Class XI Session 2023-24
Subject - Chemistry
Sample Question Paper - 4

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. 27°C in Kelvin is **[1]**

a) 227 K
b) 246.15 K
c) 300.15 K
d) 127.15 K

2. Among the following pairs of orbitals which orbital will experience the larger effective nuclear charge? (i) 2s and 3s, (ii) 4d and 4f, (iii) 3d and 3p: **[1]**

a) 4f, 3d, and 3s respectively
b) 2s, 4d and 3p respectively
c) 2s, 4d and 3d respectively
d) 4d, 3p and 2s respectively

3. During complete combustion of one mole of butane, 2658 kJ of heat is released. The thermochemical reaction for above change is **[1]**

a) $C_4H_{10}\,(g) + O_2\,(g) \rightarrow 4CO_2\,(g) + 5H_2O\,(l)\; \Delta_c H = -1329.0\; kJ\; mol^{-1}$
b) $2C_4H_{10}\,(g) + 13O_2\,(g) \rightarrow 8CO_2\,(g) + 10H_2O\,(l)\; \Delta_c H = -2658.0\; kJ$
c) $C_4H_{10}\,(g) + O_2\,(g) \rightarrow 4CO_2\,(g) + 5H_2O\,(l)\; \Delta_c H = -2658.0\; kJ\; mol^{-1}$
d) $C_4H_{10}\,(g) + \frac{13}{2}O_2\,(g) \rightarrow 4CO_2\,(g) + 5H_2O\,(l)\; \Delta_c H = +2658.0\; kJ\; mol$

4. The formula E = hν is used to calculate **[1]**

a) wave number
b) energy of the ejected electrons
c) radiation emitted by a black body
d) energy of quantum

5. For an isolated system, ΔU = 0, what will be ΔS? **[1]**

a) ΔS > 0
b) ΔS will increase for some time and then reduce
c) ΔS < 0
d) ΔS = 0

6. 2×10^8 atoms of carbon are arranged side by side. Calculate the radius of carbon atom if the length of this arrangement is 2.4 cm. **[1]**

a) 6.0×10^{-11} m
b) 6.0×10^{-11} m
c) 3.0×10^{-11} m
d) 5.7×10^{-11} m

7. Which of the following processes takes place in oxidation? **[1]**

a) Addition of hydrogen
b) Removal of oxygen
c) Addition of oxygen
d) Removal of chlorine

8. Which method is used for the separation of a mixture of sodium sulphate and sodium dichromate? **[1]**

a) Fractional crystallisation
b) Sublimation

c) Steam distillation
d) Simple distillation

9. The hydrocarbon which can react with sodium in liquid ammonia is________. **[1]**

a) $CH_3CH=CHCH_3$
b) $CH_3CH_2C \equiv CH$
c) $CH_3CH_2CH_2C \equiv CCH_2CH_2CH_3$
d) $CH_3CH_2C \equiv CCH_2CH_3$

10. Where is nitrogen found in the periodic table? **[1]**

a) 3^{nd} period, group 15
b) 2^{nd} period, group 15
c) 2^{nd} period, group 14
d) 2^{nd} period, group 18

11. The sign of ΔG for a spontaneous and non-spontaneous process respectively are **[1]**

a) positive and negative
b) negative and positive
c) zero and positive
d) positive and zero

12. A liquid hydrocarbon is converted to a mixture of gaseous hydrocarbon by _______. **[1]**

a) hydrolysis
b) oxidation
c) cracking
d) distillation

13. **Assertion (A):** Cyclopentadienyl anion is much more stable than allyl anion. **[1]**

Reason (R): Cyclopentadienyl anion is aromatic in character.

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:** Alkylbenzene is not prepared by Friedel-Crafts alkylation of benzene. **[1]**

Reason: Alkyl halides are less reactive than acyl halides.

a) If both Assertion & Reason are true and the reason is the correct explanation of the assertion.
b) If both Assertion & Reason are true but the reason is not the correct explanation of the assertion.
c) If Assertion is true statement but Reason is false.
d) If both Assertion and Reason are false statements.

