# CUET UG (Chemistry)

# 29 May 2024

# Question 1

## Which of the following gases at 298 K and 1 atm pressure is having maximum solubility in water?

**Options:**

A. Methanal, $K_H$= 0.000018

B. Argon,$K_H$= 40.3

C. Methane,$K_H$= 0.41

D. $CO_2$,$K_H$= 1.6

**Answer: A**

## Solution:

**CONCEPT**:

**Henry's Law Constant (KH)**

- The solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid.
- This relationship is given by Henry's Law, which states:

  C = KH * P

- Where C is the concentration of the gas in the liquid, KH is the Henry's Law constant, and P is the partial pressure of the gas.
- Lower values of KH indicate higher solubility of the gas in water.

**EXPLANATION**:

- Given the Henry's Law constants (KH) for the gases at 298 K and 1 atm pressure:
  - Methanal, KH = 0.000018
  - Argon, KH = 40.3
  - Methane, KH = 0.41
  - CO2, KH = 1.6
- According to Henry's Law, the gas with the lowest KH value will have the highest solubility in water.
- Among the given gases, Methanal has the lowest KH value (0.000018).

**Therefore, Methanal has the maximum solubility in water at 298 K and 1 atm pressure.**

---

# Question 2

## Which of the following is/are the bases of DNA?

## (A) Adenine

## (B) Uracil

## (C) Thymine

## (D) Cytosine

## Choose the correct answer from the options given below:

**Options:**

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

B. (B) and (C) only

C. (A), (C) and (D) only

D. (A) and (B) only

**Answer: C**

## Solution:

**CONCEPT**:

**Bases of DNA**

- DNA (Deoxyribonucleic Acid) is made up of four nitrogenous bases which pair specifically to form the double-stranded structure.
- The four bases in DNA are:
  - Adenine (A)
  - Thymine (T)
  - Cytosine (C)
  - Guanine (G)
- These bases pair up specifically: Adenine with Thymine and Cytosine with Guanine.
- Uracil (U) is found in RNA (Ribonucleic Acid) and replaces Thymine in RNA.

**EXPLANATION**:

- Uracil (B) is not a base in DNA but is present in RNA.
- The bases of DNA are Adenine (A), Thymine (C), and Cytosine (D), along with Guanine (not listed here).
- Therefore, the correct answer includes (A), (C), and (D) only.

**Therefore, the correct answer is option 3: (A), (C), and (D) only.**

---

# Question 3

## Match List-I with List-II:

| | List-I (Amino Acid) | | List-II (Nature of Amino Acid) |
|---|---|---|---|
| (A) | Valine | (I) | Basic amino acid |
| (B) | Glycine | (II) | Neutral optically active aminoacid |
| (C) | Lysine | (III) | Acidic amino acid |
| (D) | Glutamic acid | (IV) | Neutral optically inactive aminoacid |

## Choose the correct answer from the options given below:

### Options:

A.

(A) - (I), (B) - (II), (C) - (III), (D) - (IV)

B.

(A) - (I), (B) - (III), (C) - (II), (D) - (IV)

C.

(A) - (I), (B) - (II), (C) - (IV), (D) - (III)

D.

(A) - (II), (B) - (IV), (C) - (I), (D) - (III)

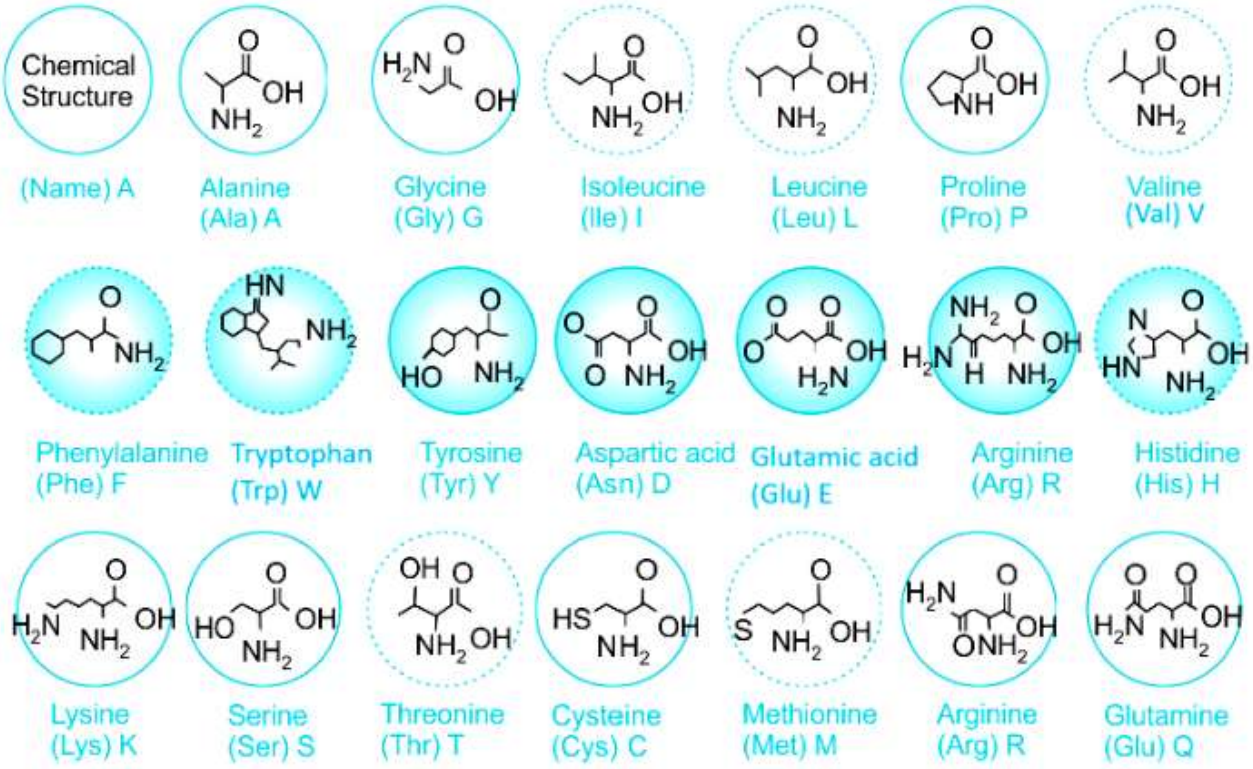
**Answer: D**

## Solution:

**CONCEPT**:

**Nature of Amino Acids**

- Amino acids can be classified based on the nature of their side chains (R-groups) into acidic, basic, and neutral amino acids.
- Neutral amino acids can further be classified based on their optical activity into optically active and optically inactive amino acids.




**EXPLANATION**:

- Valine is a neutral amino acid with a nonpolar side chain, making it optically active.

  **(A) Valine - (II) Neutral optically active amino acid**

- Glycine is the simplest amino acid with a hydrogen as its side chain, making it optically inactive.

  **(B) Glycine - (IV) Neutral optically inactive amino acid**

- Lysine has an amino group in its side chain, which makes it a basic amino acid.

  **(C) Lysine - (I) Basic amino acid**

- Glutamic acid has a carboxyl group in its side chain, making it an acidic amino acid.

  **(D) Glutamic acid - (III) Acidic amino acid**

**Therefore, the correct matching is (A) - (II), (B) - (IV), (C) - (I), (D) - (III)**

---

# Question 4

## Which of the following solvents is having its lowest Ebullioscopic constant?

| Solvent | Boiling Point (K) |
|---|---|
| Chloroform | 334.4 |
| Diethyl Ether | 307.8 |
| Benzene | 353.3 |
| Carbon disulphide | 319.4 |

**Options:**

A.

Chloroform

B.

Diethyl Ether

C.

Benzene

D.

Carbon disulphide

**Answer: B**

## Solution:

**CONCEPT**:

**Ebullioscopic Constant ($K_b$)**

- The Ebullioscopic constant ($K_b$) is a property of the solvent that gives the increase in boiling point when a solute is dissolved in it, per molal concentration of the solute.
- It is given by the formula:

  $K_b = (R \times T_b^2 \times M) / (1000 \times \Delta H_{vap})$

**EXPLANATION**:

- The boiling point ($T_b$) of the solvent is directly related to the Ebullioscopic constant ($K_b$).
- Given the boiling points of the solvents:
  - Chloroform: 334.4 K
  - Diethyl Ether: 307.8 K
  - Benzene: 353.3 K
  - Carbon disulphide: 319.4 K
- The solvent with the lowest boiling point will generally have the lowest Ebullioscopic constant.
- Among the given solvents, Diethyl Ether has the lowest boiling point of 307.8 K.

**Therefore, the solvent with the lowest Ebullioscopic constant is Diethyl Ether.**

---

# Question 5

## Which among the following compound is formed, when aldehyde reacts with HCN in presence of base?

## Which among the following compound is formed, when aldehyde reacts with HCN in presence of base?

**Options:**

A. Cyanide

B. Isocyanide

C. Cyanohydrin

D. Hydrogen cyanide

**Answer: C**

## Solution:

**CONCEPT**:

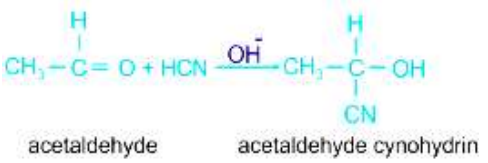
**Cyanohydrin Formation**

- When an aldehyde reacts with hydrogen cyanide (HCN) in the presence of a base, a cyanohydrin compound is formed.
- The reaction involves the nucleophilic addition of the cyanide ion ($CN^-$) to the carbonyl carbon of the aldehyde.

**EXPLANATION**:

- In the given reaction:

  R-CHO + HCN → R-CH(OH)-CN




- 
  - The reaction is catalyzed by a base, which deprotonates the HCN to form the cyanide ion ($CN^-$).
  - The $CN^-$ ion attacks the carbonyl carbon of the aldehyde, forming a tetrahedral intermediate.
  - This intermediate is then protonated to form the final cyanohydrin product (R-CH(OH)-CN).

