Class XI Session 2023-24
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. The number of moles of solute present in 1 kg of solvent is called: **[1]**

a) molarity
b) normality
c) mole fraction
d) molality

2. Pairing of electrons in the orbitals belonging to the same subshell (p, d or f) does not take place until each orbital belonging to that subshell is singly occupied. This is called **[1]**

a) Pauli’s exclusion principle
b) Hund’s rule of maximum multiplicity
c) Aufbau principle
d) None of these

3. Maximum entropy will be in which of the following? **[1]**

a) water vapour
b) snow
c) liquid water
d) Ice

4. Number of angular nodes for 4d orbital is ________. **[1]**

a) 2
b) 1
c) 3
d) 4

5. The enthalpy of combustion of methane, graphite and dihydrogen at 298 K are, -890.3 kJ mol^{-1}, -393.5 kJ mol^{-1} and -285.8 kJ mol^{-1} respectively. Enthalpy of formation of CH_4 (g) will be **[1]**

a) +74.8 kJ mol^{-1}
b) +52.26 kJ mol^{-1}
c) -74.8 kJ mol^{-1}
d) -52.27 kJ mol^{-1}

6. Chlorine's (Cl) relative atomic mass is 35.5. this half number is due to **[1]**

a) a half neutron
b) a half proton
c) isotopes
d) a half electron

7. Which of the following are not redox reactions? **[1]**

a) $K_4[Fe(CN)_6] + H_2SO_4 + H_2O \rightarrow K_2SO_4 + CO + FeSO_4 + (NH_4)_2SO_4$.

b) $CuSO_4 + NH_3 \rightarrow [Cu(NH_3)_4SO_4$.

c) $Mg + N_2 \rightarrow Mg_3N_2$.

d) $I_2 + 3Cl_2 \rightarrow 2ICl_3$

a) c, d
b) b, d
c) b only
d) a, b

8. Write the state of hybridisation of carbon in $H_2C = O$ and mention the molecular geometry also. **[1]**

a) sp hybridised carbon, linear
b) sp^2 hybridised carbon, trigonal planar
c) sp^3 hybridised carbon, tetrahedral
d) sp^3 hybridised carbon, trigonal pyramidal

9. Which conformation of ethane has the lowest potential energy? **[1]**

a) Eclipsed
b) Skewed
c) Staggered
d) All will have equal PE

10. Which one of the following is isoelectronic with Ne? **[1]**

a) mg^{2+}
b) Al^{3+}
c) N^{3-}
d) All of these

11. Standard enthalpy of fusion or molar enthalpy of fusion is: **[1]**

a) the enthalpy change that accompanies melting of one kg of a solid substance in the standard state.
b) the enthalpy change that accompanies vaporization of one kg of a solid substance in the standard state.
c) the enthalpy change that accompanies melting of one mole of a solid substance in the standard state.
d) the enthalpy change that accompanies vaporization of one mole of a solid substance in the standard state.

12. Boiling point of alkanes are: **[1]**

a) is independent of branching.
b) decreases with increase in molecular mass.
c) is independent of molecular mass.
d) increases with increase in molecular mass.

13. **Assertion (A):** Simple distillation can help in separating a mixture of propan-1-ol (boiling point 97°C) and propanone (boiling point 56°C). **[1]**

Reason (R): Liquids with a difference of more than 20°C in their boiling points can be separated by simple distillation.

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):** Addition of HBr on  in presence of peroxide give  as major product. **[1]**

Reason (R): Addition of HBr on alkene proceed by carbocation intermediate.

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

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

c) A is true but R is false.

d) A is false but R is true.

15. **Assertion (A):** The nuclear isomers are the atoms with the same atomic number and same mass number, but with different radioactive properties. **[1]**

Reason (R): The nucleus in the excited state will evidently have a different half-life as compared to that in the ground state.

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):** Atomic mass has no unit but is expressed in amu. **[1]**

Reason (R): It is the average mass of an atom taking care of the relative abundance of all its possible isotopes.

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. Lead chloride has a solubility product of 1.7×10^{-5} at 298 K. Calculate its solubility at this temperature. **[2]**

18. Which element do you think would have been named by: **[2]**

i. Lawrence Berkeley Laboratory
ii. Seaborg's group?

