Class XI Session 2024-25
Subject - Chemistry
Sample Question Paper - 10

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. Gas is found to have the formula $(CO)_x$. Its vapour density is 70. The value of x will be **[1]**

a) 7 b) 4

c) 6 d) 5

2. If a cation B^{3+} has 18 electrons, the atomic number of element B will be **[1]**

a) 12 b) 21

c) 24 d) 15

3. The enthalpy change when one mole of solute dissolves in a specified amount of solvent is called **[1]**

a) enthalpy of dilution b) enthalpy of dissociation

c) enthalpy of association d) enthalpy of solution

4. Match List-I with List-II and select the correct answer using the code given below the lists: **[1]**

List-I	**List-II**
Sub-atomic particles	Persons responsible
(A) Electron	(p) Jamesh Chadwick
(B) Proton	(q) J.J. Thomson
(C) Neutron	(r) Rutherford
(D) Nucleus	(s) Goldstein

a) (A)-(p), (B)-(p), (C)-(q), (D)-(s)
b) (A)-(q), (B)-(s), (C)-(r), (D)-(p)
c) (A)-(r), (B)-(s), (C)-(p), (D)-(q)
d) (A)-(q), (B)-(s), (C)-(p), (D)-(r)

5. By convention, the standard enthalpies of formation of all elements in their most stable states are: **[1]**

a) different for each element
b) zero
c) less than zero
d) unity

6. An electron beam undergoes diffraction. This wave character of electrons is used in the making of: **[1]**

a) Light microscope
b) fluorescence microscope
c) ompound microscope
d) electron microscope

7. On the reaction **[1]**

$2Ag + 2H_2SO_4 \longrightarrow Ag_2SO_4 + 2H_2O + SO_2$ sulphuric acid acts as an?

a) a reducing agent
b) an oxidizing agent
c) a catalyst
d) an acid as well as an oxidant

8. Glycine is a functional isomer of ________. **[1]**

a) ethylamine
b) nitromethane
c) nitroethane
d) ethanamide

9. Which product is obtained by passing ethanol vapours over heated alumina? **[1]**

a) C_2H_2
b) C_2H_6
c) C_2H_4
d) CH_4

10. The correct increasing order of atomic radii for the same element is ____ ? **[1]**

a) covalent radius < Metallic radius < van der Waal's radius
b) covalent radius < crystal radius < Metallic radius
c) van der Waal's radius < Metallic radius < covalent radius
d) Metallic radius < covalent radius < van der Waal's radius

11. Lattice enthalpies are determined by **[1]**

a) Hess' law
b) Born-Haber cycle
c) lattice cycle
d) endothermic reaction

12. Halogenation of alkanes is a: **[1]**

a) Rearrangement reaction
b) Elimination reaction
c) Addition reaction
d) Substitution reaction

13. **Assertion (A):** The carbon atoms of the benzene ring may be numbered for identification of substituent groups, just as continuous chains of carbon atoms are numbered. **[1]**

Reason (R): The smallest set of numbers designating the substituents is the preferred set.

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):** Alkanes are stable to acids, alkalies, oxidising agents etc. at room temperature. **[1]**

Reason (R): Alkanes are less reactive at room temperature.

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):** Electronic configuration of an element is $1s^2\ 2s^1$. **[1]**

Reason (R): In 2s, 2 signifies the maximum capacity of s-subshell.

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):** 22.4 L of N_2 at NTP and 5.6 LO_2 at NTP contain equal number of molecules. **[1]**

Reason (R): Under similar conditions of temperature and pressure all gases contain equal number of molecules.

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) Both A and R are false.

Section B

17. The following concentration were obtained for the formation of NH_3 from N_2 and H_2 at equilibrium at 500 K. **[2]**

$[N_2] = 1.5 \times 10^{-2}$M. $[H_2] = 3.0 \times 10^{-2}$M and $[NH_3] = 1.2 \times 10^{-2}$M. Calculate the equilibrium constant.