**Therefore, when an aldehyde reacts with HCN in the presence of a base, the compound formed is cyanohydrin.**

---

# Question 6

The correct decreasing order of basic strength of following amines in aqueous solution is:

$CH_3NH_2$, $(CH_3)_2NH$, $(CH_3)_3N$, $NH_3$

# The correct decreasing order of basic strength of following amines in aqueous solution is:

# $CH_3NH_2$, $(CH_3)_2NH$, $(CH_3)_3N$, $NH_3$

### Options:

A. $CH_3NH_2 > (CH_3)_2NH > NH_3 > (CH_3)_3N$

B. $CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N > NH_3$

C. $NH_3 > (CH_3)_3N > (CH_3)_2NH > CH_3NH_2$

D. $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$

**Answer: D**

# Solution:

**CONCEPT**:

**Basic Strength of Amines**

- The basic strength of amines is influenced by several factors, including the electron-donating or electron-withdrawing nature of substituents attached to the nitrogen atom.
- In aqueous solution, the basic strength of amines is determined by their ability to accept a proton ($H^+$).
- Alkyl groups are electron-donating groups that increase the electron density on the nitrogen atom, making the amine more basic.
- The basic strength of amines in aqueous solution generally follows the trend:

  Secondary amines > Primary amines > Tertiary amines > Ammonia

**EXPLANATION**:

- In the given amines:

  $CH_3NH_2$ (methylamine), $(CH_3)_2NH$ (dimethylamine), $(CH_3)_3N$ (trimethylamine), $NH_3$ (ammonia)

  - Dimethylamine ($(CH_3)_2NH$) is a secondary amine and has two electron-donating methyl groups, making it the most basic.
  - Methylamine ($CH_3NH_2$) is a primary amine and has one electron-donating methyl group, making it less basic than dimethylamine.
  - Trimethylamine ($(CH_3)_3N$) is a tertiary amine, but the steric hindrance around the nitrogen atom makes it less basic than methylamine and dimethylamine.
  - Ammonia ($NH_3$) has no alkyl groups and is the least basic.
- Therefore, the correct decreasing order of basic strength of the given amines in aqueous solution is:
  - $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$

**Therefore, the correct answer is$(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$.**

---

# Question 7

A new C-C bond formation is possible in :

(A) Cannizzaro reaction

(B) Friedel-Crafts alkylation

(C) Clemmensen reduction

(D) Riemer-Tiemann reaction

Choose the correct answer from the options given below:

## A new C-C bond formation is possible in :

## (A) Cannizzaro reaction

## (B) Friedel-Crafts alkylation

## (C) Clemmensen reduction

## (D) Riemer-Tiemann reaction

## Choose the correct answer from the options given below:

**Options:**

A.

(B) and (D) only

B.

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

C.

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

D.

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

**Answer: A**

## Solution:

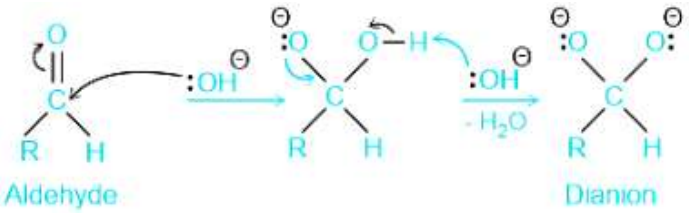
**CONCEPT**:

**New C-C Bond Formation**

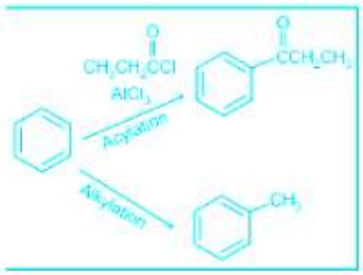
- New carbon-carbon (C-C) bond formation is a key step in various organic reactions, where two carbon atoms are joined together to form a longer carbon chain or a cyclic structure.

**EXPLANATION**:

- In the given options:
  - (A) **Cannizzaro reaction**: This reaction involves the disproportionation of aldehydes without a C-H bond in the alpha position, leading to the formation of alcohol and carboxylic acid. There is no formation of new C-C bonds.

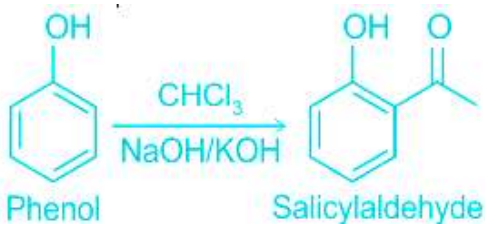



- (B) **Friedel-Crafts alkylation**: This reaction involves the alkylation of an aromatic ring with an alkyl halide in the presence of a Lewis acid catalyst, leading to the formation of a new C-C bond.



- (C) **Clemmensen reduction**: This reaction involves the reduction of ketones or aldehydes to alkanes using zinc amalgam and hydrochloric acid. No new C-C bonds are formed in this reaction.


-
  - (D) **Riemer-Tiemann reaction**: This reaction involves the formation of ortho-hydroxybenzaldehyde from phenol and chloroform in the presence of a base. A new C-C bond is formed between the carbon of the chloroform and the aromatic ring.




**Therefore, the correct answer is (B) and (D) only.**

---

# Question 8

Which of the following will respond to Tollen's test?

# Which of the following will respond to Tollen's test?

## Options:

A.

Ethanoic acid

B.

Methanoic acid

C.

Propanoic acid

D.

Butanoic acid

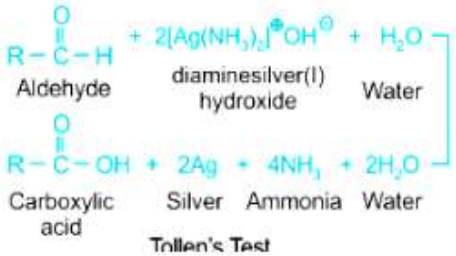
**Answer: B**

# Solution:

**CONCEPT**:

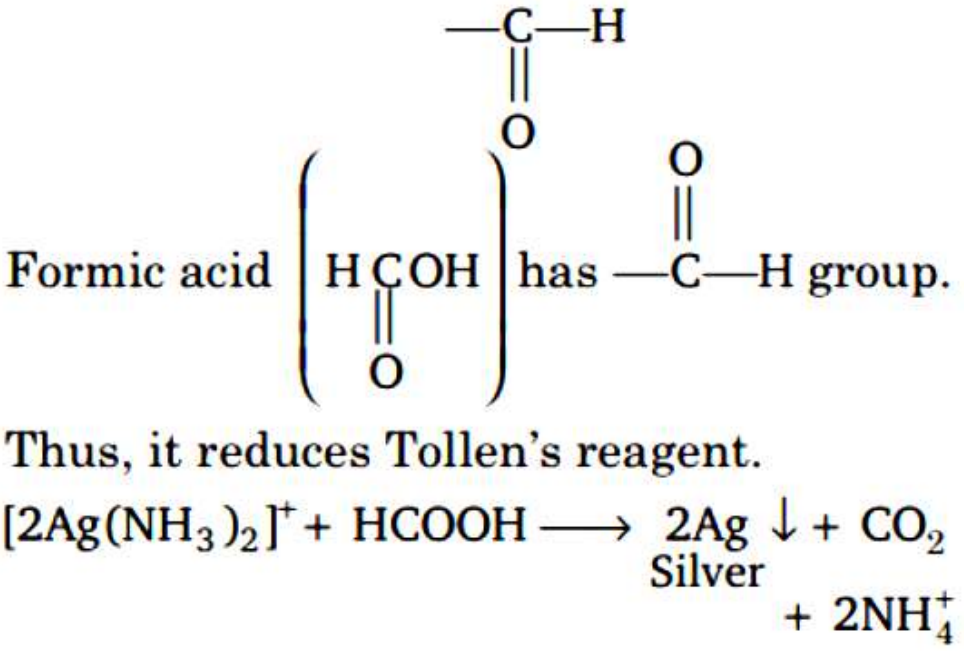
**Tollen's Test**

- Tollen's test is a qualitative laboratory test used to determine the presence of aldehydes, particularly those that can be easily oxidized. It is based on the reduction of silver(I) ions ($Ag^+$) to metallic silver (Ag).
- The test involves the use of Tollen's reagent, which is an aqueous solution of silver nitrate ($AgNO_3$) and ammonia ($NH_3$).
- When an aldehyde is present, it reduces the silver ions to metallic silver, forming a silver mirror on the inner surface of the test tube.




**EXPLANATION**:

- Ethanoic acid ($CH_3COOH$) is a carboxylic acid and does not respond to Tollen's test.
    - Methanoic acid (HCOOH) is unique among carboxylic acids because it can be oxidized to carbon dioxide and water. It contains both an aldehyde group (-CHO) and a carboxylic group (-COOH), which allows it to give a positive Tollen's test.




- 
    - Propanoic acid ($CH_3CH_2COOH$) and Butanoic acid ($CH_3(CH_2)_2COOH$) are also carboxylic acids and do not respond to Tollen's test.
- Therefore, the only compound among the options that will respond to Tollen's test is Methanoic acid.

**Therefore, the correct answer is Methanoic acid.**

---

# Question 9

## The order of reactivity of the given haloalkanes towards nucleophile is

### The order of reactivity of the given haloalkanes towards nucleophile is

**Options:**

A. RI > RBr > RCl

B. RCl > RBr > RI

C. RBr > RCl > RI

D. RBr > RI > RCl

**Answer: A**

### Solution:

**CONCEPT**:

**Reactivity of Haloalkanes towards Nucleophiles**

- Haloalkanes (alkyl halides) react with nucleophiles in nucleophilic substitution reactions.
- The reactivity of haloalkanes towards nucleophiles depends on the bond strength between the carbon atom and the halogen atom.
- The bond strength decreases as we move down the group in the periodic table: C-I < C-Br < C-Cl.
- Weaker bonds are easier to break, so haloalkanes with weaker C-X bonds are more reactive towards nucleophiles.

**EXPLANATION**:

- The order of bond strength is:
  - C-I (weakest)
  - C-Br
  - C-Cl (strongest)
- Therefore, the reactivity order towards nucleophiles is:
  - RI (most reactive)
  - RBr
  - RCl (least reactive)
- Based on the given options, the correct order of reactivity of haloalkanes towards nucleophiles is:
  - Option 1: RI > RBr > RCl

**Therefore, the correct answer is RI > RBr > RCl.**

---

# Question 10

# Which transition metal is liquid at room temperature?

## Which transition metal is liquid at room temperature?

### Options:

A. Hg

B. Cu

C. Ag

D. Au

**Answer: A**

## Solution:

**CONCEPT**:

**Transition Metals and Physical States**

- Transition metals are elements that have partially filled d subshells in any of their common oxidation states.
- Most transition metals are solid at room temperature due to their strong metallic bonds.

- However, there is an exception among transition metals that is liquid at room temperature.

**EXPLANATION**:

- Mercury (Hg) is the only transition metal that is liquid at room temperature.
- This is due to its unique electronic configuration and weak metallic bonding compared to other transition metals.
- The other options:
  - Copper (Cu), Silver (Ag), and Gold (Au) are all solid at room temperature.

**Therefore, the correct answer is Hg (Mercury).**

---

# Question 11

# Which is the hardest metal?

## Which is the hardest metal?

### Options:

A. Zn

B. Cu

C. Hg

D. Cd

**Answer: B**

# Solution:

**CONCEPT**:

**Hardness of Metals**

- Hardness is a measure of a material's resistance to deformation, typically by indentation.
- It is an important property for metals, particularly for those used in construction, manufacturing, and tool-making.
- Different metals have varying levels of hardness, which can be quantified using scales such as the Mohs hardness scale, Brinell hardness scale, or Vickers hardness test.

