Class XI Session 2025-26
Subject - Chemistry
Sample Question Paper - 5

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. The gram molar mass of CO_2 is: **[1]**

   a) 46 g
   b) 78 g
   c) 44 g
   d) 88 g

2. Due to the presence of electrons in the inner shells, the electron in the outer shell will not experience the full positive charge of the nucleus (Z_e). This is known as: **[1]**

   a) shielding of the outer shell electrons from the nucleus by the inner shell electrons
   b) charge stealing by inner shell electrons from the outer shell electrons
   c) shielding of the inner shell electrons from the nucleus by the outer shell electrons
   d) charge stealing by outer shell electrons from the inner shell electrons

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

   a) kJ mol
   b) $KJ\ mol^{-1}$
   c) $JK^{-1}\ mol$
   d) $JK^{-1}\ mol^{-1}$

4. The pair of ions having same electronic configuration is _____. **[1]**

   a) Cr^{3+}, Fe^{3+}
   b) Sc^{3+}, Cr^{3+}
   c) Fe^{3+}, Co^{3+}
   d) Fe^{3+}, Mn^{2+}

5. An isochoric process takes place at constant: **[1]**

   a) temperature
   b) concentration

c) volume

d) pressure

6. The electronic configuration $1s^2 2s^2 2p^1$ belongs to **[1]**

a) Lithium

b) Boron

c) Carbon

d) Beryllium

7. The standard emf of a galvanic cell involving 3 moles of electrons in its redox reaction is 0.59 V. The equilibrium constant for the reaction of the cell is _____. **[1]**

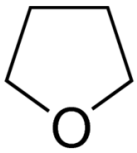
a) 10^{30}

b) 10^{25}

c) 10^{15}

d) 10^{20}

8. The organic compound given below is one of the four options given below. Choose the most appropriate one. **[1]**



a) alicyclic compound

b) aromatic heteroyclic compound

c) aliphatic heterocyclic compound

d) benzenoid compound

9. The following reaction is: **[1]**

$(CH_3)_3C\text{-}Br \xrightarrow{H_2O} (CH_3)_3C\text{-}OH$

a) Elimination reaction

b) Substitution reaction

c) Free radical reaction

d) Displacement reaction

10. The size of isoelectronic species: F^-, Ne and Na^+ is affected by **[1]**

a) nuclear charge (Z)

b) valence principal quantum number (n)

c) none of the factors because their size is the same.

d) electron-electron interaction in the outer orbitals

11. A reaction, A + B $\rightarrow$ C + D + q is found to have a positive entropy change. The reaction will be: **[1]**

a) spontaneous at all temperature.

b) nonspontaneous at all temperature.

c) spontaneous only at low temperature.

d) spontaneous only at high temperature.

12. The compound formed as a result of oxidation of ethyl benzene by $KMnO_4$ is **[1]**

a) benzophenone

b) acetophenone

c) benzyl alcohol

d) benzoic acid

13. **Assertion (A):** Free radicals are short lived and highly reactive. **[1]**

Reason (R): Free radicals are highly unstable.

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 (A):** Activating groups are electron donors. **[1]**

Reason (R): Nitroso group is activating group.

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):** Matter waves consist of oscillating electric and magnetic fields. **[1]**

Reason (R): Matter waves require medium for propagation.

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):** Molecular mass of methane is 16.034u. **[1]**

Reason (R): Molecular mass of methane, which contains one carbon atom and four hydrogen atoms.

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. PCl_5, PCl_3 and Cl_2 are at equilibrium at 500 K in a closed container and their concentrations are 0.8×10^{-3} mol L^{-1}, 1.2×10^{-3} mol L^{-1} and 1.2×10^{-3} mol L^{-1}, respectively. Calculate the value of K_c for the reaction $PCI_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ will be **[2]**

OR

Neutral solutions have pH = 7 at 298 K. A sample of pure water is found to have pH < 7. Does it mean that it is acidic? Explain.

