Previous Years' Paper

Common University Entrance Test for UG Programmes

CUET-UG - Chemistry

Entrance Exam, 2025

(After the list of questions, the solution will Start.)

Q1. The value of van't Hoff factor, i, for CH_3COOH solution in water will be

1. Between 1 and 2

2. Less than 1

3. 2

4. 1

Q2. The following solutions were prepared by dissolving 1 g of solute in 1 L of the solution. Arrange the following solutions in decreasing order of their molarity

(A) Glucose (molar mass = 180 g mol-^{1})

(B) NaOH (molar mass = 40 g mol-^{1})

(C) NaCI (molar mass = 58.5 g mol-^{1})

(D) KCI (molar mass = 74.5 g mol^1)

Choose the correct answer from the options given below:

1. (A), (D), (C), (B)

2. (A), (B), (D), (C)

3. (B), (C), (D), (A)

4. (D), (C), (A), (B)

Q3. Match List-I with List-II

List-I	**List-II**
Solutions	**Explanation**
(A) Saturated solution	(I) Solution having two components.

(B) Isotonic solutions	(II) A solution whose osmotic pressure is more than that of another.
(C) Binary solution	(III) A solution which contains the maximum amount of solute that can be dissolved in a given amount of solvent at a given temperature.
(D) Hypertonic solution	(IV) The solutions having same osmotic pressure at a given temperature.

Choose the correct answer from the options given below:

1. (A) – (I), (B) – (III), (C) – (III), (D) – (IV)

2. (A) – (I), (B) – (III), (C) – (II), (D) – (IV)

3. (A) – (I), (B) – (II), (C) – (IV), (D) – (III)

4. (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

Q4. Give the reason for low concentration of oxygen in the blood and tissues of people living at high altitude

1. Both low temperature and high atmospheric pressure

2. low temperature

3. Low atmospheric pressure

4. High atmospheric pressure

Q5. Calculate the molality of KI if the density of 20% (mass/mass) aqueous solution of Kl is 1.202 g mL^{-1}.

(Molar mass of Kl is 166 g mol^{-1})

1. 1.5 mol kg^{-1}

2. 1.2 mol kg^{-1}

3. 15 mol kg^{-1}

4. 0.12 mol kg^{-1}

Q6. The unit of E_{cell} is

1. V m

2. S cm^{-1}

3. V

4. S cm^{-2} mol^{-1}

Q7. Match List-I with List-II

List-I	List-II
Property	**Unit**
(A) Cell constant	(I) $\mathrm{cm^{-1}}$
(B) Molar conductance	(II) $\mathrm{ohm^{-1}\ cm^{2}\ mol^{-1}}$
(C) Specific conductance	(III) $\mathrm{ohm^{-1}\ cm^{-1}}$
(D) Conductance	(IV) $\mathrm{ohm^{-1}}$

Choose the correct answer from the options given below:

1. (A) – (I), (B) – (II), (C) – (III), (D) – (IV)

2. (A) – (I), (B) – (III), (C) – (II), (D) – (IV)

3. (A) – (I), (B) – (II), (C) – (IV), (D) – (III)

4. (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

Q8. The following statements describe various properties of a Mercury cell:

(A) It converts energy of combustion into electrical energy

(B) It is rechargeable

(C) The cell reaction involved is $\mathbf{Zn(Hg) + HgO(s) \longrightarrow ZnO(s) + Hg(l)}$

(D) It is a low current device used in hearing aids

Choose the correct answer from the options given below:

1. (A), (B) and (D) only

2. (A) and (C) only

3. (A), (B), (C) and (D)

4. (C) and (D) only

Q9. Which cell is used in automobiles and inverters?

1. Mercury cell

2. Dry cell

3. Lead storage cell

4. Fuel cell

Q10. A galvanic cell behaves as electrolytic cell when?

1. $E_{cell} = E_{ext}$

2. $E_{cell} = 0$

3. $E_{ext} > E_{cell}$

4. $E_{cell} > E_{ext}$

Q11. Which of the following does not represent a correct application of the coordination compound?

1. cis-platin effectively inhibit the growth of tumours.

2. chlorophyll help in photosynthesis

3. desferrioxime B is used in treatment of lead poisoning

4. cyanocobalamine, antipernicious anemia factor is a coordination compound of Co

Q12. Arrange the following ions in increasing order of the number of 3d electrons:

(A) Cr^{2+}

(B) Cu^{+}

(C) Ti^{3+}

(D) Mn^{+}

Choose the correct answer from the options given below:

1. (B), (A), (C), (D)

2. (C). (A). (D). (B)

3. (C), (D), (A), (B)

4. (D), (B), (C), (A)

Q13. The atomic number of Lanthanum is 57. Its electronic configuration will be ....

1. $[Xe]5d^16s^2$

2. $[Xe]4f^15d^2$

3. $[Xe]4f^3$

4. $[Xe]4f^15d^16s^1$

Q14. Match List-I with List-II

List-I **Compound/Elements**	**List-II** **Uses**
(A) Magnesium based alloy is constituent of	(I) Bullets
(B) Lanthanoid oxide	(II) Petroleum cracking
(C) Mixed oxides of Lanthanoids are employed in	(III) Television screen
(D) Misch metal	(IV) Lanthanoid metal and iron

Choose the correct answer from the options given below:

1. (A) – (I), (B) – (III), (C) – (III), (D) – (IV)

2. (A) – (I), (B) – (III), (C) – (II), (D) – (IV)

3. (A) – (I), (B) – (II), (C) – (IV), (D) – (III)

4. (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

Q15. What is the color of Fe^{3+}(aqs) ion?

1. Yellow

2. Violet

3. Colourless

4. Bluepink

Q16. Why is HCI not used to make the medium acidic in oxidation reactions of $KMnO_4$ in acidic medium?

1. $KMnO_4$ is weaker oxidizing agent than HCI

2. $KMnO_4$ oxidises HCI into Cl_2 which is also an oxidizing agent

3. Both HCI and $KMnO_4$ act as oxidizing agent

4. $KMnO_4$ act as a reducing agent in the presence of HCI

Q17. Acidified potassium dichromate oxidizes sulphides (S^{2-}) to ……………… .

1. SO_4^{2-}

2. SO_3^{2-}

3. sulphur (S)

4. SO_2

Q18. What is the decreasing order of field strength of given ligands?

(A) S^{2-}

(B) Ethylenediamine

(C) NCS^-

(D) CN^-

Choose the correct answer from the options given below:

1. (A), (C), (B), (D)

2. (A), (B), (C), (D)

3. (D), (B), (C), (A)

4. (D), (C), (B), (A)

Q19. What is the IUPAC name of $[Pt(NH_3)_2Cl_2]$?

1. Diamminedichloridoplatinum (IV)

2. Diamminedichloridoplatinum (II)

3. Diamminedichloridoplatinum (0)

4. Dichloridodiammineplatinum (IV)

Q20.

Select the correct statements for $[Fe(CN)_6]^{3-}$ complex:

(A) Paramagnetic

(B) sp^3d^2hybridization

(C) Magnetic moment = 5.92 BM

(D) d^2sp^3 hybridization

Choose the correct answer from the options given below:

1. (A) and (D) only

2. (A), (B) and (C) only

3. (B) and (C) only

4. (B), (C) and (D) only

Q21. Match List-I with List-II

List-I	**List-II**
Concepts	**Related Terms**
(A) Ambident nucleophiles	(I) Symmetrical object
(B) Plane polarized light	(II) Saytzeff rule
(C) Superimposable mirror image	(III) Cyanides and nitrites
(D) β-elimination reaction	(IV) Nicol Prism

Choose the correct answer from the options given below:

1. (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

2. (A) – (I), (B) – (III), (C) – (II), (D) – (IV)

3. (A) – (I), (B) – (II), (C) – (IV), (D) – (III)

4. (A) – (III), (B) – (IV), (C) – (II), (D) – (I)

Q22. Optically active alkyl halide undergoing S_N2 substitution involves

1. retention of configuration

2. recemic mixture

3. inversion of configuration

4. formation of carbocation

Q23. Gabriel phthalimide synthesis is used for the preparation of

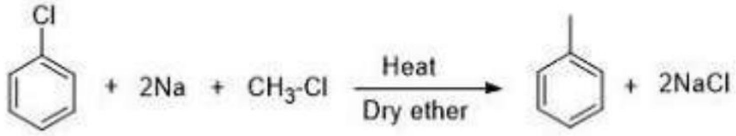
1. tertiary amine

2. acid synthesis

3. primary amine

4. secondary amine

Q24.



The above reaction is an example of

1. Sandmeyer's reaction

2. Wurtz reaction

3. Wurtz Fittig reaction

4. Kolbe reaction

Q25. The reagent(s) used in hydroboration oxidation of propene are

(A) B_2H_6

(B) H_2O

(C) H_2O_2

(D) OH-

Choose the correct answer from the options given below:

1. (A), (B) and (D) only

2. (A), (B) and (C) only

3. (A), (B), (C) and (D)

4. (B), (C) and (D) only

26. The carbohydrate used as storage molecule in plants is

1. Starch

2. Glycogen

3. Cellulose

4. Glucose

Q27. Hell-Volhard Zelinsky reaction is used for the formation of

1. alcohols

2. aldehydes

3. ketones

4. α-halocarboxylic acids

Q28. What is the correct sequence of increasing reactivity of the following compounds towards nucleophilic addition reaction?

(A) Ethanal

(B) Propanone

(C) Propanal

(D) Butanone

Choose the correct answer from the options given below:

1. (A), (B), (C), (D)

2. (D), (B), (C), (A)

3. (A), (C), (B), (D)

4. (C), (B), (D), (A)

Q29. Which of the following reagent(s) is required for the conversion of Benzene to methyl benzoate?

(A) $Br_2/FeBr_3$

(B) Mg, dry Ether

(C) CO_2, $H3O^+$

(D) Methanol, Conc. H_2SO_4

Choose the correct answer from the options given below:

1. (A), (B) and (C) only

2. (A), (B) and (D) only

3. (A), (B), (C) and (D)

4. (B), (C) and (D) only

Q30. Which reagent will distinguish Benzophenone from acetone?

1. Fehling's reagent

2. Tollen's reagent

3. 2,4-DNP reagent

4. I_2/NaOH

Q31. The structural feature in carbonyl compound for Aldol condensation

1. presence of at least one β-hydrogen

2. presence of at least one α-hydrogen

3. Concentrated base

4. lack of α hydrogen

Q32. The nitrogen atom in amines is trivalent and possess an unshared pair of electrons. The geometry of trimethyl amine is …………………… .

1. Tetrahedral

2. Pyramidal

3. Square planar

4. Triangular

Q33. What happens when C_6H_5-O-R is treated with HX?

