}$

ii. $H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$ $K_w = 1.0 \times 10^{-14}$

As $K_a >> K_w$, [1] is the principle reaction.

	HF +	$H_2O \rightleftharpoons$	H_3O^+ +	F^-
Initial concentration (M)	0.02		0	0
Change (M)	–0.02α		+0.02α	+0.02α
Equilibrium concentration (M)	0.02 – 0.02 α		0.02 α	0.02α

Substituting equilibrium concentrations in the equilibrium reaction for principal reaction gives:

$K_a = (0.02\alpha)^2 / (0.02 - 0.02\alpha)$

= $0.02\ \alpha^2 / (1 - \alpha) = 3.2 \times 10^{-4}$

We obtain the following quadratic equation:

$\alpha^2 + 1.6 \times 10^{-2}\alpha - 1.6 \times 10^{-2} = 0$

The quadratic equation in α can be solved and the two values of the roots are:

α = + 0.12 and – 0.12

The negative root is not acceptable and hence,

α = 0.12

This means that the degree of ionization, α = 0.12, then equilibrium concentrations of other species viz., HF, F^- and H_3O^+ are given by:

$[H_3O^+] = [F^-] = c\alpha = 0.02 \times 0.12$

= 2.4×10^{-3} M

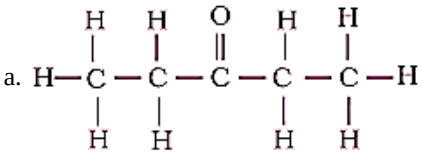
$[HF] = c(1 - \alpha) = 0.02(1 - 0.12)$

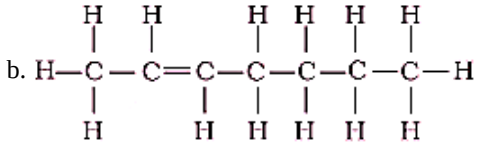
= 17.6×10^{-3} M

pH = – log$[H^+]$ = –log(2.4×10^{-3}) = 2.62

33. Answer:

(i) i. The structural formula is as follows:

a. 

b. 

ii. SO_3 acts as an electrophile because three highly electronegative oxygen atoms are attached to Sulphur atom in SO_3 which makes sulphur atom electron deficient.

OR

i. **Electrophiles:** The name electrophiles means electron loving. Electrophiles are electron defficient. They may be positive ions or neutral molecules.
Ex: $H^+, Cl^+, Br^+, NO_2^+, R_3C^+, RN_2^+, AlCl_3, BF_3$
Nucleophiles: The name nucleophiles means 'nucleus loving' and indicates that it attacks the region of low electron density (positive centres) in a subtracts molecule. They are electron rich they may be negative ions or neutral molecules.
Ex: $Cl^-, Br^-, CN^-, OH^-, RCH_2^-, NH_3, RNH_2, H_2O, ROH$ etc.

ii. According to the question, Mass of organic compound = 0.75 g

Volume of H_2SO_4 used = $30cm^3$

Normality of H_2SO_4 = 0.25N

$1000cm^2$ of 1N NH_3 contains 14g of nitrogen

$30cm^3$ of 0.25N NH_3 contains nitrogen $= \frac{14}{1000} \times 30 \times 0.25$ = 0.105 g

Therefore, % of nitrogen = $\frac{Mass\ \text{of nitrogen}}{\text{Mass of substance}} \times 100$

= $\frac{0.105}{0.75} \times 100$ = 14 %