18. In terms of period and group where will you locate the element with Z = 114? **[2]**

19. How much copper can be obtained from 100 g of copper sulphate ($CuSO_4$)? **[2]**

20. Write equations for the preparation of **[2]**

i. $HC{\equiv}CD$ and

ii. $DC{\equiv}CD$

OR

Name the organic products of the reaction of but-2-ene with each of the following reagents and write a balanced equation for each reaction.

i. Hydrogen bromide

ii. Bromine dissolved in tetrachloromethane

21. Give the number of electrons in the species: H_2^+, H_2 and O_2^+. **[2]**

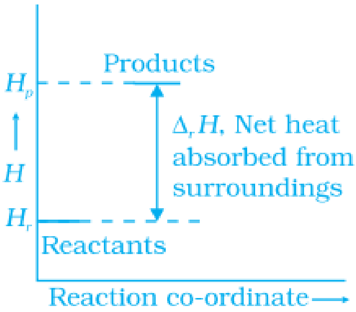
Section C

22. Although geometries of NH_3 and H_2O molecules are distorted tetrahedral, the bond angle in water is less than that of ammonia. Discuss. **[3]**

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

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

(b) Enthalpy diagram for a particular reaction is given in Figure. Is it possible to decide the spontaneity of a reaction from the given diagram? Explain. **[1]**



(c) What is the enthalpy of formation of the most stable form of an element in its standard state? **[1]**

24. Calculate the work done when 11.2 g of iron dissolves in hydrochloric acid in **[3]**

   i. a closed vessel
   ii. an open beaker at $25^\circ C$

   (Atomic mass of Fe = 56 u)

25. What are the oxidation numbers of the underlined $\underline{C}H_3\underline{C}H_2OH$ element and how do you rationalise your results? **[3]**

26. Emission transitions in the Paschen series end at orbit n = 3 and start from orbit n and can be represeted as v = 3.29×10^{15} (Hz) $[1/3^2 - 1/n^2]$ Calculate the value of n if the transition is observed at 1285 nm. Find the region of the spectrum. **[3]**

27. Which of the following will have the most negative electron gain enthalpy and which the least negative? P, S, Cl, F. Explain your answer. **[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 phenomenon of the existence of two or more compounds possessing the same molecular formula but different properties is known as isomerism. Such compounds are called isomers. Compounds having the same molecular formula but different structures (manners in which atoms are linked) are classified as structural isomers. Structural isomers are classified as chain isomer, position isomer, functional group isomer. Meristematic arises due to different alkyl chains on either side of the functional group in the molecule and stereoisomerism and can be classified as geometrical and optical isomerism. Hyperconjugation is a general stabilising interaction. It involves delocalisation of σ electrons of the C-H bond of an alkyl group directly attached to an atom of an unsaturated system or to an atom with an unshared p orbital. This type of overlap stabilises the carbocation because electron density from the adjacent σ bond helps in dispersing the positive charge.

   i. Why Isopentane, pentane and Neopentane are chain isomers?
   ii. The molecular formula C_3H_8O represents which isomer?
   iii. What type of isomerism is shown by Methoxypropane and ethoxyethane?

   OR

   Why hyperconjugation is a permanent effect?

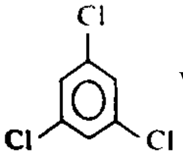
30. **Read the following text carefully and answer the questions that follow:** **[4]**

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) Write chemical equation for the combustion of hexyne. **[1]**

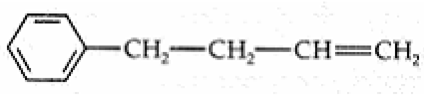
(b) What are conformations? **[1]**

(c) Suggest the name of a Lewis acid other than anhydrous aluminium chloride which can be used during ethylation of benzene. **[1]**

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

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

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

(g) Write an IUPAC name:  **[1]**

32. At certain temperature and under a pressure of 4 atm, PCl_5 is 10% dissociated. **[5]**

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

OR

Calculate the pH of a buffer which is 0.1 M in acetic acid and 0.15 M in sodium acetate. Given that the ionisation constants of acetic acid are 1.75×10^{-5}. Also, calculate the change in pH of the buffer if to 1L of the buffer

i. 1 cc of 1 M NaOH is used.

ii. 1 cc of 1 M HCI is added. Assume that the charge in volume is negligible.

iii. What will be the buffer index of the above buffer?