19. Oxygen is prepared by the catalytic decomposition of potassium chlorate ($KCIO_3$). Decomposition of potassium chlorate gives potassium chloride (KCI) and oxygen (O_2). If 2.4 moles of oxygen is needed for an experiment, how many grams of potassium chlorate must be decomposed? **[2]**

20. An alkene (molecular weight = 56) on reaction with trioxygen followed by zinc/CH_3COOH gave only ethanal. Identify the Structure of the alkene. **[2]**

OR

How will you convert benzene into

i. p - nitrobromobenzene
ii. m - nitrobromobenzene

21. In each of the following pairs of salts, which one is more stable? **[2]**

i. Ferrous and ferric salts
ii. Cuprous and cupric salts

Section C

22. Describe the change in hybridisation (if any) of the Al atom in the following reaction. **[3]**

$AlCl_3 + Cl^- \rightarrow AlCl_4^-$

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

(i) Give the mathematical expression of enthalpy. **[1]**

(ii) Neither q nor W is a state function but q + W is a state function. Explain why? **[1]**

(iii) The standard heat of formation of Fe_2O_3 (s) is 824.2kJ mol^{-1} Calculate heat change for the reaction. **[1]**

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

24. 100 mL of a liquid is contained in an insulated container at a pressure of 1 bar. The pressure is steeply increased to 100 bar. The volume of the liquid is decreased by 1 mL at this constant pressure. Find ΔH and ΔU . **[3]**

25. Identify the type of redox reaction taking place in the following. **[3]**

i. $3\overset{0}{Mg}(s) + \overset{0}{N}_2(g) \rightarrow \overset{+2}{Mg}_3\overset{-3}{N}_2(s)$

ii. $3\overset{0}{Mg}(s) + \overset{0}{N}_2(g) \rightarrow \overset{+2}{Mg}_3\overset{-3}{N}_2(s)$

iii. $2\overset{+1}{K}\overset{+5}{CI}\overset{-2}{O}_3(s) \rightarrow 2\overset{+1}{K}\overset{-1}{CI}(s) + 3O_2(g)$

iv. $\overset{0}{Ca}(s) + 2\overset{+1}{H}_2\overset{-2}{O}(l) \rightarrow \overset{+2}{Ca}(\overset{-2}{O}\overset{+1}{H})_2(aq) + \overset{0}{H}_2(g)$

v. $\overset{0}{Br}_2(l) + 2\overset{-1}{I}\ (aq) \rightarrow 2\ \overset{-1}{Br}\ (aq) + \overset{0}{I}_2(s)$

vi. $\overset{0}{Cl}_2(g) + 2OH(aq) \rightarrow \overset{-1}{C}IO(aq) + \overset{-1}{C}I(aq) + H_2O(I)$

26. What transition in a hydrogen spectrum would have the same wavelength Balmer transition n = 4 to n = 2 of $\overline{v} = \frac{1}{\lambda} = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ spectrum? **[3]**

27. The electronic configuration of some elements are given below: **[3]**

a. $1s^2, 2s^2, 2p^6, 3s^2$

b. $1s^2, 2s^2, 2p^6$

c. $1s^2, 2s^2, 2p^2$

d. $1s^2, 2s^2, 2p^6, 3s^1$

e. $1s^2, 2s^2, 2p^5$

Answer the following questions:

i. Name the elements.
ii. Which of these have the lowest Ionization enthalpy?
iii. Which is a halogen?
iv. Which is an alkali metal?
v. Which is an inert gas?

28. The reactant which is entirely consumed in reaction is known as limiting reagent. In the reaction 2A + 4B → 3C + 4D, when 5 moles of A react with 6 moles of B, then **[3]**

i. Which is the limiting reagent?
ii. Calculate the amount of C formed?

Section D

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

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

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

OR

Is tetrahydrofuran is aromatic compounds?

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

(iii) Difference between heterocyclic and homocyclic compound.

