Class XI Session 2024-25
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. If the concentration of glucose ($C_6H_{12}O_6$) in blood is 0.9 g L^{-1}, what will be the molarity of glucose in blood? **[1]**

a) 50 M
b) 0.005 M
c) 0.5 M
d) 5 M

2. Among the following pairs of orbitals 2s and 3s, 4d and 4f, 3d and 3p, the orbitals that will experience the larger effective nuclear charge will be: **[1]**

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

3. If V_f is the final volume and V_i is the initial volume and p_{ex} external pressure then the work is done can be calculated by? **[1]**

a) $\int\limits_{V_i}^{V_f} p_{ex} dV$
b) $\int\limits_{0}^{V_f} p_{ex} dV$
c) $-\int\limits_{V_i}^{V_f} p_{ex} dV$
d) $-\int\limits_{V_i}^{0} p_{ex} dV$

4. Around 10^{15} Hz corresponds to the region of the electromagnetic spectrum **[1]**

a) ultraviolet region
b) infrared region
c) visible light
d) microwave region

5. Standard Molar Enthalpy of formation is: **[1]**

a) the standard enthalpy change for the
b) the standard enthalpy change for the

formation of one mole of a compound from its elements in at a pressure of 10 bar and 30°C.

formation of one kg of a compound from its elements in their most stable states of aggregation.

c) the standard enthalpy change for the formation of one mole of a compound from its elements in their most stable states of aggregation.

d) the standard enthalpy change for the formation of one mole of a compound from its elements in at a pressure of 2 bar and 25^{o} C.

6. de-Broglie equation is **[1]**

a) $\lambda = \frac{hv}{m}$

b) $\lambda = \frac{mv}{h}$

c) λ = hmv

d) $\lambda = \frac{h}{mv}$

7. In the ethylene molecule the two carbon atoms have the oxidation number **[1]**

a) -1, -2

b) -1, -1

c) -2,-2

d) +2, -2

8. In which method oil bath is used? **[1]**

a) Distillation under reduced pressure

b) Steam distillation

c) Simple distillation

d) Fractional distillation

9. Presence of a nitro group in a benzene ring: **[1]**

a) deactivates the ring towards electrophilic substitution.

b) activates the ring towards electrophilic substitution.

c) renders the ring basic.

d) deactivates the ring towards nucleophilic substitution.

10. Which of the following compounds is/are amphoteric in nature? **[1]**

a) As_2O_3

b) Both AI_2O_3 and As_2O_3

c) CI_2O_7

d) AI_2O_3

11. The bond enthalpy depends on? **[1]**

a) Electronegativity

b) All of these

c) Bond length

d) Size of the atom

12. On passing vapours of phenol over heated zinc dust it gets reduced to **[1]**

a) benzene

b) toluene

c) C_6H_5OH

d) aniline

13. **Assertion (A):** The IUPAC name for $\mathrm{CH_3CH = CH - C \equiv CH}$ is pent-3-en-1-yne and not pent-2-en-4-yne. **[1]**
Reason (R): While deciding the locants for double and triple bonds, lowest sum rule is always followed.

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):** Acetylene is acidic in nature. **[1]**

Reason (R): Acetylene is sp hybridised.

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 energy of quantum of radiation is given by $E = h\nu$. **[1]**

Reason (R): Quantum in the energy equation signifies the principal quantum number.

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):** A certain element X, forms three binary compounds with chlorine-containing 59.68%, 68.95% and 74.75% chlorine respectively. These data illustrate the law of multiple proportions. **[1]**

Reason (R): According to law of multiple proportions, the relative amounts of an element combining with some fixed amount of a second element in a series of compounds are the ratios of small whole numbers.

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.

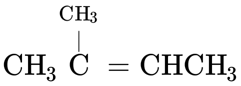
Section B

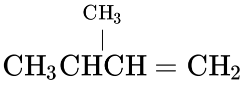
17. The dissociation of HI is independent of pressure, while dissociation of PCl_5 depends upon the pressure applied. Why? **[2]**

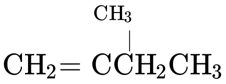
18. Why does electronegativity value increases across a period and decreases down period? **[2]**

19. How much potassium chlorate should be heated to produce 2.24L of oxygen at NTP? **[2]**

20. Arrange the following alkenes in the decreasing order of stability. **[2]**

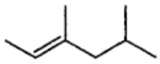
i. 
$\mathrm{CH_3\overset{\overset{CH_3}{|}}{C}=CHCH_3}$