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

(a) i. Explain the principle of paper chromatography. **[2.5]**

ii. Classify the following reactions in one of the reaction type studied in this unit. **[2.5]**

i. $CH_3CH_2Br + HS^- \longrightarrow CH_3CH_2SH + Br^-$

ii. $(CH_3)_2C = CH_2 + HCl \longrightarrow (CH_3)_2CCl - CH_3$

iii. $CH_3CH_2Br + HO^- \longrightarrow CH_2 = CH_2 + H_2O + Br^-$

iv. $(CH_3)_3C\text{-}CH_2OH + HBr \longrightarrow (CH_3)_2CBr\ CH_2CH_3 + H_2O$

OR

i. Write the structural formula of **[2.5]**

  i. o-ethylanisole,
  ii. p-nitroaniline,
  iii. 2, 3-dibromo-1-phenylpentane,
  iv. 4-ethyl-1-fluoro-2-nitrobenzene

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\.

(d) 5

Explanation: Vapour density = 70

Molecular mass = 2 × 70 = 140

Formula is $[CO]_x$

Therefore molecular mass = $(12 + 16)_x$ = 140

= x × 28 = 140

∴ x = 5

2\.

(b) 21

Explanation: In the formation of a cation with 3^+ charges, the atom loses 3 electrons.

The no. of electrons in the atom will be 18 + 3 = 21.

In a neutral atom, the no. of protons is equal to the no. of electrons. So atomic no. is 21.

3\.

(d) enthalpy of solution

Explanation: Enthalpy of solution is the enthalpy change when one mole of solute dissolved in a specified amount of solvent.

4\.

(d) (A)-(q), (B)-(s), (C)-(p), (D)-(r)

Explanation: (A)-(q), (B)-(s), (C)-(p), (D)-(r)

5\.

(b) zero

Explanation: By convention, the standard enthalpies of formation of all elements in their most stable states (reference states) are zero.

6\.

(d) electron microscope

Explanation: An electron microscope uses an 'electron beam' to produce the image of the object and magnification is obtained by 'electromagnetic fields'; unlike light or optical microscopes, in which 'light waves' are used to produce the image and magnification is obtained by a system of 'optical lenses'.

7\.

(d) an acid as well as an oxidant

Explanation: sulfuric acid (H_2SO_4) is a strong acid, signifying that it fully dissociates into H_3O^+ and HSO_4^- in an aqueous environment (the bisulfate ion is amphiprotic, but usually behaved as a weak bronsted acid given it's feeble alkalinity).

Now, consider some oxidizing agents: F_2, O_2, Cl_2, etc. All of these species are driven by high electronegativities/electron affinities, a result of quantum mechanical effects that contribute to the properties of these agents. However, the H^+ (H_3O^+) ion is essentially a naked proton, resulting in an extremely dense positive charge; this will force it's reduction by more electropositive species by either physical gaining of electrons or the sharing of a lone pair.

Furthermore, the bisulfate/sulfate ion is capable of forming entropically preferable compounds due to the presence of oxygen, another powerful oxidizing agent.

8\.

(c) nitroethane

Explanation: $\underset{\text{Nitroethane}}{CH_3 - CH_2 - NO_2}\ \underset{\text{Glycine}}{HOOC - CH_2 - NH_2}$

9\.

(c) C_2H_4

Explanation: It is an example of dehydration of alcohols to give alkenes.

$$\underset{alcohol}{RCH_2 - CH_2OH} \xrightarrow[-H_2O]{Al_2O_3, 623K} \underset{alkene}{RCH = CH_2}$$

For example,

$$\underset{ethanol}{C_2H_5OH} \xrightarrow[-H_2O]{Al_2O_3, 623K} \underset{ethene}{CH_2 = CH_2}$$

Thus, when ethanol vapours are passed over heated alumina, the alcohol gets dehydrated to form ethene, as given above.

10. **(a)** covalent radius < Metallic radius < van der Waal's radius

Explanation: For the same element ,

- Metallic radius of atoms are always greater than corresponding covalent radius.
- Metallic radius is always lesser than van der Waal's radius

Hence , the correct increasing order of atomic radii of an element is covalent < Metallic < van der Waal's radius.

11.

(b) Born-Haber cycle

Explanation: Born-Haber cycle

12.

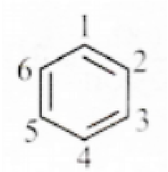
(d) Substitution reaction

Explanation: Halogenation of alkanes is a substitution reaction because the hydrogen atoms are replaced by halogens in the presence of sunlight to give the corresponding alkyl halides. The reaction follows a free radical mechanism.