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

The molecular orbital theory is based on the principle of a linear combination of atomic orbitals. According to this approach when atomic orbitals of the atoms come closer, they undergo constructive interference as well as destructive interference giving molecular orbitals, i.e., two atomic orbitals overlap to form two molecular orbitals, one of which lies at a lower energy level (bonding molecular orbital). Each molecular orbital can hold one or two electrons in accordance with Pauli's exclusion principle and Hund's rule of maximum multiplicity.

For molecules up to N_2, the order of filling of orbitals is:

$$\sigma(1s)^{*}_{\sigma}(1s),\sigma(2s)^{*}_{\sigma}(2s),\pi(2p_x)=\pi(2p_y),\sigma(2p_z),{}^{*}_{\pi}(2p_x)=\overset{*}{\pi}(2p_y),\overset{*}{\sigma}(2p_z)$$

and for molecules after N_2, the order of filling is:

$$\sigma(1s)^{*}_{\sigma}(1s),\sigma(2s)^{*}_{\sigma}(2s),\sigma(2p_z),\pi(2p_x)=\pi(2p_y),{}^{*}_{\pi}(2p_x)=\overset{*}{\pi}(2p_y),\overset{*}{\sigma}(2p_z)$$

Bond order = $\frac{1}{2}$[bonding electrons - antibonding electrons]

Bond order gives the following information:

i. If bond order is greater than zero, the molecule/ion exists otherwise not.
ii. Higher the bond order, higher is the bond dissociation energy.
iii. Higher the bond order, greater is the bond stability.
iv. Higher the bond order, shorter is the bond length.

(i) Arrange the following negative stabilities of CN, CN^+ and CN^- in increasing order of bond.

(ii) The molecular orbital theory is preferred over valence bond theory. Why?

(iii) Ethyne is acidic in nature in comparison to ethene and ethane. Why is it so?

OR

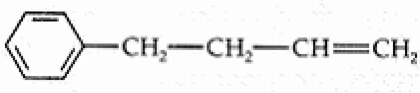
Bonding molecular orbital is lowered by a greater amount of energy than the amount by which antibonding molecular orbital is raised. Is this statement correct?

Section E

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

(i) Can a catalyst change the position of equilibrium in a reaction? **[1]**

(ii) To which category of compounds does cyclohexane belong? **[1]**

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

(iv) What is hydrogenation? **[1]**

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

(vi) 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]**

(vii) State Le chatelier’s principle. **[1]**

32. Calculate the degree of ionization of 0.05 M acetic acid if its pK_a value is 4.74. How is the degree of dissociation affected when its solution also contains **[5]**

a. 0.01 M
b. 0.1 M HCl?

OR

Write a relation between $\triangle G$ and Q and define the meaning of each term and answer the following:

a. Why a reaction proceeds forward when $Q < K$ and no net reaction occurs when $Q = K$.
b. Explain the effect of an increase in pressure in terms of reaction quotient Q for the reaction:
$CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$

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

(i)
- i. Why is nitric acid added to sodium extract before adding silver nitrate for testing halogens? **[2.5]**
- ii. How does **[2.5]**
  - i. an electron withdrawing group (EWG) and
  - ii. an electron donating group (EDG) influence the acid strength of carboxylic end?

OR

- i. Suggest a method to purify **[2.5]**
  - i. a liquid which decomposes at its boiling point.
  - ii. kerosene oil containing water.
  - iii. camphor containing traces of common salt.
- ii. Differentiate between the principle of estimation of nitrogen in an organic compound **[2.5]**
  - i. Dumas method
  - ii. Kjeldahl's method.

Solution

Section A

1.

(d) molality

Explanation: Mathematically, molality is expressed as, $Molality(m) = \frac{No.\,of\,moles\,of\,solute}{Mass\,of\,solvent\,in\,kg}$

2.

(b) Hund’s rule of maximum multiplicity

Explanation: Pairing of electrons in the orbitals belonging to the same subshell (p, d or f) does not take place until each orbital belonging to that subshell has got one electron each, i.e. it is singly occupied. This is called Hund’s rule of maximum multiplicity.

3. **(a)** water vapour

Explanation: water vapour

4. **(a)** 2

Explanation: Explanation: number of angular node=l
for 4d orbital, l=2

5.

