

Previous IPE
SOLVED PAPERS

MARCH-2025 (TS)

PREVIOUS PAPERS

IPE: MARCH-2025 (TS)

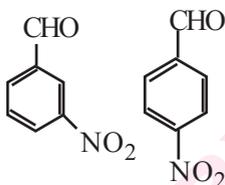
Time : 3 Hours

JR.CHEMISTRY

Max.Marks : 60

SECTION-A**I. Answer ALL questions :****10 × 2 = 20**

1. State law of chemical equilibrium.
2. What is Boltzman's Constant? Give its value.
3. The empirical formula of a compound is CH_2O . Its molecular weight is 90. Calculate the molecular formula of the compound.
4. Lithium salts are mostly hydrated. Why?
5. Describe the important uses of Caustic Soda.
6. How does Graphite function as a lubricant?
7. What is 'producer gas'?
8. What is PAN? What effect is caused by it?
9. What is Chemical Oxygen Demand (COD)?
10. Write IUPAC names of:

SECTION-B**II. Answer any SIX of the following Questions.****6 × 4 = 24**

11. Explain the hybridisation involved in PCl_5 molecule.
12. Balance the following redox reactions by ion-electron method.

$$\text{Cr}_2\text{O}_7^{2-} + \text{SO}_2(\text{g}) \rightarrow \text{Cr}^{3+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \text{ (ion acidic solution)}$$
13. Explain extensive and intensive properties.
14. Explain the structure of diborane.
15. Name the isotopes of hydrogen. What is the ratio of the masses of these isotopes?
16. Deduce (a) Graham's law and (b) Dalton's law from kinetic gas equation.
17. Write the conjugate acid and conjugate base of each of the following:
a) OH^- b) H_2O c) HCO_3^- d) H_2O_2 .
18. Explain the formation of Coordinate Covalent bond with one example.

SECTION-C**III. Answer any TWO of the following Questions.****2 × 8 = 16**

19. How are the quantum numbers n , l and m_l arrived at? Explain the significance of these quantum numbers.
20. Define IE_1 and IE_2 . Why is $\text{IE}_2 > \text{IE}_1$ for a given atom? Discuss the factors that effect IE of an element.
21. Explain Markownikoff's rule and Kharash effect (Anti-markownikoff).

IPE TS MARCH-2025

ANSWERS

SECTION-A

1. State law of chemical equilibrium.

A: **Law of chemical equilibrium:** In a balanced chemical equation, the **ratio** of 'the product of molar concentrations of the products' to 'the product of the molar concentrations of the reactants' is constant at a given temperature.

2. What is Boltzman's Constant? Give its value.

A: 1) Boltzman's constant is the 'gas constant per molecule'.
2) Boltzman's constant, $k = \frac{R}{N} = 1.38 \times 10^{-23} \text{ JK}^{-1}\text{molecule}^{-1}$

3. The empirical formula of a compound is CH_2O . Its molecular weight is 90. Calculate the molecular formula of the compound.

A: Molecular weight of the given compound = 90
Empirical formula weight = $12 + 2 + 16 = 30$;

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{90}{30} = 3$$

Molecular formula = (Empirical formula)_n = $(\text{CH}_2\text{O})_3 = \text{C}_3\text{H}_6\text{O}_3$

4. Lithium salts are mostly hydrated. Why?

A: 1) Lithium is the smallest in size among the alkali metals. Hence, Li^+ ion can polarize water molecules more easily than other alkali metals.
2) As a result, Li^+ has maximum degree of hydration and so lithium salts are mostly hydrated.
3) **Ex:** $\text{LiCl} \cdot 2\text{H}_2\text{O}$

5. Describe the important uses of Caustic Soda.

A: **Sodium hydroxide (NaOH) is used in the following:**

- 1) Soap, paper industries.
- 2) 'Petroleum refining'.
- 3) 'Mercerising cotton'.
- 4) 'Laboratory reagent'.