13.

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

Explanation: Nomenclature in benzene ring:



For only one substituent, no numbering is required. According to the latest IUPAC system of nomenclature, the lowest set of locants is preferred even if it violates the lowest sum rule.

1, 3-dimethylbenzene is preferred as it corresponds to the smallest total set of numbers.

14.

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

Explanation: The electronegativities of carbon (2.60) and hydrogen (2.1) do not differ appreciably. Thus the bond electrons in C-H are practically equally shared between them and the bond is almost nonpolar. The C-C bond is completely nonpolar and polar reagents find no reaction sites on alkane molecules.

15.

(c) A is true but R is false.

Explanation: 1 and 2 are principal quantum numbers, n identifies the shell, determines the size of the orbital and also to a large extent the energy of the orbital. Maximum capacity of s-subshell is two because it has only one orbital.

16.

(d) Both A and R are false.

Explanation: Molar volume (at NTP) = 22.4 L

Now 22.4 L of N_2 = volume occupied by 1 mole of N_2 = 28 g = 6.023×10^{23} molecules.

Similarly $O_2 = 2 \times 16 = 32$ g, 32 g

6.023×10^{23} molecules = 22.4 L

$\therefore$ 22.4 L = 6.023×10^{23}

or $5.6 \text{ L} = \frac{6.023 \times 10^{23} \times 5.6}{22.4} = \frac{1}{4} \times 6.023 \times 10^{23}$

According to Avagadro's hypothesis equal volume of all gases contain equal number of molecules under similar conditions of temperature and pressure.

Section B

17. For the given reaction : $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$; The equilibrium constant can be written as follows:

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$

Given

$[N_2] = 1.5 \times 10^{-2} M$

$[H_2] = 3.0 \times 10^{-2}$ M

$[NH_3] = 1.2 \times 10^{-2}$ M

Put the given values in above expression, we get.

$K_c = \frac{[1.2 \times 10^{-2} M]^2}{[1.5 \times 10^{-2} M][3.0 \times 10^{-2} M]^3}$

$= 0.106 \times 10^4 = 1.06 \times 10^3 M$

18. For Z = 114, the electronic configuration is [Rn] $5f^{14}\ 6d^{10}\ 7s^2\ 7p^2$. The outermost electronic configuration provides the information that the element lies in the 7^{th} period and belongs to the carbon family i.e. Group 14.

19. Calculations:

1 mole of $CuSO_4$ contains 1 mole (1 g atom) of Cu

Molar mass of $CuSO_4$

$= 63.5 + 32 + 4 \times 16$

$= 159.5$ g mol^{-1}

Thus, Cu that can be obtained from 159.5 g of $CuSO_4$

= 63.5 g

$\therefore$ Copper (Cu) that can be obtained from 100 g of copper sulphate ($CuSO_4$)

$= \frac{63.5}{159.5} \times 100$ g

= 39.81 g

20. i. $HC \equiv CH \xrightarrow{NaNH_2} HC \equiv C^- Na^+ \xrightarrow{D_2O} HC \equiv CD$

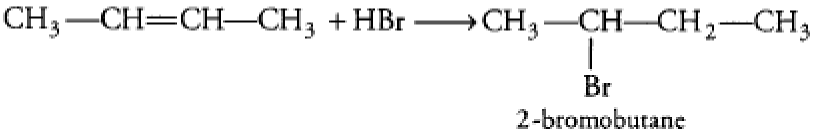
Here, Strong base $NaNH_2$ deprotonated the alkynes to give so-called acetylide ions.

ii. $HC \equiv CH \xrightarrow{2Na} Na^+C^- \equiv C^-Na^+ \xrightarrow{D_2O} DC \equiv CD$

Here, sodium metal is one-electron reducing agent.

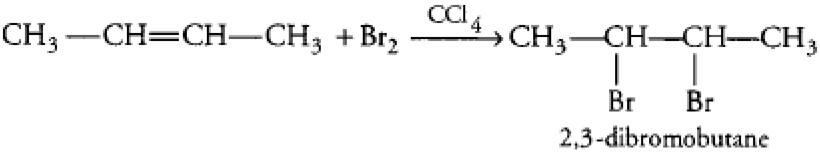
OR

i. But-2-ene is a symmterical alkene and reaction with HBr gives 2-Bromobutane.



