PART – I

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

PART - II

16. Calcination is the process of heating an ore in the absence or limited supply of air below its melting point to remove moisture and volatile impurities and convert it into oxide form.
17. When boric acid is heated with ammonia, it forms boron nitride.
Reaction:
$H_3BO_3 + NH_3 \xrightarrow{\text{heat}} BN + 3H_2O$
Thus, boric acid $\longrightarrow$ boron nitride (BN) by heating with ammonia.
18. Sulphuric acid acts as a dehydrating agent because it removes water from substances.
Example:
$C_{12}H_{22}O_{11} \xrightarrow{\text{conc. } H_2SO_4} 12C + 11H_2O$
19. Common ion effect: -
The suppression of ionisation of a weak electrolyte when a strong electrolyte having a common ion is added is called the common ion effect.
Example: -
Ionisation of acetic acid decreases on adding sodium acetate:
$CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$
Addition of CH_3COONa increases CH_3COO^-, shifting equilibrium left and reducing ionisation.
20. For the reaction
$Fe^{3+} + Br^- \rightarrow Fe^{2+} + \frac{1}{2}Br_2$
Given:
$E^\circ(Fe^{3+}/Fe^{2+}) = +0.771\ V$
$E^\circ(Br_2/Br^-) = +1.09\ V$
Standard cell potential:
$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode} = 0.771 - 1.09 = -0.319\ V$
Since $E^\circ_{cell} < 0$, the reaction is not feasible.
21. Kolbe's reaction:
When an aqueous solution of sodium or potassium salt of a carboxylic acid is subjected to electrolysis, it gives an alkane.
General reaction:
$2RCOONa \xrightarrow{\text{electrolysis}} R - R + 2CO_2 + H_2 + 2NaOH$
Example:
$2CH_3COONa \xrightarrow{\text{electrolysis}} C_2H_6 + 2CO_2 + H_2 + 2NaOH$
22. (i) α-D-Glucopyranose

- The -OH on the anomeric carbon (C1) is axial (down).

powershell

```
              O
             /  \
 HO—C1   C5—OH
     |              |
     H             H
 H—C2     C4—OH
     |             |
    OH           H
     |
    C3—OH
     |
     H
```

(ii). β-D-Glucopyranose

- The - OH on the anomeric carbon (C1) is equatorial (up).

powershell

```
                O
               / \
 HO—C1   C5—OH
     |             |
     OH          H
 H—C2     C4—OH
     |             |
    OH            H
     |
    C3—OH
     |
     H
```

Key difference:

- αOH on C1 down
- β : OH, on C1 up

23. Antibiotics:

Antibiotics are chemical substances produced by microorganisms that kill or inhibit the growth of other microorganisms without harming the host.

Example: Penicillin, Streptomycin.

24. Short solution:

The order of a reaction is the sum of the powers of the concentrations of reactants in its rate law.

Example: For rate $= k[A]^m[B]^n$, order $= m + n$.

PART - III

25. Uses of Helium:

(i) Filling balloons and airships – lighter than air and non-flammable.
(ii) Coolant in nuclear reactors and MRI machines – due to very low boiling point.
(iii) Protective gas in welding – prevents oxidation.
(iv) Breathing mixtures for deep-sea divers – reduces risk of nitrogen narcosis.
(v) Leak detection – due to its small atomic size.

26. Fe^{3+} is more stable than Fe^{2+} in aqueous solution because Fe^{3+} has a half-filled $3d^5$ configuration, which provides extra stability due to exchange energy and symmetrical distribution of electrons.

Short reason: Half-filled d^5 (Fe^{3+}: [Ar] $3d^5$) is more stable than $3d^6$ (Fe^{2+}: [Ar] $3d^6$).

If you want, I can also give the stability trend in terms of standard electrode potentials in one line.

27. Step (1): Relation between edge length and radius in CCP In CCP (FCC) structure:

$\text{Face diagonal } = 4r$

and

$\text{Face diagonal } = \sqrt{2}a$

So,

$\sqrt{2}a = 4r \Rightarrow a = \frac{4r}{\sqrt{2}} = 2\sqrt{2}r$

Step (2): Substitute $r = 125$pm

$a = 2\sqrt{2} \times 125$

$\sqrt{2} \approx 1.414$

$a = 2 \times 1.414 \times 125$

$a = 2.828 \times 125$

$a \approx 353.5$pm

28. Arrhenius equation:

$k = Ae^{-E_a/(RT)}$

Where:

k = rate constant of the reaction

A = frequency factor (or pre-exponential factor)

E_a = activation energy (in J/mol)

R = gas constant (8.314 J/molK)

T = absolute temperature (in K)

e = base of natural logarithm (~2.718)

Explanation: The equation shows that the rate of a reaction increases with temperature and decreases with higher activation energy.

29. Effect of Temperature: -

- Physisorption: Decreases as temperature rises because it's exothermic (like condensation), so heat shifts equilibrium away from adsorption.

Chemisorption: -

- Increases initially because heat provides activation energy to form strong chemical bonds.
- Decreases at very high temperatures as the strong bonds break, disrupting the adsorbed layer.
- A gas physically adsorbed at low temp can become chemically adsorbed at high temp (e.g., H_2 on Ni).

Effect of Pressure: -

- Physisorption: Increases significantly with pressure because more gas molecules collide with the surface, forming multimolecular layers.
- Chemisorption:
- Increases with pressure, favoring bond formation.
- Levels off at high pressures as the surface becomes saturated (unimolecular layer formation).

30. Knoevenagel Reaction:

It is a condensation reaction between an aldehyde or ketone having an α-hydrogen and an active methylene compound (like malonic ester, ethyl cyanoacetate) in the presence of a weak base to form an α,β-unsaturated compound.

General reaction:

$R-CHO + CH_2(COOR)_2 \xrightarrow{\text{Base}} R-CH=CH-COOR + H_2O$

Key points:

- Catalyzed by weak bases (like piperidine).
- Forms $C=C$ bond conjugated with a carbonyl.
- Example: Benzaldehyde + Malonic ester → Cinnamic acid derivative.

31. Reaction of Primary Amine with Carbon Disulphide (CS_2) :

$R-NH_2 + CS_2 + NaOH \rightarrow R-NH-CS_2Na + H_2O$

- These forms a dithiocarbamate salt.
- On acidification, it gives dithiocarbamic acid:

$R-NH-CS_2Na + HCl \rightarrow R-NH-CS_2H + NaCl$

32. Peptide Bond:

- A peptide bond is an amide bond formed between the carboxyl group ($-COOH$) of one amino acid and the amino group ($-NH_2$) of another.
- Formation: By condensation (removal of water).

$H_2N-CH(R)-COOH + H_2N-CH(R')-COOH$

$\rightarrow H_2N-CH(R)-CO-NH-CH(R')-COOH + H_2O$

- Characteristics:

- Planar and rigid due to partial double-bond character.
- Links amino acids to form proteins and peptides.

33. Short Solution:

(i) IUPAC Name: Dicyanido-dichlorocobalt(III) chloride

(ii) Central Metal Ion: Co^{3+}

(iii) Coordination Number: 4 (2 CN^{-} + 2 Cl^{-})

PART - IV

34. (a) (i) Minerals: -

- Definition: Naturally occurring chemical compounds with a definite crystalline structure and composition, found in the Earth's crust.
- Examples: Feldspar, quartz, mica, and even bauxite and clay are minerals.
- Composition: Can contain metals but might not have enough for economical extraction.

Ores: -

- Definition: A mineral or rock deposit rich enough in a particular metal to make its extraction commercially worthwhile.
- Examples: Bauxite (aluminum ore), hematite (iron ore), chalcopyrite (copper ore).
- Economic Factor: The presence of impurities doesn't matter as much as the concentration of the valuable metal being high enough for profit.

(ii) Silica (SiO_2) acts as a flux in copper extraction. It reacts with impurities like FeO to form slag ($FeSiO_3$), which can be easily removed.

OR

(b) (i) Uses of Boric Acid (H_3BO_3):

- Antiseptic: Used in eye drops and ointments.
- Insecticide: Kills ants, cockroaches, and other insects.
- Glass & Ceramics: Used in making heat-resistant glass and ceramics.
- Flame Retardant: Added to fabrics and wood to reduce flammability.
- Buffer Solution: In laboratories for pH control.
- Cosmetics & Medicine: In powders and creams for skin care.

(ii) Silicates: -

- Silicates are compounds containing silicon and oxygen, usually combined with metals.
- They have the general formula SiO_4^{4-} (silicate ion) or derivatives of it.
- Examples: Quartz (SiO_2), Mica ($KAl_3Si_3O_{10}(OH)_2$), Feldspar ($KAlSi_3O_8$).
- They are the largest class of minerals in the Earth's crust.

Short: Silicates are silicon–oxygen compounds, often with metals, forming most of the Earth's minerals.

35. (a) Lanthanoid Contraction: Gradual decrease in ionic radii of lanthanoids ($La^{3+} \rightarrow Lu^{3+}$) due to poor shielding of 4f electrons.

Consequences:

- Similarity of 4th and 5th period elements (e.g., Zr & Hf).
- Increased density of later lanthanoids.
- Affects stability of oxidation states and complex formation.

OR

(b) (i) Double Salts: -

- Formed by the combination of two different salts in a definite ratio.
- Exist only in solid state; lose their identity in solution.
- Example: $KAl(SO_4)_2 \cdot 12H_2O$ (Alum)

Coordination Compounds: -

- Consist of a central metal atom/ion bonded to ligands (ions or molecules) via coordinate covalent bonds.
- Can exist in solid and solution.
- Example: $[Fe(CN)_6]^{3-}$, $[Co(NH_3)_6]^{3+}$

Short:

- Double salts = two salts combined, stable only in solid state.
- Coordination compounds = metal + ligands, stable in solid and solution.

(ii) Coordination Compound used in Medicine: Cisplatin $[Pt(NH_3)_2Cl_2]$ - used in cancer treatment.

Biologically Important Coordination Compound: Hemoglobin $[Fe(C_6H_4\ N_2)_4]$ - transports oxygen in blood.

36. (a) For Simple Cubic (SC) structure:

- Atoms per unit cell: 1
- Edge length: $a = 2r$ (r = atomic radius)
- Volume of atom: $V_{\text{atom}} = \frac{4}{3}\pi r^3$
- Volume of unit cell: $V_{\text{cell}} = a^3 = (2r)^3 = 8r^3$

$$\text{Packing Efficiency} = \frac{V_{\text{atom}}}{V_{\text{cell}}} \times 100 = \frac{\frac{4}{3}\pi r^3}{8r^3} \times 100 = \frac{\pi}{6} \times 100 \approx 52\%$$

OR

(b) (i) For a zero-order reaction:

$A \rightarrow$ products, rate $= k$

Step (1): Write rate law

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

Step (2): Integrate

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

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

Step (3): Rearrange

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

Step (4): Half-life (optional):

$$t_{1/2} = \frac{[A]_0}{2k}$$

Integrated Rate Law (Zero Order):

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

(ii) Buffer Index (β):
- Definition: Buffer index is a measure of the resistance of a buffer solution to changes in pH on addition of an acid or base.
- Mathematically:

$$\beta = \frac{dn_{\text{acid or base}}}{d(\text{pH})}$$

37. (a) (i) Galvanic Cell Notation: -
Definition: A shorthand way to represent a galvanic (voltaic) cell, showing the electrodes, electrolytes, and phases.
(ii) Gold Number: -
Definition: The minimum amount of a protective colloid (in mg) required to prevent the coagulation of 10 mL of a gold sol when 1 mL of 10% NaCl is added.
Short: Gold number measures the protective power of a colloid; smaller gold number → better protective colloid.

OR

(b) Lucas Test: -
Purpose: To distinguish primary, secondary, and tertiary alcohols.
Reagent: **Lucas reagent =

38. (a) (i) $CH_3MgBr + CO_2 \xrightarrow{\text{dry ether}} CH_3COOMgBr \xrightarrow{\text{HCl}} CH_3COOH$

Explanation: Grignard reagent reacts with CO_2 to form magnesium salt, which on acid hydrolysis gives acetic acid.

(ii) Biodegradable Polymers: Polymers that can be broken down by microorganisms into water, carbon dioxide, and biomass.

Example: Polyhydroxybutyrate (PHB), Polylactic acid (PLA).