6. How does Graphite function as a lubricant ?

- A:** 1) Graphite has two-dimensional layer structure.
2) These layers can easily slide one over the other because of weak vanderwaal forces. Hence, graphite is used as a lubricant.
-

7. What is 'producer gas'?

- A:** The mixture of CO and N₂ is called 'producer gas'.
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8. What is PAN? What effect is caused by it?

- A:** 1) PAN means Peroxy acetyl nitrate(C₂H₃O₅N).
2) It is a component of Photochemical smog.

3) Effects of PAN:

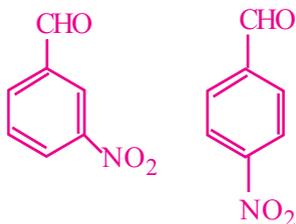
- i) It has toxic effect.
 - ii) It is respiratory irritant and eye irritant.
 - iii) It causes corrosion of metals, building materials, rubber, painted surfaces.
-

9. What is COD?

- A:** 1) **COD** is Chemical Oxygen Demand .

It is an index for measuring the 'degree of pollution of water'. (Contamination in water bodies).

- 2) COD is the 'amount of oxygen required' to oxidise organic substances present in the polluted water.
-

10. Write IUPAC names of:

- A:** 3-nitro benzene carbaldehyde, 4-nitro benzene carbaldehyde

SECTION-B

11. Explain the hybridisation involved in PCl_5 molecule.

A: 1) The central atom of PCl_5 is Phosphorus

2) Atomic number of P is 15.

Its ground state E.C = $[\text{Ne}]3s^23p^3$

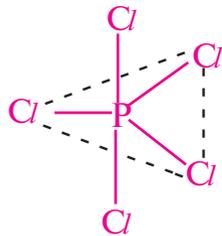
Its Excited state E.C = $[\text{Ne}]3s^13p_x^13p_y^13p_z^13d^1$

3) In its excited state the central P atom undergoes sp^3d hybridisation.

4) It forms five sp^3d hybrid orbitals.

5) The five ' sp^3d ' hybrid orbitals of P, overlap axially with $3p_z$ orbital of five Cl atoms and they form five strong $sp^3d - p_z \sigma$ bonds.

6) The shape of PCl_5 molecule is Trigonal bipyramidal with bond angles $120^\circ, 90^\circ, 180^\circ$

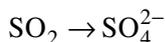


12. Balance the following redox reactions by ion-electron method.

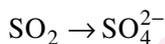


A: 1) Skeleton ionic equation $\text{Cr}_2\text{O}_7^{2-} + \text{SO}_2 \rightarrow \text{Cr}^{3+} + \text{SO}_4^{2-}$
 $\quad\quad\quad +6 \quad -2 \quad +4 \quad -2 \quad +3 \quad +6 \quad -2$

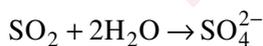
2) Oxidation half reaction



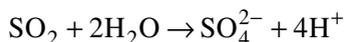
3) Balance the atoms other than O and H



4) Balance of oxygen atoms



5) Balance of hydrogen atoms



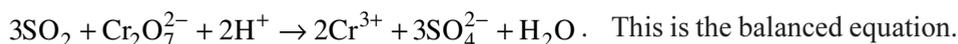
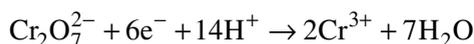
6) Balance of charges



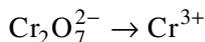
7) Equalizing of electrons



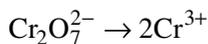
8) Adding the two half reactions



2) Reduction half reaction



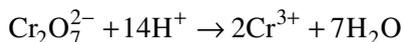
3) Balance the atoms other than O and H



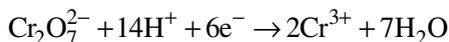
4) Balance of oxygen atoms



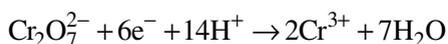
5) Balance of hydrogen atoms



6) Balance of charges



7) Equalizing of electrons



13. Explain extensive and intensive properties.

A: 1) Intensive properties: The properties of a system which do not depend on the total amount of substance are called intensive properties.

