PART - I

1. (c)
2. (d)
3. (d)
4. (a)
5. (d)
6. (d)
7. (d)
8. (a)
9. (c)
10. (b)
11. (d)
12. (d)
13. (d)
14. (c)
15. (d)

PART – II

16. Uses of Borax ($Na_2B_4O_7 \cdot 10H_2O$): -
(i) In glass and ceramic industry – used in making borosilicate glass and enamels.
(ii) As a flux – in metallurgy for soldering and welding metals.
(iii) In qualitative analysis – used in the borax bead test for identification of metal ions.
(iv) In detergents and soaps – acts as a cleaning and bleaching agent.
(v) As a water softener – removes temporary hardness of water.
(vi) In medicinal preparations – mild antiseptic (in limited use).

17. d-block elements exhibit variable oxidation states because:
(i) Small energy difference between (n–1) d and ns orbitals
Both ns and (n–1) d electrons have nearly the same energy, so different numbers of electrons can participate in bonding.
(ii) Participation of d-electrons in bond formation
Besides ns electrons, d-electrons can also be lost or shared, leading to different oxidation states.
(iii) Stability from different electronic configurations
Some oxidation states are stabilized by half-filled or fully filled d-subshells.

18. A unit cell is the smallest repeating structural unit of a crystal lattice which, when repeated periodically in three dimensions, generates the entire crystal structure.

19. Ostwald's dilution law: -
For a weak electrolyte, the degree of ionization increases with dilution and is related by
$K = \frac{C\alpha^2}{1-\alpha}$
where K is the dissociation constant, C the concentration, and α the degree of ionization.

20. Equivalent conductance:
It is the conductance of all the ions produced by one gram-equivalent of an electrolyte when placed between two electrodes 1 cm apart.
Unit: $ohm^{-1}\ cm^2\ equivalent^{-1}$

21. Two factors affecting electrolytic conductance:
(i) Concentration (or dilution) of the electrolyte
(ii) Nature of the electrolyte / mobility of ions

22. Electro-osmosis: -
It is the movement of a liquid through a porous membrane or capillary under the influence of an applied electric field, while the solid particles remain stationary.3

23. Peptide bond: -
A peptide bond is an amide linkage (–CO–NH–) formed when the carboxyl group of one amino acid reacts with

the amino group of another amino acid with elimination of a water molecule.
It links amino acids together to form proteins.

24. Starting compound: Nitromethane ($CH_3–NO_2$)
- With Sn/HCl (6[H]) → complete reduction of nitro group to amine
A = CH_3NH_2 (methylamine)
- With Zn/NH_4Cl (4[H]) → partial reduction of nitro group to hydroxylamine
B = CH_3NHOH (N-methylhydroxylamine)

PART – III

25. Coordination number:
It is the number of nearest neighbouring atoms surrounding a given atom in a crystal lattice.
Coordination number in bcc structure:
In a body-centred cubic (bcc) lattice, each atom is surrounded by 8 nearest neighbours.

26. Interhalogen compounds:
These are compounds formed between two different halogen elements.
Examples: -
- ClF_3
- BrF_5

27. Difference between double salts and coordination compounds:
Double salts: -
Dissociate completely into all constituent ions in aqueous solution and lose their identity.
Example: Mohr's salt $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$
Coordination compounds: -
Do not dissociate into all ions; the complex ion retains its identity in solution.
Example: $[Cu(NH_3)_4]SO_4$

28. Factors responsible for anomalous behaviour of first p-block elements:
(i) Small atomic size
(ii) High electronegativity
(iii) High ionization energy
(iv) Absence of vacant d-orbitals

29. Faraday's laws of electrolysis: -
(i) First law: -
The mass of a substance deposited or liberated at an electrode is directly proportional to the quantity of electricity passed through the electrolyte.
(ii) Second law: -
When the same quantity of electricity is passed through different electrolytes, the masses of substances deposited are proportional to their equivalent weights.

30. (i) Ethylene glycol → Acetaldehyde
By heating with concentrated H_2SO_4 (dehydration).

$$HO - CH_2 - CH_2 - OH \xrightarrow[\Delta]{\text{conc. } H_2SO_4} CH_3CHO$$

CH_3CHO
(ii) Glycerol → Acrolein
By heating with $KHSO_4$ or concentrated H_2SO_4 (dehydration).

$$HO - CH_2 - CHOH - CH_2OH \xrightarrow[\Delta]{KHSO_4/\text{ conc. } H_2SO_4} CH_2 = CH - CHO$$

31. Tests for carboxylic acid ($-COOH$) group: -
(i) Sodium bicarbonate test:
Carboxylic acids react with $NaHCO_3$ giving brisk effervescence of CO_2.
$RCOOH + NaHCO_3 \rightarrow RCOONa + CO_2 \uparrow + H_2O$
(ii) Litmus test: -
Turns blue litmus red due to acidic nature.

32. Differences between DNA and RNA (any three):
Sugar: -
DNA contains deoxyribose, while RNA contains ribose.

Nitrogen base: -
DNA has thymine, whereas RNA has uracil instead of thymine.
Structure: -
DNA is double-stranded, while RNA is single-stranded.

33. Classification of solids: -
Covalent (network) solids:
(i) Diamond, (vi) SiO_2
Metallic solids:
(ii) Brass
Ionic solids:
(iii) NaCl
Molecular solids:
(iv) Naphthalene, (v) Glucose

PART - IV

34. (a) Froth flotation process: -
It is a concentration method for sulphide ores, based on the difference in wettability of ore and gangue.
- The finely powdered ore is mixed with water to form a slurry.
- Collectors (e.g., xanthates) are added to make the sulphide ore particles hydrophobic.
- Frothing agents (e.g., pine oil) are added to produce stable froth.
- Air is blown through the mixture; the ore particles attach to air bubbles and rise as froth.
- The froth containing the ore is skimmed off, while the gangue remains in water.

Thus, the ore is separated and concentrated.

OR

(b)(i) Bleaching action of sulphur dioxide (SO_2):
Sulphur dioxide bleaches by reduction.
- In the presence of moisture, SO_2 forms sulphurous acid (H_2SO_3).
- This acid removes oxygen from coloured substances, converting them into colourless compounds.

$SO_2 + H_2O \rightarrow H_2SO_3$

Coloured substance $+ H_2SO_3 \rightarrow$ Colourless substance

- The bleaching is temporary, because the colour may reappear on exposure to air due to re-oxidation.

Hence, SO_2 acts as a reducing agent and shows temporary bleaching action.

(ii) Two uses of Helium: -
(i) Used in airships and weather balloons because it is light and non-inflammable.
(ii) Used as an inert shielding gas in arc welding.

35. (a)(i) Interstitial compounds: -
These are compounds formed when small atoms (such as H, B, C, or N) occupy the interstitial spaces in the crystal lattice of transition metals.
Examples: -
- Titanium carbide (TiC)
- Iron nitride (Fe_4N)

They are usually hard, have high melting points, and retain metallic conductivity.

(ii) Ti^{3+}
- $Ti(Z = 22) : [Ar]3d^2 4s^2$
- T^{33}: $[Ar]3d^1$
- Unpaired electrons $n = 1$

$\mu = \sqrt{1(1+2)} = \sqrt{3} = 1.73BM$

Mn^{2+}
- $Mn(Z = 25) : [Ar]3d^5 4s^2$
- Mn^{2+}: $[Ar]3d^5$
- Unpaired electrons $n = 5$

$\mu = \sqrt{5(5+2)} = \sqrt{35} = 5.92BM$

OR

(b) (i) Limitations of Valence Bond (VB) theory:
- Fails to explain the colour and electronic spectra of coordination compounds.
- Cannot account for the magnetic properties (strong vs weak field ligands) accurately.

- Does not explain the relative stability of complexes quantitatively.
- Fails to explain the inner orbital and outer orbital complexes clearly in all cases.

(ii) $[Ni(CN)_4]^{2-}$ is diamagnetic (VB theory explanation):

- Ni^{2+} electronic configuration:

$Ni(Z = 28): [Ar]3d^8 4s^2 \Rightarrow Ni^{2+}: [Ar]3d^8$

- CN^- is a strong field ligand, so it causes pairing of 3 d electrons in Ni^{2+}.
- After pairing, one 3d orbital becomes vacant.
- The complex uses dsp^2 hybridisation (one 3 d, one 4 s, two 4 p orbitals) forming a square planar structure.
- Since all electrons are paired, the complex shows diamagnetic behaviour.

36. (a) (i) Differences between rate and rate constant of a reaction:

Dependence: -

- Rate of reaction depends on the concentration of reactants.
- Rate constant (k) is independent of concentration at a given temperature.

Nature: -

- Rate changes as the reaction proceeds.
- Rate constant remains constant for a given reaction at fixed temperature.

(ii) For a zero-order reaction

$A \rightarrow$ Products

Rate law: -

$$-\frac{d[A]}{dt} = k$$

Integrating: -

$$\int_{[A]_0}^{[A]} d[A] = -k \int_0^t dt$$

$$[A] - [A]_0 = -kt$$

$$[A] = [A]_0 - kt$$

This is the integrated rate law for a zero-order reaction.

OR

(b) This is an acidic buffer (acetic acid + sodium acetate).

Use Henderson-Hasselbalch equation: -

$$\text{pH} = \text{p}K_a + \log\frac{[\text{ salt }]}{[\text{ acid }]}$$

Given: -

$K_a = 1.8 \times 10^{-5} \Rightarrow \text{p}K_a = -\log(1.8 \times 10^{-5}) \approx 4.74$

$[\text{ salt }] = 0.20\text{M}, [\text{ acid }] = 0.18\text{M}$

$$\text{pH} = 4.74 + \log\left(\frac{0.20}{0.18}\right)$$

$$\log\left(\frac{0.20}{0.18}\right) = \log(1.11) \approx 0.045$$

$\text{pH} = 4.74 + 0.045 = 4.79$

pH of the buffer ≈ 4.79

37. (a) (i) Benzoin - Benzoin condensation: -

$$2C_6H_5CHO \xrightarrow{KCN} C_6H_5CH(OH)COC_6H_5$$

(ii) Cinnamic acid - Perkin reaction: -

$$C_6H_5CHO + CH_3COONa \xrightarrow{heat} C_6H_5CH = CHCOOH$$

(iii) Malachite green - Condensation with dimethylaniline + oxidation

$$C_6H_5CHO + 2C_6H_5\ N(CH_3)_2 \xrightarrow{HCL} [\text{ Leuco form }] \xrightarrow{Oxidation} \text{Malachite green}$$

OR

(b) (i) 3° Alcohol (Tertiary): - Clear solution turns cloudy (turbid) instantly.

Reason: Forms a stable tertiary carbocation quickly.

2° Alcohol (Secondary): -Turbidity appears after 3-5 minutes.

Reason: Forms a moderately stable secondary carbocation.

1° Alcohol (Primary): - Remains clear at room temperature; turbidity only appears upon heating.

Reason: Forms a highly unstable primary carbocation, requiring energy (heat) to react.

Procedure Summary: -
(1) Add the alcohol to a test tube.
(2) Add freshly prepared Luca's reagent (conc. HCl + anhydrous $ZnCl_2$).
(3) Observe the time taken for the solution to become cloudy (turbid) at room temperature.
(ii) Here's a concise list of uses of diethyl ether ($C_2H_5–O–C_2H_5$):
(1) As a solvent – widely used for fats, oils, resins, and some organic reactions.
(2) As an anesthetic – previously used in surgery (now mostly replaced by safer anesthetics).
(3) In Grignard reactions – as a reaction medium because it stabilizes the Grignard reagent.
(4) As an extraction agent – for separating organic compounds from aqueous solutions.
(5) As a starting fluid for engines – due to its high volatility and flammability.
Short version: Solvent, anesthetic, Grignard reagent medium, extraction, engine starter.

38. (a) Adsorption Theory of Catalysis (Short Solution):
Concept: Catalyst increases reaction rate by adsorbing reactant molecules on its surface.
Steps: -
(i) Adsorption: Reactants stick to catalyst surface.
(ii) Reaction: Bonds in reactants are weakened → reaction occurs on surface.
(iii) Desorption: Products leave the surface, catalyst is regenerated.
Summary: Reaction occurs on the catalyst surface via adsorption → bond weakening → faster reaction.

OR

(b) Given: -
- A: $C_2H_3\ N$ → on reduction gives B: $C_2H_7\ N$ → reacts with nitrous acid to give C: C_2H_6O
Step 1: -Identify compounds
- $A = CH_3 - CN$ (Acetonitrile)
- $B = CH_3 - CH_2 - NH_2$ (Ethylamine, primary amine)
- $C = CH_3 - CH_2 - OH$ (Ethanol)
Step 2: -Reactions
(1). Reduction of nitrile: -

$$CH_3 - CN \xrightarrow{Na(Hg)/C_2H_5OH} CH_3 - CH_2 - NH_2$$

(2). Carbylamine test (for B):

$$CH_3 - CH_2 - NH_2 + CHCl_3 + 3KOH \rightarrow CH_3 - CH_2 - N = C: + 3KCl + 3H_2O$$

(3). Reaction with nitrous acid: -

$$CH_3 - CH_2 - NH_2 + HNO_2 \rightarrow CH_3 - CH_2 - OH + N_2 + H_2O$$