15. **Assertion (A):** Orbitals form the basis of the electronic structure of atoms. **[1]**

Reason (R): An atomic orbital is the wave function ψ for an electron in an atom.

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):** One mole of SO_2 contains double the number of molecules present in one mole of O_2. **[1]**

Reason (R): Molecular weight of SO_2 is double to that of O_2.

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. Glycine is an α-amino acid. It exists in the form of Zwitter ion as $^{+}NH_3CH_2COO^{-}$. **[2]**

Write the formula of its

i. conjugate acid
ii. conjugate base

18. Explain why cation are smaller and anions larger in radii than their parent atoms? **[2]**

19. Round up the following upto three significant figures: **[2]**

i. 34.216
ii. 10.4107
iii. 0.04597

iv. 2808

20. Rotation around carbon-carbon single bond of ethane is not completely free. Justify the Statement. **[2]**

OR

Despite their - I effect, halogens are o - and p-directing in haloarenes. Explain.

21. Calculate the energy of each of the photons which **[2]**

i. correspond to light of frequency 3×10^{15} Hz

ii. have wave length of 0.50 $\overset{0}{A}$

Section C

22. Arrange the following in order of increasing: **[3]**

i. dipole moment H_2O, H_2S, BF_3

ii. covalent character LiCI, LiBr, LiI

iii. covalent character NaCI, $MgCI_2$, $AICI_3$

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

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

(ii) Water can be lifted into the water tank at the top of the house with the help of a pump. Then why is it not considered to be spontaneous? **[1]**

(iii) Define surroundings. **[1]**

24. At 60^o C, dinitrogen tetroxide is fifty percent dissociated. Calculate the standard free energy change at this temperature and at one atmosphere. **[3]**

25. Calculate the oxidation state of **[3]**

i. Mn in $KMnO_4$ and

ii. N in NO_3^-.

26. Correct the following electronic configuration of the elements in the ground state. **[3]**

i. $1s^2 2s^1, 2p_x^2, 2p_y^2, 2p_z^2, 3s^2, 2p_x^1$

ii. $1s^2 2s^1, 2p_x^1, 2p_y^1, 2p_z^1$

iii. $1s^2 2s^1$, $2p^6$, $3s^2$, $3p^6$, $3d^5$

iv. $1s^2$ $2s^2$, $2p^6$,$3s^2$, $3p^6$, $3d^4$, $4s^2$

27. Write the general outer electronic configuration of s, p ,d and f-block elements? **[3]**

28. A sugar syrup of weight 214.2 g contains 34.2 g of sugar ($C_{12}H_{22}O_{11}$). Calculate **[3]**

i. molal concentration, and

ii. mole fraction of sugar in the syrup

Section D

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

Once an organic compound is extracted from a natural source or synthesised in the laboratory, it is essential to purify it. Various methods used for the purification of organic compounds are based on the nature of the compound and the impurity present in it. Finally, the purity of a compound is ascertained by determining its melting or boiling point. This is one of the most commonly used techniques for the purification of solid organic compounds. In crystallisation Impurities, which impart colour to the solution are removed by adsorbing over activated charcoal. In distillation Liquids having different boiling points vaporise at different temperatures. The vapours are cooled and the liquids so formed are collected separately. Steam Distillation is applied to separate substances which are steam volatile and are immiscible with water. Distillation under reduced pressure: This method is used to purify liquids having very high boiling points.

(i) Which method can be used to separate two compounds with different solubilities in a solvent?

OR

Why chloroform and aniline are easily separated by the technique of distillation?

(ii) Distillation method is used to separate which type of substance?

(iii) Which technique is used to separate aniline from aniline water mixture?

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

When anions and cations approach each other, the valence shell of anions are pulled towards the cation nucleus and thus, the shape of the anion is deformed. The phenomenon of deformation of anion by a cation is known as polarization and the ability of the cation to polarize the anion is called as polarizing power of cation. Due to polarization, sharing of electrons occurs between two ions to some extent and the bond shows some covalent character.

The magnitude of polarization depends upon a number of factors.

(i) Out of $AlCl_3$ and AlI_3 which halides show maximum polarization?