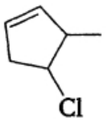
ii. 
$\mathrm{CH_3\overset{\overset{CH_3}{|}}{C}HCH=CH_2}$

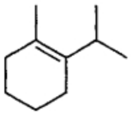
iii. 
$\mathrm{CH_2=\overset{\overset{CH_3}{|}}{C}CH_2CH_3}$

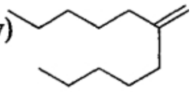
OR

Give the IUPAC names of each of the following:

(i) 

(ii) 

(iii) 

(iv) 

21. Calculate the wavelength of the radiation which would cause photochemical dissociation of a chlorine molecule. The bond dissociation energy Cl - Cl of bond is 245 kJ mol^{-1}. **[2]**

Section C

22. Explain the important aspect of resonance with reference to the CO_3^{2-} ion. **[3]**

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

(a) Two litres of an ideal gas at a pressure of 10 atm expands isothermally at 25 °C into a vacuum until its **[1]** total volume is 10 litres. How much heat is absorbed and how much work is done in the expansion against a constant external pressure of 1 atm?

(b) What is free energy in terms of thermodynamics? **[1]**

(c) Define a system. **[1]**

24. How will you calculate work done on an ideal gas in a compression, when the change in pressure is carried out in infinite steps? **[3]**

25. i. Use the following reactions to arrange the elements A, B, C and D in order of their redox reactivity **[3]**

    a. $A + B^+ \rightarrow A^+ + B$

    b. $B + D^+ \rightarrow B^+ + D$

    c. $C^+ + D \rightarrow$ No reaction

    d. $B + C^+ \rightarrow B^+ + C$

    ii. On the basis of above redox activity series, predict which of the following reactions would you expect to occur?

    a. $A^+ + C \rightarrow A + C^+$

    b. $A^+ + D \rightarrow A + D^+$

26. What is the number of photons of light with wavelength 4000 pm which provides 1 J of energy? **[3]**

27. Among the elements B, AI, C and Si **[3]**

    i. Which has the highest first ionization enthalpy?
    ii. Which has the most negative electron gain enthalpy?
    iii. Which has the largest atomic radius?
    iv. Which has the most metallic character?

28. Calculate the number of atoms in each of the following **[3]**

    i. 52 mole of Ar
    ii. 52 u of He
    iii. 52 g of He.

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]**

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. (1)
ii. The molecular orbital theory is preferred over valence bond theory. Why? (1)
iii. Ethyne is acidic in nature in comparison to ethene and ethane. Why is it so? (2)

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? (2)

Section E

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

(a) Convert 1-bromopropane to 2-bromopropane. **[1]**
(b) Although benzene is highly unsaturated it does not undergo addition reactions. **[1]**
(c) How is alkene produced by vicinal dihalide? **[1]**
(d) How will you convert ethanoic acid into ethene? **[1]**
(e) What is the number of σ and π bond in N ≡ C – CH = CH – C ≡ N? **[1]**
(f) Write the general formula for alkynes. **[1]**
(g) What do you mean by delocalization? **[1]**

32. Determine the solubilities of silver chromate, barium chromate, ferric hydroxide, lead chloride and mercurous iodide at 298 K from their solubility product constants. **[5]**

i. $K_{sp}(Ag_2CrO_4) = 1.1 \times 10^{-12}$,
ii. $_{Ksp}(BaCrO_4) = 1.2 \times 10^{-10}$,
iii. $K_{sp}[Fe(OH)_3] = 1.0 \times 10^{-3}$,

Determine also the molarities of individual ions.

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]**

(a) i. a. Define the following terms: **[2.5]**

i. Enantiomers

ii. Racemic mixture

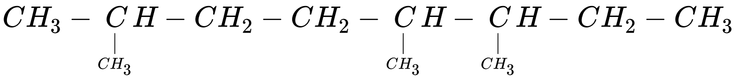
b. Why is chlorobenzene resistant to nucleophilic substitution reaction?

ii. What is the general molecular formula of saturated monohydric alcohols? **[2.5]**

OR

i. Two liquids (A) and (B) can be separated by the method of fractional distillation. The boiling point of a liquid (A) is less than the boiling point of a liquid (B). Which of the liquids do you expect to come out first in the distillate? Explain. **[2.5]**

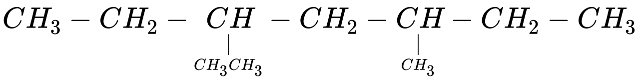
ii. Structures and IUPAC names of some hydrocarbons are given below. Explain why the names given in the parentheses are incorrect. **[2.5]**

a. 

