Class XI Session 2025-26
Subject - Chemistry
Sample Question Paper - 7

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. Give the number of electrons in the species, O_2 and O_2^+. **[1]**

   a) 16 and 15 b) 32 and 16

   c) 16 and 8 d) 16 and 14

2. The effective distance between the centre of the nucleus of an ion and the point up to which the nucleus has an influence on its electron cloud is called_____. **[1]**

   a) covalent radius b) anionic radius

   c) cationic radius d) ionic radius

3. The electrons are ejected from the metal surface when the light of certain frequencies strikes the surface is called _____. **[1]**

   a) Thomson model for electron b) Faraday's cathode ray discharge model

   c) Photoelectric effect d) Planck's quantum theory

4. Calculate the difference between C_p and C_v for 10 moles of an ideal gas. **[1]**

   a) 0.831 J b) 831.4 J

   c) 83.14 J d) 8.314 J

5. The carbon atoms of benzene are: **[1]**

   a) non-hybridised b) sp^3 - hybridised

   c) sp^2 - hybridised d) sp - hybridised

6. Which one of the following depends upon variations in temperature? **[1]**

a) Molality
b) Both Normality and Molarity
c) Molarity
d) Normality

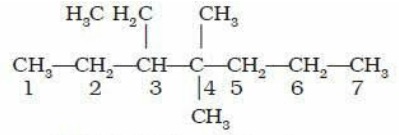
7. Choose the correct answer. A thermodynamic state function is a quantity: **[1]**

a) used to determine heat changes.
b) whose value is independent of path.
c) whose value depends on temperature only.
d) used to determine pressure volume work.

8. Which of these is not a characteristic of Aromatic Hydrocarbons? **[1]**

a) Carbon atoms form a an open chain.
b) Carbon atoms form a closed chain or ring.
c) They are special type of cyclic compounds.
d) They may contain double bonds.

9. Which of the following is the correct IUPAC name of the given compound? **[1]**



a) 4, 4-Bis(methyl)-3-ethylheptane
b) 3-Ethyl-4, 4-dimethylheptane
c) 5-Ethyl-4, 4-dimethylheptane
d) 4, 4-Dimethyl-3-ethylheptane

10. Enthalpies of formation of CO(g), CO_2(g), N_2O(g), and N_2O_4(g) are -110, –393, 81, and 9.7 kJ mol^{-1} respectively. Find the value of $\Delta_r H$ for the reaction: $N_2O_4\left(g\right) + 3CO\left(g\right) \rightarrow N_2O\left(g\right) + 3CO_2\left(g\right)$ **[1]**

a) - 850 kJ
b) -802 kJ
c) -778 kJ
d) -600 kJ

11. The decomposition of hydrogen peroxide to form water and oxygen is an example of: **[1]**

a) Disproportionation reaction
b) Combination reactions
c) Displacement reactions
d) Decomposition reactions

12. According to quantum mechanics, $|\psi|^2$ (r) the wave function squared gives: **[1]**

a) probability of finding a neutron
b) probability density of finding a proton
c) probability density of finding an electron
d) probability of finding an electron

13. **Assertion (A):** Fluoride has the lowest and iodide has the highest boiling point. **[1]**
Reason (R): Boiling points of haloalkanes increases with increasing atomic mass.

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):** Moving phase is liquid and stationary phase is solid in paper chromatography. **[1]**
Reason (R): Paper chromatography is used for analysis of polar organic compounds.

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):** In case of isoelectronic ions the ionic size increases with the increase in atomic number. **[1]**
Reason (R): The greater the attraction of nucleus, greater is the ionic radius.

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

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

c) A is true but R is false.

d) Both A and R are false.

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.

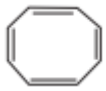
b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

Section B

17. Explain why the system are not aromatic. **[2]**



OR

Suggest a route to prepare ethyl hydrogensulphate (CH_3 - H_2 - OSO_2 - OH) starting from ethanol (C_2H_5OH).

18. Give the main features of f-block elements. **[2]**

19. Determine the molecular formula of an oxide of iron in which the mass per cent of iron and oxygen are 69.9 and 30.1 respectively. **[2]**

20. Wavelengths of different radiations are given below: **[2]**

λ = (A) 300 nm

λ (B)= 300 μ m

λ (C)= 3 nm

λ (D) =30$\overset{o}{A}$

Arrange these radiations in the increasing order of their energies.