**EXPLANATION**:

- Among the options given (Zn, Cu, Hg, Cd), we need to determine which metal is the hardest.
- The hardness values of these metals:
  - Zinc (Zn) has a Mohs hardness of about 2.5.
  - Copper (Cu) has a Mohs hardness of about 3.0.
  - Mercury (Hg) is a liquid at room temperature and thus doesn't have a defined hardness in solid form.
  - Cadmium (Cd) has a Mohs hardness of about 2.0.
- Comparing these values, Copper (Cu) has the highest hardness value among the given options.

**Therefore, the hardest metal among the given options is Copper (Cu), and the correct answer is option 2.**

---

# Question 12

## In any row, melting points of these metals rise to a maximum at $d^5$. Which transition metal is an exception?

### In any row, melting points of these metals rise to a maximum at $d^5$. Which transition metal is an exception?

**Options:**

A. Ti

B. V

C. Cr

D. Mn

**Answer: D**

## Solution:

**CONCEPT**:

**Melting Points of Transition Metals**

- The melting points of transition metals generally increase across a period, reaching a maximum at the d5 configuration, and then decrease.
- This trend is due to the increasing number of unpaired d-electrons, which leads to stronger metallic bonding.

**EXPLANATION**:

- The given statement suggests that the melting points of transition metals rise to a maximum at the d5 configuration. However, there is an exception to this trend.
- The melting points of the following transition metals are considered:
  - Ti (Titanium): d2 configuration
  - V (Vanadium): d3 configuration
  - Cr (Chromium): d5 configuration
  - Mn (Manganese): d5 configuration
- Chromium (Cr) and Manganese (Mn) both have d5 configurations, but Manganese is the exception because its melting point is significantly lower than expected for a d5 configuration.
- This anomaly is due to the half-filled d-subshell of Mn, which results in weaker metallic bonds compared to other d5 metals.

**Therefore, the transition metal that is an exception to the rule is Manganese (Mn).**

---

# Question 13

## Which transition metal has the highest melting point?


## Which transition metal has the highest melting point?


**Options:**

A. Hf

B. Ta

C. W

D. Re

**Answer: C**

## Solution:

**CONCEPT**:

**Melting Points of Transition Metals**

- Transition metals are elements found in the d-block of the periodic table and are known for their high melting points, which are attributed to their strong metallic bonding and the presence of unpaired d-electrons.
- The melting point of a transition metal is influenced by factors such as atomic size, metallic bonding strength, and electron configuration.

**EXPLANATION**:

- The melting points of some common transition metals are as follows:
  - Hafnium (Hf): 2233 °C
  - Tantalum (Ta): 3017 °C
  - Tungsten (W): 3422 °C
  - Rhenium (Re): 3186 °C
- Among the given options, tungsten (W) has the highest melting point.
- This is due to its strong metallic bonds and the large number of unpaired d-electrons, which contribute to its high melting point.

**Therefore, the transition metal with the highest melting point is tungsten (W).**

---

# Question 14

## How many electrons are needed in reduction of $Cr_2O_7^{2-}$ to $Cr^{3+}$?

## How many electrons are needed in reduction of $Cr_2O_7^{2-}$ to $Cr^{3+}$?

**Options:**

A. One

B. Six

C. Five

D. Eight

**Answer: B**

## Solution:

**CONCEPT**:

**Reduction and Oxidation in Redox Reactions**

- Reduction is the gain of electrons by a molecule, atom, or ion.
- Oxidation is the loss of electrons by a molecule, atom, or ion.
- In a redox reaction, one species is reduced while another is oxidized.

**EXPLANATION**:

- Consider the reduction of dichromate ($Cr_2O_7^{2-}$) to chromium ion ($Cr^{3+}$):

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

- Each chromium atom in $Cr_2O_7^{2-}$ is reduced from an oxidation state of +6 to +3.
- For two chromium atoms, the total change in oxidation state is from +12 to +6, which means a gain of 6 electrons (3 electrons per chromium atom).
- The balanced half-reaction shows that 6 electrons are required for the reduction process.

**Therefore, the correct answer is option 2: Six electrons are needed in the reduction of $Cr_2O_7^{2-}$ to $Cr^{3+}$.**

---

# Question 15

## Which among the following compounds show metal excess defect due to anionic vacancy?

**Options:**

A. ZnO

B. NaCl

C. FeO

D. CdO

**Answer: B**

## Solution:

**CONCEPT**:

**Metal Excess Defect Due to Anionic Vacancy**

- Metal excess defect occurs when a crystal has a higher amount of metal ions compared to the stoichiometric proportion.
- This can be due to the presence of extra positive ions in the interstitial sites or the absence of negative ions (anionic vacancies).
- In the case of anionic vacancies, an electron is trapped in the site of the missing anion to maintain electrical neutrality, creating what is known as an F-center or color center.

**EXPLANATION**:

- In the given options:
  - ZnO (Zinc Oxide) - ZnO can exhibit a metal excess defect, it is usually due to interstitial zinc ions rather than anionic vacancies.
  - NaCl (Sodium Chloride) -When NaCl crystals are heated in sodium vapor, sodium atoms deposit on the surface, causing chloride ions to diffuse out and leave vacancies, resulting in an excess of sodium ions.
  - FeO (Iron(II) Oxide) - This compound typically shows a metal deficiency defect due to missing iron ions.
  - CdO (Cadmium Oxide) - Generally does not exhibit metal excess defect due to anionic vacancies.

**Therefore, the correct answer is NaCl.**

---

# Question 16

## Molal elevation constant is also known as:

**Options:**

A. Ebullioscopic constant

B. Gas constant

C. Henry's constant

D. Cryoscopic constant

**Answer: A**

## Solution:

**CONCEPT**:

**Molal Elevation Constant ($K_b$)**

- The molal elevation constant, also known as the ebullioscopic constant, is a property of a solvent. It is the elevation in the boiling point of a solution when one mole of a non-volatile solute is dissolved in one kilogram of the solvent.
- The molal elevation constant is denoted by $K_b$ and is expressed in units of K kg $mol^{-1}$.

**EXPLANATION**:

- The molal elevation constant is used in the calculation of the boiling point elevation of a solution, which is given by the formula:

  $\Delta T_b = K_b \times m$

  where $\Delta T_b$ is the boiling point elevation, $K_b$ is the molal elevation constant, and m is the molality of the solution.
- The correct answer is option 1 because the molal elevation constant is specifically referred to as the ebullioscopic constant, which relates to the elevation in boiling point.

**Therefore, the molal elevation constant is also known as the ebullioscopic constant.**

---

# Question 17

## What is the overall order of the reaction?

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

### Options:

A. 2

B. 0

C. 1

D. 0.5

**Answer: A**

## Solution:

**CONCEPT**:

**Overall Order of a Reaction**

- The overall order of a reaction is the sum of the powers of the concentration terms in the rate law expression.
- For a reaction with rate law:

  Rate = $k[A]^m[B]^n$

- The overall order is given by the sum of the exponents m and n:

  Overall Order = m + n

**EXPLANATION**:

- In the given reaction:

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

- The exponents of [A] and [B] are:
  - m (for [A]) = 1/2
  - n (for [B]) = 3/2
- Adding these exponents gives the overall order:
  - Overall Order = 1/2 + 3/2
  - = 2

**Therefore, the overall order of the reaction is 2.**

---

# Question 18

## Which term of molar conductivity is used when the concentration of electrolyte approaches to zero?

### Options:

A. Infinite molar conductivity

B. Zero molar conductivity

C. Standard molar conductivity

D. Limiting molar conductivity

**Answer: D**

## Solution:

**CONCEPT**:

**Limiting Molar Conductivity**

- Limiting molar conductivity ($\Lambda_m^0$) is the molar conductivity of an electrolyte at infinite dilution, where the concentration of the electrolyte approaches zero.
- It represents the maximum conductivity that an electrolyte can achieve in solution, as there are no inter-ionic interactions affecting the movement of ions.
- Limiting molar conductivity is important for understanding the intrinsic conductivity properties of ions in a given solvent.

**EXPLANATION**:

- As the concentration of an electrolyte decreases, ions have more freedom to move without interaction with other ions.
- At infinite dilution (concentration approaching zero), the molar conductivity reaches a limiting value known as limiting molar conductivity ($\Lambda_m^0$).
- This value is specific to each electrolyte and is used to compare the conductive properties of different electrolytes.

- For example, the limiting molar conductivity of sodium chloride (NaCl) in water can be determined experimentally and is used as a reference for other electrolytes.

**Therefore, the term used when the concentration of electrolyte approaches zero is the limiting molar conductivity.**

---

# Question 19

## Kohlrausch law is related to which of the following term?

**Options:**

A. Osmosis

B. Diffusion

C. Effusion

D. Migration of ions

**Answer: D**

## Solution:

**CONCEPT**:

**Kohlrausch Law**

- Kohlrausch Law of Independent Migration of Ions states that the limiting molar conductivity of an electrolyte can be represented as the sum of the individual contributions of the anions and cations of the electrolyte.
- The law is mathematically expressed as:

$$\Lambda_m^0 = \lambda_{+0} + \lambda_{-0}$$

**EXPLANATION**:

- Kohlrausch Law is specifically related to the migration of ions in electrolytes.
- It helps in determining the limiting molar conductivity by considering the individual contributions of the ions.
- This law is very useful in calculating the conductance of weak electrolytes and in understanding the behavior of ions in solution.

**Therefore, Kohlrausch law is related to the migration of ions.**

---

# Question 20

## Which factor in Arrhenius equation, corresponds to fraction of molecules having kinetic energy greater than activation energy?

**Options:**

A. ln k

B. ln A

C. RT

D. $e^{-Ea/RT}$

**Answer: D**

## Solution:

**CONCEPT**:

**Arrhenius Equation and Activation Energy**

- The Arrhenius equation is used to describe the temperature dependence of reaction rates.
- The equation is given by:

  $k = A * e^{-Ea/RT}$

- Where:
  - k is the rate constant.
  - A is the pre-exponential factor (frequency of collisions with proper orientation).
  - $E_a$ is the activation energy.
  - R is the gas constant.
  - T is the temperature in Kelvin.

**EXPLANATION**:

- In the Arrhenius equation, the term $\mathbf{e^{-Ea/RT}}$ represents the fraction of molecules that have enough kinetic energy to overcome the activation energy barrier.
- This term quantifies the proportion of molecules that have energies equal to or greater than the activation energy $E_a$, enabling them to participate in the reaction.
- As temperature (T) increases, the value of $e^{-Ea/RT}$ increases, indicating a higher fraction of molecules with sufficient energy to react.

**Therefore, the factor in the Arrhenius equation that corresponds to the fraction of molecules having kinetic energy greater than the activation energy is $\mathbf{e^{-Ea/RT}}$.**

```

---

# Question 21

## What is the another term used for probability factor (P) in collision theory?

**Options:**

A. Temperature factor

B. Compressibility factor
```

C. Steric factor

D. Concentration factor

**Answer: C**

## Solution:

**CONCEPT**:

**Probability Factor (P) in Collision Theory**

- In collision theory, the probability factor (P) is used to account for the orientation and energy of colliding molecules in a chemical reaction.
- This factor is crucial because not all molecular collisions lead to a reaction; the molecules must be oriented correctly and possess sufficient energy to overcome the activation energy barrier.