(c) -74.8 kJ mol^{-1}

Explanation: $\mathrm{CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O\ \ \Delta H_1 = -890.3 KJ/mol}$ ...(1)
$\mathrm{C(s) + O_2 \rightarrow CO_2\ \ \Delta H_2 = -393.5 KJ/mol}$ ...(2)
$\mathrm{H_2 + 0.5O_2 \rightarrow H_2O\ \ \Delta H_3 = -285.8 KJ/mol}$ ...(3)
$\mathrm{C(s) + 2H_2 \rightarrow CH_4\ \ \Delta H = \Delta H_2 + 2\left(\Delta H_3\right) - \Delta H_1}$
$\triangle$H = -393.5 +2(-285.8) - (-890.3)
= -74.8 kJ/mol

6.

(c) isotopes

Explanation: isotopes

7.

(d) a, b

Explanation: a) $K_4[Fe(CN)_6] + H_2SO_4 + H_2O \rightarrow K_2SO_4 + CO + FeSO_4 + (NH_4)_2SO_4$

b) $CuSO_4 + NH_3 \rightarrow [Cu(NH_3)_4SO_4$
Since, oxidation number of each element does not change in these reactions, so these are not redox reactions.

8.

(b) sp^2 hybridised carbon, trigonal planar

Explanation: Due to the presence of a double bond in the carbonyl carbon ($> \mathrm{C} = \mathrm{O}$), carbon is sp^2 hybridised. This hybridization leads to a trigonal planar geometry which means a bond angle of 120° around the C.

9.

(c) Staggered

Explanation: In staggered conformation of ethane, any two H-atoms on adjacent C-atoms are as far apart as possible. As a result, the repulsions between the electron clouds of σ-bonds of two non bonded H-atoms are minimum and hence stability is maximum.

10.

(d) All of these

Explanation: Isoelectronic species have same number of electrons.
Ne (Z=10) has 10 electrons.

N (Z=7) has 7 electrons and with addition of 3 more electrons it becomes N^{3-} anion which has 10 electrons.

Mg (Z=12) has 12 electron and with removal of 2 electrons it becomes Mg^{2+} cation which has 10 electrons.

Al (Z=13) has 13 electrons and with removal of 3 electrons it becomes Al^{3+} cation which has 10 electrons.

Since all the species have same number of electrons that is 10 , so they are isoelectronic.

11.

(c) the enthalpy change that accompanies melting of one mole of a solid substance in the standard state.

Explanation: Molar enthalpy of fusion (always increases i.e. ΔH = positive) is the amount of energy needed to change completely one mole of a substance from the solid phase to the liquid phase in the standard state.

12.

(d) increases with increase in molecular mass.

Explanation: As molecular mass increases, the magnitude of Van der Waals forces of attraction increases and hence boiling point increases accordingly.

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

Explanation: The liquids are having sufficient difference in their boiling points. Liquids having different boiling points vaporize at different temperatures. The vapours are cooled and the liquids so formed are collected separately.

14.

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

Explanation: Both A and R are true but R is not the correct explanation of A.

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

Explanation: The nuclear isomerism in the nuclei of the same mass number and same atomic number arises due to different radioactive properties. The reason for nuclear isomerism is the different energy states of two isomeric nuclei. One may be in the ground state and the other in an excited state. The nucleus in the excited state will have a different half-life.

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

Explanation: Atomic mass = $\frac{\text{Average mass of an atom}}{1/12\times \text{ Mass of an atom of }{}^{12}\text{C}}$

Average mass of an atom

$= \frac{\text{R·A(1)}\times\text{MNo}+\text{R·A(2)}\times\text{M.No}}{\text{R·A(l)}+\text{R.A(2)}}$

Here R.A = Relative abundance, M.No = Mass number and 1 and 2 refers the two possible isotopes. As atomic mass is a ratio so its has no unit.

Section B

17. According to the question, the solubility product of lead chloride at 298 K is 1.7×10^{-5}.

Reaction:

$$\text{PbCl}_2(s) \rightleftharpoons \text{Pb}^{2+}(aq) + 2\text{Cl}^-(aq)$$

Let the solubility of $PbCl_2$ be S mol/L.

