Class XI Session 2025-26
Subject - Chemistry
Sample Question Paper - 2

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. Match the following: **[1]**

Column A	**Column B**
i. Number of millimoles	a. $\frac{\text{Molarity}}{\text{Valency}}$
ii. Number of milliequivalents	b. Normality $\times$ volume in mL
iii. Normality	c. Valency $\times$ molarity
	d. Molarity $\times$ volume in mL

a) i - b, ii - d, iii - a b) i - d, ii - b, iii - c

c) i - a, ii - b, iii - d d) i - d, ii - c, iii - b

2. To which the terms stationary phase and mobile phase are associated? **[1]**

a) Distillation under reduced pressure b) Chromatography

c) Differential Extraction d) Spectroscopy

3. Red phosphorus reacts with liquid bromine in an exothermic reaction **[1]**
$2P(s) + 3Br_2(l) \rightarrow 2PBr_3(g)$; $\triangle H = -243kJ$ Calculate the enthalpy change when 2.63 g phosphorus reacts with an excess of bromine in this way.

a) −10.3 kJ b) −6.8 kJ

c) −12.3 kJ d) −8.3 kJ

4. Find the INCORRECT match. **[1]**

a) Solid with highest density - Os

b) Liquid with highest density - Hg

c) Non-metal with highest melting point - S

d) Metal with highest melting point - W

5. Calculate the standard enthalpy of formation of $CH_3OH(l)$ from the following data: **[1]**

$CH_3OH\ (1) + O_2(g) \rightarrow CO_2(g) + 2H_2O\ (1)$; $\Delta_r H^o$ = -726 kJ mol^{-1}

$C(graphite) + O_2(g) \rightarrow CO_2(g)$; $\Delta_c H^o$ = -393 kJ mol^{-1}

$H_2(g + O_2(g) \rightarrow H_2O\ (1)$; $\Delta_c H^o$ = -286 kJ mol^{-1}

a) -209 kJ mol^{-1}

b) -339 kJ mol^{-1}

c) -269 kJ mol^{-1}

d) -239 kJ mol^{-1}

6. The wavelength of a ball of mass 0.1 kg moving with a velocity of 10 ms^{-1} will be: **[1]**

a) 6.626×10^{-35} m

b) 6.626×10^{-34} m

c) 7.626×10^{-34} m

d) 6.626×10^{34} m

7. Which of the following reactions represent(s) redox process? **[1]**

a) Corrosion of metals

b) All of these

c) Manufacturing of caustic soda

d) Electrochemical process for extraction of highly reactive metals and non-metals

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

a) Fractional distillation

b) Simple distillation

c) Steam distillation

d) Distillation under reduced pressure

9. A gas decolourised by $KMnO_4$ solution but gives no precipitate with ammoniacal cuprous chloride is _____. **[1]**

a) Ethane

b) Acetylene

c) Methane

d) Ethene

10. Study the structures given below carefully and choose the type of isomerism they represent. **[1]**

$CH_3 - \overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}} - CH_3$ and $CH_3 - \overset{\overset{CH_3}{|}}{CH} - CH_2 - CH_3$

a) functional isomerism

b) position isomerism

c) chain isomerism

d) metamerism

11. In a closed system, which of the following take place? **[1]**

a) The boundaries prevent the flow of matter out of it but not vice versa.

b) The boundaries permit the flow of matter into or out of it.

c) The boundaries permit the flow of matter into it but not vice versa.

d) The boundaries prevent the flow of matter into or out of it.

12. What product is obtained by heating ethylidene chloride with alcoholic KOH? **[1]**

a) Ethyne

b) Ethane

c) Methane

d) Ethene

13. **Assertion (A):** Alkynes show geometrical isomerism. **[1]**

Reason (R): Geometrical isomerism arises due to the restricted rotation of a double bond.

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):** Alkanes are stable to acids, alkalies, oxidising agents etc. at room temperature. **[1]**

Reason (R): Alkanes are less reactive at room temperature.

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):** Total number of electrons in a subshell is designated by (2l + 1), where l = azimuthal quantum number. **[1]**

Reason (R): l can have value 0, 1, 2... n - 1, where n is 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):** The balancing of chemical equations is based on the law of conservation of mass. **[1]**

Reason (R): Total mass of reactants is equal to the total mass of products.

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. Calculate formal charge on each O-atom of O_3 molecule. **[2]**

OR

Explain why carbon has a valency of four and not two and why are the four C - H bonds in methane identical.

18. Classify the following species into Lewis acids and Lewis bases and show how these act as Lewis acid/base: **[2]**

a. OH^-

b. F^-

c. H^+

d. BCl_3

19. 0.12 g of an organic compound containing phosphorous gave 0.22 g of $Mg_2P_2O_7$ by usual analysis. Calculate the percentage of phosphorous in the compound. **[2]**

20. The aqueous solution of sugar does not conduct electricity. However, when sodium chloride is added to water, it conducts electricity. How will you explain this statement on the basis of ionisation and how is it affected by the concentration of sodium chloride? **[2]**

21. Which of the two: O_2NCH_2 CH_2O^- or $CH_3CH_2O^-$ is expected to be more stable and why? **[2]**

Section C

22. Write structures of different isomeric alkyl groups corresponding to the molecular formula C_5H_{11}. Write IUPAC **[3]**

names of alcohols obtained by attachment of –OH groups at different carbons of the chain.

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

(a) i. What is the mass of a neutron? **[1]**

ii. What is the charge of a neutron?

(b) State Heisenberg's Uncertainty Principle. **[1]**

(c) What is the wavelength of light emitted when the electron in a hydrogen atom undergoes a transition from an energy level with n = 4 to an energy level with n = 2? **[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. Justify that the following reactions are redox reactions: **[3]**

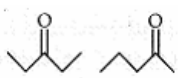
i. $CuO + H_2(g) \longrightarrow Cu(s) + H_2O(g)$

ii. $Fe_2O_3(s) + 3CO(g) \longrightarrow 2Fe(s) + 3CO_2(g)$

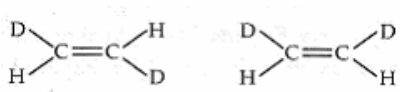
iii. $4BCl_3(g) + 3LiAlH_4(s) \longrightarrow 2B_2H_6(g) + 3LiCl(s) + 3\ AlCl_3(s)$

26. What is the relationship between the members of following pairs of structures? Are they structural or geometrical isomers or resonance contributors? **[3]**

i.



ii.



iii. H - C(+OH)(=O) - OH H - C(OH)(+) - OH

27. Express the change in internal energy of a system when **[3]**

i. No heat is absorbed by the system from the surroundings, but work (w) is done on the system. What type of wall does the system have?

ii. No work is done on the system, but q amount of heat is taken out from the system and given to the surroundings. What type of wall does the system have?

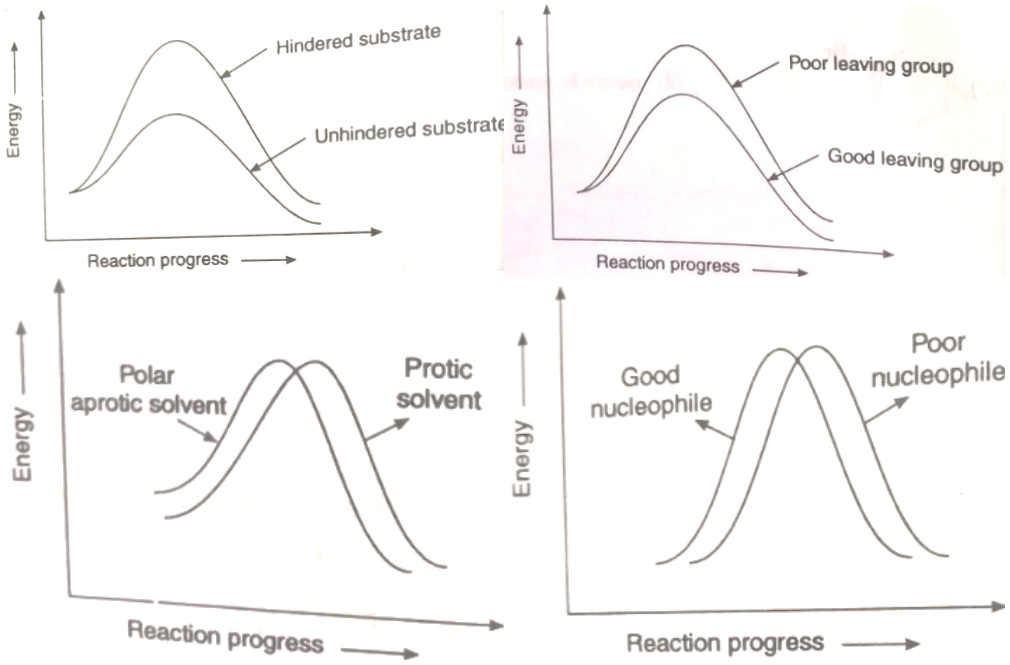
iii. w amount of work is done by the system and q amount of heat is supplied to the system. What type of system would it be?

28. If 0.561 g of KOH is dissolved in water to give 200 mL of solution at 298 K, calculate the concentrations of potassium, hydrogen and hydroxyl ions. What is its pH? **[3]**

Section D

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

Bimolecular nucleophilic substitution (S_N2) has four variable, i.e., substrate structure, nucleophile, leaving group and solvent, reaction energy level diagram for these factors are given in the following diagrams:



i. How does steric hindrance effect stability? (1)

ii. How does more reactive nucleophile decrease the ΔG and increase the rate of reaction? (1)

iii. Why are SN_1 reactions generally carried in polar solvents? (2)

OR

How does Protic solvent affect the ΔG and rate of reaction? (2)

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

The orbital wave function or ψ for an electron in an atom has no physical meaning. 1s orbital the probability density is maximum at the nucleus and it decreases sharply as we move away from it. After reaching a small maxima it decreases again and approaches zero as the value of r increases further. These probability density variation can be visualised in terms of charge cloud diagrams. Boundary surface diagrams of constant probability density for different orbitals give a fairly good representation of the shapes of the orbitals. A boundary surface or contour surface is drawn in space for an orbital on which the value of probability density $|\psi|^2$ is constant. The size of the s orbital increases with increase in n, that is, 4s > 3s > 2s > 1s and the electron is located further away from the nucleus as the principal quantum number increases.

i. Why is the energy of 1s electron lower than 2s electron? (1)

ii. Why don't we draw a boundary surface diagram within the probability of finding the electron is 100%? (1)

iii. Calculate the total number of angular nodes and radial nodes present in the 3p orbital. (2)

OR

Describe the shape of s orbitals? (2)

Section E

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

(a) What type of bond exists in multiple bonds (double/triple)? **[1]**

(b) Why is dipole moment of CO_2, BF_3, CCl_4 is zero? **[1]**

(c) Define bond order. **[1]**

(d) Which of the following has the highest lattice energy and why? **[1]**

CsF, CsCl, CsBr, CsI

(e) Write the significance of plus and minus sign in representing the orbitals. **[1]**

(f) Arrange the bonds in order of increasing ionic character in the molecules: LiF, K_2O, N_2 and ClF_3 **[1]**

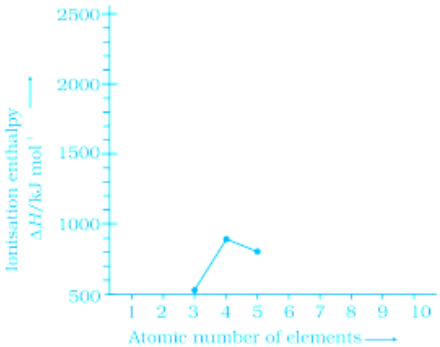
(g) Calculate the number of bond pairs and lone pairs in IF_5 molecule. **[1]**

32. Define electron gain enthalpy. What is its unit ? Discuss the factors which influence the electron gain enthalpy. **[5]**

OR

Ionization enthalpies of elements of the second period are given below: Ionisation enthalpy / k cal mol^{-1}: 520, 899, 801, 1086, 1402, 1314, 1681, 2080.

Match the correct enthalpy with the elements and complete the graph given in Fig. Also, write symbols of elements with their atomic number.



33. i. Give an example of a molecule in which **[5]**

a. The ratio of the molecular formula and the empirical formula is 6: 1.

b. Molecular weight is two times of the empirical formula weight.

c. The empirical formula is CH_2O and the ratio of molecular formula weight and empirical formula weight is 6.

ii. 1.615 g of anhydrous $ZnSO_4$ was left in moist air. After a few days its weight was found to be 2.875 g. What is the molecular formula of hydrated salt?

(At. masses: Zn = 65.5, S = 32, O=16, H = 1)

OR

i. The density of the water at room temperature is 1.0 g/mL. How many molecules are there in a drop of water if its volume is 0.05 mL?

ii. 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.

Solution

Section A

1.

(b) i - d, ii - b, iii - c

Explanation:

i. Number of milimoles

$= \frac{\text{wt.in gm} \times 1000}{\text{mol. wt}}$

= molarity $\times$ volume in mL

ii. Number of milliequivalents (meq)

$= \frac{\text{wt.in gm} \times 1000}{\text{Eq. wt}}$

= normality $\times$ volume in mL

iii. Normality = x $\times$ molarity

Where x = $\frac{\text{mol.wt}}{\text{Eq.wt}}$,

x = Valency or change in oxidation number.

2.

(b) Chromatography

Explanation:

Chromatography is associated with the stationary phase and mobile phase.