(ii) Out of $AlCl_3$ and $CaCl_2$ which one is more covalent in nature?

(iii) The non-aqueous solvent like ether is added to the mixture of LiCl, NaCl and KCl. Which will be extracted into the ether?

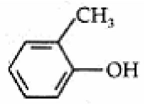
OR

Out of CaF_2 and CaI_2 which one has a minimum melting point?

Section E

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

(i) Write the IUPAC name given below: **[1]**

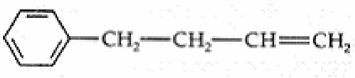


(ii) Why does the iodination of benzene is carried out in the presence of nitric acid or iodic acid? **[1]**

(iii) Although benzene is highly unsaturated it does not undergo addition reactions. **[1]**

(iv) Why is benzene extraordinarily stable though it contains three double bonds? **[1]**

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



(vi) Why do alkynes not show geometrical isomerism? **[1]**

(vii) How will you distinguish between acetylene and ethylene? **[1]**

32. What is the pH of 0.001 M aniline solution? The ionisation constant of aniline is 4.27×10^{-10}. **[5]**

Calculate the degree of ionisation of aniline in the solution. Also calculate the ionisation constant of the conjugate acid of aniline.

OR

The ionization constant of benzoic acid is 6.46×10^{-5} and K_{sp} for silver benzoate is 2.5×10^{-13}. How many times is silver benzoate more soluble in a buffer of pH 3.19 compared to its solubility in pure water?

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

(i)

i. Which of the two: $O_2NCH_2\ CH_2O^-$ or $CH_3CH_2O^-$ is expected to be more stable and why? **[2.5]**

ii. Show the polarization of carbon-magnesium bond in the following structure: $CH_3—CH_2—CH_2—CH_2—Mg—X$. **[2.5]**

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.

(c) 300.15 K

Explanation: The relation between Kelvin (K) & ^{o}C is given by the expression, K = (^{o} C + 273.15)

∴ plugging in 27 (given) for ^{o}C in the above expression we get,
K = (27 + 273.15) = 300.15

∴ 27^{o} C = 300.15 K

2.

(b) 2s, 4d and 3p respectively

Explanation: Nuclear charge is defined as the net positive charge experienced by an electron in the orbital of a multi-electron atom. The closer the orbital, the greater is the nuclear charge experienced by the electron (s) in it.
(i) 2s is closer to the nucleus than 3s.Hence 2s will experience larger effective nuclear charge.
(ii) 4d will experience greater nuclear charge than 4f since 4d is closer to the nucleus than 4f.
(iii) 3p will experience greater nuclear charge since it is closer to the nucleus than 3f because 3p is closer to nucleus than 3f.

3.

(b) $2C_4H_{10}\left(g\right)+13O_2\left(g\right)\rightarrow 8CO_2\left(g\right)+10H_2O\left(l\right)\Delta_cH=-2658.0\;kJ\;mol^{-1}$

Explanation: Enthapy of combustion is the energy released when 1mole of a hydrocarbon (butane) reacts completely in presence of excess of oxygen. The chemical equation for exothermic reaction for combustion of one mole of butane is represented as;

$2C_4H_{10}\left(g\right)+13O_2\left(g\right)\rightarrow 8CO_2\left(g\right)+10H_2O\left(l\right)\Delta_cH=-2658.0\;kJ\;mol^{-1}$

4.

(d) energy of quantum

Explanation: Max Planck theorized that energy was transferred in chunks known as quanta, equal to $h\nu$. The variable h is a constant equal to 6.63 × 10^{-34} J·s and the variable νrepresents the frequency in 1/s.
This equation allows us to calculate the energy of photons, given their frequency.
If the wavelength is given, the energy can be determined by first using the wave equation $(c=\lambda\times\nu)$ to find the frequency, then using Planck's equation to calculate energy.