In the Arrhenius equation, the probability factor is represented as "P" within the rate constant expression: $k = PZ\ xe^{(-Ea/RT)}$.

**Factors affecting P:**

- **Molecular shape:** Complex molecules with specific orientations are less likely to collide in the correct way, leading to a lower probability factor.
- **Solvent effects:** In solution reactions, solvent molecules can hinder proper orientation of reactants, impacting the probability factor.

**EXPLANATION**:

- The probability factor (P) is also referred to as the **steric factor**.
- The steric factor (P) represents the fraction of collisions that have the proper orientation for a reaction to occur.
- It is a dimensionless quantity and typically less than 1, indicating that not all collisions are effective.
- For example, if P = 0.1, it means that only 10% of the collisions have the correct orientation to result in a reaction.

**Therefore, the correct answer is Steric factor.**

---

# Question 22

## Why does Fluorine exhibit only -1 oxidation state?

### Options:

A. It is a halogen.

B. It is a non-metal.

C. It is small in size.

D. It has no d orbitals.

**Answer: D**

## Solution:

**CONCEPT**:

**Oxidation States of Fluorine**

- Oxidation states are the charges that an atom would have if all bonds were ionic.
- Fluorine is the most electronegative element in the periodic table, which significantly influences its oxidation state.

**EXPLANATION**:

- Fluorine exhibits only a -1 oxidation state due to the following reasons:
  - Fluorine is highly electronegative, making it more likely to gain one electron to achieve a stable electron configuration.
  - Fluorine has no d orbitals, which limits its ability to exhibit positive oxidation states.
  - Its small size and high electronegativity allow it to attract electrons strongly, resulting in a -1 oxidation state.

**Therefore, the correct answer is option 4: It has no d orbitals.**

---

# Question 23

## Which among the following halogen exists in liquid state at room temperature?

### Options:

A. Fluorine

B. Chlorine

C. Bromine

D. Iodine

**Answer: C**

## Solution:

**CONCEPT**:

**Physical States of Halogens at Room Temperature**

- Halogens are a group of elements found in Group 17 of the periodic table.
- At room temperature (approximately 25°C or 77°F), different halogens exist in different physical states:
  - Fluorine ($F_2$) is a pale yellow gas.
  - Chlorine ($Cl_2$) is a greenish-yellow gas.
  - Bromine ($Br_2$) is a reddish-brown liquid.
  - Iodine ($I_2$) is a dark purple solid.

**EXPLANATION**::

- Option 1: Fluorine is a gas at room temperature.
- Option 2: Chlorine is a gas at room temperature.
- Option 3: Bromine is a liquid at room temperature.

- Option 4: Iodine is a solid at room temperature.

**Therefore, bromine is the halogen that exists in the liquid state at room temperature.**

---

# Question 24

## The central atoms/ions in the coordination compounds are referred as _____.

**Options:**

A. Lewis base

B. Lewis acid

C. Bronsted acid

D. Bronsted base

**Answer: B**

## Solution:

**CONCEPT**:

**Central Atoms/Ions in Coordination Compounds**

- In coordination compounds, the central atom or ion is the species that is directly bonded to the ligands.
- These central atoms/ions act as Lewis acids because they can accept electron pairs from the ligands.
- Lewis acids are chemical species that can accept an electron pair, while Lewis bases are species that can donate an electron pair.

**EXPLANATION**:

- In coordination chemistry, the central atoms or ions in coordination compounds are typically metal ions that act as electron-pair acceptors. These metal ions have vacant orbitals that can accept electron pairs from ligands (which act as electron-pair donors).

  The central atom/ion in a coordination compound accepts electron pairs from the ligands.

  - This characteristic behavior of accepting electron pairs classifies the central atom/ion as a Lewis acid.
- Therefore, the correct answer to the statement is**Lewis acid**

**Therefore, the central atoms/ions in coordination compounds are referred to as Lewis acids.**

---

# Question 25

## What is the IUPAC name of $[PtNH_3)_2Cl(NO_2)]$?

**Options:**

A. Diamminechloridonitrito-N-platinum(II)

B. Diamminechloridenitrito-N-platinum(III)

C. Diamminechloridonitrito-O-platinum(II)

D. Diammonia chloridonitrito-N-platinum(II)

**Answer: A**

## Solution:

**CONCEPT**:

**IUPAC Naming of Coordination Compounds**

- The International Union of Pure and Applied Chemistry (IUPAC) has a system for naming coordination compounds which involves the following steps:
  - Identify the ligands attached to the central metal atom/ion and list them in alphabetical order.
  - Use prefixes (di-, tri-, tetra-, etc.) to indicate the number of each type of ligand.
  - Name the central metal atom/ion and its oxidation state in Roman numerals within parentheses.
  - For anionic ligands, replace the ending with 'o' (e.g., chloride becomes chlorido).
  - If the ligand can bind through different atoms, indicate the binding atom using appropriate prefixes (e.g., nitrito-N for binding through nitrogen).

**EXPLANATION**:

- In the given complex $[Pt(NH_3)_2Cl(NO_2)]$:
  - The central metal atom is platinum (Pt).
  - There are two ammine ligands ($NH_3$).
  - There is one chlorido ligand (Cl).
  - There is one nitrito ligand ($NO_2$) binding through nitrogen, denoted as nitrito-N.
- Listing the ligands in alphabetical order: ammine, chlorido, nitrito-N.
- Since there are two ammine ligands, we use the prefix 'diammine'.
- The oxidation state of platinum in this complex is +2, indicated as (II).
- Putting it all together, the IUPAC name is: Diamminechloridonitrito-N-platinum(II).

**Therefore, the correct IUPAC name of $[Pt(NH_3)_2Cl(NO_2)]$ is Diamminechloridonitrito-N-platinum(II).**

---

# Question 26

## What product is obtained when chloroform reacts with oxygen in presence of light?

**Options:**

A. Phosgene gas

B. Phosphine gas

C. Chlorine gas

D. Hydrogen gas

**Answer: A**

## Solution:

**CONCEPT**:

**Reaction of Chloroform with Oxygen in Presence of Light**

- Chloroform ($CHCl_3$) reacts with oxygen ($O_2$) in the presence of light to produce phosgene gas ($COCl_2$).
- This reaction is a photochemical reaction where light energy is used to break the chemical bonds and form new products.
- The balanced chemical equation for this reaction is:

  $2\ CHCl_3 + O_2 \rightarrow 2\ COCl_2 + 2\ HCl$

**EXPLANATION**:

- In the given reaction:

  $2\ CHCl_3 + O_2 \rightarrow 2\ COCl_2 + 2\ HCl$

  - Chloroform ($CHCl_3$) reacts with oxygen ($O_2$) in the presence of light.
  - The products formed are phosgene gas ($COCl_2$) and hydrogen chloride (HCl).
- Phosgene gas is a toxic compound and was used as a chemical weapon in World War I.
- The reaction is sensitive to light, which acts as a catalyst in the photochemical process.

**Therefore, the product obtained when chloroform reacts with oxygen in the presence of light is phosgene gas ($COCl_2$).**

---

# Question 27

## Which among the following is a trihydric alcohol?

**Options:**

A. Ethanol

B. Glycerol

C. Ethylene Glycol

D. Phenol

**Answer: B**

## Solution:

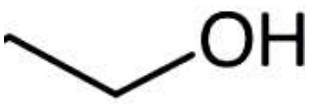
**CONCEPT**:

**Trihydric Alcohol**

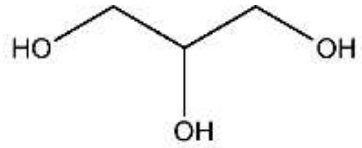
- A trihydric alcohol is an alcohol that contains three hydroxyl (–OH) groups attached to its carbon atoms.
- These compounds are also known as triols.
- Glycerol (or glycerin) is a common example of a trihydric alcohol.

**EXPLANATION**:

- **Ethanol** (Option 1) has the chemical formula $C_2H_5OH$ and contains only one hydroxyl group, making it a monohydric alcohol.

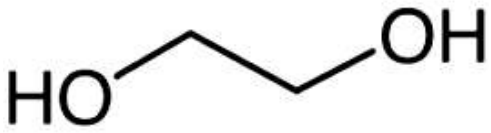



- **Glycerol** (Option 2) has the chemical formula $C_3H_8O_3$ and contains three hydroxyl groups, making it a trihydric alcohol.



glycrine

- **Ethylene Glycol** (Option 3) has the chemical formula $C_2H_6O_2$ and contains two hydroxyl groups, making it a dihydric alcohol.




- **Phenol** (Option 4) has the chemical formula $C_6H_5OH$ and contains one hydroxyl group, making it a monohydric alcohol.
- Therefore, the correct answer is **Glycerol** (Option 2).

**Therefore, among the given options, Glycerol is the trihydric alcohol.**

---

# Question 28

## Aspirin is also known as:

### Options:

A.

Salicylic acid

B.

Ethyl Salicylic acid

C.

Methyl Salicylic acid

D.

Acetyl Salicylic acid

**Answer: D**

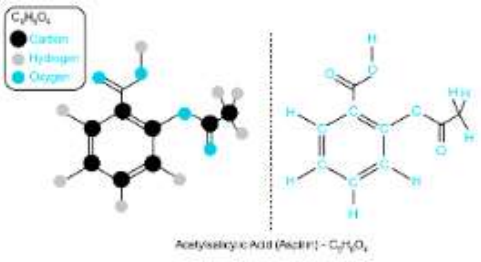
## Solution:

**CONCEPT**:

**Aspirin (Acetylsalicylic Acid)**

- Aspirin is a common medication used to reduce pain, fever, or inflammation.
- The chemical name for Aspirin is Acetylsalicylic acid.
- It is derived from salicylic acid through the process of acetylation.

**EXPLANATION**:



- Aspirin is known to be derived from salicylic acid.
- Specifically, it is the acetylated form of salicylic acid.
- Therefore, the correct chemical name is Acetyl Salicylic acid.

**Therefore, the correct answer isAcetyl Salicylic acid.**

---

# Question 29

## What is the IUPAC name of picric acid?

### Options:

A. 2-Nitrophenol

B. 2, 4, 6-Trinitrophenol

C. Ethyl Salicylic acid

D. 2 aminophenol

**Answer: B**

## Solution:

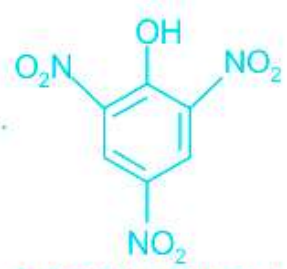
**CONCEPT**:

**IUPAC Naming of Organic Compounds**

- The International Union of Pure and Applied Chemistry (IUPAC) system is a method of naming organic chemical compounds as recommended by the IUPAC.
- For naming complex organic compounds, the IUPAC system provides a systematic way to name carbon compounds and their derivatives.