$CH_3 - \underset{CH_3}{\underset{|}{C}}H - CH_2 - CH_2 - \underset{CH_3}{\underset{|}{C}}H - \underset{CH_3}{\underset{|}{C}}H - CH_2 - CH_3$

2,5,6- Trimethyloctane

[and not 3,4,7- Trimethyloctane]

b. 

$CH_3 - CH_2 - \underset{CH_3CH_3}{\underset{|}{CH}} - CH_2 - \underset{CH_3}{\underset{|}{CH}} - CH_2 - CH_3$

3-Ethyl-5-methylheptane

[and not 5-Ethyl-3-methylheptane]

Solution

Section A

1\.

(b) 0.005 M

Explanation: $Molarity = \frac{Concentration\ in\ g/L}{Molar\ mass}$

Concentration of glucose in blood= 0.9 g/L

Molar mass of glucose ($C_6H_{12}O_6$) = 6 × 12 + 12 × 1 + 6 × 16 = 180 g mol^{-1}

$Molarity = \frac{0.9}{180}$ = 0.005 M

2\.

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

Explanation: An electron is shielded from the attractive interactions of the nucleus by the electrons in the inner shells.The repulsive and attractive interactions of an electron depend on the shell and the orbital in which the electron is present.

3\.

(c) $-\int\limits_{V_i}^{V_f} p_{ex} dV$

Explanation: $-\int\limits_{V_i}^{V_f} p_{ex} dV$ = w

It is equal to the integration of change in volume with respect to the initial and final volume.

4\.

(c) visible light

Explanation: Electromagnetic radiation in this range of wavelengths is called visible light or simply light. A typical human eye will respond to wavelengths from about 390 to 700 nm. In terms of frequency, this corresponds to a band in the vicinity of 430–770 THz.

5\.

(c) the standard enthalpy change for the formation of one mole of a compound from its elements in their most stable states of aggregation.

Explanation: The standard enthalpy change for the formation of one mole of a compound from its elements in their most stable states of aggregation (reference states) is called standard molar enthalpy of formation.

6\.

(d) $\lambda = \frac{h}{mv}$

Explanation: Louis de-Broglie proposed that matter, like light , has a dual character.It exhibits wave as well as particle nature. The wavelength of the wave associated with a particle of mass m moving with velocity v is given by

$\lambda = \frac{h}{mv}$

7\.

(c) -2,-2

Explanation: In general carbon molecule have 4 valence electrons and in ethylene molecule ($H_2C = CH_2$) each carbon atom is surrounded by 6 valence electron so by calculating its oxidation number we will get 4 - 6= -2. so, thats why carbon have -2,-2 oxidation number.

8\.

(d) Fractional distillation

Explanation: Fractional distillation

9\. **(a)** deactivates the ring towards electrophilic substitution.

Explanation: This is because the Nitro is an electron-withdrawing group, it pulls the electron density from the ring towards itself thereby decreasing the electron density in the ring and deactivating the ring towards attack by the electrophile.

10.

(b) Both AI_2O_3 and As_2O_3

Explanation: $A1_2O_3$ and As_2O_3 are amphoteric in nature. Amphoteric oxides behave as acidic with bases and basic with acids.

11.

(b) All of these

Explanation: The bond enthalpy depends on many factors sizes of atoms involved in the bond, differences in their electronegativity, bond length, electron affinities, etc.

12. **(a)** benzene

Explanation: Phenol is reduced to benzene.

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

Explanation: When double and triple bonds are presently lowest sum rule is followed thus in $\overset{5}{C}H_3\overset{4}{C}H=\overset{3}{C}H-\overset{2}{C}=\overset{1}{C}H$
Sum of locants (1 + 3) = 4.
In $\underset{1}{C}H_3\underset{2}{C}H=\underset{3}{C}H-\underset{4}{C}\equiv\underset{5}{C}H$
Sum of locants (2 + 4) = 6
So it is named as pent-3-en-1-yne.

14.

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

Explanation: The acidic nature in acetylene is described on the basis of higher electronegativity of sp hybridized carbon atom which pulls more effectively the C - H bond pair to lose H^+.