5. **(a)** $\Delta S > 0$

Explanation: For an isolated system, $\triangle U=\ 0$ and for a spontaneous process, Total entropy change must be positive.

$$\triangle S=\ \frac{q_{rev}}{T}=\frac{\triangle H}{T}=\ \frac{\triangle U\ +p\triangle V}{T}=\ \frac{0+p\triangle V}{T}$$

Moreover, $i.e.\ T\triangle S>0$ $Or\ \ \ \triangle S>0$

6. **(a)** 6.0 × 10^{-11} m

Explanation: Total Length = 2.4 cm

Total number of atoms along the length = 2 × 10^{8}

Therefore diameter of each atom = $\frac{2.4}{2\times10^8}$ = 1.2 × 10^{-8} cm

And the radius of the atom = $\frac{1.2\times10^{-8}}{2}$ = 0.60 × 10^{-8} cm = 6.0 × 10^{-11}m.

7.

(c) Addition of oxygen

Explanation: Addition of oxygen takes place in oxidation.

8. **(a)** Fractional crystallisation

Explanation: Fractional crystallisation

9.

(b) $CH_3CH_2C \equiv CH$

Explanation: Terminal alkynes react with Na in the presence of liquid NH_3 to form higher alkynes. The alkyne contains acidic H at the end (i.e. the H bonded to C_1 of the chain). Therefore, it is easily replaced with highly electropositive metals such as Na in liquid ammonia, to form sodium alkaline ion which can react further in the presence of a suitable catalyst to yield higher alkynes/hydrocarbons.

10.

(b) 2nd period, group 15

Explanation: Nitrogen is the seventh element on the periodic table. It is located in period 2 and group 15. It is at the top of the periodic table, between carbon and oxygen.

11.

(b) negative and positive

Explanation: ΔG gives a criteria for spontaneity at constant pressure and temperature.

i. If ΔG is negative (< 0), the process is spontaneous.

ii. If ΔG is positive (>0), the process is non-spontaneous.

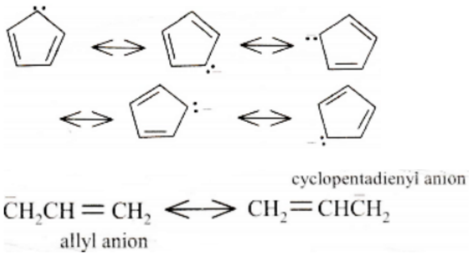
12.

(c) cracking

Explanation: Pyrolysis of higher alkanes into a mixture of lower alkanes, alkenes, etc. is called cracking. Preparation of oil gas from kerosene oil and petrol gas from petrol is based upon the process of cracking.

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

Explanation:



Here the resonance approach is a poor predictor of stability. The Huckel rule. based on molecular orbital theory is a much better predictor of stability for this aromatic and antiaromatic system.

14.

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

Explanation: Assertion: Di, tri alkylated benzenes are also formed in addition to monoalkylated benzene and the separation of these products is difficult. Alkylbenzene is prepared by Friedel-Craft's alkylation of benzene followed by the reduction of acyl benzene to the alkylbenzene. This gives mono alkylated products.

Reason: The carbonyl C atom is more electrophilic than C atom of alkyl halides.

Hence, both Assertion and Reason are are false statements.

15.

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

Explanation: Whenever an electron is described by a wave function, the electron occupies that orbital. Since many such wave functions are possible for an electron, many atomic orbitals are possible in an atom corresponding to it. Orbitals form the basis of the electronic structure of atoms. Each orbital has a definite energy. All the information about the electron in an atom is stored in its orbital wave function ψ and quantum mechanics make it possible to extract this information out of ψ.

16.

(d) A is false but R is true.

Explanation: One mole of any substance corresponds to 6.023×10^{23} entities irrespective of its weight.

Molecular weight of $SO_2 = 32 + 2 \times 16 = 64$g

Molecular weight of $O_2 = 2 \times 16 = 32$g

Therefore Molecular weight of SO_2 is double to that of O_2.

Section B

17. Conjugate acid $^{+}NH_3CH_2COOH$

Conjugate base $NH_2CH_2COO^-$

18. A variation in size of a cation or anion is due the difference in effective nuclear charge on the outermost electrons. In cation, on loss of an electron the effective nuclear charge experienced is more by the remaining valence electrons. They are more tightly held towards centre, thereby the size of the cation decreases. On the other hand in anion, the effective nuclear charge on valence electrons decrease with addition of each new electron. Moreover, there are more inter-electron repulsions in the valence shell. The combination of these two effects eventually increase the size of anion.