1. RX and C_6H_5OH are formed

2. ROH and C_6H_5X are formed

3. $C_6H_4X_2$ and ROH are formed

4. RX and C_6H_5X are formed

Q34. In the nitration of benzene using a mixture of conc. H_2SO_4 and conc. HNO_3, the nitrating species is

1. NO_2^-

2. NO_2^+

3. NO^+

4. NO_2 and NO_2^+

Q35. Which of the following compounds will not give azo coupling reaction with benzene diazonium chloride?

1. Nitrobenzene

2. Aniline

3. o-Toluidine

4. Phenol

Q36. Amylose is a water-soluble part of starch. What is the percentage solubility of it?

1. 20 to 30%

2. 15 to 20%

3. 30 to 60%

4. 50 to 70%

Q37. What is an example of globular protein?

(A) Insulin

(B) Keratin

(C) Albumin

(D) Myosin

Choose the correct answer from the options given below:

1. (A), (B) and (D) only

2. (A) and (C) only

3. (A), (B), (C) and (D)

4. (B), (C) and (D) only

Q38. Which types of bonds or interactions are found in the β-helix of protein?

1. Ionic bond

2. Covalent interaction

3. H-bond

4. Banana bond

Q39. Match the amino acid given in List-I with their one letter code given in List-II

List-I	List-II

Name of amino acid	**One letter code**
(A) Lysine	(I) W
(B) Tryptophan	(II) Q
(C) Tyrosine	(III) K
(D) Glutamine	(IV) Y

Choose the correct answer from the options given below:

1. (A) – (II), (B) – (I), (C) – (III), (D) – (IV)

2. (A) – (III), (B) – (I), (C) – (IV), (D) – (II)

3. (A) – (II), (B) – (III), (C) – (IV), (D) – (I)

4. (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

Q40. Arrange the following compounds in increasing order of their acidic strength:

(A) 3-nitrophenol

(B) 3, 5-Dinitrophenol

(C) 2, 4, 6 -Trinitrophenol

(D) Phenol

Choose the correct answer from the options given below :

1. (D), (C), (B), (A)

2. (C), (A), (B), (D)

3. (D), (A), (B), (C)

4. (A), (B), (C), (D)

Read the passage carefully and answer the questions :

The speed at which a chemical reaction takes place is called the rate of reaction. The rate of reaction depends on various factors like concentration of the reactants, temperature, etc. The relation between the rate of reaction and the concentration of reacting species is represented by the equation $r = k[A]^x[B]^Y$, where x and y are the order of the reaction with respect to the reactants A and B, respectively. The overall order of the reaction is x ++ y.

The rate of reaction can also be increased by the use of a catalyst which provides an alternate pathway of lower activation energy. It increases the rate of forward and backward reaction to an equal extent. It does not alter the Gibbs energy of the reaction.

Q41. The rate of a gaseous reaction is given by r = k[A][B]. If the volume of the reaction vessel is suddenly reduced to (1/4)th of its initial value, the reaction rate relating to the initial rate will become

1. 2 times

2. 1/4 times

3. 16 times

4. 1/16 times

Q42. Calculate the order of a reaction whose Rate = $k\,[A]^{1/2}\,[B]^{3/2}$.

1. second order

2. half order

3. first order

4. zero order

Q43. The rate law of a reaction is given by r = $k[CH_3OCH_3]^{3/2}$, If the pressure is measured in bar and time in minutes, then the unit of rate constant will be

1. $bar^{1/2}\ min^{-1}$.

2. $bar^{-3/2}\ min^{-1}$.

3. $bar^{-1/2}\ min^{-1}$.

4. $bar^{3/2}\ min^{-1}$.

Q44. If the rate of reaction becomes twenty-seven times upon increasing the concentration of reactant by three times, the order of this reaction is

1. 0

2. 1

3. 3

4. 2

Q45. The role of a catalyst is to change

1. Gibbs energy of the reaction.

2. Enthalpy of a reaction.

3. Activation energy of a reaction.

4. Equilibrium constant.

Read the passage carefully and answer the questions :

Replacement of a hydrogen atom in a hydrocarbon by an alkoxy or carboxyl group yields a class of compounds known as ethers. Ethers are classified as symmetrical or unsymmetrical on the basis of groups attached to the oxygen atoms. Diethyl ether, a symmetrical ether, has been widely used as an inhalation anesthetic. Ethers can be prepared by acid catalyzed intermolecular dehydration of alcohols and Williamson's synthesis. Acid catalyzed dehydration of alcohols is not generally preferred as it gives a mixture of elimination and substitution products. In Williamson's synthesis, an alkyl halide is allowed to react with sodium alkoxide. Ethers containing substituted Alkyl groups may also be prepared by this method. The C-O bond in ether is weakly polar and is cleaved under drastic conditions with excess of hydrogen halides. In electrophilic substitution, the alkoxy group deactivates the aromatic ring and directs the incoming group to ortho and para positions.

Q46. When ethanol is dehydrated in the presence of H_2SO_4 at 443 K and 413 K respectively the products formed are

1. Ethane and ethoxythane

2. Ethylmethyl ether and butene

3. Ethylmethyl ether and propene

4. Ethene and ethoxyethane

Q47. The major product in the reaction of anisole with bromine in ethanoic acid, is:

1. o- bromoanisole

2. *p*-bromoanisole

3. *m*-bromoanisole

4. *o*-bromoanisole and *p*-bromoanisole

Q48. In Williamson synthesis, the alkoxide ion attacks the alkyl halide via which pathway?

1. S_N^2

2. S_N^1

3. Depends on nature of alkoxide ion

4. Depends on the nature of Alkyl halide

Q49. Which is most reactive hydrogen halide for cleavage of ethers?

1. HF

2. HCI

3. HBr

4. HI

Q50. Which type of ether is anisole?

1. Dialkyl ether

2. Diaryl ether

3. Phenyl Alkyl ether

4. Alkoxy Alkyl ether

Solution

Q1.

Ans.

Step 1. Understanding the Question

We are asked to find the **van't Hoff factor (i)** for **acetic acid (CH_3COOH)** dissolved in water.

The van't Hoff factor indicates the **number of particles** produced in solution compared to the number initially dissolved.

Step 2. Concept of van't Hoff Factor

The van't Hoff factor i is given by:

$$i = \frac{\text{actual number of particles in solution}}{\text{number of formula units dissolved}}$$

- For **non-electrolytes** (no ionization): $i = 1$
- For **strong electrolytes** (complete ionization): $i > 1$
- For **weak electrolytes** (partial ionization): $1 < i < \text{maximum ion value}$

Step 3. Ionization of Acetic Acid

Acetic acid is a **weak electrolyte**, so it ionizes **partially** in water as:

$$\mathrm{CH_3COOH} \rightleftharpoons \mathrm{CH_3COO^-} + \mathrm{H^+}$$

If ionization were **complete**, there would be **2 particles** formed per molecule, so $i = 2$.

But because ionization is **partial**, the actual value of i lies **between 1 and 2.**

✅ **Final Answer: The value of van't Hoff factor i for CH_3COOH in water is between 1 and 2.**

Correct Option: 1)

Q2.

Ans.

Step 1: Understanding Molarity

Molarity is defined as the number of moles of solute per liter of solution:

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{volume of solution (in liters)}}$$

We are given that 1 g of each solute is dissolved in 1 L of solution, so the molarity is simply determined by calculating the moles of each solute.

Step 2: Calculation of Moles for Each Solute

1. **Glucose (A):**
    - **Molar Mass** = 180 g/mol
    - **Moles of Glucose** = $\frac{1\,\mathrm{g}}{180\,\mathrm{g/mol}} = 0.00556\,\mathrm{mol}$
    - **Molarity of Glucose** = $\frac{0.00556}{1} = 0.00556\,\mathrm{M}$
2. **NaOH (B):**
    - **Molar Mass** = 40 g/mol
    - **Moles of NaOH** = $\frac{1\,\mathrm{g}}{40\,\mathrm{g/mol}} = 0.025\,\mathrm{mol}$
    - **Molarity of NaOH** = $\frac{0.025}{1} = 0.025\,\mathrm{M}$
3. **NaCl (C):**
    - **Molar Mass** = 58.5 g/mol
    - **Moles of NaCl** = $\frac{1\,\mathrm{g}}{58.5\,\mathrm{g/mol}} = 0.01709\,\mathrm{mol}$
    - **Molarity of NaCl** = $\frac{0.01709}{1} = 0.01709\,\mathrm{M}$
4. **KCl (D):**
    - **Molar Mass** = 74.5 g/mol
    - **Moles of KCl** = $\frac{1\,\mathrm{g}}{74.5\,\mathrm{g/mol}} = 0.01342\,\mathrm{mol}$
    - **Molarity of KCl** = $\frac{0.01342}{1} = 0.01342\,\mathrm{M}$

Step 3: Molarity Comparison

After calculating the molarity of each solution, we compare their values:

- **NaOH (B):** 0.025 M
- **NaCl (C):** 0.01709 M

- **KCl (D):** 0.01342 M
- **Glucose (A):** 0.00556 M

Step 4: Arranging in Decreasing Order of Molarity

- **NaOH (B)** has the highest molarity.
- **NaCl (C)** comes next.
- **KCl (D)** follows.
- **Glucose (A)** has the lowest molarity.

The solutions in decreasing order of molarity are: **NaOH > NaCl > KCl > Glucose**

Final Answer: (A), (B), (D), (C)

Correct Option: 2)

Q3.

Ans.

The correct answer is **4. (A) – (III), (B) – (IV), (C) – (I), (D) – (II)**

Explanation:

- **Saturated solution → (III):** Contains the **maximum amount of solute** that can dissolve in a given amount of solvent at a given temperature; any extra solute remains undissolved.
- **Isotonic solutions → (IV):** Two solutions that have the **same osmotic pressure** at the same temperature (so no net osmosis).
- **Binary solution → (I):** A solution having **two components** (typically one solute + one solvent).
- **Hypertonic solution → (II):** A solution whose **osmotic pressure is higher** than that of another (the reference) solution.

Q4.

Ans.

Step 1. Understanding the Concept

At **high altitudes**, the **atmospheric pressure** is much lower than at sea level, meaning there is less **oxygen** in the air. The partial pressure of oxygen decreases, leading to **hypoxia** (low oxygen levels) in the blood and tissues of individuals living or traveling at high altitudes. This reduction in oxygen availability makes it more difficult for the body to obtain enough oxygen, leading to symptoms like fatigue and shortness of breath.

Step 2. Checking Each Option

- **1. Both low temperature and high atmospheric pressure**:

  → **Incorrect.** ✕ High altitudes are associated with **low atmospheric pressure**, not high pressure. Low temperatures can exist at high altitudes, but it is the low atmospheric pressure that is primarily responsible for the reduced oxygen levels.

- **2. Low temperature**:

  → **Incorrect.** ✕ While temperature can decrease at higher altitudes, it is the **low atmospheric pressure** that is the primary reason for reduced oxygen concentration in the blood and tissues, not temperature.

- **3. Low atmospheric pressure**:

  → **Correct.** ✅ The lower atmospheric pressure at high altitudes means that the **partial pressure of oxygen** is reduced. This decreases the amount of oxygen available for the lungs to absorb and for the blood to carry to tissues, leading to lower oxygen concentrations in the blood.

- **4. High atmospheric pressure**:

  → **Incorrect.** ✕ High atmospheric pressure is not associated with high altitudes. In fact, the oxygen concentration is higher at sea level where atmospheric pressure is higher.

✅ **Final Answer: Low atmospheric pressure**

Correct Option: 3)

Q5.

Ans.

Step 1. Understanding the Concept

To calculate the **molality** (m) of a solution, the formula is:

$$m = \frac{\text{moles of solute}}{\text{mass of solvent (in kg)}}$$

Where:

- **Moles of solute** is given by:

$$\text{moles of solute} = \frac{\text{mass of solute}}{\text{molar mass of solute}}$$

- **Mass of solvent** is the total mass of the solution minus the mass of the solute.

Step 2. Given Data

- **Mass percent of KI** = 20% (mass/mass)
- **Density of solution** = 1.202 g/mL
- **Molar mass of KI** = 166 g/mol

Step 3. Step-by-Step Calculation

1. **Assume the mass of the solution is 100 g.** This makes the calculations easier because the mass percent is given as 20%.
   - Mass of **KI (solute)** = 20% of 100 g = 20 g
   - Mass of **water (solvent)** = 100 g - 20 g = 80 g
2. **Convert mass of solvent into kilograms**:

$$80\,\text{g} = 0.08\,\text{kg}$$

3. **Calculate moles of KI**:

$$\text{moles of KI} = \frac{20\,\text{g}}{166\,\text{g/mol}} = 0.1205\,\text{mol}$$

4. **Calculate molality**:

$$m = \frac{0.1205\,\text{mol}}{0.08\,\text{kg}} = 1.50625\,\text{mol/kg}$$

Rounding to two significant figures:

$$m \approx 1.5\,\text{mol/kg}$$

☑ **Final Answer: 1.5 mol kg^{-1}**

Correct Option: 1)

Q6.

Ans.

Step 1. Understanding the Concept

The **cell potential** (denoted as E_{cell}) is the measure of the potential difference between the anode and cathode in an electrochemical cell. It is measured in **volts (V)**, which is the standard unit for electric potential.

The relationship is:

$$E_{\text{cell}} = E_{\text{cathode}} - E_{\text{anode}}$$

The unit for electric potential (voltage) is the **volt (V)**, which is defined as **joule per coulomb (J/C)**.

Step 2. Checking Each Option

- **1. V m**:

  → **Incorrect.** ✕ This is not the unit of E_{cell}, as it represents **volt-meter**, a unit that would relate to electric field or potential energy, but not cell potential.

- **2. S cm^{-1}**:

  → **Incorrect.** ✕ This is the unit for **conductivity** (Siemens per centimeter), not for cell potential.

- **3. V**:

  → **Correct.** ☑ The unit of E_{cell} is the **volt (V)**, which is the standard unit of electrical potential or voltage.

- **4. S cm^{-2} mol^{-1}**:

  → **Incorrect.** ✕ This is the unit for **specific conductivity** or **molar conductivity** and is not used for cell potential.

☑ **Final Answer: 3. V**

Correct Option: 3)

Q7.

Ans.

- **(A) Cell constant**: The **cell constant** is a factor that relates the measured resistance of a solution to its conductivity. It is defined as the ratio of the distance between the electrodes to the area of the cross-section of the solution.

  → **Correct Unit**: **(I)** cm^{-1}

- **(B) Molar conductance**: **Molar conductance** is the conductance of a solution containing 1 mole of electrolyte in a given volume of solution.

  → **Correct Unit**: **(II)** $ohm^{-1}\ cm^2\ mol^{-1}$

- **(C) Specific conductance**: **Specific conductance**, also known as conductivity, is the conductance of a unit volume of solution.

  → **Correct Unit**: **(III)** $ohm^{-1}\ cm^{-1}$

- **(D) Conductance**: **Conductance** is the ability of a solution to conduct electricity, and it is inversely related to resistance.

  → **Correct Unit**: **(IV)** ohm^{-1}

✓ **Final Answer: (A) - (I), (B) - (II), (C) - (III), (D) - (IV)**

Correct Option: 1)

Q8.

Ans.

Step 1. Understanding the Mercury Cell

A Mercury cell is a type of electrochemical cell commonly used in small devices, such as hearing aids, and is known for its high energy density. It involves a reaction between mercury oxide and zinc.

The general cell reaction is:

$$\mathrm{Zn\ (Hg) + HgO\ (s) \rightarrow ZnO\ (s) + Hg\ (l)}$$

Mercury cells do **not** convert combustion energy into electrical energy and are **non-rechargeable**.

Step 2. Checking Each Option

- **(A) It converts energy of combustion into electrical energy**:

  → Incorrect. ✗ Mercury cells do **not** rely on combustion. They generate energy through electrochemical reactions, not combustion.

- **(B) It is rechargeable**:

  → Incorrect. ✗ Mercury cells are **non-rechargeable**. Once the energy is used up, the cell cannot be recharged.

- **(C) The cell reaction involved is $\mathrm{Zn(Hg)} + \mathrm{HgO(s)} \longrightarrow \mathrm{ZnO(s)} + \mathrm{Hg(l)}$**:

  → Correct. ☑ This is the correct reaction for a Mercury cell.

- **(D) It is a low current device used in hearing aids**:

  → Correct. ☑ Mercury cells are commonly used in low current devices like hearing aids.

☑ **Final Answer: (C) and (D) only**

Correct Option: 4)

Q9.

Ans.

Step 1. Understanding the Concept

Different types of cells and batteries are used in various applications based on their characteristics. Here's a brief overview of each type mentioned:

- **Mercury Cell**: A primary cell that uses mercury oxide as the cathode. These are small and long-lasting but are rarely used in high-power applications like automobiles or inverters due to their environmental impact.
- **Dry Cell**: A type of battery where the electrolyte is in a paste form, commonly used in devices like flashlights, remote controls, and small gadgets. They don't supply the long-term power required for high-power applications like automobiles or inverters.
- **Lead Storage Cell**: Commonly used in automobiles as **lead-acid batteries**, these cells are rechargeable and provide the necessary power to start the engine and supply electricity to the car. They are

also used in inverters for backup power because of their ability to store and deliver a large amount of energy.

- **Fuel Cell**: A device that generates electricity through a chemical reaction, usually involving hydrogen and oxygen. These are more commonly explored in specialized applications like hydrogen-powered vehicles but are not typical in most standard automobiles or inverters.

Step 2. Checking Each Option

- **1. Mercury Cell**:

  → **Incorrect.** ✕ Mercury cells are not used in automobiles or inverters because they are not designed for high power applications.

- **2. Dry Cell**:

  → **Incorrect.** ✕ While dry cells are widely used in small electronic devices, they do not provide the necessary power for automobiles or inverters.

- **3. Lead Storage Cell**:

  → **Correct.** ☑ Lead storage cells (lead-acid batteries) are the standard batteries used in **automobiles** for starting the engine and in **inverters** for power backup.

- **4. Fuel Cell**:

  → **Incorrect.** ✕ While fuel cells are used in some experimental or specialized vehicles, they are not commonly used in most automobiles or inverters.

☑ **Final Answer: Lead Storage Cell**

Correct Option: 3)

Q10.

Ans.

Step 1: Understanding the behavior of galvanic and electrolytic cells

- A **galvanic cell** is a **voltaic cell** where **spontaneous reactions** occur, producing electrical energy (positive E_{cell}).

- An **electrolytic cell** requires an **external voltage** to drive a non-spontaneous reaction (negative E_{cell}).

Step 2: Comparing Galvanic and Electrolytic Cells

- **Galvanic cell**:
  - The cell potential (E_{cell}) is **positive**, and it generates electricity.
- **Electrolytic cell**:
  - The cell potential (E_{cell}) is **negative**, and it requires an **external voltage (E_{ext})** to drive the reaction in the opposite direction.

Step 3: Condition when a galvanic cell behaves like an electrolytic cell

- A galvanic cell behaves like an **electrolytic cell** when the **external voltage (E_{ext})** applied is **greater** than the **cell potential (E_{cell})**. This forces the reaction to reverse, making a **non-spontaneous** reaction occur.

Step 4: Explanation of the options

1. $E_{\text{cell}} = E_{\text{ext}}$:
   - **Incorrect.** ✕ This condition means the cell is at equilibrium and the system will not change.
2. $E_{\text{cell}} = 0$:
   - **Incorrect.** ✕ When $E_{\text{cell}} = 0$, the cell is at equilibrium, and no reaction occurs.
3. $E_{\text{ext}} > E_{\text{cell}}$:
   - **Correct.** ☑ When the **external voltage (E_{ext})** is greater than the cell potential (E_{cell}), the cell behaves like an **electrolytic cell**, and the reaction proceeds in the reverse direction.
4. $E_{\text{cell}} > E_{\text{ext}}$:
   - **Incorrect.** ✕ This would mean that the galvanic cell is still operating as a **galvanic cell**, not an electrolytic cell.

☑ **Final Answer: $E_{\text{ext}} > E_{\text{cell}}$**

Correct Option: 3)

Q11.

Ans.

Step 1. Understanding the Concept of Coordination Compounds

A **coordination compound** consists of a central metal atom or ion bonded to surrounding ligands (molecules or ions) through coordinate covalent bonds. Coordination compounds play crucial roles in biological processes and medical treatments, as well as in industrial applications.

Step 2. Evaluating Each Statement

1. **Cis-platin effectively inhibits the growth of tumours.**

   → **Correct.** ✅ **Cisplatin** (a coordination compound of platinum) is used as a **chemotherapeutic agent.** It is known for its ability to inhibit DNA replication, thereby preventing the growth of cancer cells. It is widely used to treat various cancers, including testicular, ovarian, and bladder cancer.

2. **Chlorophyll helps in photosynthesis.**

   → **Correct.** ✅ **Chlorophyll** is a **coordination compound** of magnesium (Mg) at the center of its structure. It plays a crucial role in photosynthesis by absorbing light and converting it into chemical energy.

3. **Desferrioxamine B is used in the treatment of lead poisoning.**

   → **Incorrect.** ❌ **Desferrioxamine B** is a chelating agent used to treat **iron poisoning** or iron overload, not lead poisoning. It binds to iron ions and helps in their removal from the body. For lead poisoning, other chelating agents such as **EDTA (ethylenediaminetetraacetic acid)** or **dimercaprol** are typically used.

4. **Cyanocobalamin, the anti-pernicious anemia factor, is a coordination compound of Co.**

   → **Correct.** ✅ **Cyanocobalamin** (Vitamin B12) is a coordination compound of **cobalt** (Co). It plays a vital role in the production of red blood cells and the maintenance of nerve cells, and its deficiency leads to pernicious anemia.

Step 3. Conclusion

- Statement **3** is **incorrect** because **desferrioxamine B** is used for iron poisoning, not lead poisoning.
- All other statements represent correct applications of coordination compounds.

✅ Final Answer: Desferrioxamine B is used in the treatment of lead poisoning

Correct Option: 3)

Q12.

Ans.

Step 1: Understanding the electronic configurations of the ions

To determine the number of 3d electrons in each ion, we first look at the **electronic configuration** of the neutral atoms and then account for the loss of electrons when the ion is formed.

1. **Cr^{2+} (Chromium ion)**:
   - Chromium (Cr) has an atomic number of **24**. The neutral configuration of Cr is:

     $$\mathrm{Cr} : [Ar]\,3d^5\,4s^1$$

   - For **Cr^{2+}**, 2 electrons are removed, primarily from the **4s orbital**. So, the configuration of **Cr^{2+}** is:

     $$\mathrm{Cr}^{2+} : [Ar]\,3d^4$$

   - Therefore, Cr^{2+} has **4** electrons in the 3d orbital.
2. **Cu^{+} (Copper ion)**:
   - Copper (Cu) has an atomic number of **29**. The neutral configuration of Cu is:

     $$\mathrm{Cu} : [Ar]\,3d^{10}\,4s^1$$

   - For **Cu^{+}**, 1 electron is removed, primarily from the **4s orbital**. So, the configuration of **Cu^{+}** is:

$$\mathrm{Cu}^{+} : [Ar]\, 3d^{10}$$

  - Therefore, Cu^+ has **10** electrons in the 3d orbital.

3. **Ti^{3+} (Titanium ion)**:
   - Titanium (Ti) has an atomic number of **22**. The neutral configuration of Ti is:

$$\mathrm{Ti} : [Ar]\, 3d^{2}\, 4s^{2}$$

   - For **Ti^{3+}**, 3 electrons are removed, primarily from the **4s orbital**. So, the configuration of **Ti^{3+}** is:

$$\mathrm{Ti}^{3+} : [Ar]\, 3d^{1}$$

   - Therefore, Ti^{3+} has **1** electron in the 3d orbital.

4. **Mn^+ (Manganese ion)**:
   - Manganese (Mn) has an atomic number of **25**. The neutral configuration of Mn is:

$$\mathrm{Mn} : [Ar]\, 3d^{5}\, 4s^{2}$$

   - For **Mn^+**, 1 electron is removed, primarily from the **4s orbital**. So, the configuration of **Mn^+** is:

$$\mathrm{Mn}^{+} : [Ar]\, 3d^{5}$$

   - Therefore, Mn^+ has **5** electrons in the 3d orbital.

Step 2: Arranging the ions in increasing order of 3d electrons

- **Ti^{3+}** has **1** 3d electron.
- **Cr^{2+}** has **4** 3d electrons.
- **Mn^+** has **5** 3d electrons.
- **Cu^+** has **10** 3d electrons.

So, the increasing order of the number of 3d electrons is:

$$\mathrm{Ti}^{3+}\,(<)\,\mathrm{Cr}^{2+}\,(<)\,\mathrm{Mn}^{+}\,(<)\,\mathrm{Cu}^{+}$$

☑ **Final Answer: (C), (A), (D), (B)**

Correct Option: 3)

Q13.

Ans.

Step 1: Understanding the atomic number of Lanthanum

- The **atomic number of Lanthanum** (La) is **57**, which means it has **57 electrons.**
- Lanthanum is part of the **lanthanide series.**

Step 2: Writing the electron configuration for Lanthanum

- The electron configuration of **Xenon (Xe)**, which has the atomic number **54**, is:

  $\mathrm{Xe} : [Kr]4d^{10}5s^2$

- Lanthanum (atomic number 57) will have three more electrons than Xenon:
  - These extra electrons go into the **5d orbital** and **5s orbital** because Lanthanum has a configuration that lies at the beginning of the lanthanide series, just before the start of the **4f orbitals.**

Thus, the electron configuration for Lanthanum is:

$$\mathrm{La} : [Xe]5d^1 6s^2$$

Step 3: Reviewing the options

1. **[Xe] $5d^1$ $6s^2$**:
   - ✅ **Correct.**
   - This matches the electron configuration for Lanthanum, where the **extra 3 electrons** after Xenon go into the **5d orbital** and **6s orbital.**
2. **[Xe] $4f^1$ $5d^2$**:
   - ❌ **Incorrect.**

   - This configuration suggests that Lanthanum has electrons in the **4f orbital**, which is not correct for Lanthanum as it doesn't start filling the **4f orbitals** until the next element, Cerium.

3. **[Xe] $4f^3$**:
   - ❌ **Incorrect.**
   - This would indicate that **3 electrons** have gone into the **4f orbital**, which is incorrect because **Lanthanum's configuration** doesn't involve filling the **4f orbitals** yet.
4. **[Xe] $4f^1\ 5d^1\ 6s^1$**:
   - ❌ **Incorrect.**
   - This configuration is wrong because it incorrectly places electrons in both the **4f orbital** and the **6s orbital**.

✅ **Final Answer: [Xe] $5d^1\ 6s^2$**

Correct Option: 1)

Q14.

Ans.

(A) Magnesium based alloy is constituent of: An alloy containing about 95% magnesium and 5% Mischmetal (an alloy of lanthanoid metals) is **pyrophoric**, meaning it produces sparks when struck. This property is utilized in making tracer **bullets** and lighter flints.

→ Correct Match: (I) Bullets

(B) Lanthanoid oxide: The oxides of certain lanthanoids, like europium and yttrium, are excellent **phosphors.** Phosphors are materials that emit light when struck by electrons, a principle used to create color images on older cathode-ray tube (CRT) **television screens**.

→ Correct Match: (III) Television screen

(C) Mixed oxides of Lanthanoids are employed in: Mixtures of lanthanoid oxides act as efficient **catalysts.** A major industrial application is in the catalytic **cracking of petroleum**, where they help break down large hydrocarbon molecules into smaller, more useful fractions like petrol.

→ Correct Match: (II) Petroleum cracking

(D) Misch metal: This is a well-known alloy. By definition, **Misch metal** is primarily composed of a mixture of **lanthanoid metals** (around 95%) and **iron** (around 5%), along with trace impurities.

→ Correct Match: (IV) Lanthanoid metal and iron

☑ **Final Answer: (A) - (I), (B) - (III), (C) - (II), (D) - (IV)**

Correct Option: 2)

Q15.

Ans. The correct answer is **1. Yellow**.

Detailed Step-by-Step Solution

This question is about the characteristic colors of transition metal ions in aqueous solutions, a topic from the "d- and f-Block Elements" chapter.

1. Identify the Ion and its Electronic Configuration

- The ion in question is the aqueous iron(III) ion, Fe^{3+}(aq).
- The atomic number of Iron (Fe) is 26. Its ground-state electronic configuration is $[Ar]3d^6 4s^2$.
- To form the Fe^{3+} ion, an iron atom loses three electrons (two from the 4s orbital and one from the 3d orbital).
- Therefore, the electronic configuration of Fe^{3+} is $[Ar]3d^5$.

2. Understand the Origin of Color

- In an aqueous solution, the Fe^{3+} ion is surrounded by six water molecules, forming the complex ion $[Fe(H_2O)_6]^{3+}$.
- The color of transition metal ions is typically due to the absorption of light, which promotes an electron from a lower-energy d-orbital to a higher-energy d-orbital. This is called a d-d transition.
- The color we observe is the complementary color of the light that is absorbed.

3. The Specific Case of Fe^{3+}(aq)

- For Fe^{3+}, which has a half-filled d-orbital configuration (d^5), the d-d transitions are "spin-forbidden". This means they are very weak, and if they were the only factor, the solution would be almost colorless or very pale violet.

- However, aqueous solutions of Fe^{3+} are distinctly yellow or brownish. This is due to a phenomenon called hydrolysis.
- The high positive charge of the Fe^{3+} ion pulls electrons from the surrounding water ligands, making them acidic. A proton (H^+) is released, forming a hydroxo complex:

$$[Fe(H_2O)_6]^{3+}_{(aq)} \rightleftharpoons [Fe(H_2O)_5(OH)]^{2+}_{(aq)} + H^+_{(aq)}$$

(pale violet) *(yellow)*

- The intense yellow color is caused by a Ligand-to-Metal Charge Transfer (LMCT) band in the hydroxo complex, $[Fe(H_2O)_5(OH)]^{2+}$. In this process, an electron momentarily transfers from the hydroxide ligand (OH^-) to the central Fe^{3+} ion. This type of electron transfer is highly probable and strongly absorbs light in the blue-violet region of the spectrum, causing the solution to appear yellow.

Conclusion

While the pure hexaaquairon(III) ion is pale violet, it readily hydrolyzes in water to form a yellow-colored complex. Therefore, the commonly observed color of an Fe^{3+}(aq) solution is yellow.

Q16.

Ans.

The reason **HCl** is not used to make the medium acidic in oxidation reactions of **$KMnO_4$** in acidic medium is because **$KMnO_4$** oxidizes **HCl** to **Cl_2**, which is also an oxidizing agent. This would interfere with the reaction as **Cl_2** itself can oxidize other substances, thus reducing the effectiveness of **$KMnO_4$** as an oxidizing agent.

Step 1: Understanding the Chemistry

- **$KMnO_4$** is a strong oxidizing agent that acts in acidic, neutral, and basic media. In acidic medium, **$KMnO_4$** is reduced to **Mn^{2+}**.
- **HCl**, when in the presence of **$KMnO_4$**, can get oxidized to **Cl_2** (chlorine gas), which is also an oxidizing agent. This creates a situation where both **$KMnO_4$** and **Cl_2** are acting as oxidizing agents, potentially leading to side reactions and the interference of chlorine gas in the desired oxidation process.

Step 2: Analyzing the Options

- **1. $KMnO_4$ is a weaker oxidizing agent than HCl**:

  → Incorrect. ✕ **$KMnO_4$** is actually a much stronger oxidizing agent than **HCl**.

- **2. $KMnO_4$ oxidizes HCl into Cl_2 which is also an oxidizing agent**:

  → Correct. ☑ The reaction between **$KMnO_4$** and **HCl** results in the formation of **Cl_2**, which itself is an oxidizing agent, interfering with the reaction.

- **3. Both HCl and $KMnO_4$ act as oxidizing agents**:

  → Incorrect. ✕ **HCl** does not act as an oxidizing agent in the reaction; it is oxidized to **Cl_2**.

- **4. $KMnO_4$ acts as a reducing agent in the presence of HCl**:

  → Incorrect. ✕ **$KMnO_4$** does not act as a reducing agent; it is the oxidizing agent in this reaction.

☑ Final Answer: $KMnO_4$ oxidizes HCl into Cl_2 which is also an oxidizing agent

Correct Option: 2)

Q17.

Ans.

Step-by-Step Solution

Step 1: Identify the reactants and their roles

- **Acidified potassium dichromate ($K_2Cr_2O_7$ / H^+):**
  - A strong **oxidizing agent.**
  - Chromium is in the **+6 oxidation state** and gets reduced to **Cr^{3+}** during the reaction.
- **Sulphide ion (S^{2-}):**
  - Acts as the **reducing agent.**
  - Sulfur has an oxidation state of **-2** and will be **oxidized** when reacting with the dichromate.

Step 2: Determine the oxidation product

- The **sulphide ion (S^{2-})** is oxidized from **-2** to **0**, forming **elemental sulfur (S)**.
- This sulfur often appears as a **yellow or pale precipitate**.

Step 3: Write the half-reactions

1. **Reduction (Dichromate ion):**

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

2. **Oxidation (Sulphide ion):**

$$S^{2-} \rightarrow S + 2e^-$$

Step 4: Combine half-reactions to balance electrons

- Multiply the oxidation half-reaction by 3 to match the 6 electrons in the reduction half-reaction:

$$3S^{2-} \rightarrow 3S + 6e^-$$

- Add both half-reactions to get the overall reaction:

$$Cr_2O_7^{2-} + 14H^+ + 3S^{2-} \rightarrow 2Cr^{3+} + 3S + 7H_2O$$

Step 5: Conclusion

- The **sulphide ion (S^{2-})** is oxidized to **elemental sulfur (S)**.
- Higher oxidation states of sulfur like **SO_3^{2-}, SO_2, SO_4^{2-}** are **not formed** in this reaction.

✓ **Final Answer: Sulphur (S)**

Correct Option: 3)

Q18.

Ans.

Step 1: Understanding Ligand Field Strength

The **field strength** of a ligand refers to its ability to split the d-orbital energies in a metal complex, which is influenced by the ligand's charge and the ability to donate electron density to the central metal ion. Ligands that strongly donate electron density to the metal tend to produce a greater splitting of the d-orbitals, which is associated with stronger field ligands.

The general order of field strength for different types of ligands is based on their position in the spectrochemical series. The spectrochemical series ranks ligands by their field strength, with ligands such as **CN^-** being strong field ligands and **S^{2-}** being weak field ligands.

Step 2: Reviewing the Ligands

- **(A) S^{2-} (Sulfide ion)**: This is a weak field ligand that does not cause significant splitting of d-orbitals. It is at the lower end of the spectrochemical series.
- **(B) Ethylenediamine (en)**: This is a moderately strong field ligand, but it is weaker than cyanide and thiocyanate.
- **(C) NCS^- (Thiocyanate)**: This ligand can act as either a weak or strong field ligand depending on its coordination mode. However, in general, it is a moderate field ligand.
- **(D) CN^- (Cyanide)**: This is a very strong field ligand, known for causing large splitting of the d-orbitals. It is one of the strongest ligands in the spectrochemical series.

Step 3: Decreasing Order of Field Strength

Based on the strength of the ligands in the spectrochemical series:

- **CN^-** is the strongest field ligand.
- **Ethylenediamine (en)** is weaker than **CN^-**, but stronger than **NCS^-**.
- **NCS^-** is a weaker field ligand than **en**, but stronger than **S^{2-}**.
- **S^{2-}** is the weakest field ligand among the given choices.

✓ **Final Answer: (D), (C), (B), (A)**

Correct Option: 4)

Q19.

Ans.

Step 1. Understanding the Concept

The IUPAC nomenclature of **coordination compounds** follows these rules:

1. **Name the ligands first**, in **alphabetical order**, followed by the **metal name**.
    - Ligands are named **ammine** for NH_3 and **chlorido** (or chloro in older literature) for Cl^-.
2. **Indicate the number of each ligand** using prefixes: di-, tri-, tetra-, etc.
3. **Oxidation state of the metal** is given in **Roman numerals** in parentheses after the metal.

Step 2. Analyzing the Complex $[Pt(NH_3)_2Cl_2]$

- **Ligands:**
    - **NH_3** → ammine
    - **Cl^-** → chlorido
- **Number of ligands:**
    - 2 NH_3 → **diammine**
    - 2 Cl^- → **dichlorido**
- **Metal:** Platinum (**Pt**)
- **Oxidation state of Pt:**

$$x + 2(0) + 2(-1) = 0 \implies x - 2 = 0 \implies x = +2$$

- **Final IUPAC Name: Diamminedichloridoplatinum(II)**

Step 3. Checking Each Option

1. **Diamminedichloridoplatinum (IV)** → ✕ Incorrect, oxidation state is +2, not +4.
2. **Diamminedichloridoplatinum (II)** → ☑ Correct.
3. **Diamminedichloridoplatinum (0)** → ✕ Incorrect, Pt is not in 0 oxidation state.
4. **Dichloridodiammineplatinum (IV)** → ✕ Incorrect, wrong oxidation state and alphabetical order of ligands is incorrect.

☑ **Final Answer: Diamminedichloridoplatinum (II)**

Correct Option: 2)

Q20.

Ans.

Step 1. Understanding the Concept

The complex $[Fe(CN)_6]^{3-}$ is a **hexacyanoferrate(III)** complex:

- **Central metal:** Fe^{3+} (oxidation state +3)
- **Electronic configuration of Fe^{3+}:**

$$Fe^{3+} : [Ar]\, 3d^5$$

- **Ligand:** CN^- (cyanide), a **strong field ligand** according to the **spectrochemical series**, which causes **pairing of electrons** in the 3d orbitals (low-spin complex).
- **Geometry:** Octahedral
- **Hybridization: d^2sp^3** (low-spin octahedral complex)
- **Magnetic properties:**
  - Fe^{3+} in a **low-spin** state has **1 unpaired electron** in the 3d orbital.
  - Magnetic moment (μ) = $\sqrt{n(n+2)}$ BM,

    where n = number of unpaired electrons:

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

Step 2. Checking Each Statement

(A) Paramagnetic → ✅ Correct

The complex has **1 unpaired electron**, so it is **paramagnetic.**

(B) sp^3d^2 hybridization → ❌ Incorrect

Octahedral complexes with **strong field ligands** like CN^- use **inner orbital hybridization**, which is **d^2sp^3**, not sp^3d^2.

(C) Magnetic moment = 5.92 BM → ❌ Incorrect

Magnetic moment depends on **unpaired electrons.** Here, there is **only 1 unpaired electron**, so μ ≈ **1.73 BM**, not 5.92 BM.

(D) d^2sp^3 hybridization → ✅ Correct

  - Fe^{3+} is a **low-spin octahedral complex**, and inner d-orbitals are involved in hybridization: $\mathbf{d^2sp^3}$.

✓ **Final Answer: (A) and (D) only**

Correct Option: 1)

Q21.

Ans.

The correct answer is **1. (A)–(III), (B)–(IV), (C)–(I), (D)–(II)**

Explanation:

- **Ambident nucleophiles** → Cyanides and nitrites (III)
- **Plane polarized light** → Nicol prism (IV)
- **Superimposable mirror image** → Symmetrical object (I)
- **β-elimination reaction** → Saytzeff rule (II)

Q22.

Ans.

The correct answer is **3. inversion of configuration**

Explanation:

The S_N2 reaction is a bimolecular nucleophilic substitution reaction. It is a concerted reaction, meaning the bond-breaking and bond-forming occur simultaneously in a single transition state. The nucleophile attacks the substrate from the side opposite to the leaving group, leading to an inversion of the stereochemical configuration at the chiral center. This is often referred to as Walden inversion.

Q23.

Ans.

Step 1: Understanding Gabriel Phthalimide Synthesis

The **Gabriel Phthalimide Synthesis** is a method used to prepare **primary amines** from **alkyl halides**. The reaction involves the following steps:

1. **Phthalimide** (a cyclic imide) is treated with a strong base (e.g., KOH) to form an **enolate ion**.

2. The **enolate ion** attacks an **alkyl halide** (R–X), forming a **phthalimide derivative**.
3. The resulting **phthalimide derivative** is hydrolyzed (usually with hydrazine, N_2H_4) to release the **primary amine**.

Step 2: Reaction mechanism and product

- The **key feature** of the Gabriel Phthalimide synthesis is the formation of **primary amines** through the nucleophilic substitution of an alkyl halide.
- The product of this reaction is a **primary amine**.

☑ **Final Answer: Primary amine**

Correct Option: 3)

Q24.

Ans.

The correct answer is **3. Wurtz Fittig reaction**.

Explanation:

1. Analyze the Given Reaction

Let's break down the chemical reaction provided:

- **Reactants:**
    - Chlorobenzene (C_6H_5Cl): This is an **aryl halide** (a halogen attached to a benzene ring).
    - Sodium (Na): An alkali metal, highly reactive.
    - Methyl chloride (CH_3Cl): This is an **alkyl halide** (a halogen attached to an alkyl group).
- **Reaction Conditions:**
    - **Heat:** Provides the necessary activation energy.
    - **Dry Ether:** A non-polar aprotic solvent is used because sodium reacts violently with water or alcohol.
- **Products:**

  - Toluene ($C_6H_5CH_3$): An **alkylbenzene** (an alkyl group attached to a benzene ring).
  - Sodium Chloride ($NaCl$): An inorganic salt.

The overall reaction shows an aryl halide and an alkyl halide coupling together in the presence of sodium to form an alkylbenzene.

2. Evaluate the Options

Let's examine why the Wurtz-Fittig reaction is the correct choice and the others are not.

- **Sandmeyer's reaction:** This reaction is used to synthesize aryl halides from aryl diazonium salts ($Ar\ N_2^+X^-$) using cuprous salts (Cu_2Cl_2, Cu_2Br_2, etc.). The given reaction does not involve a diazonium salt.
- **Wurtz reaction:** This reaction involves the coupling of **two alkyl halides** with sodium in dry ether to form a higher alkane.
  - *General Form:* $2R - X + 2Na \rightarrow R - R + 2NaX$
  - Our reaction involves one aryl halide and one alkyl halide, not two alkyl halides.
- **Wurtz-Fittig reaction:** This is a modification of the Wurtz reaction. It involves the reaction between an **aryl halide** and an **alkyl halide** with sodium in dry ether to form a substituted aromatic compound (alkylbenzene).
  - *General Form:* $Ar - X + R - X + 2Na \rightarrow Ar - R + 2NaX$
  - The given reaction fits this pattern perfectly: $C_6H_5 - Cl$ (Aryl halide) + $CH_3 - Cl$ (Alkyl halide) + 2Na → $C_6H_5 - CH_3$ (Alkylbenzene) + $2NaCl$.
- **Kolbe reaction:** This reaction involves the treatment of sodium phenoxide with carbon dioxide (CO_2) to form salicylic acid. This is completely different from the given reaction.

Conclusion

The reaction shows the coupling of an aryl halide (chlorobenzene) and an alkyl halide (methyl chloride) using sodium metal in dry ether. This is the definition of the **Wurtz-Fittig reaction**. It's a very useful method for attaching an alkyl chain to a benzene ring.

Q25.

Ans.

The correct answer is **3. (A), (B), (C) and (D)**.

Explanation:

Hydroboration–oxidation converts propene (an alkene) into an alcohol using two stages:

- **Hydroboration:** Use B_2H_6 (source of BH_3). BH_3 adds across the double bond.
- **Oxidation:** Then treat with H_2O_2 in **basic medium (OH^-)**. The base activates H_2O_2 so that oxygen replaces boron.
- The reaction is done in **water (H_2O)**, which finally protonates the alkoxide to give the alcohol.

Therefore, all four reagents are involved: (A) B_2H_6, (B) H_2O, (C) H_2O_2, and (D) OH^-.

(For propene, the product is propan-1-ol; anti-Markovnikov, syn addition.)

Q26.

Ans.

Step 1: Understanding the Storage Carbohydrate in Plants

In plants, carbohydrates are stored primarily in the form of **starch**, which is a polysaccharide made up of glucose units. Starch serves as the main energy storage molecule in plants, found in parts like roots, tubers, seeds, and fruits.

Step 2: Reviewing the Options

(1) Starch: Correct. Starch is the storage form of glucose in plants. It is made up of two components: amylose (linear) and amylopectin (branched).

(2) Glycogen: Incorrect. Glycogen is the storage carbohydrate in animals, not plants.

(3) Cellulose: Incorrect. Cellulose is a structural carbohydrate, forming the cell walls in plants, but it is not used for energy storage.

(4) Glucose: Incorrect. Glucose is a simple sugar and is used directly for energy, but it is not stored in its free form in plants.

The correct carbohydrate used as a storage molecule in plants is **starch**.

☑ **Final Answer: Starch**

Correct Option: 1)

Q27.

Ans.

The **Hell-Volhard-Zelinsky (HVZ) reaction** is used for the halogenation of carboxylic acids at the **α-position**, which is the carbon adjacent to the carboxyl group (-COOH). This reaction is specifically employed to form **α-halocarboxylic acids** by introducing a halogen atom (such as chlorine or bromine) at the α-carbon of the carboxylic acid in the presence of phosphorus or another catalyst. The product formed is **α-halocarboxylic acids**, which is the primary use of the HVZ reaction.

(1) Alcohols:

→ Incorrect. ✗

The HVZ reaction does not produce alcohols; it is specifically used for halogenating carboxylic acids.

(2) Aldehydes:

→ Incorrect. ✗

The HVZ reaction does not produce aldehydes; it targets the α-position of carboxylic acids.

(3) Ketones:

→ Incorrect. ✗

The HVZ reaction does not form ketones; its focus is on halogenation at the α-carbon of carboxylic acids.

(4) α-halocarboxylic acids:

→ Correct. ☑

The HVZ reaction is used to form **α-halocarboxylic acids**, where a halogen is attached to the α-position of a carboxylic acid.

Final Answer: α-halocarboxylic acids

Correct Option: 4)

Q28.

Ans.

Step 1: Understanding nucleophilic addition reactions

In a **nucleophilic addition reaction**, the nucleophile attacks the **carbonyl carbon** of a **carbonyl compound** (such as aldehydes and ketones). The reactivity of the carbonyl compound depends on several factors:

- **Electron-donating or electron-withdrawing groups** attached to the carbonyl group.
- **Steric hindrance**: Larger substituents around the carbonyl group can increase steric hindrance, making it harder for the nucleophile to attack.
- **Aldehydes** are typically **more reactive** than ketones because they have one alkyl group and a hydrogen atom attached to the carbonyl carbon, making the carbonyl carbon more **electrophilic**.
- Among ketones, the **smallest ketone** (in terms of the size of alkyl groups) will generally be more reactive because it has less **steric hindrance**.

Step 2: Analyzing the given compounds

1. **Ethanal (A)**:
    - **Aldehydes** are generally more reactive than **ketones** due to the **presence of one hydrogen atom** at the α-position, which makes the carbonyl carbon more electrophilic. So, **ethanal** will be highly reactive.
2. **Propanal (C)**:
    - **Propanal** is also an **aldehyde** but with a slightly **larger alkyl group** (ethyl group). It is still more reactive than ketones but less reactive than **ethanal** due to the larger alkyl group.
3. **Propanone (B)**:
    - **Propanone** (a ketone) has two methyl groups attached to the carbonyl group. Ketones are generally less reactive than

    aldehydes, so **propanone** will be less reactive than **ethanal** and **propanal**.

4. **Butanone (D)**:
    - **Butanone** is also a **ketone**, but it has two **larger alkyl groups** (ethyl groups) compared to **propanone**, which increases **steric hindrance** and reduces its reactivity in nucleophilic addition reactions.

Step 3: Correct sequence of increasing reactivity

- **Most reactive**: **Ethanal (A)** (aldehyde with the least steric hindrance)
- **Next**: **Propanal (C)** (aldehyde with a larger alkyl group)
- **Then**: **Propanone (B)** (ketone with small methyl groups)
- **Least reactive**: **Butanone (D)** (ketone with larger alkyl groups)

✓ **Final Answer: (A), (C), (B), (D)**

Correct Option: 3)

Q29.

Ans.

The correct answer is **3. (A), (B), (C) and (D)**

Explanation:

To make **methyl benzoate ($C_6H_5COOCH_3$)** from **benzene**:

1. **Br_2/$FeBr_3$**: Electrophilic bromination → **bromobenzene (C_6H_5Br).**
2. **Mg, dry ether**: Forms **Grignard reagent, C_6H_5MgBr.**
3. **CO_2, then H_3O^+**: Carboxylation of Grignard → **benzoic acid (C_6H_5COOH).**
4. **Methanol, conc. H_2SO_4**: Fischer esterification → **methyl benzoate.**

All four reagents are needed in this sequence, so option **(A), (B), (C) and (D)** is correct.

Q30.

Ans.

The correct answer is **4. I_2/NaOH**

Explanation:

The **iodoform test** (I_2/NaOH) is positive only for **methyl ketones** (CH_3-CO-).

- **Acetone** (CH_3-CO-CH_3) has this group → gives a yellow iodoform precipitate.
- **Benzophenone** (Ph-CO-Ph) has no CH_3 next to C=O → no reaction.

Fehling's and Tollens' reagents don't react with simple ketones, and 2,4-DNP reacts with both, so they can't distinguish them.

Q31.

Ans.

Step 1: Understanding Aldol Condensation

Aldol condensation is a reaction where two **carbonyl compounds** (either aldehydes or ketones) undergo a reaction in the presence of a **base**. The reaction typically proceeds in two steps:

1. **Formation of an enolate ion**: The base abstracts a hydrogen atom from the **α-carbon** (the carbon adjacent to the carbonyl group), forming an **enolate ion**.
2. **Nucleophilic attack**: The enolate ion attacks the carbonyl carbon of another molecule, forming a β-hydroxy carbonyl compound (an **aldol**), which may further undergo dehydration to form an **α,β-unsaturated carbonyl compound**.

For Aldol condensation to occur, the carbonyl compound must have at least one **α-hydrogen** to form the enolate ion.

Step 2: Explanation of the options

1. **Presence of at least one β-hydrogen**:
    - ✗ **Incorrect.**
    - **Explanation**: The **β-hydrogen** (hydrogen on the carbon next to the carbonyl group) is not critical for forming the **enolate ion** in the first step of Aldol condensation. The important feature for **Aldol condensation** is the **α-hydrogen**, not the β-hydrogen.
2. **Presence of at least one α-hydrogen**:
    - ☑ **Correct.**

    - **Explanation**: The **α-hydrogen** is located on the carbon adjacent to the carbonyl group. **Aldol condensation** requires this α-hydrogen because it is **abstracted by a base** to form the **enolate ion**, which then participates in the reaction. Without this hydrogen, the carbonyl compound cannot undergo Aldol condensation.

3. **Concentrated base**:
    - ✕ **Incorrect.**
    - **Explanation**: A **concentrated base** (e.g., NaOH or KOH) is often used to promote the reaction by deprotonating the α-hydrogen, but it is a **reaction condition**, not a structural feature of the carbonyl compound. The key structural feature is the **presence of α-hydrogens**.
4. **Lack of α-hydrogen**:
    - ✕ **Incorrect.**
    - **Explanation**: If a carbonyl compound **lacks α-hydrogens**, it **cannot undergo Aldol condensation.** For example, **benzaldehyde** has no α-hydrogens and cannot participate in Aldol condensation, whereas **acetaldehyde** has α-hydrogens and can react in this manner.

✅ **Final Answer: Presence of at least one α-hydrogen**

Correct Option: 2)

Q32.

Ans.

Step 1: Understanding the structure of trimethylamine $(CH_3)_3N$

- **Trimethylamine** $(CH_3)_3N$ consists of a central nitrogen atom bonded to three **methyl groups** ($-CH_3$).
- Nitrogen in amines is **trivalent** and has one **unshared pair of electrons** (lone pair).

Step 2: Hybridization of nitrogen

- The nitrogen atom in trimethylamine is **sp^3 hybridized**, meaning it has **four regions of electron density**: three bonds with methyl groups and one lone pair of electrons.

Step 3: Geometry of the molecule

- When there are **four regions of electron density** (three bonding pairs and one lone pair), the geometry around the nitrogen atom will be **pyramidal.**
- This is similar to the structure of **ammonia (NH_3)**, which also has a lone pair and three bonding pairs.

✓ **Final Answer: Pyramidal**

Correct Option: 2)

Q33.

Ans.

Step 1: Understanding the reaction

The compound **C_6H_5-O-R** is an **alkoxybenzene** (phenyl ether), where **R** represents an alkyl group (such as methyl, ethyl, etc.).

When treated with **HX** (where **X** is a halogen, such as **Cl**, **Br**, or **I**), the reaction typically involves the breaking of the **C–O bond** in the ether group. The **H** (proton) from **HX** adds to the oxygen of the ether, leading to the cleavage of the ether bond.

Step 2: Reaction mechanism

- The **ether bond** (C–O) in **C_6H_5-O-R** undergoes **nucleophilic attack** by the halide ion (X^-), leading to the formation of **phenol (C_6H_5OH)** and an alkyl halide (R–X).

The overall reaction is:

$$C_6H_5\text{-O-R} + HX \rightarrow C_6H_5OH + \text{R-X}$$

Step 3: Identifying the products

- The products of this reaction are **phenol (C_6H_5OH)** and **alkyl halide (R-X)**.

☑ **Final Answer: RX and C_6H_5OH are formed**

Correct Option: 1)

Q34.

Ans.

Step 1: Understanding the nitration reaction

- The **nitration of benzene** is an example of an **electrophilic aromatic substitution** reaction.
- In this reaction, **benzene (C_6H_6)** reacts with a **nitronium ion (NO_2^+)**, which is the actual **electrophile.**

Step 2: Formation of the nitrating species

- In the nitration reaction, a mixture of **concentrated sulfuric acid (H_2SO_4)** and **concentrated nitric acid (HNO_3)** is used.
- The **nitronium ion (NO_2^+)** is generated by the following reaction:

$$HNO_3 + H_2SO_4 \rightarrow NO_2^+ + HSO_4^- + H_2O$$

- This reaction occurs because **H_2SO_4** acts as a **catalyst** and helps in the formation of **NO_2^+** from **HNO_3.**

Step 3: Identifying the nitrating species

- The **nitronium ion (NO_2^+)** is the **electrophile** that reacts with the electron-rich benzene ring to form the nitrobenzene product.
- The **NO_2^-** ion is not the electrophile in this reaction.

☑ **Final Answer: NO_2^+**

Correct Option: 2)

Q35.

Ans.

Step 1: Understanding Azo Coupling Reaction

- **Azo coupling reaction** is the reaction where **benzene diazonium chloride** ($C_6H_5N_2^+Cl^-$) reacts with compounds that have a **reactive position** (such as amino or hydroxyl groups).

- The **diazonium ion** ($C_6H_5N_2^+$) acts as an electrophile and can couple with compounds that are **electron-rich** at the **para** or **ortho** positions.

Step 2: Analyzing each compound

1. **Nitrobenzene**:
    - **Nitro group (NO_2)** is an **electron-withdrawing group**, which deactivates the benzene ring and **makes it less reactive** towards electrophiles, including **diazonium ions**.
    - **Does not undergo azo coupling** easily with benzene diazonium chloride.
2. **Aniline**:
    - The **amine group ($-NH_2$)** is an **electron-donating group**, which makes the benzene ring **more reactive** towards electrophiles.
    - **Undergoes azo coupling** with benzene diazonium chloride.
3. **o-Toluidine**:
    - **o-Toluidine** contains an **amine group ($-NH_2$)** and a **methyl group ($-CH_3$)**, both of which are **electron-donating groups**.
    - The **methyl group** in the **ortho position** further increases the reactivity of the ring, allowing it to undergo **azo coupling** with diazonium ions.
4. **Phenol**:
    - The **hydroxyl group (–OH)** is an **electron-donating group** and makes the benzene ring more reactive towards electrophiles.
    - **Phenol undergoes azo coupling** with benzene diazonium chloride.

Step 3: Conclusion

- **Nitrobenzene** will **not give azo coupling** because the **nitro group ($-NO_2$)** is an **electron-withdrawing group** and deactivates the ring.

☑ **Final Answer: Nitrobenzene**

Correct Option: 1)

Q36.

Ans.

Step 1. What is Amylose?

- **Amylose** is a polysaccharide made up of glucose units connected by α-1,4 glycosidic bonds.
- It is one of the two components of starch, the other being **amylopectin**.
- Amylose is typically **linear** (unbranched), whereas amylopectin is **branched**.

Step 2. Solubility of Amylose

- Amylose is known to be **water-soluble** due to its helical structure, which can form hydrogen bonds with water molecules.
- However, its solubility is relatively **low compared to amylopectin**, which is more highly branched and more easily interacts with water.

Step 3. Typical Solubility Range

- The **solubility of amylose** in water typically ranges from **15% to 20%** by weight under standard conditions.

✓ **Final Answer: 15 to 20%**

Correct Option: 2)

Q37.

Ans.

Step 1: Understanding the types of proteins

- **Globular proteins**: These are proteins that have a **compact, spherical shape**. They are usually soluble in water and perform various functions such as enzymes, hormones, and transport proteins. Examples include **insulin** and **albumin**.
- **Fibrous proteins**: These are proteins that have a **long, fibrous shape** and are typically insoluble in water. They provide structural support and include proteins like **keratin** and **myosin**.

Step 2: Analyzing each option

1. **Insulin (A)**:
    - **Insulin** is a **globular protein**. It is a **hormone** that regulates blood sugar levels and is water-soluble.
2. **Keratin (B)**:
    - **Keratin** is a **fibrous protein**, not a globular one. It is found in hair, nails, and skin and is insoluble in water.
3. **Albumin (C)**:
    - **Albumin** is a **globular protein**. It is a water-soluble protein found in blood plasma and helps in maintaining osmotic pressure.
4. **Myosin (D)**:
    - **Myosin** is a **fibrous protein**. It is involved in muscle contraction and has a long, fibrous structure.

Step 3: Correct combination of globular proteins

- **Globular proteins** in the options are **insulin (A)** and **albumin (C)**.

✓ **Final Answer: (A) and (C) only**

Correct Option: 2)

Q38.

Ans.

Step 1: Understanding the β-helix of proteins

- The **β-helix** is a type of secondary structure found in proteins, also known as the **β-pleated sheet** structure.
- It consists of **β-strands**, which are extended chains of amino acids that align side-by-side to form sheets.

Step 2: Key bonding interactions in β-helix

- In the **β-helix**, the most important interactions that stabilize the structure are **hydrogen bonds (H-bonds)**.

- **Hydrogen bonds** form between the **backbone amide hydrogen (N-H)** of one strand and the **carbonyl oxygen (C=O)** of an adjacent strand, holding the strands together in a pleated sheet-like arrangement.

Step 3: Answer analysis of options

- **Ionic bond**: This is not a primary interaction in the β-helix structure. Ionic bonds are more commonly seen in salt bridges or between charged side chains in proteins.
- **Covalent interaction**: While covalent bonds, such as **disulfide bridges**, can stabilize protein tertiary structures, they are **not the key interactions in the β-helix**.
- **H-bond**: This is the correct answer. **Hydrogen bonds** are the dominant force stabilizing the β-helix.
- **Banana bond**: This term does not exist in the context of protein structure. It is not a recognized type of bond in the β-helix.

☑ **Final Answer: H-bond**

Correct Option: 3)

Q39.

Ans.

The correct answer is **2. (A) – (III), (B) – (I), (C) – (IV), (D) – (II).**

Explanation:

Know the standard one-letter amino-acid codes:

- **Lysine → K** (L is taken by leucine, so lysine uses K).
- **Tryptophan → W** (T is taken by threonine; Trp is uniquely coded as W).
- **Tyrosine → Y** (uses its initial sound "Y").
- **Glutamine → Q** (to distinguish from glutamate/glutamic acid, which is E).

So, the correct matching is: Lysine–K (III), Tryptophan–W (I), Tyrosine–Y (IV), Glutamine–Q (II).

Q40.

Ans.

Step 1: Understanding the structure and acidity of phenolic compounds

The **acidity of phenolic compounds** is determined by the ability of the hydroxyl group (-OH) to lose a proton (H^+). The more stabilized the conjugate base (phenoxide ion), the stronger the acid.

- **Electron-withdrawing groups** (such as nitro groups) stabilize the negative charge on the oxygen atom in the conjugate base, thereby **increasing the acidity**.
- The position of the electron-withdrawing groups is important. **Electron-withdrawing groups in the ortho and para positions** relative to the hydroxyl group stabilize the phenoxide ion more effectively than those in the meta position.

Step 2: Analyzing the compounds

1. **Phenol (D)**:
    - Phenol has a hydroxyl group attached to a benzene ring, and the phenoxide ion (after deprotonation) is not stabilized by any electron-withdrawing group. Thus, phenol is the **least acidic** of the given compounds.
2. **3-Nitrophenol (A)**:
    - The **nitro group** is in the **meta position** to the hydroxyl group. Although the nitro group is an electron-withdrawing group, it has a **lesser effect** on the acidity compared to groups in the ortho or para positions. So, it is **slightly more acidic** than phenol.
3. **3,5-Dinitrophenol (B)**:
    - The nitro groups are in the **meta and para positions** to the hydroxyl group. The nitro group in the para position stabilizes the phenoxide ion better than the one in the meta position. This makes **3,5-dinitrophenol more acidic** than 3-nitrophenol.
4. **2,4,6-Trinitrophenol (C)**:
    - With **three nitro groups** in the **ortho, para, and meta positions**, **2,4,6-trinitrophenol** is the **most acidic**. The nitro groups at the

ortho and para positions provide the best stabilization of the conjugate base.

Step 3: Arranging in increasing order of acidity

- **Phenol (D)**: Least acidic.
- **3-Nitrophenol (A)**: Slightly more acidic than phenol.
- **3,5-Dinitrophenol (B)**: More acidic than 3-nitrophenol.
- **2,4,6-Trinitrophenol (C)**: Most acidic.

✓ **Final Answer: (D), (A), (B), (C)**

Correct Option: 3)

Q41.

Ans.

Given:

The rate of a gaseous reaction is expressed as:

$$r = k[A][B]$$

where:

- r is the rate of the reaction,
- k is the rate constant,
- $[A]$ and $[B]$ are the concentrations of the reactants A and B, respectively.

Step 1: Understand the effect of reducing the volume on concentration

When the volume of the reaction vessel is reduced, the concentration of the gases will increase, because concentration is inversely proportional to the volume. Mathematically:

$$C = \frac{n}{V}$$

where C is the concentration, n is the number of moles, and V is the volume.

If the volume is reduced to $\frac{1}{4}$ of its initial value, the concentration will increase by a factor of 4.

New concentration of $A = 4 \times [A]$ and New concentration of $B = 4 \times [B]$

Step 2: Analyze the impact on the rate

Since the rate law is $r = k[A][B]$, the new rate after the volume reduction will be:

$$r_{\text{new}} = k(4[A])(4[B]) = 16 \times k[A][B] = 16r_{\text{initial}}$$

Step 3: Conclusion

The new rate will be 16 times the initial rate.

✓ **Final Answer: The reaction rate will become 16 times the initial rate.**

Correct Option: 3)

Q42.

Ans.

Given:

The rate law for the reaction is:

$$\text{Rate} = k[A]^{1/2}[B]^{3/2}$$

Where:

- $[A]$ is the concentration of reactant A,
- $[B]$ is the concentration of reactant B,
- k is the rate constant.

Step 1: Determine the overall order of the reaction

The overall order of a reaction is the sum of the exponents of the concentration terms in the rate law.

- The exponent of $[A]$ is $\frac{1}{2}$,
- The exponent of $[B]$ is $\frac{3}{2}$.

So, the overall order of the reaction is:

$$\text{Order of reaction} = \frac{1}{2} + \frac{3}{2} = 2$$

Step 2: Conclusion

The reaction is of second order.

✓ **Final Answer: The order of the reaction is second order**.

Correct Option: 1)

Q43.

Ans.

Step 1: Understanding the Rate Law

The rate law is given by:

$$r = k[CH_3OCH_3]^{3/2}$$

Here:

- r is the rate of reaction (typically in concentration per unit time, e.g., mol/L·min).
- k is the rate constant.
- $[CH_3OCH_3]$ is the concentration of the reactant CH_3OCH_3 (in this case, it's given in pressure units, i.e., bar).
- The exponent 3/2 indicates that the concentration is raised to the power of 3/2.

Step 2: Units of Rate of Reaction *r*

The rate of reaction r has units of concentration per time. Since pressure is measured in bar, and time is in minutes, the units of r would be:

$$r = \text{concentration per time} = \text{bar min}^{-1}$$

Step 3: Analyzing the Units of the Rate Constant *k*

The general form of the rate law is:

$$r = k[\text{Reactant}]^n$$

For this reaction:

$$r = k[CH_3OCH_3]^{3/2}$$

The unit of r is bar min^{-1}, and the unit of concentration $[CH_3OCH_3]$ is bar.

Therefore, the unit of k can be derived as follows:

$$\text{Unit of } r = (\text{Unit of } k) \times (\text{Unit of concentration})^{3/2}$$

Substituting the known units:

$$\text{bar min}^{-1} = (\text{Unit of } k) \times (\text{bar})^{3/2}$$

Now, solve for the unit of k:

$$\text{Unit of } k = \frac{\text{bar min}^{-1}}{(\text{bar})^{3/2}} = \text{bar}^{-1/2}\,\text{min}^{-1}$$

Step 4: Final Answer: The unit of the rate constant k is bar$^{-1/2}$ min^{-1} .

Correct Option: 1)

Q44.

Ans.

Step 1: Understanding the Question

The question asks to determine the order of the reaction based on how the rate changes when the concentration of the reactant is increased.

- The rate of reaction increases **27 times** when the concentration of the reactant is increased **3 times**.

Step 2: Rate Law and Reaction Order

The rate law for a reaction is given by:

$$r = k[A]^n$$

where:

- r is the rate of reaction,
- k is the rate constant,
- $[A]$ is the concentration of the reactant,
- n is the order of the reaction with respect to A.

Step 3: Relating Rate Change to Concentration Change

According to the question:

- The concentration of the reactant increases by a factor of 3, so the new concentration is $3[A]$.

- The rate of reaction increases by a factor of 27, meaning the new rate is $27\,r$.

So, using the rate law, the new rate can be written as:

$$27\,r = k(3[A])^n$$

Step 4: Solving for the Order n

Now, we can relate the new rate to the original rate:

$$\frac{27r}{r} = \frac{k(3[A])^n}{k[A]^n}$$

Simplifying the equation:

$$27 = 3^n$$

Now solve for n:

$$3^n = 27$$

Since $27 = 3^3$, we get:

$$n = 3$$

Step 5: Final Answer: The order of the reaction is 3.

Correct Option: 3)

Q45.

Ans.

Step 1: Understanding the Question

The question asks about the role of a catalyst in a chemical reaction.

Step 2: Key Information from the Passage

From the passage:

- A catalyst provides an alternate pathway for the reaction with **lower activation energy**.
- It does **not** alter the **Gibbs energy** of the reaction.
- It does **not** change the **enthalpy** of the reaction.
- It does **not** change the **equilibrium constant**.

Step 3: Analyzing the Role of a Catalyst

- **Gibbs Energy**: A catalyst does not change the Gibbs energy of a reaction. Gibbs energy is related to the spontaneity of the reaction, and a catalyst only affects the rate of reaction, not the overall energy balance.
- **Enthalpy**: A catalyst does not change the enthalpy of the reaction. Enthalpy change is a thermodynamic property that depends on the reactants and products.
- **Activation Energy**: A catalyst works by lowering the activation energy required for the reaction to proceed. It provides an alternate reaction pathway with lower activation energy, making the reaction proceed faster.
- **Equilibrium Constant**: A catalyst does **not** change the equilibrium constant. It only speeds up the reaction in both directions equally (forward and backward) but does not shift the equilibrium.

Step 4: The catalyst changes the activation energy of the reaction by providing an alternate pathway with lower activation energy.

☑ **Final Answer: Activation energy of a reaction.**

Correct Option: 3)

Q46.

Ans.

Step 1. Recall temperature-dependent dehydration of ethanol (with conc. H_2SO_4):

- **Lower temp (~413 K):** Intermolecular dehydration → **ether formation** (diethyl ether, i.e., **ethoxyethane**).

$$2\,C_2H_5OH \xrightarrow[413\;K]{\text{conc. } H_2SO_4} C_2H_5OC_2H_5 + H_2O$$

- **Higher temp (~443 K):** Intramolecular dehydration → **alkene formation** (ethene).

$$C_2H_5OH \xrightarrow[443\;K]{\text{conc. } H_2SO_4} C_2H_4 + H_2O$$

Step 2. Match with the question:

At **443 K → ethene**; at **413 K → ethoxyethane**.

☑ **Final Answer: Ethene and ethoxyethane**

Correct Option: 4)

Q47.

Ans.

Step 1. Understanding the Question

We are asked to identify the **major product** when **anisole (methoxybenzene)** reacts with **bromine in ethanoic acid**. This is an **electrophilic aromatic substitution** reaction.

Step 2. Concept – Directive Influence of the –OCH_3 Group

- The **–OCH_3 group** in anisole is an **electron-donating group** because of its lone pairs on oxygen.
- It **activates the benzene ring** and directs the incoming electrophile (Br^+) to the **ortho (2-position)** and **para (4-position)** due to **resonance** and **inductive effects.**

Resonance structures show high electron density at ortho and para positions, making them more reactive towards electrophiles like Br^+.

Step 3. Reaction Explanation

When anisole reacts with **Br_2 in ethanoic acid**, **bromination** occurs mainly at the **ortho** and **para** positions.

The reaction can be represented as:

$$\mathrm{C_6H_5OCH_3} + Br_2 \xrightarrow{\mathrm{CH_3COOH}} o\text{-bromoanisole} + p\text{-bromoanisole}$$

Step 4. Major Product

- Both **ortho-bromoanisole** and **para-bromoanisole** are formed.
- The **para product predominates** because of **less steric hindrance** between the bulky –OCH_3 group and the incoming bromine atom.

☑ **Final Answer: o-bromoanisole and p-bromoanisole**

Correct Option: 4)

Q48.

Ans.

Step 1. Understanding the Question

In **Williamson's synthesis**, ethers are prepared by reacting an **alkoxide ion (R–O⁻)** with an **alkyl halide (R′–X)**:

$$R–O^-Na^+ + R\prime–X \rightarrow R–O–R\prime + NaX$$

We are asked to identify which **reaction mechanism** (S_N1 or S_N2) governs this process.

Step 2. Mechanism Explanation

- The **alkoxide ion (R–O⁻)** is a strong nucleophile.
- The reaction involves a **single-step nucleophilic substitution** where the nucleophile attacks the electrophilic carbon of the alkyl halide **from the opposite side**, displacing the halide ion.
- This **backside attack** is a characteristic of the S_N2 **mechanism**.

Thus, the mechanism of the reaction is **bimolecular nucleophilic substitution (S_N2)**.

Step 3. Important Points

- The reaction proceeds **best with primary alkyl halides**, as they allow easy backside attack.
- **Tertiary alkyl halides** are unsuitable because of **steric hindrance**—they prefer **elimination reactions** instead.

☑ **Final Answer:** The alkoxide ion attacks the alkyl halide via an S_N2 mechanism.

Correct Option: 1)

Q49.

Ans.

Step 1. Understanding the Question

The question asks which **hydrogen halide (HX)** is **most reactive** for the **cleavage of ethers**.

Ethers are generally stable compounds, and cleavage requires a **strong acid** (HX) that can **protonate the ether oxygen** and provide a **good nucleophile (X^-)** to attack the carbon.

Step 2. Reaction Concept

The general reaction for ether cleavage is:

$$R–O–R' + HX \rightarrow R–X + R'–OH$$

The reaction involves two key steps:

1. **Protonation of ether oxygen** → makes it a better leaving group.
2. **Nucleophilic attack by X^-** → breaks the C–O bond.

The **reactivity** depends on:

- **Acid strength of HX** (ability to protonate ether oxygen)
- **Nucleophilicity of X^-** (ability to attack carbon)

Step 3. Comparing Reactivities

The order of **acid strength and nucleophilicity** among hydrogen halides is:

$$HI > HBr > HCl > HF$$

- **HI** is the **strongest acid** and provides the **most nucleophilic iodide ion (I^-).**
- I^- can easily attack the alkyl group after protonation, leading to efficient cleavage.
- **HF** is the weakest because of its strong H–F bond and poor nucleophilicity of F^-.

☑ **Final Answer: Most reactive hydrogen halide for ether cleavage is HI.**

Correct Option: 4)

Q50.

Ans.

Step 1. Understanding the Question

The question asks to identify the **type of ether** that **anisole** is classified into.

Anisole is a chemical compound that has the following structure:

- **Phenyl group** (C_6H_5) attached to an **alkoxy group** ($-OCH_3$, where CH_3 is the methyl group).

Step 2. Identifying the Type of Ether

Ethers are classified based on the groups attached to the oxygen atom.

There are four main types:

1. **Dialkyl ethers**: Both groups attached to oxygen are alkyl groups (e.g., CH_3OCH_3).
2. **Diaryl ethers**: Both groups attached to oxygen are aromatic (aryl) groups (e.g., $C_6H_5OC_6H_5$).
3. **Phenyl alkyl ethers**: One group is a **phenyl group** (C_6H_5), and the other group is an **alkyl group** (e.g., $C_6H_5OCH_3$).
4. **Alkoxy alkyl ethers**: Both groups attached to oxygen are alkyl groups, and one of them may have an alkoxy group.

Step 3. Identifying Anisole

Anisole has a **phenyl group (C_6H_5)** and an **alkoxy group ($-OCH_3$)**. Therefore, it fits the **phenyl alkyl ether** category.

☑ **Final Answer: Anisole is a phenyl alkyl ether**.

Correct Option: 3)