18. Write the alkenes that give the following compounds on ozonolysis: **[2]**

i. $CH_3COCH_2CH_3 + CH_3CHO$

ii. $CH_3 - \underset{\underset{O}{||}}{C}CH_2CH_2\underset{\underset{O}{||}}{C}H + H\underset{\underset{O}{||}}{C}H + CH_3CHO$

19. How would you justify the presence of 18 elements in the 5th period of the Periodic Table? **[2]**

20. How many significant figures should be present in the answer of the following calculations? **[2]**

i. $\frac{0.02856 \times 298.15 \times 0.112}{0.5785}$

ii. 5×5.364

iii. 0.0125 + 0.7864 + 0.0215

21. Write the complete symbol for the atom with the given atomic number (Z) and atomic mass (A) **[2]**

i. Z = 17, A = 35

ii. Z = 92, A = 233

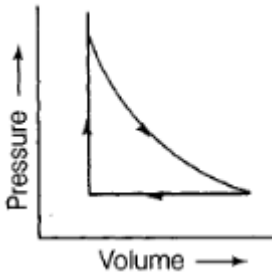
iii. Z = 4, A = 9

Section C

22. Although both CO_2 and H_2O are triatomic molecules, the shape of H_2O molecule is bent while that of CO_2 is linear. Explain this on the basis of dipole moment. **[3]**

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

(a) A sample of 1.0 mole of a monoatomic ideal gas is taken through a cyclic process of expansion and compression as shown in the figure. What will be the value of ΔH for the cycle as a whole? **[1]**



(b) From thermodynamic point of view, to which system the animals and plants belong? **[1]**

(c) Give the mathematical expression of heat capacity. **[1]**

24. Give main differences between a reversible process and an irreversible process. **[3]**

25. What are the oxidation numbers of the underlined $K\underline{I}_3$ element and how do you rationalise your results? **[3]**

26. What is the maximum number of emission lines when the excited electron of a atom in n = 6 drops to the ground state? **[3]**

27. What is the significance of the terms - **isolated gaseous atom** and **ground state** while defining the ionization enthalpy and electron gain enthalpy? **[3]**

28. What is the difference between molality and molarity? **[3]**

Section D

29. **Read the following text carefully and answer the questions that follow:** **[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? (1)

ii. Does Pyridine, pyrrole, thiophene are all heteroaromatic compounds (1)

iii. Difference between heterocyclic and homocyclic compound. (2)

OR

Is tetrahydrofuran is aromatic compounds? (2)

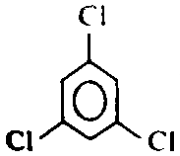
30. **Read the following text carefully and answer the questions that follow:** **[4]**

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:

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

i. Out of  and  which compounds have zero dipole moments? (1)

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? (1)

iii. The dipole moment of NF_3 is very much less that of NH_3. Why? (2)

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? (2)

Section E

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

(a) What are cycloalkanes? **[1]**

(b) Classify the hydrocarbons according to the carbon-carbon bond. **[1]**

(c) Suggest a route for the preparation of nitrobenzene starting from acetylene? **[1]**

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

(e) Why does the iodination of benzene is carried out in the presence of nitric acid or iodic acid? **[1]**

(f) Methane does not react with chlorine in dark. Why? **[1]**

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

32. The ionization constant of HF is 3.2×10^{-4}. Calculate the degree of dissociation of HF in its 0.02 M solution. **[5]**

Calculate the concentration of all species present (H_3O^+, F^- and HF) in the solution and its pH.

OR

Determine the solubilities of silver chromate, barium chromate, ferric hydroxide, lead chloride and mercurous iodide at 298 K from their solubility product constants.

i. $K_{sp}(Ag_2CrO_4) = 1.1 \times 10^{-12}$,

ii. $K_{sp}(BaCrO_4) = 1.2 \times 10^{-10}$,

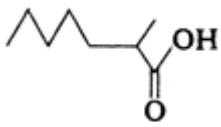
iii. $K_{sp}[Fe(OH)_3] = 1.0 \times 10^{-3}$,

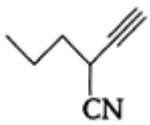
Determine also the molarities of individual ions.

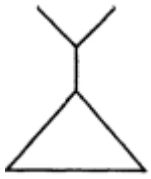
33. **Answer:** **[5]**

(a) i. Describe the method, which can be used to separate two compounds with different solubilities in a solvent S. **[2.5]**

ii. Expand each of the following bond line formula to show all the atoms including carbon and hydrogen. **[2.5]**

i. 

ii. 

iii. 