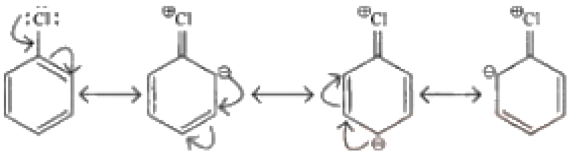
19.

Given number	Rounded off (upto three significant figures)
(i) 34.216	34.2
(ii) 10.4107	10.4
(iii) 0.04597	0.0460
(iv) 2808	2810

20. Ethane contains carbon-carbon sigma (σ) bond and electron distribution of sigma molecular orbital is symmterical around the internuclear axis of the C-C bond which is not distributed due to rotation about its axis and permits free rotation around C-C bond. However, the rotation around C—C single bond is not completely free due to repulsion between electron clouds of C-H bonds on adjacent carbon atoms. Such type of repulsive interaction is called torsional strain.

OR

Halogens present on benzene ring have -I and R effect. -I effect deactivates the ring by withdrawing electron, but +R effect increases the electron density on ortho and para positions. Hence, halogens are ortho and para directing.



21. i. Energy of photon (E) = hv

$h = 6.626 \times 10^{-34}$ J s; $v = 3 \times 10^{15}$ Hz $= 3 \times 10^{15}$ s^{-1}

$E = (6.626 \times 10^{-34}\text{ Js}) \times (3 \times 10^{15}\text{ s}^{-1}) = 1.986 \times 10^{-18}$ J

ii. Energy of photon (E) = hv = $\frac{hc}{\lambda}$

$h = 6.26 \times 10^{-34}$ Js; $c = 3 \times 10^{8}$ ms^{-1}

$\lambda = 0.50 \overset{0}{A} = 0.5 \times 10^{-10}$ m

$E = \frac{(6.626 \times 10^{-34}\text{Js}) \times (3 \times 10^{8}\text{ms}^{-1})}{(0.5 \times 10^{-10}\text{m})} = 3.98 \times 10^{-15}$ J

Section C

22. i. BF_3 is a symmetrical molecule. It has zero dipole moment. oxygen being more electronegative than S, bond moment of O - H is more than S - H. So, the dipole moments are in the order of

$BF_3 < H_2S < H_2O$

ii. The anion size in increasing order is

$CI^- < Br^- < I^-$

Hence, LiCI is least covalent and Lil most. The order is

LiCI < LiBr < Lil

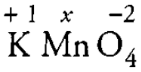
iii. Cation size in decreasing order is

$Na^+ > Mg^{2+} > AI^{3+}$

Thus, AI^{3+} ion has a maximum polarisation effect and Na+ ion has the least. Thus, the covalent order is
$NaCI < MgCI_2 < AICI_3$

23. Answer:
    (i) The mathematical expression of heat capacity is
    $q = c \times m \times \Delta T$
    where c = heat capacity
    m = mass and
    ΔT= temperature change.
    (ii) A spontaneous process should occur continuously by itself after initiation. But this is not so in the given case because water will go up so long as the pump is working.
    So, this process is not considered as a spontaneous process.
    (iii) **Surroundings:** The surroundings include everything other than the system.
    For example, if we are studying the reaction between two substances A and B kept in a beaker, the beaker containing the reaction mixture is the system and the room where the beaker is kept is the surroundings.