21. Mention the general characteristics of equilibria involving physical processes. **[2]**

Section C

22. Depict the galvanic cell in which the reaction Zn (s) + $2Ag^+$(aq) $\longrightarrow$ Zn^{2+}(aq) + 2Ag(s) takes place, Further show: **[3]**

i. which of the electrode is negatively charged,

ii. the carriers of the current in the cell, and

iii. individual reaction at each electrode.

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

(a) Define intensive properties. **[1]**

(b) One mole of acetone requires less heat to vaporise than 1 mole of water. Which of the two liquids has the higher enthalpy of vaporisation? **[1]**

(c) Out of diamond and graphite which has greater entropy?Why? **[1]**

24. The Balmer series in the hydrogen spectrum corresponds to the transition from n_1 = 2 to n_2= 3,4, ... This series lies in the visible region. Calculate the wave number of line associated with the transition in Balmer series when the electron moves to n= 4 orbit. (R_H= 109677 cm^{-1}) **[3]**

25. Predict the dipole moment of **[3]**

i. a molecule of the type AX_2 having a linear geometry.

ii. a molecule of the type AX_4 having tetrahedral geometry.

iii. a molecule of the type AX_2 having angular geometry.

iv. a molecule of the type AX_4 having square planar geometry.

26. Dinitrogen and dihydrogen react with each other to produce ammonia according to the following chemical equation: **[3]**

N_2 (g) + $3H_2$ (g) $\longrightarrow$ $2NH_3$ (g)

i. Calculate the mass of ammonia produced if 2.00 $\times$ 10^3 g dinitrogen reacts with 1.00 $\times 10^3$ g dihydrogen

ii. Will any of the two reactants remain unreacted?

iii. If yes, which one and what would be its mass?

27. Write characteristics of all seven periods of the periodic table. **[3]**

28. For the reaction, 2A(g) + B(g) $\longrightarrow$ 2D (g); ΔU^o = -10.5 kJ and ΔS^o = -44.1 JK^{-1}. Calculate ΔG^o for the reaction and predict whether the reaction may occur spontaneously. (R = 8.314 $\times$ 10^{-3} kJ $K^{-1}mol^{-1}$, T = 298K) **[3]**

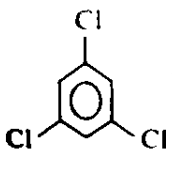
Section D

29. Covalent molecules formed by heteroatoms bound to have some ionic character. The ionic character is due to shifting of the electron pair towards A or B in the molecule AB. Hence, atoms acquire small and equal charge but opposite in sign. Such a bond which has some ionic character is described as a polar covalent bond. Polar covalent molecules can exhibit a dipole moment. The dipole moment is equal to the product of charge separation, q and the bond length, d for the bond. The unit of dipole moment is Debye. One Debye is equal to 10^{-18} esu cm. **[4]**

The dipole moment is a vector quantity. It has both magnitude and direction. Hence, the dipole moment of molecules depends upon the relative orientation of the bond dipole, but not the polarity of bonds alone. The symmetrical structure shows a zero dipole moment. Thus, a dipole moment help to predict the geometry of the molecules. Dipole moment values can be used to distinguish between cis- and trans-isomers; ortho-, meta- and para-forms of a substance, etc. The percentage of ionic character of a bond can be calculated by the application of the following formula:

% ionic character $\frac{\text{Experimental value dipole moment}}{\text{Theoretical value of dipole moment}} \times 100$

Answer the following questions:

i. Out of  and  which compounds have zero dipole moments?

ii. _____ and _____ are non-polar molecules? (xeF_4, BF_3, NH_3, H_2O)

iii. A diatomic molecule has a dipole moment of 1.2D. If the bond length is 1.0 $\times$ 10^{-8}cm, what fraction of charge does exist on each atom?

[Hind: Charge = $\frac{\text{Dipole moment}}{\text{Bond length}} = \frac{1.2\times10^{-18}}{1.0\times10^{-8}} = 1.2 \times 10^{-10}$ esu]

iv. The dipole moment of NF_3 is very much less that of NH_3. Why?

v. A covalent molecule, x-y, is found to have a dipole moment of 1.5 $\times$ 10-^{29}cm and a bond length 150 pm. What will be the percentage of ionic character of the bond?