3. **(a)** −10.3 kJ

Explanation:

The given reaction is, $2P(s) + 3Br_2(l) \rightarrow 2PBr_3(g); \Delta H = -243kJ$

moles of $P(s) = \frac{2.63}{31} = 0.084$ moles.

Heat liberated, when 2 mol of P(s) reacted = -243 kJ

Heat liberated, when 0.084 mol of P(s) reacted $= \frac{243}{2} \times 0.084 = -10.206kJ$

4.

(c) Non-metal with highest melting point - S

Explanation:

Non-metal with highest melting point - S

5.

(d) -239 kJ mol^{-1}

Explanation:

Required reaction for the formation of methanol is:

C(s) + $2H_2$(g) + $\frac{1}{2}O_2$ (g) $\rightarrow$ CH_3OH(l) $\Delta_f H^o$ = ?

Enthalpy for the combustion of methanol;

a. CH_3OH (l) + $\frac{3}{2}O_2$(g) $\rightarrow$ CO_2(g) + $2H_2O$ (l) $\Delta_f H^o$ = - 726 kJ mol^{-1} ...(1)

Enthalpy for the formation of 1 mole of CO_2(g)

b. C(s) + O_2 (g) $\rightarrow$ CO_2(g) $\Delta_f H^o$ = - 393 kJ mol^{-1} ...(2)

Enthalpy for the formation of 2 moles of H_2O(l)

c. H_2(g) + $\frac{1}{2}O_2$ (g) $\rightarrow$ H_2O(l) $\Delta_f H^o$ = - 286 kJ mol^{-1} ...(3)

Now, [eq...(3) $\times$ 2 + eq ...(2) + [by reversing equation(1)] we get]

$C(s) + 2H_2(g) + \frac{1}{2}O_2\ (g) \rightarrow CH_3OH\ (l)\ \Delta_f H^o$ = - 239 kJ mol^{-1}

6.

(b) 6.626×10^{-34} m

Explanation:

Given : mass = 0.1 kg; veloctiy = 10 m/s.

We know,

$\lambda = \frac{h}{mv}$ where h is Planck's constant.

$\lambda = \frac{6.626 \times 10^{-34}}{10 \times 0.1} = 6.626 \times 10^{-34}$ m

7.

(b) All of these

Explanation:

Electrochemical processes for the extraction of highly reactive metals and non-metals, manufacturing of chemical compounds like caustic soda, operation of dry and wet batteries and corrosion of metals fall within the range of redox processes.

8. **(a)** Fractional distillation

Explanation:

Fractional distillation

9.

(d) Ethene

Explanation:

Due to unsaturation, ethene decolourises $KMnO_4$ solution forming glycol. However, it shows no reaction with ammoniacal cupric chloride.

10.

(c) chain isomerism

Explanation:

$CH_3 - \underset{\underset{CH_3}{|}}{\overset{CH_3}{|}}{C} - CH_3$ and $CH_3 - \overset{CH_3}{\underset{|}{CH}} - CH_2 - CH_3$ are chain isomers as they have different carbon chains.

11.

(d) The boundaries prevent the flow of matter into or out of it.

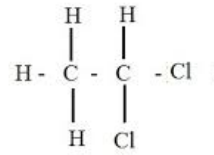
Explanation:

In a closed system, there is no flow of matter from system to surrounding or vice versa. For example, a certain quantity of fluid bounded within a closed cylinder constitutes a closed system.

12. **(a)** Ethyne

Explanation:

Ethylidene chloride is 1,1 - dichloroethane having the structural formula,



Structural formula of Ethylidene di chloride or 1,1-dichloro ethane

Ethylidene chloride, when treated with alcoholic KOH forms **ethyne**.

The reaction takes place in two steps giving vinyl chloride in the first step, which further undergoes an elimination reaction to form ethyne. as shown below,

$$\underset{(Ethylidene\ chloride)}{CH_3CHCl_2} \xrightarrow[alcoholicKOH]{} \underset{(VinylChloride)}{CH_2=CHCl} \xrightarrow[KOH(alc.)]{} \underset{(Ethyne)}{HC\equiv CH}$$

13.

(d) A is false but R is true.

Explanation:

Alkynes have linear structure and do not show geometrical isomerism.

14.

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

Explanation:

The electronegativities of carbon (2.60) and hydrogen (2.1) do not differ appreciably. Thus the bond electrons in C-H are practically equally shared between them and the bond is almost nonpolar. The C-C bond is completely nonpolar and polar reagents find no reaction sites on alkane molecules.

15.

(d) A is false but R is true.

Explanation:

(2l + 1) gives the value for number of orbitals in that subshell not the electrons. 'l' can have only values of 0, 1, 2, 3 for 's', 'p', 'd' and 'f' not only other value.

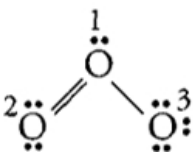
16. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

According to law of conservation of mass, in a chemical reaction total mass of the products is equal to the mass of the reactants.

Section B

17. The Lewis structure of O_3 may be drawn as



The oxygen atoms have been numbered as 1, 2 and 3. The formal charge on

i. the central O-atom marked as 1 = V - L - $\frac{1}{2}$S

= 6 - 2 - $\frac{1}{2}$ (6) = +1

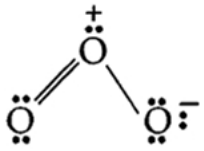
ii. the end O-atom marked as 2 = V - L - $\frac{1}{2}$S

= 6 - 4 - $\frac{1}{2}$ (4) = 0

iii. the end O-atom marked as 3 = V - L - $\frac{1}{2}$S

= 6 - 6 - $\frac{1}{2}$ (2) = -1

Hence, the O_3 molecule along with the formal charges can be represented as follows

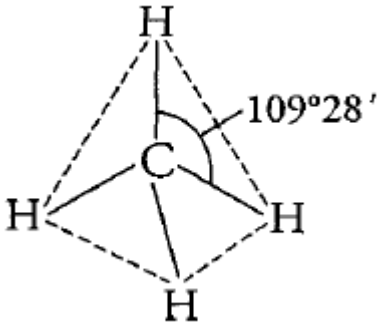


OR

The ground state electronic configuration of carbon is $1s^2, 2s^2, 2p^2$. Carbon has 4 electrons in its outermost shell. Also, it needs more four electrons to complete its octet. Therefore, the valency of carbon is 4.

Electronic configuration of carbon in excited state is $1s^2, 2s^1, 2p_x^1 2p_y^1, 2p_z^1$. One s-orbital and three p-orbitals of the valence shell mix to form four sp^3 hybrid orbitals. These hybrid orbitals are arranged tetrahedrally at an angle of 109° 28. All hybrid orbitals are identical to each other. So, four C - H bonds in methane are identical. The four sp^3 hybrid orbitals overlap with the half-filled s orbitals of four H-atoms.

Structure:



18. a. Hydroxyl ion (OH^-) acts as a Lewis base as it can donate an electron lone pair.

    b. Fluoride ion (F^-) acts as a Lewis base as it can donate any one of its four electron lone pairs.

    c. A proton (H^+) acts as a Lewis acid as it can accept a lone pair of electrons from bases like hydroxyl ion and fluoride ion.

    d. BCl_3 acts as a Lewis acid as it can accept a lone pair of electrons from species like ammonia or amine molecules.

19. $\%\ \text{of P} = \frac{62}{222} \times \frac{\text{weight of } Mg_2P_2O_7 \text{ formed} \times 100}{\text{weight of organic compound}}$

    $= \frac{62}{222} \times \frac{0.22}{0.12} \times 100$

    $= 51.20\%$

20. Sugar does not ionize in water but NaCl ionize completely in water and produces Na^+ and Cl^-.

    Conductance increases with an increase in the concentration of salt due to the release of more ions.

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

Section C

22.

Isomeric structures of – C_5H_{11} group	**Corresponding alcohols**	**IUPAC name of alcohol**
(i) $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 -$	$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - OH$	Pentan-1-ol
(ii) $CH_3 - \underset{\vert}{CH} - CH_2 - CH_2 - CH_3$	$CH_3 - \underset{\vert}{\underset{OH}{CH}} - CH_2 - CH_2 - CH_3$	Pentan-2-ol
(iii) $CH_3 - CH_2 - \underset{\vert}{CH} - CH_2 - CH_3$	$CH_3 - CH_2 - \underset{\vert}{\underset{OH}{CH}} - CH_2 - CH_3$	Pentan-3-ol
(iv) $CH_3 - \overset{CH_3}{\underset{\vert}{CH}} - CH_2 - CH_2 -$	$CH_3 - \overset{CH_3}{\underset{\vert}{CH}} - CH_2 - CH_2 - OH$	3-Methyl-butan-1-ol
(v) $CH_3 - CH_2 - \overset{CH_3}{\underset{\vert}{CH}} - CH_2 =$	$CH_3 - CH_2 - \overset{CH_3}{\underset{\vert}{CH}} - CH_2 - OH$	2-Methyl-butan-1-ol
(vi) $CH_3 - \overset{CH_3}{\underset{\vert}{C}} - CH_2 - CH_3$	$CH_3 - \overset{CH_3}{\underset{\vert}{\underset{OH}{C}}} - CH_2 - CH_3$	2-Methyl-butan-2-ol
(vii) $CH_3 - \overset{CH_3}{\underset{CH_3}{C}} - CH_2 -$	$CH_3 - \overset{CH_3}{\underset{CH_3}{C}} - CH_2OH$	2,2- Dimethyl-propan-1-ol
(viii) $CH_3 - \overset{CH_3}{\underset{\vert}{CH}} - \underset{\vert}{CH} - CH_3$	$CH_3 - \overset{CH_3}{\underset{\vert}{CH}} - \overset{OH}{\underset{\vert}{CH}} - CH_3$	3-Methyl-butan-2-ol

23. Answer:

    (i) i. The mass of 1 mole neutron = mass of 1 neutron $\times$ 6.02 $\times$ 10^{23} = $1.676 \times 10^{-24} \times 6.02 \times 10^{23}$ = 1 gm

ii. Neutron is electrically neutral i.e. it has no charge.

(ii) **Heisenberg's Uncertainty Principle :** It is impossible to determine simultaneously the exact position and exact momentum (or velocity) of a microscopic particle i.e. electron..

(iii) According to Rydberg's formula of spectral lines: $\frac{1}{\lambda} = 109677\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \text{cm}^{-1}$

Here, n_1 =2 and n_2 =4. Put these values in above equation, we get.

$\frac{1}{\lambda} = 109677\left(\frac{1}{2^2} - \frac{1}{4^2}\right) \text{cm}^{-1}$

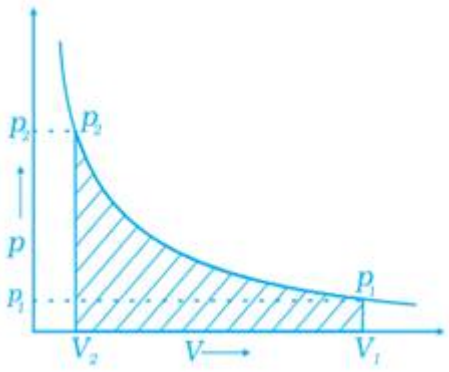
or λ = 486 nm

The colour corresponding to this wavelength is blue.

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. The given equations for different reactions are :

i. $\overset{+2-2}{\text{CuO(s)}} + \overset{0}{\underset{2}{\text{H(g)}}} \rightarrow \overset{0}{\text{Cu(s)}} + \overset{+1-2}{\text{H}_2\text{O(g)}}$

As per above equation, it is noted that.

a. an atom of oxygen (O) is removed from CuO,

∴ it is reduced to Cu, while

b. O is added to H_2 to form H_2O

∴ it is oxidized.

Further,

Oxidation number. of Cu decreases from +2 in CuO to 0 in Cu,

oxidation number of H increases from 0 in H_2 to +1 in H_2O.

∴ CuO is reduced to Cu but H_2 is oxidized to H_2O.

Thus, the reaction is a redox reaction.

ii. $\overset{+3\ -2}{\text{Fe}_2\text{O}_3}\text{(s)} + \overset{+2}{3\text{CO}}\text{(g)} \rightarrow \overset{0}{2\text{Fe}}\text{(s)} + \overset{+4}{\underset{2}{3\text{CO}}}\text{(g)}$

In the above equation for reaction, it is seen that

a. The oxidation number of Fe decreases from +3 in Fe_2O_3 to 0 in Fe, and

oxidation number of C increases from +2 in CO to +4 in CO_2.

Further,

oxygen is removed from Fe_2O_3, and

added to CO to form CO_2

therefore, Fe_2O_3 is reduced while CO is oxidized.

Thus, the given reaction is a redox reaction.

iii. Similarly, in the given equation ,

$4B^{+3}Cl^{-1}{}_3(g) + 3Li^{+1}\ Al^{+3}\ H^{-1}{}_4\ (s) \longrightarrow 2\ B^{-3}{}_2\ H^{-1}{}_6\ (g) + 3LI^{+1}\ Cl^{-1}\ (s) + 3\ Al^{+3}\ Cl^{-1}{}_3$

Oxidation number of B decreases from +3 in BCl_3 to -3 in B_2H_6

while,
oxidation number of H increases from -1 in $LiAlH_4$ to +1 in B_2H_6.

Therefore, BCl_3 is reduced and

$LiAlH_4$ is oxidized.

Further, it is noted that,
H is added to B forming B_2 H6 from BCl_3 but is removed from $LiAlH_4$,

therefore,
BCl_3 is reduced while $LiAlH_4$ is oxidised.

Thus,
the redox nature of above reaction is justfied.

26. i. Structural isomers (actually position isomers as well as metamers)
ii. Geometrical isomers
iii. Resonance contributors because they differ in the position of electrons but not atoms

27. i. Δ U = w_{ad}, wall is adiabatic
ii. Δ U = – q, thermally conducting walls
iii. Δ U = q – w, closed system.

28. Molarity of KOH, $M = \frac{\text{mass of KOH(g)} \times 1000}{\text{molar mass (KOH)} \times \text{Volume of solution (in mL)}}$

$\Rightarrow M = \frac{0.561 \times 1000}{56 \times 200}$

$\Rightarrow$ M = 0.05 mol L^{-1}

We know that, Molar mass of KOH = 39 + 16 + 1 = 56 g mol^{-1}

Reaction:

$KOH \longrightarrow K^+ + OH^-$

Now, $[K^+]$ = 0.05 M and $[OH^-]$ = 0.05 M

We know that, $[H^+][OH] = K_w = 1.0 \times 10^{-14}$

$\Rightarrow [H^+] = \frac{1.0 \times 10^{-14}}{0.05}$

$= 20 \times 10^{-14}$ M

$= 2 \times 10^{-13}$ M

We know that, $pH = -\log[H^+]$

$= -\log[2 \times 10^{-13}]$

= -0.3010 + 13

= 12.7

Section D

29. i. Steric hindrance is known to affect the stability, reactivity, and radical trapping ability of stable nitroxide radicals.
ii. More reactive nucleophiles are less stable and have higher ground state energy thereby decreasing the ΔG and increasing the rate of reaction.
iii. A polar protic solvent favors the SN_1 mechanism because polar solvents have the below properties: It stabilizes the carbocation intermediate. Polar solvents like methanol have a permanent dipole which means that a partial negative charge on the molecule will have dipole-dipole interactions with the carbocation, stabilizing it. It reduces the reactivity of the nucleophile.
OR
Protic solvents solvate the nucleophile, thereby lowering its ground-state energy, increasing ΔG and decreasing the reaction rate.

30. i. 1s electron being close to the nucleus experiences more force of attraction than 2s-electron which is away from the nucleus. Force of attraction is inversely proportional to the square of distance between the particles.
ii. No, atomic orbitals do not have sharp boundaries because the probability of finding the electrons even at large distances may become very small but not equal to zero.
iii. For the 3p – orbital, the principal quantum number is n = 3 and the azimuthal number is l = 1.
The number of angular nodes will be l = 1

The number of radial nodes is equal to n – l – 1 = 3 – 1 – 1 = 1.

OR

These are spherically symmetrical and non-directional. Shapes of 1s and 2s orbitals. The effective volume of 2s orbital is larger than Is orbital. Another important feature of 2s orbital is that there is a spherical shell within 2s (region without dots) where the probability of finding the electron is zero. This is called a node or a nodal surface.

Section E

31. Attempt any five of the following:

(i) pi (π) bond is always present in molecules containing multiple bond.

(ii) The molecules given have symmetrical shapes (e.g. CO_2 is linear, BF_3 is trigonal planar and CCl_4 is tetrahedral) and thus the dipoles gets cancelled and the net dipole moment is zero.

(iii) Bond order is defined as number of bonds between two atoms in the Lewis representation of a molecule or ion.

(iv) We know that, 'F' is the smallest in size among all halogens and is more electronegative. Therefore, it has maximum ionic character and maximum force of attraction. Hence, CsF has highest lattice energy.

(v) Plus and minus sign is used to identify the nature of electrons wave. Plus (+ve) sign denotes crest while (-ve) sign denotes trough.

(vi) $N_2 < ClF_3 < SO_2 < K_2O < LiF$

(vii) I contains 7 valence electrons, out of which five are utilized to form bond with five F atoms. Thus, it has five bond pairs.

Number of lone pairs = valence e^- - bond pairs = 7 - 5 = 2 electrons or 1 lone pair.

32. Electron gain enthalpy is the energy released when an isolated gaseous atom is converted into a negative ion by adding an extra electron.

Electron gain enthalpy is denoted by the sign $\Delta eg\ H$.

The process may be represented by

$M(g) + e^- \rightarrow M^-(g)$

Neutral gaseous anion

atom $\Delta H = \Delta eg\ H$

electron gain enthalpy is negative or positive it depends upon the nature of the element.

For example. For halogens it is highly negative, because they can acquire the noble gas configuration by accepting an extra electron.

In contrast. For noble gases have positive electron gain enthalpy because energy has to be supplied to the element.

Factors on which electron gain enthalpy depends:

(i) **Atomic size.** As the size of an atom increases, the distance between its nucleus and the incoming electron also increases. Therefore, the force of attraction between the nucleus and the incoming electron decreases and hence the electron gain enthalpy becomes less negative.

(ii) **Nuclear charge.** As the nuclear charge increases force of attraction for the incoming electron increases and thus electron gain enthalpy becomes more negative.

(iii) **Symmetry of electronic configuration.** Elements having symmetrical configuration (Either half filled or fully filled orbitals in the same sub shell) having no attraction for electron because by accepting electron their configuration becomes less stable. In that case energy has to be supplied to accept electron. Thus electron gain enthalpy will be positive.

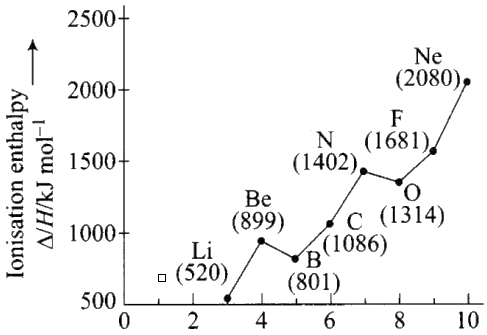
OR

As we move from left to right across a period, the ionization enthalpy keeps on increasing due to increased nuclear charge and a simultaneous decrease in the atomic radius. However, there are some exceptions which are given below-

- In spite of increased nuclear charge, the first ionisation enthalpy of B is lower than that of Be. This is due to the presence of fully filled 2s-orbital of Be [$1s^2\ 2s^2$] which is a stable electronic arrangement. Thus, higher energy is required to knock out the electron from fully filled 2s-orbital. While B [$1s^2\ 2s^2\ 2p^1$] contains valence electrons in 2s and 2p-orbitals. It can easily lose it one e^- from 2p- orbital in order to achieve noble gas configuration. Thus, the first ionisation enthalpy of B is lower than that of Be. since the electrons in 2s-orbital are more tightly held by the nucleus than those present in 2p-orbital, therefore, ionisation enthalpy of B is lower than that of Be.
- The first ionisation enthalpy of nitrogen N is higher than that of oxygen O through the nuclear charge of O is higher than that of N. This is due to the reason that in case of N, the electron is to be removed from a more stable, exactly half-filled

electronic configuration ($1s^2\ 2s^2\ 2s \times 2p^1_y\ 2p^1_z$) which is not present in O ($1s^2\ 2s^2\ 2p^2 \times 2p^1_y\ 2p^1_z$).

Therefore, the first ionization enthalpy of N is higher than that of O. The symbols of elements along with their atomic numbers are given in the following graph.



33. i. a. C_6H_6

b. H_2O_2

c. $C_6H_{12}O_6$

ii. Molecular mass of anhydrous $ZnSO_4$

= 65.5 + 32 + 4 × 16 = 161.5

1.615 g of anhydrous ZnSO4 combine with water = 1.260 g

161.5 g of anhydrous ZnSO4 combine with = $\frac{1.260}{1.615} \times 161.5$

= 126 G

OR

i. Volume of a drop of water = 0.05 mL.

Mass of a drop of water = volume × density = (0.05 mL) x (1.0 g / mL) = 0.05 g

Gram molecular mass of water (H_2O) = 2× H + 1×O = 2 × 1 + 1×16 = 18 g/mol

Here, 18 g of water = 1 mol

∴ 0.05 g of water = $\frac{1mol}{(18g)} \times (0.05g)$= 0.0028 mol

1 mole of water contains molecules = 6.022×10^{23}

0.0028 mole of water will contain molecules = $6.022 \times 10^{23} \times 0.0028 = 1.68 \times 10^{21}$ molecules

ii. Volume of the alloy = (10.0 cm)× (20.0 cm) × (15.0 cm)= 3000 cm^3.

Mass of the alloy = density × volume = (8.17 g cm^{-3}) × (3000 cm^3) = 24510 g

Percentage of nickel (Ni) in an alloy = 45.8 %

Mass of nickel (Ni) in an alloy = $(24510g) \times \frac{45.8}{100}$= 11225.6 g

Gram atomic mass of nickel (Ni) = 59 g

Therefore, 59 g Ni contains = 6.022×10^{23} atoms

11225.6 g of Ni contains = $6.022 \times 10^{23} \times \frac{(11225.6g)}{(59.0g)} = 1.15 \times 10^{20}$ atoms

Therefore, the number of Ni atoms present = 1.15×10^{20} atoms