24. According to the question, at 60^o C, dinitrogen tetroxide is fifty percent dissociated.
Reaction:
$\mathrm{N_2O_4}(g) \rightleftharpoons 2\mathrm{NO_2}(g)$
If N_2O_4 is 50 % dissociated,
$x_{\mathrm{N_2O_4}} = \frac{1-0.5}{1+0.5}$
$\Rightarrow x_{\mathrm{NO_2}} = \frac{2\times 0.5}{1+0.5}$
$p_{\mathrm{N_2O_4}} = \frac{0.5}{1.5} \times 1 \text{ atm}, \; p_{\mathrm{NO_2}} = \frac{1}{1.5} \times 1 \text{ atm}$
The equilibrium constant K_p is given by
$$K_p = \frac{\left(p_{\mathrm{NO_2}}\right)^2}{p_{\mathrm{N_2O_4}}} = \frac{1.5}{(1.5)^2(0.5)} = 1.33 \text{ atm}$$
Since
$\Delta_r G^o = -RT \ln K_p$
$\Delta_r G^o = -8.314 \text{ JK}^{-1} \text{ mol}^{-1} \times 333 \text{ K} \times 2.303 \times 0.1239 = -763.8 \text{ kJ mol}^{-1}$

25. i. 1. Let the oxidation state of Mn atom be x, other atom like O-atom have -2 while K-atom have +1.

$\overset{+1}{K}\overset{x}{Mn}\overset{-2}{O_4}$
$1 \times (+1) + (1 \times x) + 4 \times (-2) = 0$
$1 + x + (-8) = 0$
$1 + x - 8 = 0$
$x - 7 = 0$
$\therefore x = +7$
Hence, the oxidation number of Mn in MnO_4 is +7.

ii. N in $\mathrm{NO_3^-}$.
Let the oxidation number of N in $\mathrm{NO_3^-}$ be x and other atom like O^- atom is -2.
$\therefore$ Sum of the oxidation numbers of all the atoms in $\mathrm{NO_3^-} = x + 3(-2) = x - 6$
But the sum of oxidation numbers of all the atoms in $\mathrm{NO_3^-}$ ion is equal to the charge present on it i.e., -1
$\therefore x - 6 = -1$
or x = +5
Thus, the oxidation numbers of N in $\mathrm{NO_3^-}$ is +5.

26. i. $1s^2 2s^2, 2p_x^2, 2p_y^2, 2p_z^2, 3s^2$
ii. $1s^2 2s^2, 2p_x^1, 2p_y^1, 2p_z^1$
iii. $1s^2\ 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^2$
iv. $1s^2\ 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$

27. The general outer electronic configuration are:

(i) s-Block elements : ns^{1-2} where n = 2 - 7

(ii) p-Block elements : $ns^2\ np^{1-6}$ where n = 2 - 6

(iii) d-Block elements : $(n-1)d^{1-10}\ ns^{0-2}$ where n = 4 - 7

(iv) f-Block elements : $(n-2)f^{0-14}\ (n-1)d^{0-1}\ ns^2$ where n = 6 - 7

28. i. Weight of sugar syrup = 214.2 g

Weight of sugar in syrup = 34.2 g

weight of water in syrup = 214.2 - 34.2 = 180.0 g

Moles of sugar = $\frac{34.2}{342}$ = 0.1 (Molar mass = 342)

Molality = $\frac{0.1}{180} \times 1000$ = 0.56 m

ii. Moles of sugar = $\frac{34.2}{342}$ = 0.1

Moles of water = $\frac{180}{18}$ = 10

Mole fraction of sugar = $\frac{0.1}{10+0.1}$

= 0.0099

Section D

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

Once an organic compound is extracted from a natural source or synthesised in the laboratory, it is essential to purify it. Various methods used for the purification of organic compounds are based on the nature of the compound and the impurity present in it. Finally, the purity of a compound is ascertained by determining its melting or boiling point. This is one of the most commonly used techniques for the purification of solid organic compounds. In crystallisation Impurities, which impart colour to the solution are removed by adsorbing over activated charcoal. In distillation Liquids having different boiling points vaporise at different temperatures. The vapours are cooled and the liquids so formed are collected separately. Steam Distillation is applied to separate substances which are steam volatile and are immiscible with water. Distillation under reduced pressure: This method is used to purify liquids having very high boiling points.

(i) Fractional crystallizationis used to separate two compounds with different solubilities in a solvent.

OR

Chloroform and aniline are easily separated by the technique of distillation because chloroform and aniline have sufficient difference in their boiling points.

(ii)
- volatile liquids from nonvolatile impurities.
- the liquids having sufficient difference in their boiling points.