[Hint: μ_{ca} = 1.602 $\times$ 10^{-19}C $\times$ 150 $\times$ 10^{-12}m = 2.4 $\times$ 10^{-29}cm]

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

IUPAC (International Union of Pure and Applied Chemistry) system of nomenclature. Common names are useful and in many cases indispensable, particularly when the alternative systematic names are lengthy and complicated. A systematic name of an organic compound is generally derived by identifying the parent hydrocarbon and the functional group(s) attached to it. By using prefixes and suffixes, the parent name can be modified to obtain the actual name. In a branched-chain compound, small chains of carbon atoms are attached at one or more carbon atoms of the parent chain. The small carbon chains (branches) are called alkyl groups. An alkyl group is derived from a saturated hydrocarbon by removing a hydrogen atom from carbon. Abbreviations are used for some alkyl groups. For example, methyl is abbreviated as Me, ethyl as Et, propyl as Pr and butyl as Bu.

i. Draw the structure of 3-Ethyl-4,4-dimethylheptane. (1)

ii. How is the numbering in branched chain hydrocarbon done? (1)

iii. Derive the structure of 2-Chlorohexane. (2)

OR

Why CH_4 after becoming-CH_3 called a methyl group? (2)

Section E

31. K_1 and K_2 for dissociation of H_2S are 4×10^{-3} and 1×10^{-5}. Calculate sulphide ion concentration in 0.1 M H_2S solution. **[5]**

OR

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

a. 0.01 M

b. 0.1 M HCl?

32. **Answer:** **[5]**

(a) i. Which bond is more polar in the following pairs of molecules: **[2.5]**

a. H_3C-H, H_3C-Br

b. H_3C-NH_2, H_3C-OH

c. H_3C-OH, H_3C-SH

ii. Explain the principle of paper chromatography. **[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 ≡ C - CH = CH - CH ≡ CH_2

ii. Draw the resonance structures of the following compounds: **[2.5]**

i. $CH_2 = CH—\ddot{\underset{\cdot\cdot}{Cl}}:$

ii. $CH_2 = CH — CH = CH_2$

iii. $CH_2 = CH - \underset{\underset{H}{|}}{C} = O$

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

(a) What happens when benzene is treated with acetyl chloride in presence of $AlCl_3$? **[1]**

(b) Write IUPAC name: $CH_3 - CH = CH - CH_2 - CH = CH - \underset{\underset{C_2H_5}{|}}{C}H - CH_2 - CH = CH_2$ **[1]**

(c) Classify the hydrocarbons according to the carbon-carbon bond. **[1]**

(d) Arrange the following: HCl, HBr, Hl, HF in order of decreasing reactivity towards alkenes. **[1]**

(e) Why is $CH_2 = CH - CH_2 - Cl$ more easily hydrolysed than $CH_3 - CH_2 - CH_2 - Cl$? **[1]**

(f) Which of the two trans-but-2-ene or trans-pent-2-ene is non-polar? **[1]**

(g) What are benzenoids? **[1]**

Solution

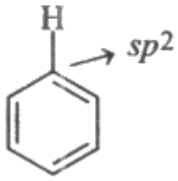
Section A

1. **(a)** 16 and 15
   Explanation:
   There are 8 protons in a single atom of oxygen and 8 neutrons. Thus, a molecule of oxygen (O_2) would contain 16 of each. To gain + charge it must have to loose one electron. So number of electrons in O_2^+ = 16-1=15.

2. **(d)** ionic radius
   Explanation:
   Since 'Ionic radius' is defined as the effective distance from the centre of the nucleus of an ion up to which it has an influence on its electron cloud. The correct answer is " ionic radius ".
   The term Ionic radius is a general term used for both the cations as well as anions.

3. **(c)** Photoelectric effect
   Explanation:
   Electrons are ejected from the metal when the light of a certain frequency strikes the surface of a metal, This phenomenon is known as the photoelectric effect and the ejected electrons are called photoelectrons.

4. **(c)** 83.14 J
   Explanation:
   83.14 J

5. **(c)** sp^2 - hybridised
   Explanation:
   

6. **(b)** Both Normality and Molarity
   Explanation:
   Since Molarity and Normality both the modes of expression to represent the strength of a solution are volume-dependent, a variation in temperature of the solution results in a change in concentration or strength of the solution. It is due to the thermal expansion of liquids.