15.

(c) A is true but R is false.

Explanation: $E = h\nu$, where h = Planck's constant = 6.626×10^{-34} Js and ν = frequency. Quantum is the smallest quantity of energy that can be emitted (or absorbed). According to Planck' theory, energy is emitted in integral multiples of $h\nu$, e.g. $h\nu$, $2h\nu$, $3h\nu$ etc.

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

Explanation: Both A and R are true and R is the correct explanation of A.

Section B

17. For, the dissociation of HI, we have the equation $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$. Here 2 moles of reactants give 2 moles of products. Hence $\Delta n = 0$ and so according to Le Chatelier's principle, dissociation of HI is independent of pressure. For the dissociation of PCl_5, we have $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$. Here 1 mole of reactant gives 2 moles of products. Hence $\Delta n = 1$ and so according to Le Chatelier's principle, dissociation of PCl_5 depends on pressure.

18. Electronegativity is the tendency of an element to attract the shared pair of electrons towards itself in a covalently bonded molecule. Electronegativity of an element is inversely proportional to its atomic size. It means with increase in atomic size , electronegativity of an element decreases.
    1. We know that atomic size increases down the group. Therefore electronegativity decreases down the group.
    2. The attraction between the outer electrons and the nucleus increases, as the atomic radius decreases in a period. The electronegativity also increases.

19. When potassium chlorate is heated, then following reaction takes place:
$2KClO_3 \rightarrow 2KCl + 3O_2$
Molecular mass of 1mol $KClO_3$ = 39 + 35.5 + 3 × 16= 122.5 g
Molecular mass of 2 mols of $KClO_3$ = 2 × 122.5 g =245 g
Volume occupied by 3 mol of oxygen = 3 × 22.4L = 67.5 L
Therefore, 67.2L of oxygen is produced from 245g of $KClO_3$
2.24L of oxygen is produced from = $\frac{245}{67.2} \times 2.24$= 8.17g of $KClO_3$

20. Stability of an alkene increases with increase in the number of electron donating substituent at the position of double bonded carbon atom. Thus, the order is (i) > (iii) > (ii).

OR

IUPAC name

i. 3, 5-dimethyl-2-hexene or 3, 5 -dimethylhex-2-ene
ii. 4-chloro-3-methylcyclopentene
iii. 1-sec-butyl-2-methylcyclohexene or 1-methyl-2-(1-methylpropyl) cyclohexen
iv. 2-pentyl-1-heptene or 2-pentylhept-1-ene

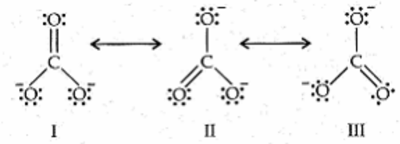
21. Bond dissociation energy required to break 1 mole of Cl-Cl bonds = 245 kJ (Given)

Therefore, Energy required to break one Cl—Cl bond $= \frac{245\times10^{3}}{6.023\times10^{23}} = 4.068 \times 10^{-19}\mathrm{J}$

Now, $E = bv = \frac{bc}{\lambda}$

$\lambda = \frac{hc}{E} = \frac{6.626\times10^{-34}\times3.0\times10^{8}}{4.068\times10^{-19}} = 4.89 \times 10^{-7}\mathrm{m}$

Section C

22. 

Resonance in, CO_3^{2-} I, II and III represent the three canonical forms.

i. In these structures, the position of nuclei is the same.
ii. All the three forms have the almost equal energy
iii. The same number of paired and unpaired electrons they differ only in their position.

23. Answer:

(i) W = $-P_{ext}.\Delta V$

P_{ext} = 1atm

ΔV = 10−2L=8L

$\therefore$W = −1×8 = −8atm−L

We have q = – w = p_{ext} (8) = 8 litre-atm

(ii) Free energy of a system is the capacity to do work.

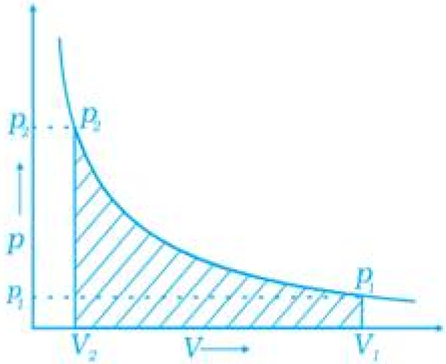
G = H-TΔS

(iii)A system in thermodynamics refers to that part of the universe in which observations are made.

24. When compression is carried out in infinite steps with the change in pressure, it is a reversible process.

Work done can be calculated from pV-plot when pressure is not constant.

A pV plot of the work of compression which is carried out by the change in pressure in infinite steps during compression from the initial volume, V_i to the final volume, V_f is shown in the figure. The work done on the gas is represented by the shaded area.



25. i. The electrochemical series or redox activity is based on the decreasing order of reduction potentials. This means that the species which gets reduced is higher in the electrochemical series as compared to the other which is to get oxidised (lose electrons).

In reaction (a), B^+ gets reduced by A and therefore B is higher than A in electrochemical series.

In reaction (b), D^+ gets reduced by B and therefore, D is higher in the electrochemical series than B.

In reaction (c), C^+ does not get reduced by D, therefore, C is lower than D in electrochemical series. But according to reaction (d), C^+ gets reduced by B and therefore, C is higher in electrochemical series than B.

Thus, the correct order is D > C > B > A

ii. Both reactions do not occur because A cannot be reduced by C as well as D.

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

h = 6.626×10^{-34} Js, c= 3×10^{8} ms^{-1}, λ = 4000 pm = 4000×10^{-12} = 4×10^{-9} m

$\therefore$ Energy of photon (E) = $\frac{(6.626\times10^{-34}\text{Js})\times(3\times10^{8}\text{ms}^{-1})}{(4\times10^{-9}\text{m})}$ = 4.969×10^{-17} J

Now, 4.969×10^{-17} J is the energy of photon = 1

$\therefore$1 J is the energy of photons = $\frac{1}{4.969\times10^{-17}}$= 2.012×10^{16} photons.

27. i. C has the highest first ionization enthalpy.
   ii. C has the most negative electron gain enthalpy.
   iii. AI has the largest atomic radius.
   iv. AI has the most metallic character.

28. i. 1 mole of Ar contains 6.022×10^{23} atoms
   $\therefore$ 52 mole of Ar will contain $6.022 \times 10^{23} \times 52 = 3.13 \times 10^{25}$ atoms
   ii. 4 u of He = 1 He atom
   $\therefore$ 52 u of He = $\frac{1}{4} \times 52$ He atoms = 13 He atoms.
   iii. 1 mol atom of He = 4g = 6.023×10^{23} atoms
   4 g of He contains 6.022×10^{23} atoms
   52 g of He will contain = $\frac{6.022\times10^{23}\times52}{4} = 7.83 \times 10^{24}$ atoms.

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. 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) 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.

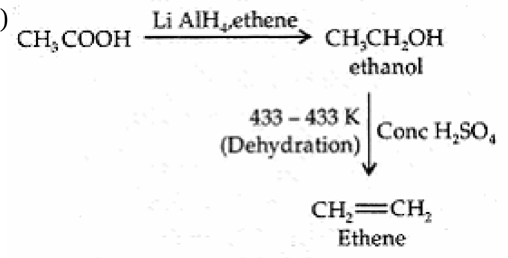
$$CH_3CH_2CH_2Br \xrightarrow{\text{KOH (alc.)}} CH_3-CH=CH_2 \xrightarrow{\text{HBr}} CH_3-\overset{\overset{\large Br}{|}}{C}H-CH_3$$

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

(iii) Alkene are produced from Vicinal dihalide by the process of dehalogenations. Vicinal dihalide on treatment with Zn metal lose a molecule of ZnX_2 to from an alkene.

$CH_2Br\text{-}CH_2Br + Zn \rightarrow CH_2=CH_2 + ZnBr_2$.

(iv)



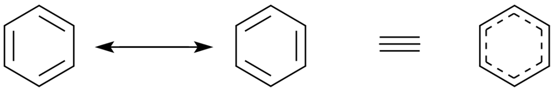
(v) In Triple bond, there are two π-bonds and one σ bond and in double bond, one is σ bond and one π-bond. Therefore, in this compound there are 7σ bonds and 5 π-bonds.

(vi) General formula of alkynes is C_nH_{2n-2}

(vii) Delocalisation implies that pairs of bonding electrons extend over three or more atoms and belong to the whole molecule.

Due to delocalization, compound becomes stable.