(iii) Aniline is separated from aniline water mixture by steam distillation as one of the substances in the mixture is water and the other, a water insoluble substance.

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

When anions and cations approach each other, the valence shell of anions are pulled towards the cation nucleus and thus, the shape of the anion is deformed. The phenomenon of deformation of anion by a cation is known as polarization and the ability of the cation to polarize the anion is called as polarizing power of cation. Due to polarization, sharing of electrons occurs between two ions to some extent and the bond shows some covalent character.

The magnitude of polarization depends upon a number of factors.

(i) AlI_3 halides show maximum polarization. The most covalent halide is AlI_3.

Since lesser, the electronegativity difference, the more covalent is the aluminum halide.

(ii) $AlCl_3$ is more covalent in nature.

(iii) LiCl will be extracted into the ether.

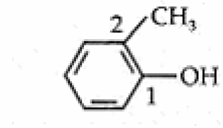
OR

CaI_2 has a minimum melting point.

Section E

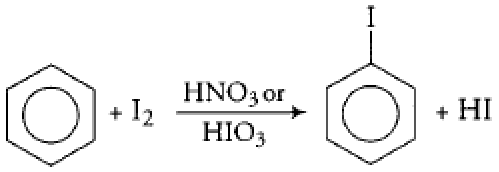
31. Attempt any five of the following:

(i)



2 – Methylphenol

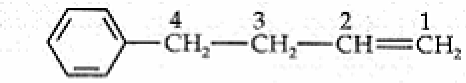
(ii) The iodination of benzene is usually brought about by refluxing benzene with iodine and conc. HNO_3 or HIO_3. HNO_3 or HIO_3 oxidises HI to I_2 and prevents the backward reaction to occur.



(iii) It is due to delocalization of π-electrons in benzene it is highly stable.

(iv) Due to resonance, benzene is extraordinarily stable.

(v)



4 – Phenylbut – 1 – ene

(vi) Alkynes have a linear structure. Alkynes have triple bond. So, rotation is not possible. Hence, alkynes cannot show geometrical isomerism.

(vii) Acetylene forms precipitate with ammoniacal silver nitrate solution, ethylene does not react with these reagents.

32. $C_6H_5NH_2 + H_2O \rightleftharpoons C_6H_5NH_3^+ + OH^-$

$$K_b = \frac{[C_6H_5NH_3^+][OH^-]}{[C_6H_5NH_2]}$$

$$= \frac{[OH^-]^2}{[C_6H_5NH_2]}$$

$[OH^-] = \sqrt{K_b \cdot C} = \sqrt{4.27 \times 10^{-10} \times 0.001}$

$[OH^-] = 6.534 \times 10^{-7}$

$pOH = -\log[OH^-] = -\log[6.534 \times 10^{-7}]$

pOH = -0.8152 + 7 = 6.18

From, pH + pOH = 14

pH = 14 - 6.18 = 7.82

$$C_6H_5NH_2 + H_2O \rightleftharpoons C_6H_5NH_3^+ + OH^-$$

Initial conc.	C	0	0
Equili. conc.	$C - C\alpha$	$C\alpha$	$C\alpha$

$K_b = \frac{C\alpha \cdot C\alpha}{C(1-\alpha)}$ [$(1-\alpha) \approx 1$ for weak base]

$K_b = C\alpha^2 = \alpha = \sqrt{\frac{K_b}{C}}$

Degree of ionisation,

$\alpha = \sqrt{\frac{4.27 \times 10^{-10}}{0.001}} = 6.53 \times 10^{-4}$

K_a of conjugate acid of aniline,

$$K_a = \frac{K_w}{K_b}$$

$= \frac{10^{-14}}{4.27 \times 10^{-10}} = 2.34 \times 10^{-5}$

OR

$$C_6H_5COOAg \rightarrow C_6H_5COO^- + Ag^+$$

Solubility of water. Suppose solubility in water = x mol L^{-1} then

$[C_6H_5COO^-] = [Ag^+] = x \text{ mol } L^{-1}$

$x^2 = K_{sp}$ or $x = \sqrt{K_{sp}} = \sqrt{2.5 \times 10^{-13}}$

$= 5 \times 10^{-7}\ mol\ L^{-1}$

Solubility in buffer of pH = 3.19

pH = 3.19 means $-\log[H^+] = 3.19$

or $\log[H^+] = -3.19 = \bar{4}.81$ or $[H^+] = 6.457 \times 10^{-4} M$

$C_6H_5COO^-$ ions now combine with the H^+ ions to form benzoic acid but $[H^+]$ remains almost constant because we have buffer solution. Now