7. **(b)** whose value is independent of path.
   Explanation:
   A state function value depends only on the state of the system and is independent of path.

8. **(a)** Carbon atoms form a an open chain.
   Explanation:

Aromatic hydrocarbon is not an open chain. They are ring structures. they contain one or more benzene rings either fused or isolated in their molecules.

9.

(b) 3-Ethyl-4, 4-dimethylheptane

Explanation:

In IUPAC name, functional groups are written in alphabetical order. Locant 3 is assigned to ethyl group and the two methyl groups are present on C-4. The longest C chain has 7 C atoms so the IUPAC name is 3-ethyl-4,4-dimethylheptane.

10.

(c) -778 kJ

Explanation:

Heat of reaction, Δ_rH = $\sum \triangle_r H_{products} - \sum \triangle_r H_{reactants}$

$\Rightarrow \Delta_r H$ = [$\Delta_f H(N_2O)$ + 3$\Delta_f H(CO_2)$] - [$\Delta_f H(N_2O_4)$ + 3$\Delta_f H(CO)$]

$\Rightarrow \Delta_r H$ = [81 + {3 $\times$ (-393)}] - 99.7 + {3 $\times$ (-110)}] kJ

$\Rightarrow \Delta_r H$ = -777.7 kJ $\approx$ -778 kJ

11. **(a)** Disproportionation reaction

Explanation:

$\overset{+1}{2H_2}\overset{-1}{O_2}(aq) \rightarrow \overset{+1}{2H_2}\overset{-2}{O} + \overset{0}{O_2}$

Here the oxygen of peroxide, which is present in -1 state, is converted to zero oxidation state in O_2 and decreases to -2 oxidation state in H_2O.

12.

(c) probability density of finding an electron

Explanation:

The probability density of finding an electron at a point within an atom, predicts the region around the nucleus where the electron can most probably be found.

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

Explanation:

For a given halogen the boiling point rises with increasing atomic mass of the halogen, so that fluoride has the lowest boiling point and iodide has the highest boiling point.

14.

(d) A is false but R is true.

Explanation:

Paper chromatography is a liquid-liquid partition chromatography in which the water adsorbed or chemically bond to cellulose of paper acts as the stationary phase while the mobile phase is another liquid which is usually a mixture of two or three solvents in which water is one of the components.

15.

(d) Both A and R are false.

Explanation:

In case of isoelectronic ions, i.e., ions, having the same number of electrons and different nuclear charge, the size decreases with increase in atomic number.

Ion	**At. No.**	**No. of electrons**	**Ionic radii**
Na^+	11	10	0.95 $\overset{o}{A}$
Mg^{2+}	12	10	0.65 $\overset{o}{A}$
Al^{3+}	13	10	0.50 $\overset{o}{A}$

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 $SO_2 = 32 + 2 \times 16 = 64g$

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

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

Section B

17. For the given compound, the number of π-electrons is 8.

By Huckel's rule,

$\Rightarrow 4n + 2 = 8$

$\Rightarrow 4n = 6$

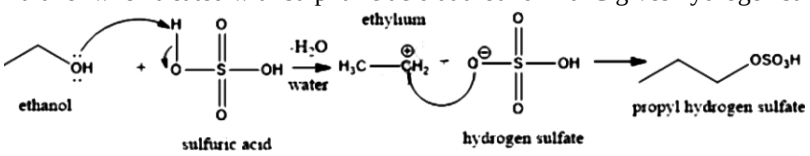
$\Rightarrow n = 3/2$

For a compound to be aromatic, the value of n must be an integer (n = 0, 1, 2…).

This is not true for the given compound as it is a fraction. Hence, it is not aromatic in nature.

OR

Ethanol when treated with sulphuric acid at around 140^oC gives hydrogen sulphate. The reaction takes place as follows.



18. The elements in which the last electron enters the f – orbital of their atoms are called f – block elements. The main features of f-block elements are given below:

1. The f-block elements are known as inner-transition elements because they involve the filling of inner subshells (4f and 5f).
2. These consist of two series of elements placed at the bottom of the periodic table known as Lanthanoids and actinoids series.
3. General electronic configuration is $(n-2)f^{1-14}\ (n-1)d^{0-1}\ ns^2$.
4. The actinides are generally radioactive elements.

19. The mass per cent of iron (Fe) = 69.9 % (given)

The mass per cent of oxygen (O) = 30.1%, (given)

Number of moles of iron present in the oxide = [69.9 / 55.85]

Number of moles of oxygen present in the oxide = [30.1 / 16]

The ratio of iron to oxygen in the oxide, = 1.25 : 1.88

or, = (1.25 / 1.25) : (1.88 / 1.25)

= 1 : 1.5

So, a whole number ratio

= 2 : 3

hence, the empirical formula of the oxide is Fe_2O_3

The empirical formula mass of $Fe_2O_3 = 2 \times 55.85 + 3 \times 16.00$

$= 159.7\ g\ mol^{-1}$

$$n = \frac{\text{Molar mass}}{\text{Empirical formula mass}}$$

n = 159.69 g / 159.7g = 0.9999

= 1 (approx.)

The molecular formula of a compound is obtained by multiplying the empirical formula with this positive integer (n)

Thus, as per the empirical formula (Fe_2O_3) of the given oxide,

n = 1.

Hence, the molecular formula is same as empirical formula, Fe_2O_3

The molecular formula of the oxide is $Fe_2\ O_3$

20. λ (A) = 300 nm = 300×10^{-9} m

λ (B)= 300 μ m = 300×10^{-6} m

λ (C)= 3 nm = 3×10^{-9} m

λ (D) =30$\mathring{A}$ = 3×10^{-9} m

We know that, $E \propto \frac{1}{\lambda}$.

Since, increasing order of wavelength is given as, 300 μm < 300 nm < 3 nm < 30$\mathring{A}$

Therefore, $\lambda(B) < (A) < \lambda(C) = \lambda(D)$

21. The general characteristics involving physical equilibria are

a. Equilibrium is possible only in a closed system at a given temperature.

b. Both the opposing processes occur at the same rate and there is a dynamic but stable condition.

c. All measurable properties of the system remain constant.

d. The magnitude of such quantities at any stage indicates the extent to which the physical process has proceeded before reaching equilibrium.

Section C

22. i. The given redox reaction is ,

Zn (s) $2Ag^+$ (aq) $\longrightarrow$ Zn^{2+} (aq) + 2 Ag (s)

Since Zn (s) gets oxidized, to Zn^{2+} (aq) ions, and Ag^+ (aq) ions gets reduced to Ag (s) metal, therefore, oxidation occurs at the zinc electrode *(*acting as anode*)* and reduction occurs at the silver electrode (as cathode*)*. Thus, the galvanic cell corresponding to the above redox reaction is depicted as:

$Zn_{(s)}$ | Zn^{2+} (aq) || Ag^+ (aq) | $Ag_{(s)}$

ii. a. Since oxidation occurs at the zinc electrode, therefore, electrons accumulate on the zinc electrode,/ anode. Hence, zinc electrode is negatively charged.

b. Electrons move from Zn anode to Ag cathode in the external circuit. Since the direction of current in the external circuit is opposite to that of the electrons so,
The carriers of current are silver cathode and Zinc anode through an external circuit in a direction from silver cathode to zinc anode.

c. The reactions occurring at the two electrodes are
At anode:

Zn (s) $\longrightarrow$ zn^{2+} (aq) + $2e^-$

At cathode

Ag^+ (aq) + e^- $\longrightarrow$ Ag (s)

23. Answer:

(i) Properties which depend on the nature of the substance and not on the amount of the substance are called intensive properties.

(ii) Lesser the heat required to vaporise 1 mole of a liquid less is its enthalpy of vaporisation. Hence, water has a higher enthalpy of vaporisation.

(iii) Graphite has greater entropy since it is loosely packed.