Ex: Density, viscosity, specific heat, temperature, pressure, vapour pressure etc.

2) Extensive properties: The properties of a system which depend on the total amount of substance are called extensive properties.

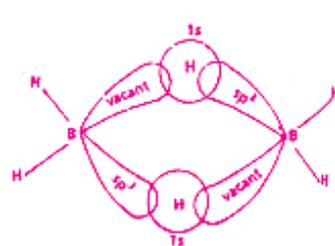
Ex: Mass, Volume, Internal energy, enthalpy, entropy, heat capacity etc.

14. Explain the structure of diborane (B_2H_6).

A: I) Structure of diborane:

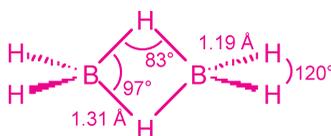
A) Hybridisation:

- 1) In diborane, Boron undergoes sp^3 hybridisation to form 4 sp^3 hybrid orbitals.
- 2) Out of 4 orbitals, 3 orbitals contain one electron each and the fourth orbital is vacant.
- 3) The two sp^3 hybrid orbitals of each Boron atom form 2 sigma bonds with two H atoms.
- 4) Overlapping of vacant orbital of one Boron, 1s orbital of hydrogen and sp^3 orbital of another Boron forms a B-H-B bridge bond.
- 5) This bridge bond is known as Banana bond (or) Tau bond.



B) Spatial Structure:

- 6) According to Electron diffraction theory, diborane has two coplanar BH_2 groups.
- 7) The four hydrogen atoms present in BH_2 groups are called **terminal hydrogens** (H_t).
- 8) The remaining 2 hydrogen atoms are called **bridge hydrogens** (H_b)
- 9) These 'two bridge hydrogens' are perpendicular to the plane of the BH_2 groups.
- 10) One bridge hydrogen lies above the plane and the other lies below the plane.



15. Name the isotopes of hydrogen. What is the ratio of the masses of these isotopes?

A: Isotopes of hydrogen:

- (i) Hydrogen ${}_1^1\text{H}$
- (ii) Deuterium ${}_1^2\text{H}$ or ${}_1^2\text{D}$
- (iii) Tritium ${}_1^3\text{H}$ or ${}_1^3\text{T}$

The ratio of their masses is 1:2:3

16. Deduce (a) Graham's law and (b) Dalton's law from kinetic gas equation.

A: (a) Graham's law: "The rate of diffusion (r) of a gas is inversely proportional to the square root of its density (d)", at constant temperature and pressure. Thus, $r \propto \frac{1}{\sqrt{d}}$

From kinetic gas equation, $PV = \frac{1}{3} m n u_{\text{rms}}^2 = \frac{1}{3} M u_{\text{rms}}^2$ ($\because mn = M$, total mass of gas)

$$\Rightarrow u_{\text{rms}}^2 = 3 \frac{PV}{M} = \frac{3P}{d}, \left(\because d = \frac{M}{V} \right) \Rightarrow u_{\text{rms}}^2 \propto \frac{1}{d} \Rightarrow u_{\text{rms}} \propto \frac{1}{\sqrt{d}}$$

But, RMS velocity, $u_{\text{rms}} \propto r$.

Hence, $r \propto \frac{1}{\sqrt{d}}$ Hence, Graham's law is derived.

(b) Dalton's law of partial pressures: "The total pressure (P) exerted by a mixture of non-reacting gaseous mixture is equal to the sum of the partial pressures of all component gases at constant temperature and volume".

- 2) Consider a gas in a vessel of volume V. Let $m_1, n_1, u_{1\text{rms}}$ denote the mass, number of moles and RMS velocity of molecules.

From the kinetic gas equation, the pressure of the gas $p_1 = \frac{1}{3} \frac{m_1 n_1 u_{1\text{rms}}^2}{V}$

- 3) If the gas is replaced by another gas in the same vessel, with $m_2, n_2, u_{2\text{rms}}$ as mass, number of moles and RMS velocity of molecules, then its pressure $p_2 = \frac{1}{3} \frac{m_2 n_2 u_{2\text{rms}}^2}{V}$

4) Now, $P = \frac{1}{3} \frac{m_1 n_1 u_{1\text{rms}}^2}{V} + \frac{1}{3} \frac{m_2 n_2 u_{2\text{rms}}^2}{V}$

$$\therefore P = p_1 + p_2$$

Hence, Dalton's law is derived.

17. Write the conjugate acid and conjugate base of each of the following:

- a) OH^- b) H_2O
 c) HCO_3^- d) H_2O_2 .

A: Species Conjugate acid Conjugate base

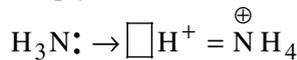
OH^-	H_2O	O^{2-}
H_2O	H_3O^+	OH^-
HCO_3^-	H_2CO_3	CO_3^{2-}
H_2O_2	H_3O_2^+	HO_2^-

18. Explain the formation of Coordinate Covalent bond with one example.

- A:** 1) **Coordinate covalent bond:** It is covalent bond formed by sharing of two electrons donated by one of the bonded atoms.
- 2) The atom which **donates** the 'electron pair' is called **donor atom**.
- 3) The other atom which **accepts** the 'electron pair' is called **acceptor atom**.
- 4) The donor atom must be having 'one or two lone pairs of electrons', while the acceptor atom has 'vacant orbitals'.
- 5) The Coordinate bond is represented by an arrow mark from donor to acceptor ($\text{A} \rightarrow \text{B}$)
- 6) **Formation of ammonium ion (NH_4^+):**

Ammonium ion is formed by the union of NH_3 molecule with H^+ ion.

In NH_3 molecule, the central 'N' atom has one lone pair of electrons and H^+ ion has empty orbital. Hence, N atom donates its lone pair to the empty orbital of H^+ ion. Thus a coordinate covalent bond is formed between N and H^+ .



SECTION-C

19. How are the quantum numbers n , l and m_l arrived at? Explain the significance of these quantum numbers.

A: The quantum numbers n , l , m_l are arrived by solving Schrodinger wave equation.

They explain

- (i) The position of electron
- (ii) Size of the orbit, shape and orientation of orbitals.

1) Principal quantum number (n):

- i) It was proposed by **Bohr**.
- ii) It is denoted by ' n '.
- iii) The values of ' n ' are **1,2,3,4.....(or) K,L,M,N.....**
- iv) **Significance:** ' n ' denotes
 - (a) **size** of the orbit (r_n)
 - (b) **energy** of the orbit (E_n)
- v) The maximum number of electrons in n^{th} orbit = $2n^2$.

2) Azimuthal quantum number (l):

- i) It was proposed by **Sommerfeld**.
- ii) It is denoted by ' l '.
- iii) The values of ' l ' are **0, 1, 2,.....,(n-1)**.
- iv) **Significance:** ' l ' denotes
 - a) **shape** of the orbitals
 - b) number of subshells in a main shell
- v) The ' l ' values 0,1, 2, 3 correspond to the sub shells s, p, d, f respectively.

3) Magnetic quantum number (m):

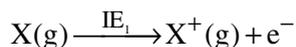
- i) It was proposed by **Lande**.
- ii) It is denoted by ' m '(or) m_l .
- iii) For a given value of l , we have, $m = 2l + 1$
- iv) **Significance:** ' m ' denotes
 - (a) '**orientation**' of the orbital in **space**.
 - (b) number of orbitals in a subshell
- v) It explains the Zeeman and Stark effect.