$$C_6H_5COOH \rightleftharpoons C_6H_5COO^- + H^+$$

$$\therefore K_a = \frac{[C_6H_5COO^-][H^+]}{[C_6H_5COOH]} \text{ or } \frac{[C_6H_5COOH]}{[C_6H_5COO^-]} = \frac{[H^+]}{K_a} = \frac{6.457 \times 10^{-4}}{6.46 \times 10^{-5}} = 10 \quad \text{.... (i)}$$

Suppose solubility in the buffer solution is 'y' mol L^{-1}. Then as most of the benzoate ions are converted into benzoic acid molecules (which remain almost ionized), we have

y = $[Ag^+]$ = $[C_6H_5COO^-]$ + $[C_6H_5COOH]$ = $[C_6H_5COO^-]$ + $10[C_6H_5COO^-]$ = $11[C_6H_5COO^-]$ using equation (i)

$\therefore [C_6H_5COO^-] = \frac{y}{11}\ \therefore K_{sp} = [C_6H_5COO^-][Ag^+]$

$2.5 \times 10^{-3} = \frac{y}{11} \times y$ or $y^2 = 2.75 \times 10^{-12}$ or $y = 1.66 \times 10^{-6}$

$\frac{y}{x} = \frac{1.66\times10^{-6}}{5\times10^{-7}}$ = 3.32

Note that in case of salts of weak acids, the solubility is more in the acidic solution than in water. The reason, in general, may be explained as follows: Taking example of C_6H_5COOAg, we have

$C_6H_5COOAg \rightleftharpoons C_6H_5COO^- + Ag^+$

In acidic solution, the anions ($C_6H_5COO^-$ in the present case) undergo protonation in presence of acid. Thus, $C_6H_5COO^-$ ions are removed. Hence, equilibrium shifts forward producing more Ag^+ ions. Alternatively, as $C_6H_5COO^-$ ions are removed, Q_{sp} decreases. In order to maintain solubility product equilibrium ($Q_{sp} = K_{sp}$), Ag^+ ion concentration must increase. Hence, solubility is more.

33. Answer:

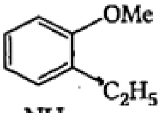
(i) i. $O_2N \leftarrow CH_2 \leftarrow CH_2 \leftarrow O^-$ is more stable then $CH_3 \rightarrow CH_2 \rightarrow O^-$ because NO_2 group has -I-effect and hence it tends to disperse the -ve charge on the O-atom. In contrast, CH_3CH_2 has + I-effect. It, therefore, tends to intensify the -ve charge and hence destabilizes it.

ii. Carbon is more electronegative than magnesium.So, Mg has a partially positive charge and C has a partially negative charge because a bonded pair of electrons attracted towards carbon.

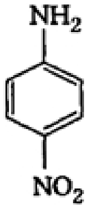
$CH_3 - CH_2 - \overset{\delta-}{C}H_2 - CH_2 < -\overset{\delta+}{M}g - X$

OR

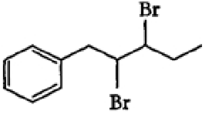
i. i.



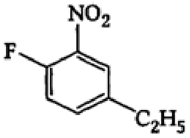
ii.

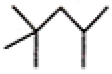
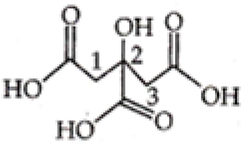
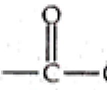
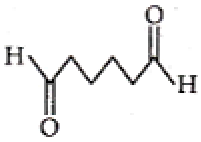
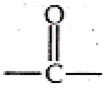


iii.



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)