24. From Rydberg formula,

Wave number, $\bar{v} = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ cm^{-1} ; Where R_H = 109677 cm^{-1}

Here n_1 =2, n_2=4 (Transition in Balmer series)

$\bar{v} = 109677 \left[\frac{1}{2^2} - \frac{1}{4^2}\right]$ = $109677 \left[\frac{1}{4} - \frac{1}{16}\right]$ = 20564.44 cm^{-1}

25. i. In AX_2 molecule with a linear geometry, the individual bond moments of A-X bonds will cancel being equal in magnitude and opposite in direction. This will cause the overall dipole moment of the molecule to be 0.

ii. In AX_4 molecule having tetrahedral geometry, the individual dipole moments of A-X bonds will cancel out being equal in magnitude and opposite in direction. This will cause the overall dipole moment of the molecule to be zero.

iii. In AX_2 molecule having angular geometry, the individual bond moments of A-X bonds will add up and thus the molecule will have a net non-zero dipole moment.

iv. In AX_4 molecule having square planar geometry the individual dipole moments of A-X bonds will cancel out being equal in magnitude and opposite in direction. This will cause the overall dipole moment of the molecule to be zero.

26. As per given equation ,

$N_{2(g)} + 3\ H_2\ (g) \longrightarrow 2\ NH_3\ (g)$

Stoichiometrically,

i. 1 mol of N_2 (i.e. = 28 g) react with 3 mols of H_2, (i.e. = 6 g of H_2)

2000 g of N_2 will react with [(6/28) (2000)]

= 428.6 g.of H_2.

Thus, N_2 is the limiting reagent while H_2 is the excess reagent.

Again,

1 mol. of B N_2, (i.e. 28 g of N_2 produce) NH_3

= 2 mole (ie. 34 g of NH_3 (g)

$\therefore$ 2000 g of N_2 will produce

= [(34 / 28) $\times$ (2000)] g

= 2428.57 g

ii. H_2 will remain unreacted**,**

because 1000 g of N_2 has been taken for reaction, out of which only 428.6 g is consumed.

iii. Mass of H_2 left unreacted

= (1000 g - 428.6 g)

= 571.4 g

27. First period is the shortest period of the periodic table. It contains 2 elements, $_1$H and $_2$He.

Second and third periods contain 8 elements each called short periods. The second period contain elements $_3$Li to $_{10}$Ne and $_{11}$Na to $_{18}$Ar.

Fourth and fifth period contains 18 elements each namely $_{19}$K to $_{36}$Kr and $_{37}$Rb to $_{54}$Xe and are long periods.

Sixth period contains 32 elements from $_{55}$Cs to $_{86}$Rn and is the longest period.

Seventh period is incomplete period. It has all other elements starting with $_{87}$Fr onwards. Elements from 93 onwards are purely synthetic and are called trans–uranium elements and their properties have not been studied properly yet.

28. According to the question, ΔU^o = - 10.5 kJ and ΔS^o = - 44.1 JK^{-1}, R = 8.314 $\times$ 10^{-3} kJ mol^{-1}, T = 298 K.

Reaction:

2A(g) + B(g) $\longrightarrow$ 2D (g)

$\Delta n_g = n_p - n_r = 2 - 3 = -1$

We know that, $\Delta H^o = \Delta U^o + \Delta n_g RT$

ΔH^o = - 10.5 + (- 1 $\times$ 8.314 $\times$ 10^{-3} $\times$ 298)

= - 12.977 kJ mol^{-1}

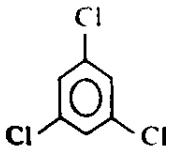
Now, $\Delta G^o = \Delta H^o - T\Delta S^o$

ΔG^o = -12.977 - (298 $\times$ - 44.1 $\times$ 10^{-3})

= 0.165 kJ mol^{-1}

The reaction will not occur spontaneously because ΔG^o is positive.

Section D

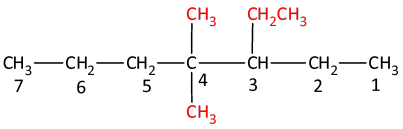
29. i. Both the molecules have zero dipole moments since both  and  shows symmetrical structure.

ii. XeF_4 and BF_3

iii. Fraction of electronic charge = $\frac{1.2\times10^{-10}}{4.8\times10^{-10}} = 0.25$

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

v. % ionic character = $\frac{1.5\times10^{-29}}{2.4\times10^{-29}} \times 100 = 62.5$

30. i. 

ii. The numbering is done in such a way that the branched carbon atoms get the lowest possible numbers.

iii. 'Hexane' indicates the presence of 6 carbon atoms in the chain. The functional group chloro is present at carbon 2. Hence, the structure of the compound is $CH_2CH_2CH_2CH_2CH(Cl)CH_3$.