$CH_3-CH=CH-CH_3 + HBr \longrightarrow CH_3-\underset{\underset{Br}{|}}{CH}-CH_2-CH_3$

ii. But-2-ene reacton with bromine dissolved in tetrachloromethane gives 2,3-dibromobutane. In reaction, Br_2 water loses its red-brown colour and becomes colourless. This decolourisation of bromine is often used as a test for a carbon-carbon double bond.



$CH_3-CH=CH-CH_3 + Br_2 \xrightarrow{CCl_4} CH_3-\underset{\underset{Br}{|}}{CH}-\underset{\underset{Br}{|}}{CH}-CH_3$

21. H_2^+ = one

H_2 = two

O_2^+ = 15

Section C

22. $\ddot{N}H_3$

$H_2\ddot{O}:$

Because of two lone pairs of electrons on O-atom repulsion on bond pairs are greater in H_2O in comparison to NH_3 .Thus the bond angle is less in H_2O molecules.

23. Answer:

(i) 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.

(ii) No, enthalpy is not the only criterion for spontaneity we need to consider enthalpy and entropy both.

(iii)The standard enthalpy of formation of any element in its most stable form is zero by definition. (which is pronounced “delta H eff naught”).It is symbolically written as ΔHf°.

The standard enthalpy of formation of any element in its standard state is zero by definition.

For example, although oxygen can exist as ozone (O_3), atomic oxygen (O), and molecular oxygen (O_2), O_2 is the most stable form at 1 atm pressure and 25°C. Similarly, hydrogen is H_2(g), not atomic hydrogen (H). Graphite and diamond are both forms of elemental carbon, but because graphite is more stable at 1 atm pressure and 25°C, the standard state of carbon is in graphite.There for H_2(g) and graphite have ΔH of values of zero.

24. Iron reacts with HCI acid to produce H_2 gas.

Reaction:

$\mathrm{Fe}(s) + 2\mathrm{HCl}(aq) \longrightarrow \mathrm{FeCl_2}(aq) + \mathrm{H_2}(g)$

Here, 1 mole of Fe i.e. 56g Fe produces 1 mol of H_2 gas.

So, 11.2 g Fe will produce H_2 gas = $\frac{1}{56} \times 11.2 = 0.2\mathrm{mol}$

i. If the reaction is carried out in closed vessel,

$\Delta V = 0$

We know that, $W = -p_{\text{ext}} \Delta V$

$\therefore W = 0$

ii. If the reaction is carried out in open beaker and external pressure is 1 atm,

initial volume = 0 because no gas is present.

Now we will calculate final volume,

We know that, $pV = nRT$

$\therefore V = \frac{nRT}{p}$

= $\frac{0.2 \times 0.0821 \times 298}{1}$

= 4.89 L

$\therefore \Delta V = V_{\text{final}} - V_{\text{initial}} = 4.89\mathrm{L}$

$W = -p_{\text{ext}} \Delta V$

$= -1 \text{ atm } \times 4.89\mathrm{L}$

$= -4.89 \text{ L atm}$

$= -4.89 \times 101.3 \text{ J}$

$= -495.4 \text{ J}$

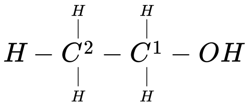
25. $\overset{x}{C_2}\overset{+1}{H_6}\overset{-2}{O}$

2x + 6 (+1) + 1 (-2) = 0

2x = - 4 or x = -2

Therefore, the average oxidation number of C is -2.

Let us consider the structure of ethanol CH_3CH_2OH



$$H - \underset{H}{\overset{H}{\underset{|}{\overset{|}{C^2}}}} - \underset{H}{\overset{H}{\underset{|}{\overset{|}{C^1}}}} - OH$$

Oxidation number of C_1 atom = 1 (+1) + 2 (+1) + x + 1 (-1) = 0

[C_1 atom in CH_3CH_2OH is attached to one CH_3 group (oxidation number = + 1), two H atoms and one -OH group (oxidation number = -1)]

x = - 2

Oxidation number of C_2 atom = 3 (+1) + x + 1 (-1) = 0

x = -2

[C_2 atom in CH_3CH_2OH is attached to three H-atoms and one -CH_2OH group (oxidation number = - 1)].

26. v = (3.29 $\times 10^{15}$ Hz) $\left(\frac{1}{3^2} - \frac{1}{n^2}\right)$

λ = 1285 nm = 1285 $\times$ 10^{-9} m = 1.285 $\times 10^{-6}$ m v = $\frac{c}{\lambda} = \frac{(3\times 10^{8}\mathrm{ms}^{-1})}{(1.285\times 10^{-6}\mathrm{m})}$ = 2.3346 $\times$ $10^{14}s^{-1}$

2.3346 $\times 10^{14}$ = 3.29 $\times 10^{15}$ $\left[\frac{1}{3^2} - \frac{1}{n^2}\right]$

$\frac{2.3346}{32.9} = \frac{1}{3^2} - \frac{1}{n^2}$ or 0.71 = $\frac{1}{9} - \frac{1}{n^2}$

$\frac{1}{n^2} = \frac{1}{9}$ - 0.071 = 0.111 - 0.071 = 0.04

n^2 = $\frac{1}{0.04}$ = 25 or n = 5

Paschen series lies in infrared region of the spectrum.

27. Electron gain enthalpy generally becomes more negative across a period as we move from left to right. Within a group, electron gain enthalpy becomes less negative down a group. However, adding an electron to the 2p-orbital leads to greater repulsion than adding an electron to the larger 3p-orbital. Hence the element with most negative electron gain enthalpy is chlorine; the one with the least negative electron gain enthalpy is phosphorus.

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

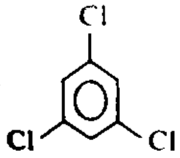
29. i. Isopentane, pentane and Neopentane are chain isomers because they have a similar molecular formula but a different carbon skeleton.

ii. The molecular formula C_3H_8O represents positional isomers because they differ in the position of substituent functional group(OH) on the carbon skeleton.

iii. Methoxypropane and ethoxyethane are metamers because none of its side are similar to each other.

OR

The σ electrons of C-H bond of the alkyl group enter into partial conjugation with the attached unsaturated system or with the unshared p orbital therefore hyperconjugation is permanent effect.

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

ii. Fraction of electronic charge = $\frac{1.2\times 10^{-10}}{4.8\times 10^{-10}} = 0.25$

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

OR

% ionic character = $\frac{1.5\times 10^{-29}}{2.4\times 10^{-29}} \times 100$ = 62.5

Section E

31. Attempt any five of the following:

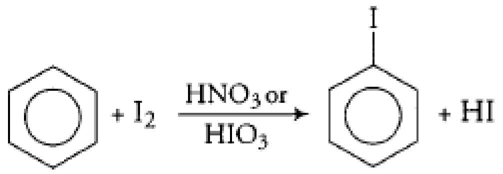
(i) $C_6H_{10}(g) + \frac{17}{2}O_2(g) \xrightarrow{\text{Heat}} 6CO_2(g) + 5H_2O(g)$

(ii) Conformations are spatial arrangements which are obtained by rotation around sigma bonds.

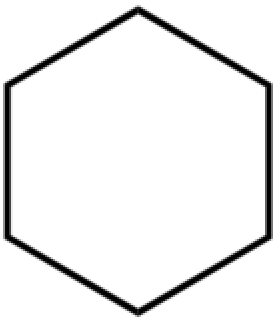
Explanation : In chemistry, **conformational isomerism** is a form of sterioisomers in which the isomers can be interconverted just by rotations about formally single bonds (refer to figure on single bond rotation).Such isomers are generally referred to as **conformational isomers** or**conformers**.

(iii)Anhydrous Ferric Chloride $(\mathrm{FeCl_3})$ is another Lewis acid which can be used.

(iv)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.



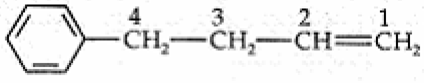
(v) **Cycloalkanes:** When carbon atoms form a closed chain or ring structures, they are known as cycloalkanes.
Example: Cyclohexane



(vi)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.

$$CH_3CH_2CH_2Br \xrightarrow{\text{KOH (alc.)}} CH_3-CH=CH_2 \xrightarrow{\text{HBr}} CH_3-\overset{\displaystyle Br}{\overset{|}{C}H}-CH_3$$

(vii)