OR

i. Which of the two structures CH_3COOH and CH_3COO^- is more stabilized by resonance? Explain. **[2.5]**

ii. An organic compound contains 69% carbon and 4.8% hydrogen, the remainder being oxygen. Calculate the masses of carbon dioxide and water produced when 0.20 g of this compound is subjected to complete combustion. **[2.5]**

Solution

Section A

1.

(c) 44 g

Explanation:

Molar mass of CO_2 = Σ (atomic mass of C, 2*atomic mass of O)

= [12+2(16)] u

Since gram molar mass

= Molar mass expressed in gms.

∴ gram molar mass of CO_2

= 44 g

2. **(a)** shielding of the outer shell electrons from the nucleus by the inner shell electrons

Explanation:

Shielding effect can be defined as a reduction in the effective nuclear charge on the electron cloud, due to a difference in the attraction forces of the electrons on the nucleus. It is also referred to as the screening effect (or) atomic shielding.

3.

(d) 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.

(d) Fe^{3+}, Mn^{2+}

Explanation:

Explanation: Fe(Z-26: $3d^6 4s^2$) and Mn (Z-25: $3d^5 4s^2$)

Fe^{3+}: $3d^5$ and Mn^{2+}: $3d^5$ will have the same no. of electrons and hence, the same electronic configuration.

5.

(c) volume

Explanation:

An isochoric process is a thermodynamic process in which the volume remains constant.

6.

(b) Boron

Explanation:

Boron is a chemical element with symbol B and atomic number 5. So electronic configuration of boron is $1s^2 2s^2 2p^1$

7. **(a)** 10^{30}

Explanation:

$nFE^0_{cell} = 2.303RT \log K$

$E^0_{cell} = \frac{2.33RT}{nF} \log K = \frac{0.0591}{n} \log K$

n = 3

$\log K = \frac{0.59 \times 3}{0.0591}$ = 29.9

$K \approx 10^{30}$

8.

(c) aliphatic heterocyclic compound

Explanation:

The aliphatic heterocyclic compounds are the cyclic analogues of amines, ethers, thioethers and their properties are influenced by the ring strain.

9.

(b) Substitution reaction

Explanation:

Substitution reaction (also known as single displacement **reaction** or single **substitution reaction**) is a chemical **reaction** during which one functional group in a chemical compound is replaced by another functional group.

10. **(a)** nuclear charge (Z)

Explanation:

The size of an isoelectronic species increases with a decrease in the nuclear charge (Z).

For example, the order of the increasing nuclear charge of F^-, Ne, and Na+ is as follows:

$F^-(Z = 9) < Ne(Z = 10) < Na^+(Z = 11)$

Therefore, the order of the increasing size of F^-, Ne and Na^+ is as follows:

$Na^+ < Ne < F^-$

Hence, the correct option is - nuclear charge (Z).

11. **(a)** spontaneous at all temperature.

Explanation:

$\Delta G = \Delta H - T\Delta S$

ΔS is positive and ΔH is negative as heat is liberated in the reaction.

So ΔG is negative hence reaction will be spontaneous at all temperatures.

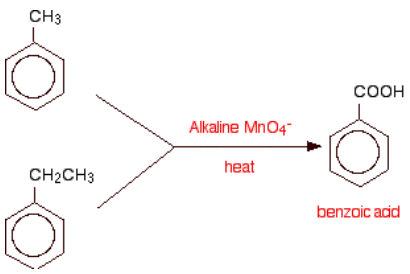
12.

(d) benzoic acid

Explanation:

All alkylbenzenes (such as $C_6H_5CH_3$ or $C_6H_5C_2H_5$) on oxidation with alkaline - $KMnO_4$

Therefore, the oxidation of ethylbenzene with alkaline $KMnO_4$ yields" Benzoic - acid.



13.

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

Explanation:

Since free radicals contain odd electrons, so they are short lived and they readily try to pair up the odd electrons to form neutral molecules, that is why they are highly reactive.

14.

(c) A is true but R is false.

Explanation:

Like halogens, the nitroso group (-N=O) is also deactivating but o, p-directing. It is deactivating because O is more electronegative than N and hence NO group as whole withdraws electrons from the benzene ring.

15.

(d) A is false but R is true.

Explanation:

Electromagnetic waves consist of oscillating electric and magnetic field.