OR

CH_4 after becoming-CH_3 called a methyl group because an alkyl group is named by substituting 'yl' for 'ane' in the corresponding alkane.

Section E

31. The first step of the dissociation of H_2S is

$H_2S \rightleftharpoons H^{\oplus} + HS^{\ominus}$

$K_1 = \frac{[H^{\oplus}][HS^{\ominus}]}{[H_2S]} = 4 \times 10^{-3}$

$[H^*] = C\alpha$, $[HS^{\ominus}]$ = Cα, [H2S] = C (1 - α)

$\therefore 4 \times 10^{-3} = \frac{C\alpha \cdot C\alpha}{C(1-\alpha)} = \frac{C\alpha^2}{(1-\alpha)}$

$4 \times 10^{-3} = \frac{0.1 \times \alpha^2}{(1-\alpha)}$ (1 - α should not be neglected)

or α = 0.18,

$\therefore [H^{\oplus}]$ = Cα = 0.1 0.18 = 0.018 M

$[HS^{\ominus}]$ = Cα = 0.1 × 0.18 = 0.018 M

[H2S] = C(1 - α) = 0.1(1 -0.18) = 0.082 M

Now, $HS^{\ominus}$ further dissociates to $H^{\oplus}$ and S^{2-};

$C_1 = [HS^{\ominus}]$ = 0.018 M

$HS^{\ominus} \rightleftharpoons H^{\oplus} + S^2$

1	0	0
(1 - α_1)	α_1	α_1

$\therefore K_2 = 1 \times 10^{-5}$ = 0.018 and thus, dissociation of $HS^{\ominus}$ further suppresses due to common ion effect and 1 - $\alpha \approx 1$.

$\therefore$ 1 × 10-5 = $\frac{0.018 \times C_1\alpha_1}{C_1(1-\alpha_1)}$ = 0.018 × α_1

$\alpha_1 = \frac{1 \times 10^{-5}}{0.018} = 5.55 \times 10^{-4}$

$[S^{2-}] = C_1\alpha_1 = 0.018 \times 5.55 \times 10^{-4}$

$= 0.099 \times 10^{-4}$

OR

pK_a = - log K_a = 4.74

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

32. Answer:

(i) i. a. CH_3–Br, since Br is more electronegative than H

b. H_3C–OH, since O is more electronegative than N.

c. H_3C–OH, since O is more electronegative than S.

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

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. Resonance structure of the given compounds are as follows:

i. $CH_2 = CH - Cl \leftrightarrow {}^+CH_2 - CH = Cl^+$

ii. $CH_2 = CH - CH = CH_2 \leftrightarrow {}^+CH_2 - CH = CH \cdot CH_2^- \leftrightarrow CH_2 - CH = CH \cdot CH_2^+$

iii. $CH_2 = CH \cdot CHO \leftrightarrow {}^+CH_2 \cdot CH = CHO^-$

33. Attempt any five of the following:

(i) Acetophenone is formed.

(ii)

$$\overset{10}{CH_3} - \overset{9}{CH} = \overset{8}{CH} - \overset{7}{CH_2} - \overset{6}{CH} = \overset{5}{CH} - \overset{4}{\underset{\underset{C_2H_5}{|}}{C}}\ H - \overset{3}{CH_2} - \overset{2}{CH} = \overset{1}{CH_2}$$

(iii) Hydrocarbons are categorized into three categories according to the carbon-carbon bond that exists between them:

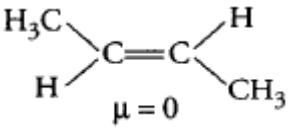
a. Saturated hydrocarbon (In which carbon-carbon single bond are present)
b. Unsaturated hydrocarbon (In which carbon-carbon double and triple bonds are present)
c. Aromatic hydrocarbon (In which alternate single and double bond and (4n+2)π electrons are present)

(iv) HI > HBr > HCl > HF

(v) Carbocation formed gets stabilised due to resonance.

(vi) In trans-but-2-ene, the dipole moments of the two C—CH_3 bonds are equal and opposite and therefore, they cancel out each other.

Hence, trans-2-butene is non-polar.



(vii) **Benzenoids:** Aromatic hydrocarbon compound containing benzene ring are known as benzenoids.

Examples for benzenoids are: