Class XI Session 2023-24
Subject - Chemistry
Sample Question Paper - 6

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. Choose the one out of the following having the highest mass, **[1]**

a) 3.011×10^{22} atoms of oxygen
b) 1 g atom of C
c) $\frac{1}{2}$ mole of CH_4
d) 10 mL of water

2. Which color of light has the greatest energy per photon? **[1]**

a) Blue
b) Green
c) Violet
d) Red

3. The enthalpies of elements in their standard states are taken as zero. The enthalpy of formation of a compound is: **[1]**

a) is never negative.
b) may be positive or negative.
c) is always negative.
d) is always positive.

4. Bohr’s model of atom explains the spectrum of: **[1]**

a) deuterium
b) Hydrogen
c) oxygen
d) carbon

5. Suppose that 1.00 kJ of heat is transferred to 2.00 mol argon (at 298 K, 1 atm). What will the final temperature T_f be if the heat is transferred at constant pressure? **[1]**

a) 301 K
b) 335 K
c) 322 K
d) 376 K

6. What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition n = 4 to n = **[1]**

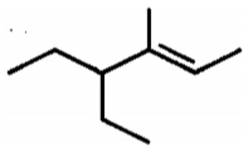
2 of He^+ spectrum?

a) n = 2 to n = 1
b) n = 6 to n = 1
c) n = 4 to n = 1
d) n = 4 to n = 2

7. Displacement of hydrogen from cold water is done by: **[1]**

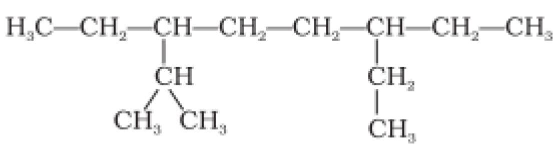
a) All alkali metals
b) All transition elements
c) All alkaline earth metals
d) Superoxides

8. The IUPAC name of the following compound is: **[1]**



a) 4-methyl-3-ethylhex-4-ene
b) 4-ethyl-3-methylhex-2-ene
c) 3-ethyl-4-methylhex-4-ene
d) 4, 4-diethyl-3-methylbut-2-ene

9. The correct IUPAC name of the following alkane is: **[1]**



a) 3 - Isopropyl - 6 - ethyloctane
b) 5 - Isopropyl - 3 - ethyloctane
c) 3,6 - Diethyl - 2 - methyloctane
d) 3 - Ethyl - 5 - isopropyloctane

10. In halogen, which of the following increases from iodine of fluorine? **[1]**

a) Electronegativity
b) Bond length
c) The ionization energy of the element
d) Oxiding power

11. Thermodynamics is applicable to: **[1]**

a) homogeneous system only
b) microscopic system only
c) macroscopic system only.
d) heterogeneous system only

12. Benzene reacts with chlorine in the presence of sunlight and in the absence of halogen carriers to give ....? **[1]**

a) $C_6H_6Cl_6$
b) CCl_4
c) C_6Cl_6
d) C_6H_5Cl

13. **Assertion (A):** C-C bond between carbon-3 and hydrogen in $CH_3CH_2CH_2Br$ experiences the least inductive effect. **[1]**

Reason (R): The magnitude of the inductive effect diminishes as the number of intervening bonds increases.

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 more acidic than ethylene. **[1]**

Reason (R): Acetylene has sp character of carbon and, therefore, more s-character.

a) Both A and R are true and R is the correct
b) Both A and R are true but R is not the

explanation of A. correct explanation of A.

c) A is true but R is false. d) A is false but R is true.

15. **Assertion (A):** VIBGYOR signifies the seven colour of visible light. **[1]**

Reason (R): Red colour corresponds to higher frequency and blue colour to lower frequency region.

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):** Isomorphous substances form crystals of the same shape and can grow in a saturated solution of each other. **[1]**

Reason (R): They have a similar constitution and chemical formulae.

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.

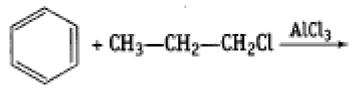
Section B

17. Explain why pure liquids and solids can be ignored while writing the equilibrium constants expression? **[2]**

18. What are representative element? **[2]**

19. Calculate the number of molecules present in 44.8 cm^3 of oxygen gas at 273 K and 2 atmosphere pressure. **[2]**

20. What will be the product obtained as a result of the following reaction and why? **[2]**



OR

The boiling point of hydrocarbons decreases with an increase in branching. Give reason.

21. The ionisation energy of H-atom (in the ground state) is x kJ. Find the energy required for an electron to jump from second to third energy level. **[2]**

Section C

22. Explain why o-hydroxybenzaldehyde is a liquid at room temperature while p-hydroxybenzaldehyde is a high melting solid. **[3]**

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

(i) What is the sign of enthalpy of formation of a highly stable compound? **[1]**

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

(iii) Identify the state functions and path functions out of the following. **[1]**

Enthalpy, entropy, heat, temperature, work, free energy.

24. Two moles of an ideal gas initially at $27°C$ and one atmospheric pressure are compressed isothermally and reversibly till the final pressure of the gas is 10 atm. Calculate q, W and ΔU for the process. **[3]**

25. PbO and PbO_2 react with HCl according to the following chemical equations: **[3]**

$2PbO + 4HCl \rightarrow 2PbCl_2 + 2H_2O$

$PbO_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$

Why do these compounds differ in their reactivity?

26. The number of electrons, protons, and neutrons in a species are equal to 18, 16 and 16 respectively. Assign the proper symbol to the species. **[3]**

27. Nitrogen has positive electron gain enthalpy whereas oxygen has negative. However, oxygen has lower ionisation enthalpy than nitrogen. Explain. **[3]**

28. An alloy of iron (53.6%), nickel (45.8 %) and manganese (0.6 %) has a density of 8.17 g cm^{-3}. Calculate the number of Ni atoms present in the alloy of dimensions 10.0 cm $\times$ 20.0 cm $\times$ 15.0 cm **[3]**

Section D

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

OR

Why hyperconjugation is a permanent effect?

(ii) The molecular formula C_3H_8O represents which isomer?

(iii) What type of isomerism is shown by Methoxypropane and ethoxyethane?

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

In order to explain the characteristic geometrical shapes of polyatomic molecules, Pauling introduced the concept of hybridisation. The orbitals undergoing hybridisation should have nearly the same energy. There are various type of hybridisations involving s, p and d-type of orbitals. The type of hybridisation gives the characteristic shape of the molecule or ion.

(i) Why all the orbitals in a set of hybridised orbitals have the same shape and energy?

(ii) Out of XeF_2 and SF_2 which molecule has the same shape as NO_2^+ ion?

(iii) Out of XeF_4 and XeF_2 which molecule doesn't have the same type of hybridisation as P(Phosphorus) has in PF_5?

OR

Unsaturated compounds undergo additional reactions. Why?

Section E

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

(i) Name the simplest alkyne. **[1]**

(ii) Explain the reason for the extraordinary stability of benzene in spite of the presence of three double bonds in it. **[1]**

(iii) Explain why alkynes are less reactive than alkenes towards addition of Br_2. **[1]**

(iv) How will you demonstrate that double bonds of benzene are somewhat different from that of olefines? **[1]**

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

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

(vii) Explain why p-xylene has a higher melting point than the corresponding ortho or meta isomers. **[1]**

32. A sample of pure PCl_5 was introduced into an evacuated vessel at 473 K. After equilibrium was attained, concentration of PCl_5 was found to be 0.5×10^{-1} mol L^{-1}. If value of K_c is 8.3×10^{-3}, what are the concentrations of PCl_3 and Cl_2 at equilibrium? **[5]**

$PCl_5 (g) \rightleftharpoons PCl_3 (g) + Cl_2(g)$

OR

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

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

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

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

Determine also the molarities of individual ions.