16.

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

Explanation:

Molecular mass is the sum of atomic masses of the elements present in a molecule.

The molecular mass of methane,

(CH_4) = (12.011 u) + 4 (1.008 u)

= 16.043 u

Section B

17. For the reaction, $PCI_5 \rightleftharpoons PCl_3 + Cl_2$

At 500 K in a closed container,

$[PCl_5] = 0.8 \times 10^{-3}$ mol L^{-1}

$[PCl_3] = 1.2 \times 10^{-3}$ mol L^{-1}

$[Cl_2] = 1.2 \times 10^{-3}$ mol L^{-1}

$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]}$

$= \frac{(1.2\times10^{-3})\times(1.2\times10^{-3})}{(0.8\times10^{-3})} = 1.8 \times 10^{-3}$

OR

Water is not acidic as pure water is neutral at all temperatures. It is given that pH < 7 for pure H_2O and hence it indicates that water is at a temperature higher than 298 K. At higher temperature, H_2O dissociates more to give large concentrations of H^+ ions and OH^- ions and so pH < 7. However, $[H^+] = [OH^-]$ at all temperatures. Therefore water is neutral.

18. i. $CH_3CH_2\underset{\underset{CH_3}{|}}{C}=O + O=\underset{\underset{H}{|}}{C}-CH_3 \xleftarrow[Zn,\ H_2O]{O_3} CH_3CH_2\underset{\underset{CH_3}{|}}{C}=CHCH_3$

ii. $CH_3-\underset{\underset{O}{||}}{C}CH_2CH_2\underset{\underset{O}{||}}{C}H + H\underset{\underset{O}{||}}{C}H + H_3C\underset{\underset{O}{||}}{C}H \xleftarrow[Zn,\ H_2O]{O_3} CH_3\underset{\underset{CH_2}{||}}{C}CH_2CH_2CH=CHCH_3$ Or $CH_3CH=\underset{\underset{CH_3}{|}}{C}CH_2CH_2CH=CH_2$

19. When n = 5 (5^{th} period), l = 0, 1, 2, 3. The order in which the energy of the available orbitals 4d, 5s, and 5p increases are 5s < 4d < 5p. The total number of orbitals available is 9. The maximum number of electrons that can be accommodated is 18; and therefore 18 elements are there in the 5th period.

20. i. The least precise term has 3 significant figures (i.e. in 0.112). Hence, the answer should have 3 significant figures.
ii. Leaving the exact number (5), the second term has 4 significant figures. Hence, the answer should have 4 significant figures.
iii. In the given addition, the least number of decimal places in the term is 4. Hence, the answer should have 4 significant figures.

21. i. $^{35}_{17}X$ (X = Cl)

ii. $^{233}_{92}X$ (X = U)

iii. $^{9}_{4}X$ (X = Be)

Section C

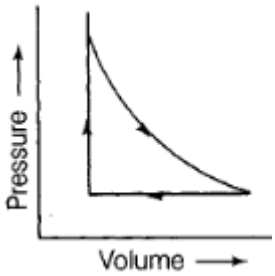
22. In CO_2 there are two C=O bonds. Each C=O bond is a polar bond.

The net dipole moment of CO_2 molecule is zero. This is possible only if CO_2 is a linear molecule (O=C=O). The dipole moments of two C=O bonds cancel the with each other.

Whereas H_2O molecule has a net dipole moment (1.84 D) H_2O molecule has a bent structure because here the O-H bonds are oriented at an angle of 104.5° and do not cancel the bond moments of each other.

23. Answer:

(i) According to the question, 1 mole of a mono atomic ideal gas is taken through a cyclic process of expansion and compression.



ΔH for a cyclic process is zero because enthalpy change is a state function.

(ii) **Open System**

(iii)The mathematical expression of heat capacity is

$q = c \times m \times \Delta T$

where c = heat capacity

m = mass and

ΔT= temperature change.

24.