4 – Phenylbut – 1 – ene

32. Calculation of K_p

$PCl_5(g)$	$\rightleftharpoons$	$PCl_3(g)$	+	Cl_2 (g)
1		0		0
$(1-\alpha)$		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 $P = \frac{K_p(1-\alpha^2)}{\alpha^2}$

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

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

OR

We have Henderson's equation

$pH = pK_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$

$= -\log(1.75 \times 10^{-5}) + \log\frac{0.15}{0.10}$

$= -(\log 1.75 + \log 10^{-5}) + \log 1.5$

$= -(0.2430 - 5) + 0.1761$

$= -(-4.757) + 0.1761$

$= 4.757 + 0.1761$

$= 4.933.$

Therefore pH of buffer is 4.933.

i. 1 cc (10^{-3} L) of 1 M NaOH contains NaOH = 10^{-3} mol. This will convert 10^{-3} mol of acetic acid into the salt so that salt formed is 10^{-3} mol.

   Now, [Acid] = 0.10 M - 10^{-3} M = 0.099 M.

   [Salt] = 0.15 M + 10^{-3} M = 0.151 M.

   Therefore by using Henderson's equation, we have

   $pH = 4.757 + \log\frac{0.151}{0.099}$

   $= 4.757 + \log 1.525$

   $= 4.757 + 0.183$

   $= 4.940$

   $\therefore$ Increase in pH = 4.940 - 4.933 = 0.007 which is negligible.

ii. 1 cc (10^{-3} L) of 1 M HCI contains HCI = 10^{-3} mol. This will convert 10^{-3} mol CH_3COONa into CH_3COOH.

   $\therefore$ Now, [Acid] = 0.10 M + 10^{-3} M = 0.101 M

   [Salt] = 0.15 M - 10^{-3} M = 0.149 M. Therefore by using Henderson's equation, we have

   $\therefore pH = 4.757 + \log\frac{0.149}{0.101}$

   $= 4.757 + \log 1.475$

   $= 4.757 + 0.168$

   $= 4.925$

   $\therefore$ Decrease in pH = 4.933 - 4.925 = 0.008 which is again negligible.

iii. Calculation of buffer index:

   No. of moles of HCl or NaOH added = 0.001 mol

   Change in pH = 0.007

   Hence, buffer index = $\frac{No.\ of\ moles\ of\ acid\ or\ base}{change\ in\ pH} = \frac{0.001}{0.007} = \frac{1}{7}$ = 0.143

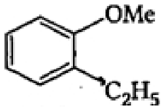
33. Answer:

(i) i. This is the simplest form of chromatography. Here a strip of paper acts as an adsorbent. It is based on the principle which is partly adsorption. The paper is made of cellulose fibres with molecules of water adsorbed on them. This acts as stationary phase. The mobile phase is the mixture of the components to be identified prepared in a suitable solvent.

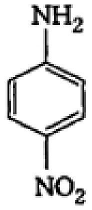
ii.
   i. Nucleophilic substitution
   ii. Electrophilic Addition
   iii. Bimolecular elimination
   iv. Nucleophilic substitution with rearrangement.

OR

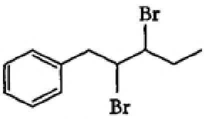
i. i.



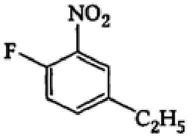
ii.

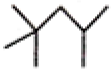
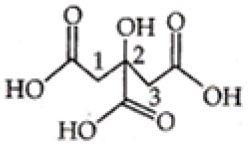
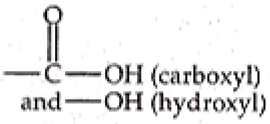
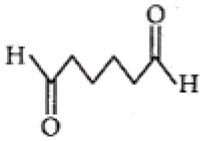
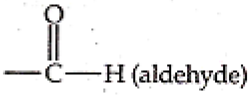


iii.



iv.



Condensed formula	**Bond line formula**	**Functional group/s**
(*a*) $(CH_3)_3CCH_2CH(CH_3)_2$		—
ii. (*b*) $HOOCCH_2C(OH)$ $(COOH)CH_2COOH$		 $-\overset{\overset{O}{\|}}{C}-OH$ (carboxyl) and $-OH$ (hydroxyl)
(*c*) $OHC(CH_2)_4CHO$		 $-\overset{\overset{O}{\|}}{C}-H$ (aldehyde)