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

(i) i. Write the IUPAC name of the compound from its given structure. **[2.5]**

$$\underset{6}{CH_3} - \underset{5}{CH_2} - \underset{4}{\overset{\overset{O}{||}}{C}} - \underset{3}{CH_2} - \underset{2}{\overset{\overset{O}{||}}{C}} - \underset{1}{CH_3}$$

ii. Name the process used to separate sugar and salt. **[2.5]**

OR

i. Write the IUPAC names of the compounds (i)-(iv) from their structures **[2.5]**

i. $CH_3 - CH_2 - \underset{\underset{OH}{|}}{CH} - CH_2 - CH_2 - \underset{\underset{CH_3}{|}}{CH} - CH_2 - CH_3$

ii. $CH_3 - CH_2 - \overset{\overset{O}{||}}{C} - CH_2 - \overset{\overset{O}{||}}{C} - CH_3$

iii. $CH_3 - \overset{\overset{O}{||}}{C} - CH_2 - CH_2 - CH_2 - COOH$

iv. $CH \equiv C - CH = CH - CH \equiv CH_2$

ii. A sample of 0.50 g of an organic compound was treated according to Kjeldahl's method. The ammonia evolved was absorbed in 50 mL of 0.5 M H_2SO_4. The residual acid required 60 mL of 0.5 M solution of NaOH for neutralisation. Find the percentage composition of nitrogen in the compound. **[2.5]**

Solution

Section A

1.

(b) 1 g atom of C

Explanation: Calculations & inference :

1 g atom of C

1 gm atomic mass of C

= 12.00 g

One mole of CH_4

= gram molar mass of CH_4

= 16 g

$\therefore$ mass of $\frac{1}{2}$ mole of CH_4 = 8.0 g

Mass of 10 ml of water

= 10 gms

(since , density of water = 1 gm / ml)

Mass of 6.022×10^{22} atoms of Oxygen

Since, 6.022×10^{23} atoms of Oxygen weighs

= its gm atomic mass (ie.16 g)

$\therefore$.mass of 3.011×10^{23} atoms of O

= 8 .0 g.

$\therefore$ mass of 3.011×10^{22} atoms of O

= 0.80 g

Thus , the mass of 1 g atom of Carbon is highest out of the above .

2.

(c) Violet

Explanation: Waves with a short wavelength have the most energy. Red waves have a relatively long wavelength (in the 700 nm range), and violet waves are much shorter - roughly half that. Because violet waves have the shortest wavelength of the visible light spectrum, they carry the most energy.

3.

(b) may be positive or negative.

Explanation: Standard molar enthalpy of formation of a compound from its elements can be +ve or –ve.

For example: $C + O_2(g) \rightarrow CO_2(g); \Delta_r H$ = 393.5 kJ mol^{-1}

$N_2(g) + \frac{1}{2}O_2(g) \rightarrow N_2O(g);\ \Delta_r H$ = +92 k J mol^{-1}

4.

(b) Hydrogen

Explanation: The emission spectrum of atomic hydrogen is divided into a number of spectral series, with wavelengths given by the Rydberg formula. These observed spectral lines are due to the electron making transitions between two energy levels in the atom.

Bohr tells us that the electrons in the Hydrogen atom can only occupy discrete orbits around the nucleus (not at any distance from it but at certain specific, quantized, positions, or radial distances each one corresponding to an energetic state of your H atom) where they do not radiate energy.

When the electron moves from one allowed orbit to another it emits or absorbs photons of energy matching exactly the separation between the energies of the given orbits (emission/absorption spectrum).

5.

(c) 322 K

Explanation: Argon is monoatomic, Here, $C_p = \frac{5}{2}R = \frac{5}{2} \times 8.314 JK^{-1}mol^{-1} = 20.79 JK^{-1}mol^{-1}$

As pressure is kept constant, $q_p = nC_p\Delta T$

$\Rightarrow 1000J = (2.00mol) \times (20.79JK^{-1}mol^{-1}) \times \Delta T$

$\Rightarrow \Delta T = 24.05K$

$\Rightarrow T_f = 298 + 24.05 = 322.05K$

6. **(a)** n = 2 to n = 1

Explanation: For He^+ ion,

We have

$\frac{1}{\lambda} = Z^2 R_h [\frac{1}{n_1^2} - \frac{1}{n_2^2}] = 2^2 R_h [\frac{1}{2^2} - \frac{1}{4^2}] = \frac{3}{4} R_h$ ....(i)

Now for the hydrogen atom

$\frac{1}{\lambda} = R_h [\frac{1}{n_1^2} - \frac{1}{n_2^2}]$ ....(ii)

Equating equation (i) and (ii), we get

$\frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{3}{4}$

Obviously, $n_1 = 1$ and $n_2 = 2$

Hence, the transition n = 2 to n = 1 in hydrogen atom will have the same wavelength as the transition, n = 4 to n = 2 in He^+ species.

7. **(a)** All alkali metals

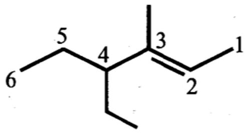
Explanation: A common characteristic of most Alkali metal is their ability to displace H_2 (g) from water. This is represented by their large, negative electrode potentials. In this event, the Group 1 metal is oxidized to its metal ion, and water is reduced to form hydrogen gas and hydroxide ions. The general reaction of an alkali metal (M) with H_2O (l) is given in the following equation:

$2M(s) + 2H_2O(l) \longrightarrow 2M + (aq) + 2OH-(aq) + H_2(g)$

From this reaction it is apparent that OH- is produced, creating a basic or alkaline environment. Group 1 elements are called alkali metals because of their ability to displace H_2 (g) from water and create a basic solution. Alkali metals are also known to react violently and explosively with water. This is because enough heat is given off during the exothermic reaction to ignite the H_2(g).

8.

(b) 4-ethyl-3-methylhex-2-ene

Explanation: 

4-ethyl-3-methylhex-2-ene

9.

(c) 3,6 - Diethyl - 2 - methyloctane

Explanation: Following the rules of nomenclature, the IUPAC name of the given compound is 3, 6-Diethyl-2-methyloctane.

10. **(a)** Electronegativity

Explanation: Electronegativity is the tendency of an atom to attract a shared paired of an electron in a bond towards itself. As we go from iodine to fluorine, electronegativity of halogens decreases but ionic radius increases. Hence, Fluorine is the most electronegative element.

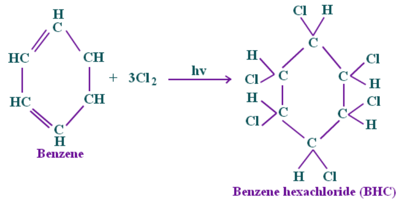
11.

(c) macroscopic system only.

Explanation: Thermodynamics does not deal with the properties of the individual atoms and molecules but deals with the matter in bulk.

12. **(a)** $C_6H_6Cl_6$

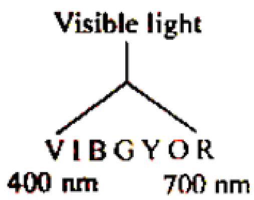
Explanation: Benzene, in the presence of sunlight and in absence of halogen carriers, undergoes an addition reaction with Cl_2 to form benzene hexachloride, $C_6H_6Cl_6$



13. **(a)** Both A and R are true and R is the correct explanation of A.
Explanation: C-C bond between carbon-3 and hydrogen in $CH_3CH_2CH_2Br$ experiences the least inductive effect because the magnitude of the inductive effect diminishes as the number of intervening bonds increases.

14. **(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.

15.
(c) A is true but R is false.
Explanation:
Visible light when passed through a prism splits into seven colours, Violet (V), Indigo (I), Blue (B), Green (G), Yellow (Y), Orange (O) and Red (R).



$\lambda = \frac{c}{v}$

Wavelength and frequency are inversely related. Red colour with higher wavelength will have lower frequency.

16. **(a)** Both A and R are true and R is the correct explanation of A.
Explanation: Examples of isomorphous compounds are K_2SO_4, K_2CrO_4, K_2SeO_4, (valency of S, Cr, Se = 6) and $ZnSO_4 \cdot 7H_2O$, $MgSO_4 \cdot 7H_2O$ $FeSO_4 \cdot 7H_2O$ (valency of Zn, Mg, Fe = 2).

Section B

17. The pure liquids and solids can be ignored while writing the equilibrium constants expression because molar concentration of a pure solid or liquid is independent of the amount present.

Molar concentration $= \frac{Number\ of\ moles}{volume} = \frac{\frac{weight}{Molar\ Mass}}{volume} = \frac{weight}{volume} \times \frac{1}{Molar\ Mass} = \frac{Density}{Molar\ Mass}$

Since the density of a pure liquid or solid is fixed at a given temperature and molar mass is also fixed. Therefore molar concentration is constant.

18. The representative elements are all the elements in s-block (Groups 1-2) and p-block (Groups 13-18) of the periodic table. These include metals, non metals and semi metals (metalloid). The representative elements in the periodic table do not exhibit variable valencies.

19. At STP, volume of O_2 gas can be calculated as applying

gas equation: $\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$

We get $\frac{44.8 \times 2}{273} = \frac{1 \times V_2}{273}$ [STP condition]

$V_2 = 89.6\ cm^3 = 0.0896\ L$

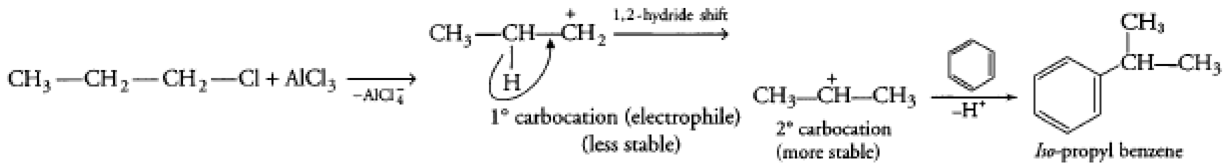
Now, applying mole concept

$\frac{\text{rolume of gas at STP (L)}}{22.4\ L} = \frac{\text{number of molecules of gas}}{\text{avogadro's number}}$

$\frac{0.0896}{22.4} = \frac{\text{number of molecules of } O_2 \text{ gas}}{6.022 \times 10^{23}}$

$\therefore$ Number of molecules of O_2 gas

$= \frac{0.0896 \times 6.022 \times 10^{23}}{22.4} = 240 \times 10^{21}$

20. 

When Friedel Crafts alkylation is carried out with a higher alkyl halide, e.g.,n-propyl chloride, the electrophile, n-propyl carbocation (1° carbocation) rearranges to form more stable iso-propyl carbocation (2° carbocation) and the main product formed will be isopropyl benzene.

OR

The effective surface area of hydrocarbon reduces due to increase in branching and hence the strength of the Vander wall's forces decreases. Thus, less energy is required to separate the molecules of compound from its liquid surface and thereby leading to a decrease in the boiling point.

21. Ionisaton energy of the hydrogen atom can be written as:

Ionisation energy = Energy in 1st orbit - Energy in infinite orbit.

Ionisation energy = $E = -\frac{E_o}{n^2}$; Where, E_o = 13.6 eV

The difference in energy $= E_{infinity} - E_1$.

S the ionisation energy from the ground state = 0 - E_1 = 0 -$(-\frac{E_o}{1^2})$= E_o = 'x' kJ

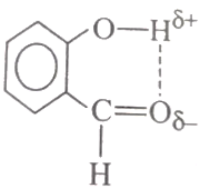
Energy in second energy level, $E_2 = -\frac{x}{2^2} = -\frac{x}{4}$

Energy in third energy level,$E_3 = -\frac{x}{3^2} = -\frac{x}{9}$

The energy required to jump the electron from 2nd to 3rd energy state = $E_3 - E_2 = -\frac{x}{9} + \frac{x}{4} = \frac{5x}{36}$.

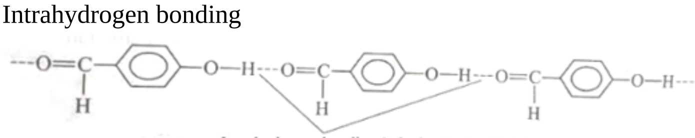
Section C

22. o-hydroxybenzaldehyde shows intramolecular hydrogen bonding whereas p-hydroxybenzaldehyde has intramolecular hydrogen bonding. Thus, p-hydroxybenzaldehyde is an aggregate of a number of molecules and therefore, it is a high melting solid.



(o-hydroxybenzaldehyde)

Intrahydrogen bonding



Interhydrogen bondipg (p-hydroxybenzaldehyde aggregate)

23. Answer:

(i) The sign of enthalpy of formation of a highly stable compound is Negative.

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

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

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

(iii)**Path function:** heat, work

State function: enthalpy, entropy, temperature, free energy.

24. According to the question, n = 2, T = 27°C = 300 K, p_1 = 1 atm, p_2 = 10 atm

We know that, W(compression) = $2.303nRT \log \frac{p_2}{p_1}$

$= 2.303 \times 2 \times 8.314 JK^{-1} mol^{-1} \times 300K \times \log \frac{10}{1}$

$= 11488.28$ J

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

For isothermal compression of ideal gas, $\Delta U = 0$

$\therefore q = -W$

$= -11488.28$ J

25. a. $2\overset{+2}{Pb}O + 4HCl \rightarrow 2\overset{+2}{Pb}Cl_2 + 2H_2O$

In reaction (a), the oxidation number of none of the atoms undergoes a change. Therefore, it is not a redox reaction. It is an acid-base reaction because PbO is a basic oxide that reacts with HCl acid.

b. $\overset{+4}{Pb}O_2 + 4HCl \rightarrow \overset{+2}{Pb}Cl_2 + \overset{0}{Cl}_2 + 2H_2O$

The reaction (b) is a redox reaction in which PbO_2 gets reduced and acts as an oxidizing agent.

26. The atomic number is equal to number of protons = 16. The element is sulphur (S).

Atomic mass number = number of protons + number of neutrons = 16 + 16 = 32

Species is not neutral as the number of protons is not equal to electrons. It is anion (negatively charged) with charge equal to excess electrons = 18 – 16 = 2

Symbol is $^{32}_{16}S^{2-}$

27. This is because of extra stability of half-filled 2p orbital of nitrogen than Oxygen as oxygen has four electrons in 2p-orbital with two electrons in same orbital which increased electron-electron repulsion. When electrons adds to half filled 2p-orbital of nitrogen energy is required. Therefore, nitrogen has positive electron gain enthalpy.

On the other hand, on removing one electron from the 2p-orbital makes half filled stable 2p-orbital but in case of nitrogen it becomes less stable. Therefore, I^{st} ionisation enthalpy of oxygen is less than nitrogen.

28. Calculation of mass of nickel (Ni) in the alloy.

Volume of the alloy = (10.0 cm) $\times$ (20.9 cm) $\times$ (15.0 cm) = 3000 cm^3

Mass of the alloy piece = Density $\times$ volume

= (8,.17 g cm^{-3}) $\times$ (300 cm^3) = 24510 g

Mass of Ni in the alloy = (24510 g) $\times \frac{45.8}{100}$

= 11225.6 g

Calculation of number of Nickel (Ni) atoms in the alloy

The gram atomic mass of Ni = 58.69

So, 58.69 g of Ni have atoms = 6.022 $\times$ 10^{23}; (as per Avogadro's hypothesis)

11225.6 g of Ni have atoms = (6.022 $\times$ $10^{23} \times$ 11225.6 / 58.69)

= 1.15 $\times 10^{26}$ atoms

Thus, the number of nickel atoms in an alloy of given dimensions is 1.15 x 10^{26}

Section D

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

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

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.

(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.

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

In order to explain the characteristic geometrical shapes of polyatomic molecules, Pauling introduced the concept of hybridisation. The orbitals undergoing hybridisation should have nearly the same energy. There are various type of hybridisations involving s, p and d-type of orbitals. The type of hybridisation gives the characteristic shape of the molecule or ion.

(i) Hybrid orbitals are formed after combining atomic orbitals and have the equivalent shape and energy in the given set of hybridised orbitals.

(ii) XeF_2 molecule has the same shape as NO_2^+ ion.

(iii) XeF_4 molecule doesn't have the same type of hybridisation as P(Phosphorus) has in PF_5.

OR

Unsaturated hydrocarbon molecules include two- or three-fold bonds of carbon. The π -bond is a multiple bond, which becomes unstable and hence adds across numerous bonds.

Section E

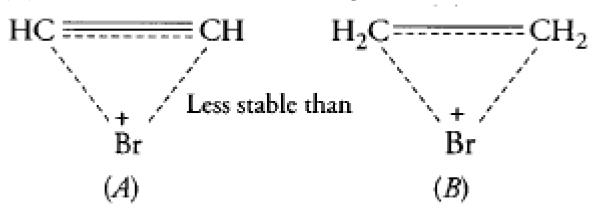
31. Attempt any five of the following:

(i) Ethyne is the simplest alkyne. Formula of ethyne is C_2H_2.

Structure: $H - C \equiv C - H$

(ii) Due to resonance, and delocalisation of electrons benzene is more stable.