Then the solution will contain S moles of Pb^{2+} ions and 2S moles of Cl^- ions respectively per litre.

$$\therefore K_{\text{sp}} = \left[\text{Pb}^{2+}\right]\left[\text{Cl}^-\right]^2$$
$$= S \times (2S)^2$$
$$= 4S^3$$
$$\Rightarrow 4S^3 = 1.7 \times 10^{-5}$$
$$\Rightarrow S^3 = \frac{1.7\times10^{-5}}{4} = 0.425 \times 10^{-5}$$

Therefore, S = 1.620×10^{-2} mol L^{-1}.

18. i. Lawrencium (Lr) with atomic number (Z) 103.
    ii. Seaborgium (Sg) with atomic number (Z) 106.

19. The balanced equation is

$$\underset{\substack{2mol \\ 2\times(39+35.5+3\times16)=245g \\ ?}}{2\,KClO_3(s)} \quad \rightarrow 2KCl(s) + \underset{\substack{3mol \\ 2.4moles}}{3O_2(g)}$$

2 mol of $KClO_3$ produced = 3 moles of O_2

3 moles of O_2 is produced by decomposition of 245g of $KClO_3$

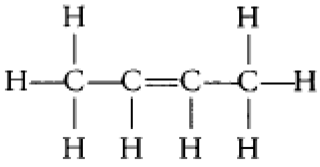
2.4 moles of O_2 will be produced by the decomposition of $KClO_3 = \frac{245 \times 2.4}{3}$ = 196.0 g .

20. Let the molecular formula of given alkene is C_nH_{2n}

$12n + 2n = 56$
or $14n = 56$
$\therefore n = 4$

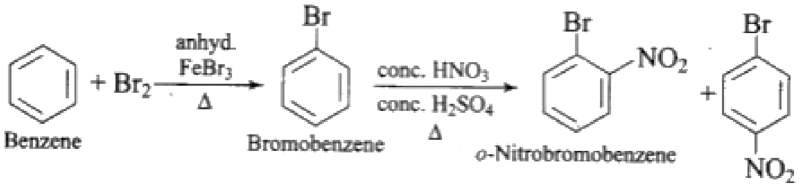
Thus, the molecular formula of alkene is C_4H_8.

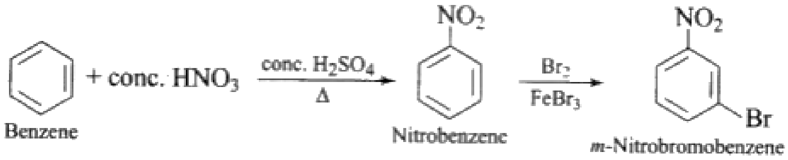
As,C_4H_8 is giving only ethanal during ozonolysis followed by reduction, Thus, given alkene is symmetrical and its structure is:



2-butene

OR

i. 

ii. 

21. i. **Ferrous and ferric salts** In ferrous salts Fe^{2+}, the configuration is $1s^2\ 2s^2,\ 2p^6,\ 3s^2,\ 3p^6,\ 3d^6$. In ferric salts Fe^{3+}, the configuration is $1s^2\ 2s^2,\ 2p^6,\ 3s^2,\ 3p^6,\ 3d^5$.

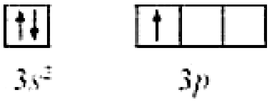
As half-filled $3d^5$ configuration is more stable therefore ferric salts are more stable than ferrous salts.

ii. **Cuprous and cupric salts** In cuprous salts, the configuration of Cu^+ is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$.

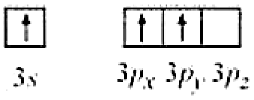
In cupric salts, the configuration of Cu^{2+} is $1s^2\ 2s^2,\ 2p^6,\ 3s^2,\ 3p^6,\ 3d^9$. Although Cu^+ has completely filled d-orbital, yet cuprous salts are less stable. This is because the nuclear charge is not sufficient enough to hold 18 electrons of Cu^+ ion present in the outermost shell.

Section C

22. The valence orbital picture of aluminum in the ground state can be shown as:



The orbital picture of aluminum in the excited state can be shown as:



Hence, it undergoes sp^2 hybridization to give a trigonal planar arrangement (in $AlCl_3$). To form $AlCl_4^-$, the empty 3pz orbital also gets involved and the hybridization changes from sp^2 to sp^3. As a result, the shape becomes tetrahedral.