Example: Delocalization in benzene



32. i. $\underset{S}{Ag_2CrO_4} \rightleftharpoons \underset{2S}{2\mathrm{Ag}^+} + \underset{S}{\mathrm{CrO}_4^{2-}}$; $K_{sp} = 1.1 \times 10^{-12}$

$K_{sp} = [Ag^+]^2 \cdot \left[\mathrm{CrO}_4^{2-}\right]$

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

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

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

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

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

and $\left[\mathrm{CrO}_4^{2-}\right] = S = 6.503 \times 10^{-5}$ M

ii. $\underset{S}{\mathrm{BaCrO}_4} \rightleftharpoons \underset{S}{\mathrm{Ba}^{2+}} + \mathrm{CrO}_4^{2-}$;

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

$K_{sp} = 1.2 \times 10^{-10} = [Ba^{2+}] \cdot \left[\mathrm{CrO}_4^{2-}\right] = S^2$

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

$[Ba^{2+}] = \left[\mathrm{CrO}_4^{2-}\right] = 1.1 \times 10^{-5}$ M

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

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

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

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

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

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

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

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

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

OR

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

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

$[C_6H_5COO^-] = [Ag^+] = x$ 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

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

$\therefore K_a = \frac{[C_6H_5COO^-][H^+]}{[C_6H_5COOH]}$ or $\frac{[C_6H_5COOH]}{[C_6H_5COO^-]} = \frac{[H^+]}{K_a} = \frac{6.457 \times 10^{-4}}{6.46 \times 10^{-5}} = 10$ .... (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 $y = 1.66 \times 10^{-6}$

$\frac{y}{x} = \frac{1.66 \times 10^{-6}}{5 \times 10^{-7}}$ = 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

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

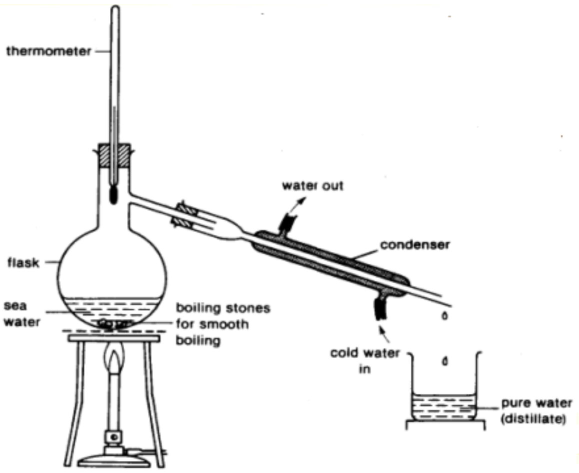
In acidic solution, the anions ($C_6H_5COO^-$ in the present case) undergo protonation in presence of acid. Thus, $C_6H_5COO^-$ ions are removed. Hence, equilibrium shifts forward producing more Ag^+ ions. Alternatively, as $C_6H_5COO^-$ ions are removed, Q_{sp} decreases. In order to maintain solubility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

33. Answer:

(i)
- i.
  - a. i)The stereoisomers related to each other as non superimposable mirror images are called enantiomers.
    ii)Equimolar mixture of d- and l- form is known as racemic mixture.
  - b. In chlorobenzene the lone pair of electrons on halogen atom is delocalized on the benzene ring. These are stabilized by resonance, hence, the energy of activation for displacement of halogen is much greater than alkyl halides.
- ii. Monohydric alcohols are the compounds derived from an alkane by replacing one H by - OH group.
  Example:
  $$\underset{\text{Methane}}{\mathrm{CH_4}} \xrightarrow{replacing\ H\ with\ OH} \underset{\text{Methanol}}{\mathrm{CH_3 - OH}}$$
  Therefore, the general molecular formula of saturated monohydric alcohols is $C_nH_{2n+1}OH$.

OR

- i. If the difference in boiling points of two liquids is not much, simple distillation cannot be used to separate them. The vapours of such liquids are formed within the same temperature range and are condensed simultaneously. The technique of fractional distillation is used in such cases. In this technique, vapours of a liquid mixture are passed through a fractionating column before condensation. The fractionating column is fitted over the mouth of the round bottom flask. The liquid [B] with a higher boiling point condense before the vapours of [A] with a lower boiling point.



ii. a. Lowest locant number, 2,5,6 is lower than 3, 5, 7

b. substituents are in equivalent position; lower number is given to the one that comes first in the name according to alphabetical order.