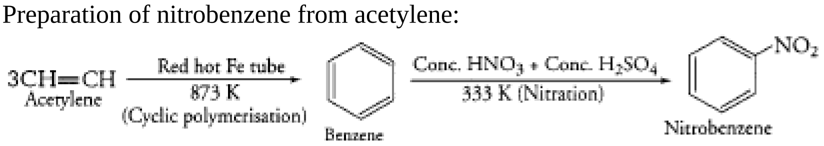
(iii) The triple bonds of alkynes, because of its high electron density, are easily attacked by electrophiles, but less reactive than alkenes due to the compact C-C electron cloud. The three-membered ring bromonium ion formed from the alkyne (A) has a full double bond causing it to be more stained and less stable than the one from the alkene (B),



Also, the carbon's of (A) that are part of the bromonium ion has more s-character than (B), further making (A) less stable than (B).

(iv) The double bonds of benzene are different from that of olefines as the double bonds of olefines decolourise Br_2 in CCl_4 and discharge the pink colour of Baeyer's reagent with simultaneous formation of a brown ppt. of MnO_2 while those of benzene do not.

(v) Preparation of nitrobenzene from acetylene:



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

(vii) The para isomer has a more symmetrical structure, allowing it to fit better into the crystal lattice than ortho or meta isomer.

So, p-xylene has a higher melting point than the corresponding ortho or meta isomers.

32. Let the initial molar concentration of PCl_5 per litre = x mol

Molar concentration of PCl_5 at equilibrium = 0.05 mol

Moles of PCl_5 decomposed = (x - 0.05) mol

Moles of PCl_3 formed = (x - 0.05) mol

Moles of Cl_2 formed = (x - 0.05) mol

The molar concentration./ litre of reactants and products before the reaction and at the equilibrium point are:

	PCl_5	$\rightleftharpoons$ PCl_3	+ Cl_2
Initial moles/litre	x	0	0.214 mol
Moles/litre at eqm. point	0.05	$(x - 0.05)$	$(x - 0.05)$

Equilibrium constant $(K_c) = 8.3 \times 10^{-3} = 0.0083$

Applying Law of chemical equilibrium,

$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} 0.0083 = \frac{(x-0.05)\times(x-0.05)}{0.05}$

$(x - 0.05)^2 = 0.0083 \times 0.05 = 4.15 \times 10^{-4}$

$(x - 0.05) = (4.15 \times 10^{-4})^{1/2} = 2.037 \times 10^{-2} = 0.02\ moles$

x = 0.05 + 0.02 = 0.07 mol

The molar concentration of PCl_3 at equilibrium. = x - 0.05 = 0.07 - 0.05 = 0.02 mol

The molar concentration of Cl_2 at equilibrium. = x - 0.05 = 0.07 - 0.05 = 0.02 mol

OR

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

33. Answer:

(i) i. The functional group present is ketone (>C=O), hence suffix ‘-one’. The presence of two keto groups is indicated by ‘di’, hence suffix becomes ‘dione’. The two keto groups are at carbons 2 and 4. The longest chain contains 6 carbon atoms, hence, parent hydrocarbon is hexane.

Thus, the IUPAC name / systematic name is Hexane-2, 4-dione.

ii. Fractional crystallization using ethanol as a solvent.

OR

i. i. 6-methyl octan-3-ol,
 ii. Hexane-2,4-dione,
 iii. 5-oxohexanoic acid,
 iv. Hexa-1, 3-dien-5-yne

ii. Volume of the acid taken = 50 mL of 0.5 M H_2SO_4

$= 25$ mL of 1.0 M H_2SO_4

Volume of alkali used for neutralisation of excess acid

$= 60$ mL of 0.5 M NaOH

$= 30$ mL of 1.0 M NaOH

$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

1 mole of $H_2SO_4 = 2$ moles of $NaOH$

Hence, 30 mL of 1.0 M NaOH = 15 mL of 1.0 M H_2SO_4

$\therefore$ Volume of acid used by ammonia = 25-15 = 10 mL

% of nitrogen $= \frac{1.4 \times N_1 \times \text{ vol. of acid used}}{w}$

(where, N_1 = normally of acid and w = mass of the organic compound taken)

% of nitrogen $= \frac{1.4 \times 2 \times 10}{0.5}$ = 56.0