23. Answer:

(i) Mathematical expression of enthalpy is H = U + pv,
where U is internal energy.

(ii) q and W are not state functions. But as we know that,
$q + W = \Delta U$, which is a state function.
Hence, q + W is a state function.

(iii) According to the question, the standard heat of formation of Fe_2O_3 (s) is 824.2 kJ mol^{-1}.

The standard heat of formation of Fe and O_2 is zero because they are in their basic standard states.

Reaction:

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

We know that, $\Delta H^\circ = \sum \Delta H_f^\circ(\text{ products }) - \sum \Delta H_f^0(\text{ reactants})$

$= \left[2 \times \Delta H_f^0 \; Fe_2O_3(s)\right] - \left[4\Delta H_f^0 \; Fe(s) + 3\Delta H_f^0 \; O_2(g)\right]$

= 2(-824.2) – [4 × 0 + 3 × 0]

= -1648.4 kJ.

24. According to the question, $p_1 = 1$ bar , $p_2 = 100$ bar, $V_1 = 100\text{mL}, V_2 = 99\text{mL}.$

We know that, $\Delta U = q + W$

For the adiabatic process, q = 0

So, $\Delta U = W$

Now, $W = -p\Delta V = -100(99 - 100) = 100$ bar ml

We know that, $\Delta H = \Delta U + \Delta pV$

$= 100 + p_2V_2 - p_1V_1$

$= 100 + (100 \times 99) - (1 \times 100)$

= 100 + 9900 - 100

= 9900 bar mL

25. i. Combination reaction
   ii. Displacement reaction
   iii. Decomposition reaction
   iv. Metal displacement reaction
   v. Non-metal displacement reaction
   vi. Disproportionation reaction

26. For an atom, $\bar{v} = \frac{1}{\lambda} = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For He^+ spectrum Z = 4,n_2 =4,n_1 = 2

$\therefore$ For hydrogen spectrum: $\bar{v} = \frac{3R_H}{4}$ and Z = 1

$\therefore \bar{v} = \frac{1}{\lambda} = R_H \times 1 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

or $R_H\left(\frac{1}{n_1^2} - \frac{1}{m_2^2}\right) = \frac{3R_H}{4}$ or $\frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{3}{4}$

This corresponding to n_1 = 1,n_2 = 2 and means that the transition has taken Lyman series from n = 2 to n = 1.

Thus, the transition is from n_2 to n_1 in case of hydrogen spectrum.

27. i. (a) Magnesium, (b) Neon (c) Carbon (d) Sodium (e) Flourine
   ii. $1s^2, 2s^2, 2p^6, 3s^1$ (Sodium)
   iii. $1s^2, 2s^2, 2p^5$ (Flourine)
   iv. $1s^2, 2s^2, 2p^6, 3s^1$ (Sodium)
   v. $1s^2, 2s^2, 2p^6$ (Neon)

28. The given equation is : 2A + 4B → 3C + 4D
   i. It is clear from the above equation that: 2 moles of ‘A’ requires 4 moles of ‘B’ for the reaction i.e. ratio of moles of A to B is 2: 4 or 1:2. Hence, for 5 moles of ‘A’, the moles of ‘B’ required = 5 mole of A $\times \frac{4 \text{ mol of } B}{2 \text{ mol of } A} = 10 \text{ mol of } B$. But we have only 6 moles of ‘B’, hence, ‘B’ is the limiting reagent.
   ii. Since 4 moles of ‘B’ gives 3 moles of ‘C’. Hence, 6 moles of ‘B’ will produce $\frac{3}{4} \times 6$ = 4.5 mole of C.

Section D

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

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

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

OR

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

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

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

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

The molecular orbital theory is based on the principle of a linear combination of atomic orbitals. According to this approach when atomic orbitals of the atoms come closer, they undergo constructive interference as well as destructive interference giving molecular orbitals, i.e., two atomic orbitals overlap to form two molecular orbitals, one of which lies at a lower energy level (bonding molecular orbital). Each molecular orbital can hold one or two electrons in accordance with Pauli's exclusion principle and Hund's rule of maximum multiplicity. For molecules up to N_2, the order of filling of orbitals is:

$$\sigma(1s)^*_\sigma(1s), \sigma(2s)^*_\sigma(2s), \pi\left(2p_x\right) = \pi\left(2p_y\right), \sigma\left(2p_z\right), ^*_\pi\left(2p_x\right) = \overset{*}{\pi}\left(2p_y\right), \overset{*}{\sigma}\left(2p_z\right)$$

and for molecules after N_2, the order of filling is:

$$\sigma(1s)^*_\sigma(1s), \sigma(2s)^*_\sigma(2s), \sigma\left(2p_z\right), \pi\left(2p_x\right) = \pi\left(2p_y\right), ^*_\pi\left(2p_x\right) = \overset{*}{\pi}\left(2p_y\right), \overset{*}{\sigma}\left(2p_z\right)$$

Bond order = $\frac{1}{2}$[bonding electrons - antibonding electrons]

Bond order gives the following information:

i. If bond order is greater than zero, the molecule/ion exists otherwise not.
ii. Higher the bond order, higher is the bond dissociation energy.
iii. Higher the bond order, greater is the bond stability.
iv. Higher the bond order, shorter is the bond length.

(i) The increasing order of negative stabilities of CN, CN^+ and CN^- is $CN^+ > CN > CN^-$.

(ii) The molecular orbital theory is preferred over valence bond theory because molecular orbital theory explains the magnetic nature of the molecule.

(iii) In ethyne, hydrogen atoms are connected to sp hybridized carbon atoms, but in ethene, they are attached to sp^2 hybridized carbon atoms and in ethane, they are attached to sp^3 hybridized carbons.

OR

The given statement is not correct because the bonding molecular orbital is lowered by a lesser amount of energy than the amount by which antibonding molecular orbital is raised.

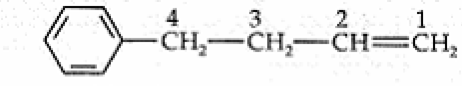
Section E

31. Attempt any five of the following:

(i) A catalyst speeds up the forward and back reaction to the same extent. Because adding a catalyst doesn't affect the relative rates of the two reactions, a catalyst cannot change the position of equilibrium in a chemical reaction

(ii) Cyclohexane belongs to saturated alicyclic hydrocarbons.

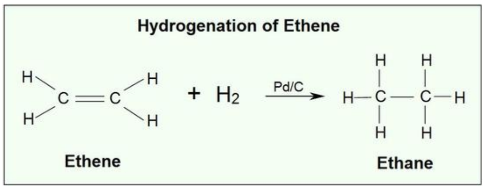
(iii)



4 – Phenylbut – 1 – ene

(iv) **Hydrogenation:** Addition of hydrogen to alkenes and alkenes in the presence of finely divided catalysts like Pt, Pd or Ni to form alkanes is known as hydrogenation.

Example:



(v) 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**.

(vi)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.

(vii)**Le chatelier’s principle:** If a system at equilibrium is subjected to change in the temperature, pressure or concentration of the reactants or the products that govern the equilibrium, then the equilibrium shifts in that direction in which this change is reduced or nullified.

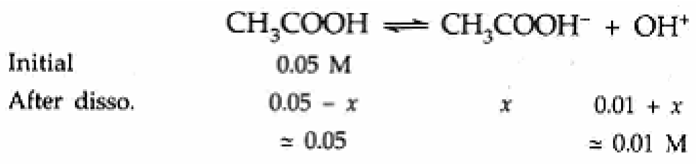
32. $pK_a = -\log K_a = 4.74$

or $\log K_a = -4.74 = \bar{5}.26 \therefore K_a = 1.82 \times 10^{-5}$

$\alpha = \sqrt{K_a/C} = \sqrt{(1.82 \times 10^{-5})/(5 \times 10^{-2})} = 1.908 \times 10^{-2}$

In presence of HCl, due to high concentration of H^+ ion, dissociation equilibrium will shift backward, i.e. dissociation of acetic acid will decrease.

a. In presence of 0.01 MHCl, if x is the amount dissociated, then



	$CH_3COOH \rightleftharpoons$	CH_3COOH^- +	OH^+
Initial	0.05 M		
After disso.	$0.05 - x$	x	$0.01 + x$
	$\simeq 0.05$		$\simeq 0.01$ M

(0.01 M H^+ ions are obtained from 0.01 M HCl)

$\therefore K_a = \frac{x(0.01)}{0.05}$ or $\frac{x}{0.05} = \frac{K_a}{0.01} = \frac{1.82\times10^{-5}}{10^{-2}} = 1.82 \times 10^{-3}$

or $\alpha = 1.82 \times 10^{-3}$ $\left(\because \alpha = \frac{Amount\ dissociate\ d}{Amount\ taken}\right)$

The degree of ionization is $\alpha = 1.82 \times 10^{-3}$

b. In the presence of 0.1 M HCl, if y is the amount of acetic acid dissociated, then at equilibrium

$[CH_3COOH] = 0.05 - y \simeq 0.05M$

$[CH_3COO^-] = y$, $[H^+] = 0.1M + y \simeq 0.1M$

$K_a = \frac{y(0.1)}{0.05}$ or $\frac{y}{0.05} = \frac{K_2}{0.1} = \frac{1.82\times10^{-5}}{10^{-1}} = 1.82 \times 10^{-4}$ i.e.

$\alpha = 1.82 \times 10^{-4}$

The degree of ionization is $\alpha = 1.82 \times 10^{-4}$

OR

a. We know that, $\Delta G = \Delta G^\circ + RT \ln Q$

Where,

ΔG° = Change in free energy as the reaction proceeds

ΔG= Standard free energy change

Q = Reaction quotient

T = Absolute temperature

Also, $\Delta G^\circ = -RT\ lnK$

$\Rightarrow \Delta G = -RT\ lnK + RTlnQ$

$\therefore \Delta G = RT\ ln\frac{Q}{K}$

If Q < K, ΔG will be negative. So, the reaction proceeds in the forward direction.

If Q = K, ΔG = 0, reaction will be at equilibrium.

b. Reaction:

$CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$

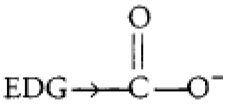
On increasing the pressure equilibrium will shift in forward direction, it means Q < K.

33. Answer:

(i) i. Nitric acid is added to sodium extract so as to decompose

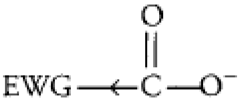
$\mathrm{NaCN} + \mathrm{HNO_3} \longrightarrow \mathrm{NaNO_3} + \mathrm{HCNNa_2S} + 2\mathrm{HNO_3} \longrightarrow 2\mathrm{NaNO_3} + \mathrm{H_2S}$

ii. The influence of the inductive effect on acidity is best understood in terms of the conjugate base, $RCOO^-$ and can be summarised as follows

i. 

$EDG \rightarrow C(=O)-O^-$

Electron withdrawing group destabilises $RCOO^-$ because there exists a repulsion between electrons from EDG and negative charge of O. Hence, EDG weakens the acid.

ii. 

$EWG \leftarrow C(=O)-O^-$

Electron withdrawing group stabilities $RCOO^-$ by taking negative charge from O. Hence, EWG strengthens the acid.

OR

1. i. Distillation under reduced pressure.
   ii. Since the two liquids are immiscible, the technique of solvent extraction with a separating funnel is used. Kerosene being lighter than water forms the upper layer while water forms the lower layer.
   The lower water layer is run off when kerosene oil is obtained. It is dried over anhydrous $CaCl_2$ or M_gSO_4 and then distilled to give pure kerosene oil.
   iii. Sublimation Camphor sublimes while common salt remains as residue in the China dish.
2. (i) **Dumas method:** The organic compound is heated strongly with excess of CuO (Cupric oxide) in an atmosphere of CO_2 when free nitrogen, CO_2 and H_2O are obtained.
   (ii) **Kjeldahl's method:** A known mass of the organic compound is heated strongly with conc. H_2SO_4 and a little potassium sulphate and a little mercury (a catalyst). As a result of reaction the nitrogen present in the organic compound is converted to ammonium sulphate.