S.no	Reversible Process	Irresversible Process
i.	It is very slow and takes an infinite time to complete.	It has appreciable speed and completes soon.
ii.	Such a process is only a concept and does not exist in a true sense.	It is real. Thus, all processes which actually occur in nature are irreversible.
iii.	A reversible process is unreal as it assumes the presence of frictionless and weightless piston.	An irreversible process can be actually performed.
iv.	A reversible process can be made to go in either direction.	An irreversible process can proceed only in one direction.
v.	The work done by the reversible process is greater than the corresponding irreversible process between two states.	The work done is lesser than that of the reversible process.
vi.	A reversible process can be brought back to the initial state without producing any permanent effect on the adjacent surroundings.	An irreversible process cannot be brought back to the initial state without avoiding a permanent change in the surroundings.
vii.	A reversible process is in equilibrium state at all stages of the operation.	An irreversible process is in equilibrium state only at the initial and final stages of the operation.

25. $\overset{+1}{K}\overset{x}{I_3}$;

Oxidation number of K is +1. 1 (+1) + 3x = 0 or x = $-\frac{1}{3}$

Therefore, the average oxidation number of I is $-\frac{1}{3}$.

It is wrong because oxidation number can never be fractional. Let us consider the structure of KI_3.

$\overset{+1}{K}\ (I - I \leftarrow I)^{-1}$ in this structure, coordinate bond is formed between I_2 molecule and I^{-1} ion.

Hence, the oxidation number of three I atoms in KI_3 are 0, (in I_2) and - 1 respectively.

26. The maximum no. of emission lines $\frac{n(n-1)}{2} = \frac{6(6-1)}{2}$ = 3 × 5 = 15

The actual transitions which are taking place are as follows:

n = 6 to n = 1, n = 5 to n = 1, n =4 to n =1, n =3 to n = 1, n = 2

$6 \rightarrow 5, 5 \rightarrow 4, 4 \rightarrow 3, 3 \rightarrow 2$

$6 \rightarrow 4, 5 \rightarrow 3, 4 \rightarrow 2, 3 \rightarrow 1$

$6 \rightarrow 35 \rightarrow 24 \rightarrow 1$

$6 \rightarrow 2, 5 \rightarrow 1$

$6 \rightarrow 1$

(5 lines), (4 lines), (3 lines), (2 lines), (1 line).

27. a. Significance of term 'isolated gaseous atom'. The atoms in the gaseous state are for separated in the sense that they do not have any mutual attractive and repulsive interactions. These are therefore regarded as isolated atoms. In this state the value of ionization enthalpy and electron gain enthalpy are not influenced by the presence of the other atoms. It is not possible to express these when the atoms are in the liquid or solid state due to the presence of inter atomic forces.

b. Significance of ground state. Ground state of the atom represents the normal energy state of an atom. It means electrons in a particular atom are in the lowest energy state and they neither lose nor gain electron. Both ionization enthalpy and electron gain enthalpy are generally expressed with respect to the ground state of an atom only.

28. Molarity: It is denoted by M. It is defined as the number of moles of solute present in 1 litre of the solution.

Thus, Molarity (M) $= \frac{\text{No. of moles of solute}}{\text{Volume of solution in litres}}$

Molality: It is defined as the number of moles of solute present in 1 kg of solvent. It is denoted by m.

Thus, Molality (m) = $\frac{No \text{ of moles of solute}}{Mass \text{ of solvent in kg}}$

Molality does not depend on temperature while molarity does. Similarly, it is useful to prepare molal solution as compared to molar because with temperature molarity changes.

Section D

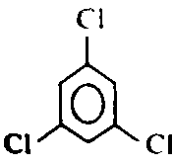
29. i. The successive members of a homologous series are differ by a -CH_2 group. The molecular mass of a -CH_2 group is 14 amu. Hence, each successive homologue of a homologous series differ by a mass of 14 amu.

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.

OR

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

30. 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.

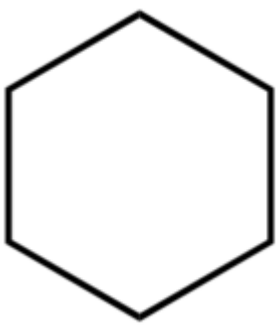
OR

% 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) **Cycloalkanes:** When carbon atoms form a closed chain or ring structures, they are known as cycloalkanes.
Example: Cyclohexane



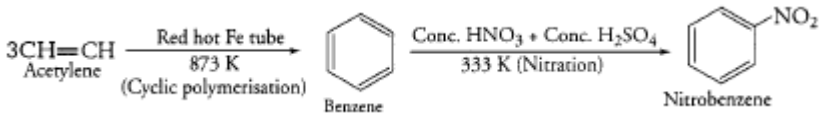
(ii) Hydrocarbons are categorized into three categories according to the carbon-carbon bond that exists between them:

a. Saturated hydrocarbon (In which carbon-carbon single bond are present)

b. Unsaturated hydrocarbon (In which carbon-carbon double and triple bonds are present)

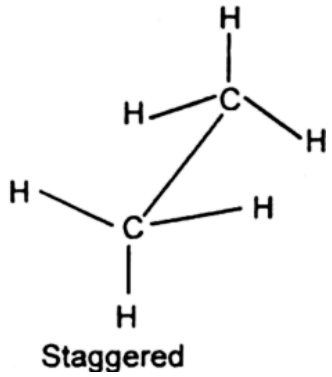
c. Aromatic hydrocarbon (In which alternate single and double bond and (4n+2)π electrons are present)

(iii)Preparation of nitrobenzene from acetylene:

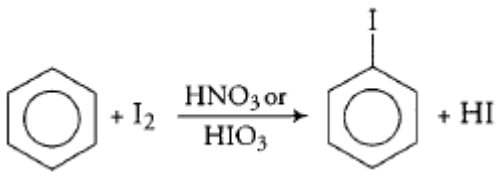


(iv)Staggered conformation of ethane is more stable.

Structure:

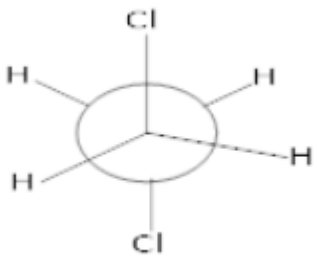


(v) The iodination of benzene is usually brought about by refluxing benzene with iodine and conc. HNO_3 or HIO_3. HNO_3 or HIO_3 oxidises HI to I_2 and prevents the backward reaction to occur.



(vi)Chlorination of methane is a free radical substitution reaction and the initiation step involves the formation of free radical $Cl_2 \rightarrow 2Cl^{\cdot}$.This requires more energy than is available at ambient temperatures and light of enough high energy will break the bond and initiate the reaction. In dark, chlorine is unable to be converted into free radicals, hence the reaction does not occur.

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



32. 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	$+0.02\alpha$	$+0.02\alpha$	
Equilibrium concentration (M)	$0.02 - 0.02\,\alpha$	$0.02\,\alpha$	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:

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

$= 2.4 \times 10^{-3}$ M

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

$= 17.6 \times 10^{-3}$ M

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

OR

i. $\underset{S}{Ag_2CrO_4} \rightleftharpoons \underset{2S}{2Ag^+} + \underset{S}{CrO_4^{2-}}$; $K_{sp} = 1.1 \times 10^{-12}$

$K_{sp} = [Ag^+]^2 \cdot [CrO_4^{2-}]$

$K_{sp} = [2S]^2 \cdot [S] = 4S^3$, $S^3 = \frac{K_{sp}}{4}$

or $S^3 = \frac{1.1 \times 10^{-12}}{4} = 0.275 \times 10^{-12}$

On solving $S = 6.503 \times 10^{-5}$ M

$[Ag^+] = 2S = 2 \times 6.503 \times 10^{-5}$ M

$= 13.006 \times 10^{-5} \approx 1.3 \times 10^{-4}$ M

and $[CrO_4^{2-}] = S = 6.503 \times 10^{-5}$ M

ii. $\underset{S}{BaCrO_4} \rightleftharpoons \underset{S}{Ba^{2+}} + CrO_4^{2-}$;

$K_{sp} = 1.2 \times 10^{-10}$ (Solubility of $BaCrO_4$ is S mol L^{-1})

$K_{sp} = 1.2 \times 10^{-10} = [Ba^{2+}] \cdot [CrO_4^{2-}] = S^2$

$S = \sqrt{1.2 \times 10^{-10}} = 1.1 \times 10^{-5}$ M

$[Ba^{2+}] = [CrO_4^{2-}] = 1.1 \times 10^{-5}$ M

iii. $\underset{S}{Fe(OH)_3} \rightleftharpoons \underset{S}{Fe^{3+}} + \underset{3S}{3OH^-}$;

$K_{sp} = 1.0 \times 10^{-38}$ (Solubility of $Fe(OH)_3$ is S mol L^{-1})

$K_{sp} = [Fe^{3+}] [OH^-]^3$

$K_{sp} = S \cdot (3S)^3 = 27S^4$ or $S^4 = \frac{K_{sp}}{27}$

$S^4 = \frac{1.0 \times 10^{-38}}{27} = 0.037 \times 10^{-38}$

$S = 1.387 \times 10^{-10}$, $S \approx 1.39 \times 10^{-10}$

$[Fe^{3+}] = 1.39 \times 10^{-10}$ M

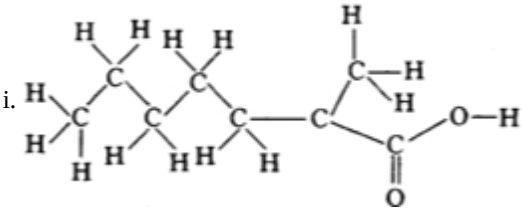
$[OH^-] = 3S = 3 \times 1.39 \times 10^{-10}$

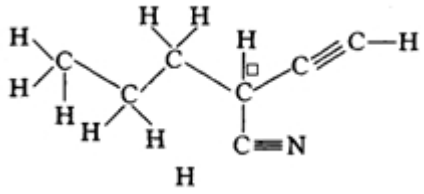
$= 4.17 \times 10^{-10}$ M

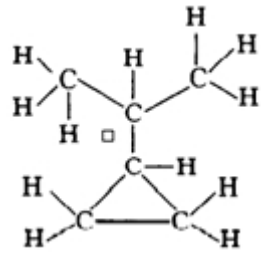
33. Answer:

(i) i. Fractional crystallization is used for this purpose. A hot saturated solution of these two compounds is allowed to cool, the less soluble compound crystallizes out while the more soluble remains in the solution. The crystal are separated from the mother liquor and the mother liquor is again concentrated and the hot solution again allowed to cool when the crystals of the second compound are obtained. These are again filtered and dried.

ii. i.

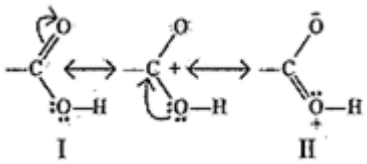


ii. 

iii. 

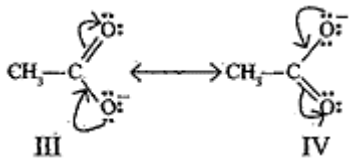
OR

i. Resonating structures of CH_3COOH are:



I II

Resonating structures of CH_3COO^- are:



III IV

Structure (III) and (IV) are of equal energy and also contribute equally towards resonance hybrid of compound CH_3COO^-.

Structure II is less stable than Structure I because in structure II separation of +ve and-ve charges exists. Therefore, the contribution of structure (II) is less than that of structure (I) towards resonance hybrid of compound CH_3COOH.

Therefore, CH_3COO^- is more stable than CH_3COOH.

ii. **Step I.** Calculation of mass of CO_2 produced

Mass of compound = 0.20 g

Percentage of carbon = 69%

$$\text{Percentage of carbon} = \frac{12}{44} \times \frac{\text{Mass of carbon dioxide formed}}{\text{Mass of compound}} \times 100$$

$$69 = \frac{12}{44} \times \frac{\text{Mass of carbon dioxide formed}}{(0.20\,\text{g})} \times 100$$

$$\therefore \text{Mass of } CO_2 \text{ formed} = \frac{69 \times 44 \times (0.20\,\text{g})}{12 \times 100} = 0.506\ \text{g}$$

Step II. Calculation of mass of H_2O produced

Mass of compound = 0.20 g

Percentage of hydrogen = 4.8%

$$\text{Percentage of hydrogen} = \frac{2}{18} \times \frac{\text{Mass of water formed}}{\text{Mass of compound}} \times 100$$

$$4.8 = \frac{2}{18} \times \frac{\text{Mass of water formed}}{(0.20\ \text{g})} \times 100$$

$$\therefore \text{Mass of } H_2O \text{ formed} = \frac{4.8 \times 18 \times (0.20\,\text{g})}{2 \times 100} = 0.0864\ \text{g}$$