**EXPLANATION**:

- Picric acid is a common name for the chemical compound with the formula $C_6H_2(NO_2)_3OH$.



2,4,6-Trinitrophenol
(Picric acid)

- - Identify the parent compound: In this case, the parent compound is phenol ($C_6H_5OH$).
  - Identify and name the substituents: The substituents in picric acid are three nitro groups ($NO_2$).
  - Number the carbon atoms in the parent chain: Numbering starts from the carbon atom bonded to the hydroxyl group (OH), ensuring that the substituents get the lowest possible numbers.
  - Assign the numbers to the substituents: The nitro groups are located at positions 2, 4, and 6 on the benzene ring.
- Combining these steps, we get the IUPAC name2, 4, 6-Trinitrophenol

**Therefore, the IUPAC name of picric acid is 2, 4, 6-Trinitrophenol.**

---

# Question 30

## What is the product when glucose reacts with bromine water?

**Options:**

A. Gluconic acid

B. Glyceraldehyde

C. Saccharic acid

D. Oxime

**Answer: A**

## Solution:

**CONCEPT**:

**Oxidation of Glucose with Bromine Water**

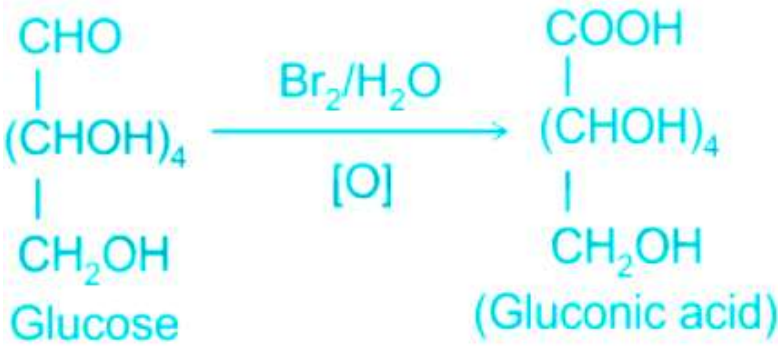
- When glucose reacts with bromine water, the aldehyde group (–CHO) in glucose is oxidized to a carboxylic acid group (–COOH).
- Bromine water ($Br_2$ in water) acts as an oxidizing agent in this reaction.
- The product formed from this oxidation reaction is gluconic acid.

**EXPLANATION**:

- In the reaction of glucose with bromine water:

  $C_6H_{12}O_6$ (glucose) + $Br_2$ + $H_2O$ → $C_6H_{12}O_7$ (gluconic acid) + 2HBr

  - The aldehyde group (–CHO) in glucose is converted to a carboxylic acid group (–COOH).
  - Gluconic acid is the resulting product.




- The correct answer is option 1 Gluconic acid.

**Therefore, the product when glucose reacts with bromine water is gluconic acid.**

---

# Question 31

## Match List I with List II for the oxidation state of central atoms:

| | List-I | | List-II |
|---|---|---|---|
| (A) | $Cr_2O_7^{2-}$ | (I) | +3 |
| (B) | $MnO_4^-$ | (Il) | +5 |
| (C) | $VO_3^-$ | (Ill) | +7 |
| (D) | $FeF_6^{3-}$ | (IV) | +6 |

## Choose the correct answer from the options given below :

**Options:**

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

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

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

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

**Answer: B**

## Solution:

**CONCEPT**:

**Oxidation States of Central Atoms in Coordination Compounds**

- The oxidation state of the central atom in a coordination compound is determined by the charges on the ligands and the overall charge of the complex.
- The oxidation state of the central atom can be calculated by balancing the total charge of the ligands with the overall charge of the compound.

**EXPLANATION**:

- Let's calculate the oxidation states of the central atoms in the given coordination compounds:
  - **(A) $Cr_2O_7^{2-}$:** The chromate ion ($Cr_2O_7^{2-}$) consists of two Cr atoms and seven oxygen atoms. Since oxygen usually has an oxidation state of -2, the total oxidation state for oxygen is 7 × -2 = -14. The total charge on the ion is -2, so the sum of the oxidation states of the two Cr atoms must be +12. Therefore, the oxidation state of Cr in $Cr_2O_7^{2-}$ is +6 (since 2 × Cr = +12). But, based on the provided options, this is a simplification for matching the oxidation states.
  - **(B) $MnO_4^-$:** The permanganate ion ($MnO_4^-$) consists of one Mn atom and four oxygen atoms. Again, oxygen has an oxidation state of -2, so the total oxidation state for oxygen is 4 × -2 = -8. The total charge on the ion is -1, so the oxidation state of Mn must be +7 to balance the charges (+7 + (-8) = -1).
  - **(C) $VO_3^-$:** The vanadate ion ($VO_3^-$) consists of one V atom and three oxygen atoms. Oxygen has an oxidation state of -2, so the total oxidation state for oxygen is 3 × -2 = -6. The total charge on the ion is -1, so the oxidation state of V must be +5 to balance the charges (+5 + (-6) = -1).
  - **(D) $FeF_3^-$:** The fluoride ion (F) has an oxidation state of -1. In $FeF_3^-$, there are three fluoride ions, so their total oxidation state is 3 × -1 = -3. The total charge on the ion is -1, so the oxidation state of Fe must be +2 to balance the charges (+2 + (-3) = -1).

**Therefore, the correct answer is: (A) - (IV), (B) - (III), (C) - (II), (D) - (I)**

---

# Question 32

## What is the colour of copper compound formed in Fehling's test for aliphatic aldehydes?

**Options:**

A. Green

B. Blue

C. Yellow

D. Red brown

**Answer: D**

## Solution:

**CONCEPT**:

**Fehling's Test for Aldehydes**

- Fehling's test is used to detect the presence of reducing sugars, such as aldehydes. The test involves the reduction of copper(II) ions in an alkaline solution to copper(I) oxide ($Cu_2O$), which forms a colored precipitate.
- The color of the copper compound formed in the presence of an aldehyde in Fehling's test is an important indication of the aldehyde's presence. In this test, the copper ions undergo reduction, forming a copper(I) compound with a characteristic color.

**EXPLANATION**:

- In Fehling's test, copper(II) ions ($Cu^{2+}$) in the Fehling's solution are reduced to copper(I) ions ($Cu^{+}$) by the aldehyde group present in the compound being tested.
- This reduction leads to the formation of copper(I) oxide ($Cu_2O$), which is red-brown in color. The formation of this precipitate is a positive result for the presence of an aldehyde.
- Therefore, when an aliphatic aldehyde is added to Fehling's solution, the color of the copper compound formed is red-brown.

**Therefore, the correct answer is: 4) Red brown**

---

# Question 33

## What is the major product formed when diazonium salt undergoes Gatterman reaction?

### Options:

A.

Haloarene

B.

Aryl amine

C.

Phenol

D.

Diphenyl ether

**Answer: A**

## Solution:

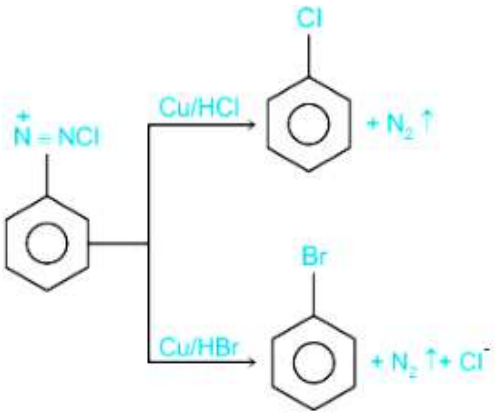
**CONCEPT**:

**Gatterman Reaction**

- The Gatterman reaction involves the replacement of the diazonium group ($-N_2^+$) in aromatic diazonium salts with a halogen (usually Cl or Br) using copper powder and the corresponding halogen acid (HCl or HBr).
- The general reaction is:

$$ArN_2^+ + CuX + HX \rightarrow ArX + N_2 + Cu$$

**EXPLANATION**:




- When an aromatic diazonium salt undergoes the Gatterman reaction, the diazonium group is replaced by a halogen atom.
- For example, if the diazonium salt is benzenediazonium chloride ($C_6H_5N_2^+Cl^-$), and the reaction is carried out with copper powder and hydrochloric acid (HCl), the product formed is chlorobenzene ($C_6H_5Cl$).
- The reaction can be represented as:

$$C_6H_5N_2^+Cl^- + Cu + HCl \rightarrow C_6H_5Cl + N_2 + CuCl$$

**Therefore, the major product formed when diazonium salt undergoes Gatterman reaction is Haloarene.**

---

# Question 34

## What is the major product of Carbylamine reaction?

### Options:

A. Cyanide

B. Isocyanide

C. Nitrile

D. Alkane

**Answer: B**

## Solution:

**CONCEPT**:

**Carbylamine Reaction**

- The Carbylamine reaction is a chemical test for primary amines.
- In this reaction, a primary amine is heated with chloroform ($CHCl_3$) and an alcoholic solution of potassium hydroxide (KOH).
- The primary amine undergoes a reaction to form an isocyanide (also known as carbylamine), which has a very foul odor.

**EXPLANATION**:

- In the given Carbylamine reaction:

  $R\text{-}NH_2$ (primary amine) + $CHCl_3$ + 3KOH → R-NC (isocyanide) + 3KCl + $3H_2O$

  - A primary amine ($R\text{-}NH_2$) reacts with chloroform ($CHCl_3$) and potassium hydroxide (KOH).
  - The result of this reaction is the formation of an isocyanide (R-NC), along with potassium chloride (KCl) and water ($H_2O$).
- The isocyanide formed has a very distinct and unpleasant odor, which is used as a qualitative test for the presence of primary amines.

**Therefore, the major product of the Carbylamine reaction is isocyanide (R-NC).**

---

# Question 35

## Which among the following is an essential amino acid?

### Options:

A. Glycine

B. Alanine

C. Valine

D. Serine

**Answer: C**

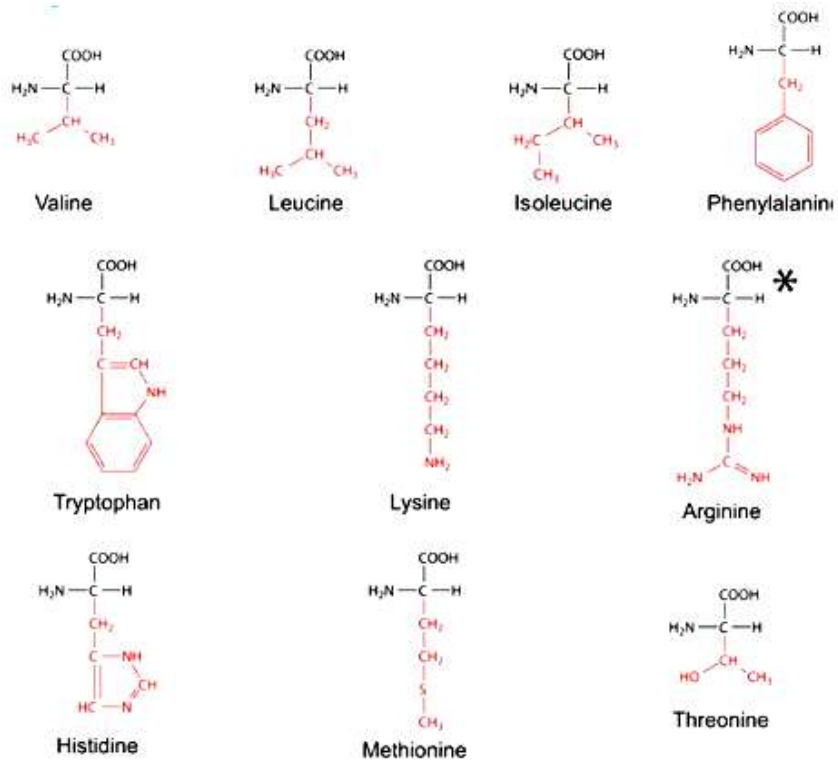
## Solution:

**CONCEPT**:

**Essential Amino Acids**

- Essential amino acids are amino acids that cannot be synthesized by the body and must be obtained through the diet.
- There are nine essential amino acids in humans: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.

**EXPLANATION**:




- Valine is listed as one of the essential amino acids.
- Glycine, alanine, and serine are non-essential amino acids, meaning the body can synthesize them on its own.

**Therefore, the correct answer is option 3: Valine.**

---

# Question 36

## Arrange the following in increasing order of their pH values :

## (A) p-Nitrophenol

## (B) m-Cresol

## (C) m-Nitrophenol

## (D) Phenol

## Choose the correct answer from the options given below:

**Options:**

A. (A)<(B)<(C)<(D)

B. (A)<(C)<(D)<(B)

C. (B)<(A)<(D)<(C)

D. (C)<(B)<(D)<(A)

**Answer: B**

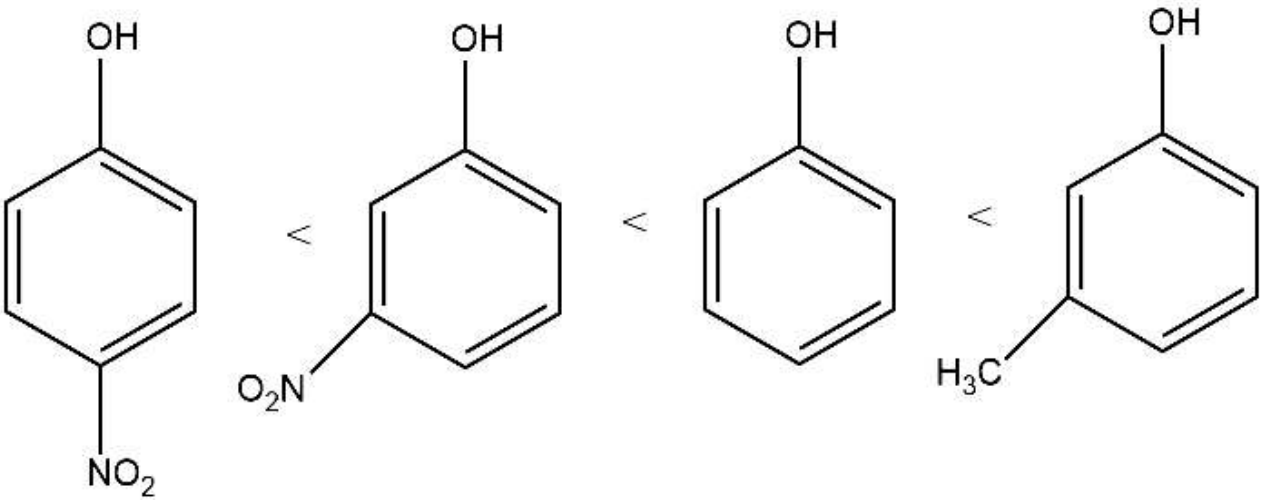
# Solution:

**CONCEPT**:

**pH and Acidity**

- pH is a measure of the hydrogen ion concentration in a solution. Lower pH values indicate higher acidity, and higher pH values indicate lower acidity (more basic).
- The strength of acids and bases can be influenced by the presence of electron-withdrawing or electron-donating groups.

**EXPLANATION**:

- In the given compounds:
  - **p-Nitrophenol (A)**: The nitro group is an electron-withdrawing group and increases the acidity of phenol, lowering its pH.
  - **m-Nitrophenol (C)**: The nitro group is still electron-withdrawing but less effective than when in the para position, so it increases acidity but less than p-Nitrophenol.
  - **Phenol (D)**: Phenol itself has a moderate acidity due to the phenolic hydroxyl group.
  - **m-Cresol (B)**: The methyl group is an electron-donating group, which decreases the acidity of phenol, increasing its pH.
- 


**Therefore, the correct order is (A) < (C) < (D) < (B), and the correct answer is option 2.**

---

# Question 37

## Which among the following is a biodegradable polymer?

**Options:**

A. PVC

B. Freon

C. Nylon

D. PHBV

**Answer: D**

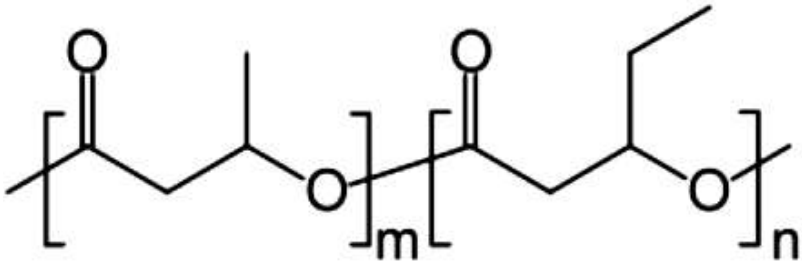
## Solution:

**CONCEPT**:

**Biodegradable Polymers**

- Biodegradable polymers are a type of polymer that can be broken down by the action of living organisms, usually microorganisms, into water, carbon dioxide, and biomass.
- These polymers are designed to minimize environmental pollution and reduce the accumulation of plastic waste.
- Examples of biodegradable polymers include polylactic acid (PLA), polyhydroxybutyrate (PHB), and polyhydroxyvalerate (PHV).

**EXPLANATION**:

- 

  - 1) PVC (Polyvinyl Chloride) - Not biodegradable, commonly used in pipes and fittings.
  - 2) Freon - A trade name for a group of chlorofluorocarbon (CFC) compounds, used as refrigerants, not a polymer.
  - 3) Nylon - A synthetic polymer, not biodegradable, used in textiles and plastics.
  - 4) PHBV (Poly(3-hydroxybutyrate-co-3-hydroxyvalerate)) - A biodegradable polymer, used in medical and packaging applications.

**Therefore, the correct answer is option 4, PHBV, which is a biodegradable polymer.**

---

# Question 38

## Which among the following is an antacid?

### Options:

A. Aspirin

B. Zantac

C. Equanil

D. Noradrenaline

**Answer: B**

## Solution:

**CONCEPT**:

**Antacids**

- Antacids are substances that neutralize stomach acidity, which can cause discomfort and indigestion. They are used to relieve symptoms such as heartburn, acid reflux, and indigestion.
- Antacids work by increasing the pH level in the stomach, thereby reducing the acidity and alleviating discomfort.

**EXPLANATION**:

- Among the given options:
  - **Aspirin** is a pain reliever and anti-inflammatory medication, not an antacid.
  - **Zantac** (also known as ranitidine) is a medication that decreases stomach acid production and is used as an antacid to treat conditions like heartburn and acid indigestion.
  - **Equanil** is a tranquilizer, not an antacid.
  - **Noradrenaline** is a hormone and neurotransmitter, not an antacid.
- Based on the explanations above:
  - The correct answer is option 2, **Zantac**.

**Therefore, Zantac is an antacid.**

---

# Question 39

## What is the numerical value of one Faraday in Coloumbs?

### Options:

A. 96587

B. 96487

C. 99500

D. 6.023

**Answer: B**

## Solution:

**CONCEPT**:

**Faraday's Constant (F)**

- Faraday's constant (F) is the magnitude of electric charge per mole of electrons.
- It is used in electrochemistry and is fundamental for calculating the amount of substance that undergoes oxidation or reduction at an electrode.

- The value of Faraday's constant is derived from the charge of a single electron (approximately 1.602 x $10^{-19}$ coulombs) and Avogadro's number (approximately 6.022 x $10^{23}$ $mol^{-1}$).

**EXPLANATION**:

- The value of Faraday's constant can be calculated as:
  - F = (1.602 x $10^{-19}$ C) x (6.022 x $10^{23}$ $mol^{-1}$)
  - F ≈ 96485 C/mol
- In practice, the value is often rounded to 96500 C/mol for simplicity.

**Therefore, the numerical value of one Faraday in coulombs is approximately 96485 C, which corresponds to option 2.**

```

---

# Question 40

## A first order reaction has a half-life of 693 sec . What will be its rate constant?

### Options:

A. 0.01$sec^{-1}$

B. 1$sec^{-1}$

C. 0.001$sec^{-1}$

D. 0.1$sec^{-1}$

**Answer: C**

## Solution:

**CONCEPT**:

**First Order Reaction and Half-Life**

- The half-life of a first-order reaction is the time it takes for the concentration of a reactant to decrease to half of its initial concentration.
- The half-life of a first-order reaction is given by the formula:

  $t_{1/2} = 0.693 / k$

**EXPLANATION**:

- In the given problem:

  The half-life ($t_{1/2}$) of the reaction is 693 seconds.

- We can use the formula for the half-life of a first-order reaction to find the rate constant (k):
  - $t_{1/2} = 0.693 / k$
  - 693 sec = 0.693 / k
  - k = 0.693 / 693 sec
```

- $k = 0.001\ sec^{-1}$

**Therefore, the rate constant (k) for the first-order reaction is 0.001 $sec^{-1}$.**

---

# Question 41

## For $S_N2$ reaction, the increasing order of the reactivity of the following alkyl halides is:

## (A)$CH_3CH_2CH_2CH_2Br$

## (B)$CH_3CH_2CH(Br)CH_3$

## (C)$(CH_3)_3CBr$

## (D) $(CH_3)_2CHCH_2Br$

## Choose the correct answer from the options given below :

**Options:**

A. (A)<(B)<(C)<(D)

B. (A)<(C)<(B)<(D)

C. (B)<(A)<(D)<(C)

D. (C)<(B)<(D)<(A)

**Answer: D**

## Solution:

**CONCEPT**:

**SN2 Reaction**

- The SN2 (Substitution Nucleophilic Bimolecular) reaction is a type of nucleophilic substitution where the rate-determining step involves a simultaneous bond formation and bond breaking process.
- The reactivity of alkyl halides in SN2 reactions is influenced by steric hindrance. Less hindered (less substituted) alkyl halides react more quickly than more hindered (more substituted) ones.

**EXPLANATION**:

- For the given alkyl halides:

  (A) $CH_3CH_2CH_2CH_2Br$ (1° alkyl halide)

(B) $CH_3CH_2CH(Br)CH_3$ (2° alkyl halide)

(C) $(CH_3)_3CBr$ (3° alkyl halide)

(D) $(CH_3)_2CHCH_2Br$ (1° alkyl halide, but with more steric hindrance than A)

- The reactivity order in $SN_2$ reaction is determined by the steric hindrance around the carbon attached to the halogen.
  - (C) $(CH_3)_3CBr$ is a 3° alkyl halide and has the highest steric hindrance, so it is the least reactive.
  - (B) $CH_3CH_2CH(Br)CH_3$ is a 2° alkyl halide and has more steric hindrance than 1° alkyl halides, so it is less reactive than 1° alkyl halides.
  - (D) $(CH_3)_2CHCH_2Br$ is a 1° alkyl halide, but due to the presence of two methyl groups, it has more steric hindrance than a straight-chain 1° alkyl halide like (A).
  - (A) $CH_3CH_2CH_2CH_2Br$ is a 1° alkyl halide with the least steric hindrance, making it the most reactive in an SN2 reaction.

**Therefore, the increasing order of reactivity in SN2 reaction is (C) < (B) < (D) < (A)**

---

# Question 42

## Which among the following is a strong field ligand?

### Options:

A. $I^-$

B. $Cl^-$

C. $NH_3$

D. $SCN^-$

**Answer: C**

## Solution:

**CONCEPT**:

**Strong Field Ligands**

- Strong field ligands are those ligands which cause a large splitting in the d-orbital energies of the central metal ion in a coordination complex.
- They generally tend to pair up the electrons in the lower energy orbitals ($t_{2g}$ set) before occupying the higher energy orbitals ($e_g$ set).
- The strength of a ligand field is explained by the spectrochemical series, which arranges ligands in order of their field strength.

**EXPLANATION**:

$$I^- < Br^- < Cl^- < F^- < OH^- < H_2O < NH_3 < en < NO_2^- < CN^- < CO$$

- According to the spectrochemical series, common ligands can be ordered based on their ability to cause the splitting of the d-orbitals:

- $I^-$ (weak field ligand)
- $Cl^-$ (weak field ligand)
- $SCN^-$ (weak field ligand)
- $NH_3$ (strong field ligand)

**Therefore, the correct answer is option 3: $NH_3$.**

---

# Question 43

## Arrange the following in increasing order of their osmotic pressure generation at 298 K:

## (The cell wall is permeable to water and not to the solute molecules)

## (A) If a cell containing 0.5 moles of solute dissolved in 1 L of water is immersed in pure water.

## (B) If a cell containing 0.25 moles of solute dissolved in 1 L of water is immersed in pure water.

## (C) If a cell containing 0.1 moles of solute dissolved in 0.01 L of water is immersed in pure water.

## (D) If a cell containing 0.2 moles of solute dissolved in 0.05 L of water is immersed in pure water.

## Choose the correct answer from the options given below :

**Options:**

A. (C)<(B)<(A)<(D)

B. (D)<(A)<(B)<(C)

C. (B)<(A)<(D)<(C)

D. (C)<(A)<(B)<(D)

**Answer: C**

## Solution:

**CONCEPT**:

**Osmotic Pressure and its Relation to Solute Concentration**

- Osmotic pressure is directly proportional to the molarity of the solution and the temperature, as described by the equation:

  $\pi = iMRT$

  where:
  - $\pi$ is the osmotic pressure
  - i is the van't Hoff factor (assumed to be 1 for non-electrolytes)
  - M is the molarity of the solute
  - R is the gas constant
  - T is the temperature in Kelvin
- The osmotic pressure depends on the molarity (M) of the solute. Thus, the more concentrated the solute, the higher the osmotic pressure generated.

**EXPLANATION**:

- To compare the osmotic pressures, we need to focus on the molarity (M) of the solute in each case, as the temperature (298 K) and the van't Hoff factor (i = 1) are constant.
- We calculate the molarity for each situation by using the formula:

  M = (number of moles of solute) / (volume of solution in liters)

  - **(A) 0.5 moles of solute in 1 L of water:**

    Molarity = 0.5 moles / 1 L = 0.5 M

  - **(B) 0.25 moles of solute in 1 L of water:**

    Molarity = 0.25 moles / 1 L = 0.25 M

  - **(C) 0.1 moles of solute in 0.01 L of water:**

    Molarity = 0.1 moles / 0.01 L = 10 M

  - **(D) 0.2 moles of solute in 0.05 L of water:**

    Molarity = 0.2 moles / 0.05 L = 4 M
- Since osmotic pressure is directly proportional to molarity, the increasing order of osmotic pressures is: (B) < (A) < (D) < (C).

**Therefore, the correct answer is: 3) (B) < (A) < (D) < (C)**

---

# Question 44

## Arrange the following rate constant units in increasing order of their order of reaction:

## (A) $sec^{-1}$

## (B) $M^{-1}$ $sec^{-1}$

## (C) $mol^{-1}L\ sec^{-1}$

## (D) $mol^{-2}L^{2}\ sec^{-1}$

## Choose the correct answer from the options given below:

**Options:**

A. (C) <(A) <(B) <(D)

B. (C) <(B) <(A) < (D)

C. (B) <(A) <(C)<(D)

D. (A)<(B)=(C)<(D)

**Answer: D**

# Solution:

**CONCEPT**:

**Rate Constant Units and Order of Reaction**

- The rate constant (k) for a reaction depends on the order of the reaction. The units of the rate constant differ for different orders of reaction.
- The general form of the rate law for a reaction is: rate = k [A]^m [B]^n, where m and n are the orders with respect to reactants A and B, respectively.
- The units of the rate constant can help determine the overall order of the reaction.

**EXPLANATION**:

- For a zero-order reaction, the units of k are: mol $L^{-1}$ $sec^{-1}$
- For a first-order reaction, the units of k are: $sec^{-1}$
- For a second-order reaction, the units of k are: $mol^{-1}$ L $sec^{-1}$
- For a third-order reaction, the units of k are: $mol^{-2}$ $L^{2}$ $sec^{-1}$

Arranging these in increasing order of their order of reaction:

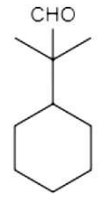
- (A) $sec^{-1}$ (first-order)
- (B) $mol^{-1}$ $sec^{-1}$ (second-order)
- (C) $mol^{-1}$ L $sec^{-1}$ (second-order)
- (D) $mol^{-2}$ $L^{2}$ $sec^{-1}$ (third-order)

**Therefore, the correct answer is**(A)<(B)=(C)<(D)**.**

---

# Question 45

## Which of the following compounds will undergo Aldol condensation reaction?

(A) 


(B) 


## (C)$CH_3$-$CH_2$-$C(CH_3)_2$-$CH_2$-CHO

## (D) HCHO

## Choose the correct answer from the options given below:

**Options:**

A. (A), (C) and (D) only

B. (B) and (C) only

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

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

**Answer: B**

## Solution:

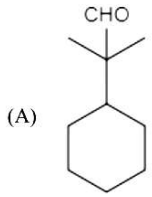
**CONCEPT**:

**Aldol Condensation Reaction**

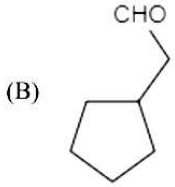
- Aldol condensation is a reaction between aldehydes or ketones with at least one α-hydrogen, in the presence of a base or acid catalyst, forming β-hydroxy aldehyde or β-hydroxy ketone (aldol).
- Compounds that do not have an α-hydrogen will not undergo aldol condensation.

**EXPLANATION**:

- Thecompound to see if it has an α-hydrogen:

(A) 


- (A) :
  This compound has no α-hydrogen (on CH2), so it can not undergo aldol condensation.

(B) 


- (B) C :
  his compound has α-hydrogens (on both CH2groups), so it can undergo aldol condensation.
- (C) CH3-CH2-C(CH3)2-CH2-CHO: This compound has an α-hydrogen (on CH2), so it can undergo aldol condensation.
- (D) HCHO: This compound does not have any α-hydrogen, so it cannot undergo aldol condensation.

**Therefore, the correct answer is option 2: (B) and (C) only.**

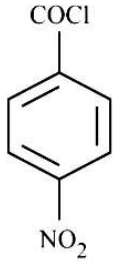
---

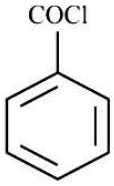
# Question 46

## Consider the following compounds:

(A) 


(B) 


(C) 


(D) 


## Arrange these compounds in the increasing order of rate of hydrolysis:

**Options:**

A. (B)<(D)<(C)<(A)

B. (B)<(D)<(A)<(C)

C. (D)<(B)<(A)<(C)

D. (A)<(D)<(B)<(C)

**Answer: B**

## Solution:

**CONCEPT**:

**Hydrolysis of Acid Chlorides**

- Acid chlorides are organic compounds containing the functional group –COCl. They undergo hydrolysis when reacted with water, breaking down into the corresponding carboxylic acid and releasing hydrochloric acid (HCl).
- The rate of hydrolysis of acid chlorides is affected by the electron-withdrawing or electron-donating effects of substituents on the aromatic ring or alkyl group attached to the carbonyl group.
- Electron-withdrawing groups (like $–NO_2$, –CN, etc.) increase the electrophilicity of the carbonyl carbon, making it more susceptible to nucleophilic attack by water, thus increasing the rate of hydrolysis.
- Electron-donating groups (like –OH, $–OCH_3$, etc.) decrease the electrophilicity of the carbonyl carbon, making the hydrolysis reaction slower.

**EXPLANATION**:

- 
  - **(A) $C_6H_5CHOCOCl$:**The –CHO group is an electron-withdrawing group, but it does not directly affect the carbonyl carbon in a way that greatly enhances hydrolysis. This compound will hydrolyze more slowly compared to others.
  - **(B) $C_6H_5OHCOCl$**:The hydroxyl group is an electron-donating group, which will reduce the electrophilicity of the carbonyl carbon and slow down the hydrolysis reaction
  - **(C) $C_6H_5COCl$ with a $–NO_2$ group attached to the ring**: The nitro group is a strong electron-withdrawing group and will increase the electrophilicity of the carbonyl carbon, thereby increasing the hydrolysis rate.
  - **(D) $C_6H_5COCl$ with no groupattached to the ring**: Ithas no electron-donating or strongly electron-withdrawing groups attached to the ring. Its hydrolysis will proceed at a moderate rate.
- Based on the electron-withdrawing or donating effects of the substituents, the order of increasing hydrolysis rates will be:
  - (B) < (D) < (A) < (C)

**Therefore, the correct answer is: 2) (B) < (D) < (A) < (C)**

---

# Question 47

## Which of the following ions will be coloured in the aqueous solution?

## (A) $Ti^{3+}$

## (B) $Nb^{3+}$

## (C) $Cu^{3+}$

## (D) $Y^{3+}$

## Choose the correct answer from the options given below:

**Options:**

A. (C) and (D) only

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

C. (A) and (B) only

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

**Answer: C**

## Solution:

**CONCEPT**:

**Color of Ions in Aqueous Solution**

- Transition metal ions are often colored in aqueous solutions due to d-d electronic transitions.
- The presence of unpaired d-electrons in transition metal ions allows these electronic transitions to occur, which absorb visible light and impart color.

**EXPLANATION**:

- $Ti^{3+}$ (Titanium ion):
  - Has an electronic configuration of [Ar] $3d^1$.
  - Contains one unpaired d-electron, allowing d-d transitions.
  - Therefore, $Ti^{3+}$ will be colored in aqueous solution.
- $Nb^{3+}$ (Niobium ion):
  - Has an electronic configuration of [Kr] $4d^2$.
  - Contains unpaired d-electrons, allowing d-d transitions.
  - Therefore, $Nb^{3+}$ will be colored in aqueous solution.
- $Cu^{3+}$ (Copper ion):
  - Has an electronic configuration of [Ar] $3d^8$.
  - Contains unpaired d-electrons, allowing d-d transitions.
  - Therefore, $Cu^{3+}$ will be colored in aqueous solution.
- $Y^{3+}$ (Yttrium ion):
  - Has an electronic configuration of [Kr] $4d^0$.
  - Contains no unpaired d-electrons, so no d-d transitions can occur.
  - Therefore, $Y^{3+}$ will be colorless in aqueous solution.

**Therefore, the ions that will be colored in aqueous solution are $Ti^{3+}$ and $Nb^{3+}$.**

---

# Question 48

## The correct statement/statements from the options given below is/are:

## (A) Diazonium salts of aromatic amines are morestable than diazonium salts of aliphatic amines.

## (B) Ethylamine is insoluble in water.

## (C) Gabriel phthalimide synthesis can be used to prepare primary amines.

## (D) Beacuse of +R-effect of -$NH_2$ group, aniline will undergo Friedel-Crafts acylation reaction.

## Choose the correct answer from the options given below:

**Options:**

A. (A) and (B) only

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

C. (A) and (C) only

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

**Answer: B**

## Solution:

**CONCEPT**:

**Analysis of the Statements about Amines and Their Reactions**

- **(A) Diazonium salts of aromatic amines are morestable than diazonium salts of aliphatic amines:** This statement is **correct**. Diazonium salts of **aromatic amines** are **more stable** than those of aliphatic amines. The stability arises from the resonance stabilization provided by the benzene ring in aromatic diazonium salts, whereas aliphatic diazonium salts lack such resonance and decompose rapidly.
- **(B) Ethylamine is insoluble in water:** This statement is **incorrect**. Ethylamine ($C_2H_5NH_2$) is **soluble** in water because it forms hydrogen bonds with water molecules, making it highly miscible.
- **(C) Gabriel phthalimide synthesis can be used to prepare primary amines:** This statement is **correct**. Gabriel phthalimide synthesis is a well-known method for preparing primary amines by reacting phthalimide with an alkyl halide, followed by hydrolysis to release the primary amine.
- **(D) Because of the +R-effect of the -$NH_2$ group, aniline will undergo Friedel-Crafts acylation reaction:** This statement is **correct**. The +R (resonance donating) effect of the -$NH_2$ group makes aniline an electron-rich benzene derivative, which facilitates electrophilic substitution reactions like Friedel-Crafts acylation.

**EXPLANATION**:

- **(A) is incorrect** because aromatic diazonium salts are more stable than aliphatic diazonium salts due to resonance stabilization.
- **(B) is incorrect** because ethylamine is soluble in water due to hydrogen bonding.
- **(C) is correct** because Gabriel phthalimide synthesis is a reliable method for preparing primary amines.
- **(D) is correct** because the +R effect of -$NH_2$ in aniline facilitates Friedel-Crafts acylation.

**Therefore, the correct answer is: 2) (A), (C), and (D) only**

---

# Question 49

## Match List-I with List-II:

| | List-I | | List-II |
|---|---|---|---|
| (A) | $Mn^{2+}$ | (I) | Pyrolusite ore |
| (B) | Spin only Magnetic Moment | (Il) | An alloy of 4f metal, iron andtraces of S, C, Al and Ca |
| (C) | $MnO_2$ | (Ill) | $\mu_s = \sqrt{n(n+2)}BM$ |
| (D) | Misch metal | (IV) | Highest oxidation states |

## Choose the correct answer from the options given below:

### Options:

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

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

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

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

**Answer: C**

## Solution:

**EXPLANATION**:

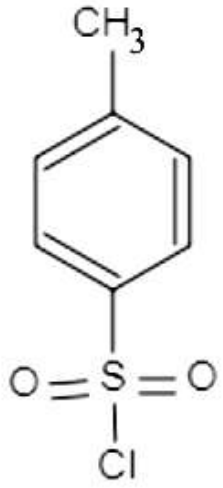
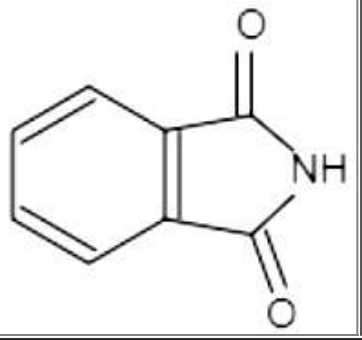
- For $Mn^{2+}$:
  - Manganese in the +2 oxidation state can exhibit the highest oxidation states among the given choices.
- For Spin only Magnetic Moment:
  - The formula for the spin-only magnetic moment is given by $\mu_s = \sqrt{n(n+2)}BM$, which matches with option (III).
- For $MnO_2$:
  - $MnO_2$ is a common form of pyrolusite ore, which matches with option (I).
- For Misch metal:
  - Misch metal is an alloy of 4f metal, iron, and traces of S, C, Al, and Ca, which matches with option (II).

**Therefore, the correct matching is (A) - (IV),(B) - (III), (C) - (I) (D) - (II)**

---

# Question 50

## Match List-I with List-II:

| | List-II (Compound) | | List-II } (Property) |
|---|---|---|---|
| (A) | $COCL_2$ | (I) | To distinguish between primary, secondary and tertiary amines |
| (B) |  | (Il) | Poisonous gas |
| (C) |  | (Ill) | Synthesis of primary amines |
| (D) |  | (IV) | Zwitter ion |

## Choose the correct answer from the options given below:

**Options:**

A.

(A) - (II), (B) - (I), (C) - (IV), (D) - (III)

B.

(A) - (II), (B) - (I), (C) - (III), (D) - (IV)

C.

(A) - (I), (B) - (II), (C) - (IV), (D) - (III)

D.

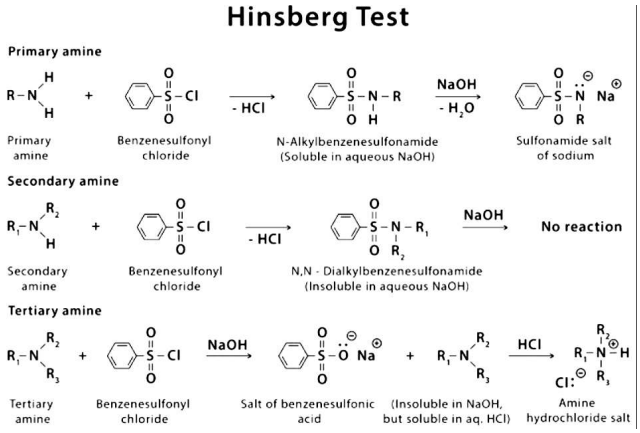
(A) - (I), (B) - (II), (C) - (III), (D) - (IV)

**Answer: A**

# Solution:

**EXPLANATION**:

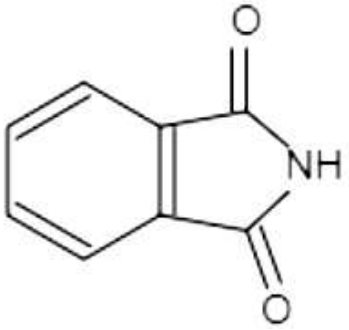
- **(A) $COCl_2$ (Phosgene):** Phosgene gas.
- **(B) $CH_3SO_2Cl$ (Methyl sulfonyl chloride):**




This compund is used to distinguish between primary, secondary, and tertiary amines based on their reaction with the compound. This matches with property (II) (To distinguish between primary, secondary, and tertiary amines).This compound is used in the synthesis of primary amines, where it reacts with ammonia or amines to form the corresponding sulfonamide. Therefore, (B) matches with (I) (Synthesis of primary amines).

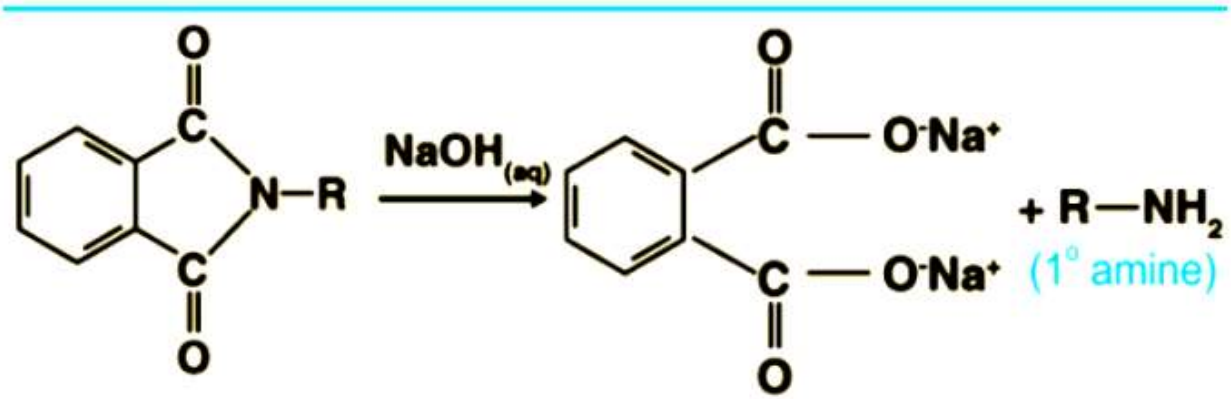
- **(C)** 

**:**
Ammonia can form a zwitterion under certain conditions, where both a positive and a negative charge exist within the same molecule. Therefore, (C) matches with (IV) (Zwitter ion).




**(D) :**

Benzenesulfonic acid is involved in the synthesis of primary amines, as it can react with amines in various synthetic processes.




Thus, (D) matches with (III) (Synthesis of primary amines).

**Therefore, the correct matching is: (A) - (II), (B) - (I), (C) - (IV), (D) - (III).**

---