4) Spin Quantum number (s):

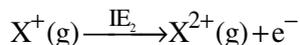
- i) It was proposed by Uhlenbeck and Goudsmith..
- ii) It is denoted by ' s '.
- iii) The values of ' s ' are $+\frac{1}{2}$ (clockwise spin) and $-\frac{1}{2}$ (anti-clockwise spin).
- iv) **Significance:** ' s ' signifies direction of spin of electrons.

20. Define IE_1 and IE_2 . Why is $IE_2 > IE_1$ for a given atom? Discuss the factors that effect IE of an element.

A: 1) **First Ionisation Enthalpy (IE_1):** It is the **minimum** amount of energy required to remove a valence electron from an **isolated, neutral, gaseous atom (X)**.



2) **Second Ionisation Enthalpy (IE_2):** It is the minimum amount of energy required to remove the valence electron from the **unipositive gaseous ion (X^+)**.



3) $IE_2 > IE_1$:

Reason: When compared to the parent atom X, the unipositive ion X^+ contains more protons than electrons. So its positive nuclear charge increase. Hence, the force of attraction on the valence electrons increases. So more energy is required to remove the electron in the second case. Hence, IE_2 is greater than IE_1 .

4) **Factors that effect IE :**

i) **Atomic Radius(AR) :** As atomic radius decreases, the nuclear force of attraction on the valence electrons increases. So, IE value also increases.

ii) **Nuclear Charge(NC):** When the 'effective nuclear charge' increases, the force of attraction on the valence electrons increases. So, IE value also increases.

iii) **Electronic Configuration(EC):** Atoms with completely filled (or) half-filled sub-shells are more **stable** than the others. So, IE values are more for stable atoms.

iv) **Screening Effect(SE):** The electrons present in the 'inner orbits', act as a 'screen' between nucleus and valence electrons. When the number of electrons in the inner orbits increases, the screening effect also increases. This screening effect reduces the effective nuclear charge. So, IE value decreases.

v) **Penetrating Effect (PE):** In a given shell, the penetrating power of the 'valence electrons' decreases in the order of $s > p > d > f$. So, IE value decreases in the same order.

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IE

↓AR ↑

↑NC ↑

↑EC ↑

↑SE ↓

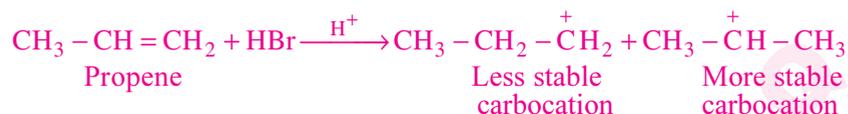
↓PE ↓

21. Explain Markownikoff's rule and Kharash effect(Anti-markownikoff).

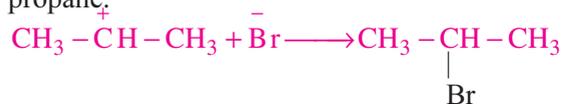
A: Addition of Hydrogen halides: Addition of HX to a double bond generally follows Markownikoff's rule.

Statement of Markownikoff's rule: The rule states that addition of hydrogen halides to unsymmetrical alkenes takes place in such a manner that the positive part of the reagent attach itself to that carbon atom which has more number of hydrogen atoms.

Explanation: It follows electrophilic addition mechanism.



Since 2° carbocation is more stable than 1° carbocation, the major product formed is 2-Bromo propane.

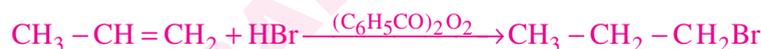


2-Bromopropane

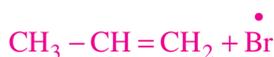
Note: Markownikoff's rule is only applicable for unsymmetrical alkenes.

Anti Markownikoff's rule or peroxide effect or Kharasch effect:

In the presence of peroxide (R-O-O-R) the addition of HBr to unsymmetrical alkene like propene takes place in such a way that the negative part of the reagent attach itself to that carbon atom which has more number of hydrogen atoms.



Mechanism: It follows radical addition mechanism



Step1:

