Subject : CHEMISTRY - Set C
Code : 306 E (New)

Total Time Allowed: 60 minutes	Maximum Marks : 200	Total Questions : 50	Questions to be answered : 40

Q1. Which among the following compounds show metal excess defect due to anionic vacancy?
Options:
(1) ZnO
(2) NaCl
(3) FeO
(4) CdO

Correct Answer: (1) ZnO
Solution:
ZnO exhibits a metal excess defect due to anionic vacancies, where some oxygen ions are missing, creating a charge imbalance compensated by excess zinc ions.

Quick Tip

Metal excess defects occur when there is an excess of metal cations due to missing anions.

Q2. Molal elevation constant is also known as:
Options:
(1) Ebullioscopic constant
(2) Gas constant
(3) Henry's constant
(4) Cryoscopic constant

Correct Answer: (1) Ebullioscopic constant
Solution:
The molal elevation constant is used to calculate the elevation in boiling point of a solvent upon addition of a non-volatile solute.

Quick Tip

Ebullioscopic constants vary with solvents and reflect boiling point changes due to solute addition.

Q3. What is the overall order of the reaction?
$Rate = k[\mathrm{A}]^{1/2}[\mathrm{B}]^{3/2}$

Options:
(1) 2
(2) 0
(3) 1
(4) 0.5

Correct Answer: (1) 2
Solution:
The overall order of the reaction is calculated as the sum of the powers of the concentration terms in the rate law:

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

Quick Tip

The reaction order is crucial for determining how the rate changes with concentration.

Q4. Which term of molar conductivity is used when the concentration of electrolyte approaches zero?
Options:
(1) Infinite molar conductivity
(2) Zero molar conductivity
(3) Standard molar conductivity
(4) Limiting molar conductivity

Correct Answer: (4) Limiting molar conductivity
Solution:
Limiting molar conductivity refers to the conductivity of an electrolyte at infinite dilution when ion interactions are negligible.

Quick Tip

Limiting molar conductivity helps predict ion transport in dilute solutions.

Q5. Kohlrausch law is related to which of the following terms?
Options:
(1) Osmosis
(2) Diffusion
(3) Effusion
(4) Migration of ions

Correct Answer: (4) Migration of ions
Solution:
Kohlrausch's law relates the molar conductivity of an electrolyte at infinite dilution to

the sum of the contributions of its individual ions.

Quick Tip

Kohlrausch's law is instrumental in calculating ion-specific conductivity in solutions.

Q6. Which factor in Arrhenius equation corresponds to the fraction of molecules having kinetic energy greater than activation energy?
Options:
(1) ln k
(2) ln A
(3) RT
(4) $e^{-Ea/RT}$

Correct Answer: (4) $e^{-Ea/RT}$
Solution:
In the Arrhenius equation, the factor $e^{-Ea/RT}$ corresponds to the fraction of molecules that have energy greater than the activation energy, determining the reaction rate.

Quick Tip

The factor $e^{-Ea/RT}$ in the Arrhenius equation reflects the probability that molecules will have sufficient energy to react.

Q7. What is another term used for the probability factor (P) in collision theory?
Options:
(1) Temperature factor
(2) Compressibility factor
(3) Steric factor
(4) Concentration factor

Correct Answer: (3) Steric factor
Solution:
In collision theory, the probability factor (P) is also known as the steric factor, which accounts for the geometry and orientation of colliding molecules.

Quick Tip

The steric factor represents the effect of molecular orientation on the probability of successful collisions.

Q8. Why does fluorine exhibit only -1 oxidation state?

Options:
(1) It is a halogen.
(2) It is a non-metal.
(3) It is small in size.
(4) It has no d-orbitals.

Correct Answer: (4) It has no d-orbitals.
Solution:
Fluorine is the most electronegative element and lacks d-orbitals in its valence shell. This restricts its ability to expand its octet or exhibit positive oxidation states. Fluorine can gain one electron to achieve the stable configuration of neon (Ne), resulting in an oxidation state of -1.

Quick Tip

Fluorine's high electronegativity and absence of d-orbitals make it the strongest oxidizing agent.

Q9. Which among the following halogens exists in liquid state at room temperature?
Options:
(1) Fluorine
(2) Chlorine
(3) Bromine
(4) Iodine

Correct Answer: (3) Bromine
Solution:
At room temperature, bromine (Br_2) is a liquid with a reddish-brown color. This is due to moderate intermolecular forces between its molecules. Other halogens:
- Fluorine (F_2) and chlorine (Cl_2) are gases at room temperature.
- Iodine (I_2) is a solid at room temperature.

Quick Tip

Bromine is the only non-metallic element that exists as a liquid at room temperature.

Q10. The central atoms/ions in the coordination compounds are referred to as:
Options:
(1) Lewis base
(2) Lewis acid
(3) Bronsted acid

(4) Bronsted base

Correct Answer: (2) Lewis acid
Solution:
In coordination compounds, the central atom or ion acts as a Lewis acid because it can accept electron pairs. The ligands, which donate electron pairs, act as Lewis bases.

Quick Tip

The central metal atom/ion in a coordination compound is often referred to as a Lewis acid because it can accept electron pairs from the ligands.

Q11. What is the IUPAC name of $[Pt(NH_3)_2Cl(NO_2)]$?
Options:
(1) Diamminechloridonitrito-N-platinum(II)
(2) Diamminechloridenitrito-N-platinum(III)
(3) Diamminechloridonitrito-O-platinum(II)
(4) Diammonia chloridonitrito-N-platinum(II)

Correct Answer: (1) Diamminechloridonitrito-N-platinum(II)
Solution:
The given complex is $[Pt(NH_3)_2Cl(NO_2)]$. In this complex:
- NH_3 (ammine) is a neutral ligand.
- Cl (chlorido) is a monoanionic ligand.
- NO_2 (nitrito) is a bidentate ligand with a coordination site at the nitrogen atom.
The IUPAC name is formed by naming the ligands first in alphabetical order, followed by the metal with its oxidation state.

Quick Tip

In coordination compounds, ligands are named first, followed by the metal and its oxidation state.

Q12. What product is obtained when chloroform reacts with oxygen in presence of light?
Options:
(1) Phosgene gas
(2) Phosphine gas
(3) Chlorine gas
(4) Hydrogen gas

Correct Answer: (1) Phosgene gas
Solution:
Chloroform ($CHCl_3$) reacts with oxygen (O_2) in the presence of light to form phosgene

($COCl_2$) and hydrogen chloride (HCl). The chemical equation is:

$$CHCl_3 + O_2 \longrightarrow COCl_2 + HCl$$

Quick Tip

Phosgene gas is highly toxic and forms when chloroform is exposed to air and light. Store chloroform in tightly sealed, dark-colored containers.

Q13. Which among the following is a trihydric alcohol?
Options:
(1) Ethanol
(2) Glycerol
(3) Ethylene Glycol
(4) Phenol

Correct Answer: (2) Glycerol
Solution:
A trihydric alcohol contains three hydroxyl (−OH) groups. Among the given options:
- Ethanol (C_2H_5OH) has one −OH group.
- Ethylene Glycol ($C_2H_4(OH)_2$) has two −OH groups.
- Glycerol ($C_3H_5(OH)_3$) has three −OH groups and is thus a trihydric alcohol.
- Phenol (C_6H_5OH) contains one hydroxyl group attached to an aromatic ring.

Quick Tip

Glycerol is used in the pharmaceutical and cosmetics industries due to its moisturizing properties.

Q14. Aspirin is also known as:
Options:
(1) Salicylic acid
(2) Ethyl Salicylic acid
(3) Methyl Salicylic acid
(4) Acetyl Salicylic acid

Correct Answer: (4) Acetyl Salicylic acid
Solution:
Aspirin is the common name for acetyl salicylic acid. It is synthesized by reacting salicylic acid ($C_7H_6O_3$) with acetic anhydride ($C_4H_6O_3$), producing aspirin and acetic acid as a by-product:

$$C_7H_6O_3 + C_4H_6O_3 \longrightarrow C_9H_8O_4 + CH_3COOH$$

Quick Tip

Aspirin inhibits enzymes responsible for pain and inflammation, making it an effective painkiller.

Q15. What is the IUPAC name of picric acid?
Options:
(1) 2-Nitrophenol
(2) 2,4,6-Trinitrophenol
(3) Ethyl Salicylic acid
(4) 2-Aminophenol

Correct Answer: (2) 2,4,6-Trinitrophenol
Solution:
Picric acid is a derivative of phenol (C_6H_5OH) with three nitro groups ($-NO_2$) attached at the 2, 4, and 6 positions of the benzene ring. The chemical formula of picric acid is $C_6H_2(NO_2)_3OH$. The systematic IUPAC name is 2,4,6-Trinitrophenol.

Quick Tip

Picric acid is highly flammable and was historically used in explosives.

Q16. What is the product when glucose reacts with bromine water?
Options:
(1) Gluconic acid
(2) Glyceraldehyde
(3) Saccharic acid
(4) Oxime

Correct Answer: (1) Gluconic acid
Solution:
When glucose reacts with bromine water, the aldehyde group ($-CHO$) is oxidized to a carboxylic acid group ($-COOH$), forming gluconic acid. The chemical equation is:

$$C_6H_{12}O_6 + Br_2 + H_2O \longrightarrow C_6H_{12}O_7 + {}_2HBr$$

Quick Tip

Bromine water selectively oxidizes aldehydes to carboxylic acids without affecting alcohol groups.

Q17. 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^-	(II) +5
(C) VO_3^-	(III) +7
(D) FeF_6^{3-}	(IV) +6

Options:
(1) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)
(2) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
(3) (A) - (I), (B) - (III), (C) - (IV), (D) - (II)
(4) (A) - (IV), (B) - (I), (C) - (III), (D) - (II)

Correct Answer: (2) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
Solution:
- $Cr_2O_7^{2-}$: Oxidation state of chromium is +6.
- MnO_4^-: Oxidation state of manganese is +7.
- VO_3^-: Oxidation state of vanadium is +5.
- FeF_6^{3-}: Oxidation state of iron is +3.

Quick Tip

The oxidation state of the central atom is calculated based on the charges of the ligands and the overall charge of the complex.

Q18. What is the color of the copper compound formed in Fehling's test for aliphatic aldehydes?
Options:
(1) Green
(2) Blue
(3) Yellow
(4) Red

Correct Answer: (4) Red
Solution:
In Fehling's test, copper(II) ions (Cu^{2+}) react with aliphatic aldehydes to form a red precipitate of copper(I) oxide (Cu_2O).

Quick Tip

Fehling's test is a qualitative test for aldehydes, distinguishing them by forming a characteristic red precipitate.

Q19. What is the major product formed when a diazonium salt undergoes the Gatterman reaction?

Options:
(1) Haloarene
(2) Aryl amine
(3) Phenol
(4) Diphenyl ether

Correct Answer: (1) Haloarene
Solution:
In the Gatterman reaction, a diazonium salt reacts with a halogen (e.g., Cl_2 or Br_2) in the presence of a copper(I) catalyst, resulting in the formation of a haloarene.

Quick Tip

The Gatterman reaction is used to synthesize haloarenes from diazonium salts.

Q20. What is the major product of the Carbylamine reaction?
Options:
(1) Cyanide
(2) Isocyanide
(3) Nitrile
(4) Alkane

Correct Answer: (2) Isocyanide
Solution:
The Carbylamine reaction involves the reaction of a primary amine with chloroform ($CHCl_3$) and a strong base to form an isocyanide (RNC).

Quick Tip

The Carbylamine reaction is a test for primary amines, forming isocyanides with a characteristic unpleasant odor.

Q21. Which among the following is an essential amino acid?
Options:
(1) Glycine
(2) Alanine
(3) Valine
(4) Serine

Correct Answer: (3) Valine
Solution:
Essential amino acids cannot be synthesized by the human body and must be obtained through diet. Valine is an essential amino acid, while glycine, alanine, and serine are non-essential.

Quick Tip

Valine is one of the branched-chain amino acids (BCAAs), essential for muscle metabolism and repair.

Q22. Arrange the following in increasing order of their pH values:
Compounds:
(A) p-Nitrophenol
(B) m-Cresol
(C) m-Nitrophenol
(D) Phenol

Options:
(1) (A) $<$ (B) $<$ (C) $<$ (D)
(2)(A) $<$ (C) $<$ (D) $<$ (B)
(3)(B) $<$ (A) $<$ (D) $<$ (C)
(4)(C) $<$ (B) $<$ (D) $<$ (A)

Correct Answer: (2) (A)$<$ (C) $<$ (D) $<$ (B)
Solution:
The pH values of the compounds depend on the electron-withdrawing or donating effects of substituents:
- **p-Nitrophenol (A)** is the most acidic due to the electron-withdrawing $-NO_2$ group.
- **m-Nitrophenol (C)** is less acidic than p-Nitrophenol.
- **Phenol (D)** is less acidic than m-Nitrophenol.
- **m-Cresol (B)** is the least acidic due to the electron-donating $-CH_3$ group.

Quick Tip

Electron-withdrawing groups increase acidity, while electron-donating groups decrease acidity by stabilizing or destabilizing the conjugate base.

Q23. Which among the following is a biodegradable polymer?
Options:
(1) PVC
(2) Freon
(3) Nylon
(4) PHBV

Correct Answer: (4) PHBV
Solution:
Polyhydroxybutyrate-co-hydroxyvalerate (PHBV) is a biodegradable polymer that decomposes naturally through microbial action. PVC, Freon, and Nylon are not biodegrad-

able.

Quick Tip

PHBV is an eco-friendly polymer often used in medical and packaging applications due to its biodegradability.

Q24. Which among the following is an antacid?
Options:
(1) Aspirin
(2) Zantac
(3) Equanil
(4) Noradrenaline

Correct Answer: (2) Zantac
Solution:
Zantac (ranitidine) is a histamine-2 receptor antagonist that decreases stomach acid production, making it an effective antacid. Aspirin, Equanil, and Noradrenaline serve other medicinal purposes and are not antacids.

Quick Tip

Antacids like Zantac are used to treat acid reflux and related gastric issues by neutralizing or reducing acid production.

Q25. What is the numerical value of one Faraday in Coulombs?
Options:
(1) 96587
(2) 96487
(3) 99500
(4) 6.023

Correct Answer: (2) 96487
Solution:
One Faraday is equal to the total charge carried by one mole of electrons, approximately 96487 Coulombs (C/mol). It is derived as:

$$\text{Faraday's Constant} = \text{Avogadro's number} \times \text{charge of one electron.}$$

Quick Tip

Faraday's constant is widely used in electrochemistry to calculate charge and current during redox reactions.

Q26. A first-order reaction has a half-life of 693 sec. What will be its rate constant?
Options:
(1) 0.01 sec^{-1}
(2) 1 sec^{-1}
(3) 0.001 sec^{-1}
(4) 0.1 sec^{-1}

Correct Answer: (4) 0.1 sec^{-1}
Solution:
The rate constant (k) for a first-order reaction can be calculated using the formula:

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

Substituting $t_{1/2} = 693$ sec:

$$k = \frac{0.693}{693} = 0.1\,\text{sec}^{-1}$$

Quick Tip

The half-life of a first-order reaction is constant and does not depend on the concentration of the reactant.

Q27. For SN_2 reaction, the increasing order of the reactivity of the following alkyl halides is:
Compounds:
(A) $CH_3CH_2CH_2CH_2Br$
(B) $CH_3CH_2CH(Br)CH_3$
(C) $(CH_3)_3CBr$
(D) $(CH_3)_2CHCH_2Br$

Options:
(1) (A) $<$ (B) $<$ (C) $<$ (D)
(2) (A) $<$ (C) $<$ (B) $<$ (D)
(3) (B) $<$ (A) $<$ (D) $<$ (C)
(4) (C) $<$ (B) $<$ (D) $<$ (A)

Correct Answer: (2) (A) $<$ (C) $<$ (B) $<$ (D)
Solution:
In SN_2 reactions, the reactivity decreases with increasing steric hindrance. Primary alkyl halides react faster than secondary halides, and tertiary halides react the slowest.

Quick Tip

Steric hindrance plays a crucial role in SN_2 reactions. Smaller, less hindered substrates react faster.

Q28. Which among the following is a strong field ligand?
Options:
(1) I^-
(2) Cl^-
(3) NH_3
(4) SCN^-

Correct Answer: (3) NH_3
Solution:
Ammonia (NH_3) is a strong field ligand that causes significant splitting of d-orbitals in metal complexes, leading to low-spin configurations. Other ligands, such as I^- and Cl^-, are weak field ligands.

Quick Tip

Strong field ligands like NH_3 cause greater crystal field splitting, stabilizing the d-orbitals in low-spin configurations.

Q29. Arrange the following in increasing order of osmotic pressure at 298 K:
(The cell wall is permeable to water and not to the solute molecules)
Options:
(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:

1. $(C) < (B) < (A) < (D)$
2. $(D) < (A) < (B) < (C)$
3. $(B) < (A) < (D) < (C)$
4. $(C) < (A) < (B) < (D)$

Correct Answer: (2) (D) < (A) < (B) < (C)

Solution:
Osmotic pressure (π) is directly proportional to molarity (C):

$$\pi = CRT$$

Calculating molarity:
- (A): 0.5 mol/L
- (B): 0.25 mol/L
- (C): 10 mol/L
- (D): 4 mol/L

Quick Tip

Osmotic pressure increases with solute molarity. Smaller solution volumes and higher concentrations result in higher osmotic pressures.

Q30. Arrange the following rate constant units in increasing order of their order of reaction:
Units:
(A) sec^{-1}
(B) mol $\text{L}^{-1}\text{sec}^{-1}$
(C) $\text{mol}^{-1}\text{L sec}^{-1}$
(D) $\text{mol}^{-2}\text{L}^{2}\text{sec}^{-1}$

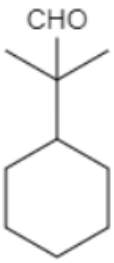
Options:
(1) (C) $<$ (A) $<$ (B) $<$ (D)
(2)(C) $<$ (B) $<$ (A) $<$ (D)
(3)(B) $<$ (A) $<$ (C) $<$ (D)
(4)(A) $<$ (B) $<$ (C) $<$(D)

Correct Answer: (1) (C)$<$ (A) $<$ (B) $<$(D)
Solution:
The units of the rate constant depend on the reaction order:
- Zero-order: mol $\text{L}^{-1}\text{sec}^{-1}$
- First-order: sec^{-1}
- Second-order: $\text{mol}^{-1}\text{L sec}^{-1}$
- Third-order: $\text{mol}^{-2}\text{L}^{2}\text{sec}^{-1}$

Quick Tip

Higher reaction orders have more complex units for the rate constant due to the involvement of additional reactant concentrations.

Q31. Which of the following compounds will undergo Aldol condensation?

(A) 

(B) 

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

(D) HCHO

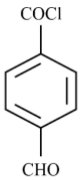
Options:
(1) (A), (C), and (D) only
(2) (B) and (C) only
(3) (B), (C), and (D) only
(4) (A), (B), (C), and (D)

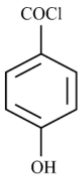
Correct Answer: (1) (A), (C), and (D) only
Solution:
Aldol condensation requires the presence of at least one α-hydrogen atom adjacent to a carbonyl group. Compounds (A), (C), and (D) contain α-hydrogens, enabling the reaction.

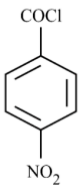
Quick Tip

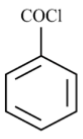
Aldol condensation occurs only in compounds with α-hydrogens adjacent to carbonyl groups.

Q32. Consider the following compounds and arrange them in increasing order of hydrolysis rate:

(A) 

(B) 

(C) 

(D) 

Options:
(1) (B) $<$ (D) $<$ (C) $<$ (A)

(2)$(B) < (D) < (A) < (C)$
(3)$(D) < (B) < (A) < (C)$
(4)$(A) < (D) < (B) <$(C)

Correct Answer: (2) (B) $< (D) < (A) <$ (C)
Solution:
Hydrolysis rate depends on electronic effects. Compounds with more electron-withdrawing groups hydrolyze faster.

Quick Tip

Electron-withdrawing groups accelerate hydrolysis by increasing electrophilicity at the reaction center.

Q33. Which of the following ions will be colored in the aqueous solution?
(A) Ti^{3+}
(B) Nb^{3+}
(C) Cu^{+}
(D) Y^{3+}
Options:
(1) (C) and (D) only
(2) (A), (B) and (D) only
(3) (A) and (B) only
(4) (A), (B), (C) and (D)

Correct Answer: (3) (A) and (B) only
Solution:
The color of aqueous solutions arises due to d-d electronic transitions.
- $\mathbf{Ti^{3+}}$: [Ar]$3d^1$ allows d-d transitions, leading to color.
- $\mathbf{Nb^{3+}}$: [Kr]$4d^2$ supports d-d transitions.
- $\mathbf{Cu^{+}}$: Fully filled $3d^{10}$ orbitals prevent transitions, making it colorless.
- $\mathbf{Y^{3+}}$: No d-electrons result in no transitions, hence colorless.

Quick Tip

Transition metal ions with unpaired d-electrons are usually colored due to d-d transitions.

Q34. The correct statements from the options given below are:
Statements:
(A) Diazonium salts of aromatic amines are less stable than diazonium salts of aliphatic amines.
(B) Ethylamine is insoluble in water.
(C) Gabriel phthalimide synthesis can be used to prepare primary amines.

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

Options:
(1) (A) and (B) only
(2) (A), (C), and (D) only
(3) (A) and (C) only
(4) (B), (C), and (D) only

Correct Answer: (2) (A), (C), and (D) only
Solution:
- Gabriel phthalimide synthesis is specific for primary amines.
- Aniline reacts in Friedel-Crafts reactions due to resonance effects.
- Diazonium salts of aromatic amines are more stable than those of aliphatic amines.

Quick Tip

Stability of diazonium salts increases with aromatic groups due to resonance stabilization.

Q35. Match List I with List II:

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

Choose the correct answer from the options given below :

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

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

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

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

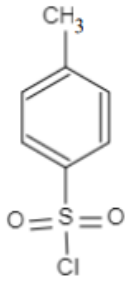
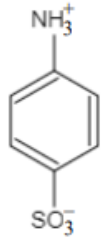
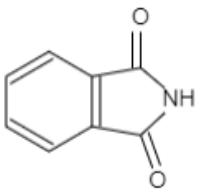
Options:
(1) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
(2) (A) - (II), (B) - (III), (C) - (I), (D) - (IV)
(3) (A) - (IV), (B) - (III), (C) - (I), (D) - (II)
(4) (A) - (I), (B) - (III), (C) - (IV), (D) - (II)

Correct Answer: (1) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
Solution:
- **(A) Mn^{2+}**: Associated with pyrolusite ore.
- **(B) Magnetic Moment**: Formula is $\mu = \sqrt{n(n+2)}$BM.
- **(C) MnO_2**: Represents highest oxidation states.
- **(D) Misch Metal**: Alloy of rare earth elements.

Quick Tip

Misch metal is a mix of rare earth elements used in lighter flints.

Q36. Match List I with List II:

List-I (Compound)	List-II (Property)
(A) $COCl_2$	(I) To distinguish between primary, secondary and tertiary amines
(B) 	(II) Poisonous gas
(C) 	(III) Synthesis of primary amines
(D) 	(IV) Zwitter ion

Options:
(1) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)
(2) (A) - (II), (B) - (I), (C) - (III), (D) - (IV)
(3) (A) - (I), (B) - (II), (C) - (IV), (D) - (III)
(4) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

Correct Answer: (2) (A) - (II), (B) - (I), (C) - (III), (D) - (IV)
Solution:
- **(A)** $\mathbf{COCl_2}$: Phosgene is a poisonous gas.
- **(B)** $\mathbf{C_6H_5SO_2Cl}$: Used to distinguish different amines.
- **(C)** $\mathbf{C_6H_4NH_3^+}$: Involved in primary amine synthesis.
- **(D)** $\mathbf{C_6H_5COOH}$: Forms a zwitterion in water.

Quick Tip

Zwitterions have both positive and negative charges within the same molecule.

Q37. Which of the following are the bases of DNA?
Options:
(A) Adenine
(B) Uracil
(C) Thymine
(D) Cytosine

Choose the correct answer from the options given below:
Options:
(1) (A), (B) and (C) only
(2) (B) and (C) only
(3) (A), (C) and (D) only
(4) (A) and (B) only

Solution:
The bases of DNA are:
- Adenine (A)
- Thymine (T)
- Cytosine (C)
- Guanine (G)

Uracil (U) is a base found in RNA, not DNA.

Quick Tip

Remember: DNA uses thymine, while RNA uses uracil instead of thymine.

Q38. 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 amino acid
(C) Lysine	(III) Acidic amino acid
(D) Glutamic acid	(IV) Neutral optically inactive amino acid

Options:
(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) - (II), (B) - (IV), (C) - (I), (D) - (III)

Correct Answer: (1) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)
Solution:
- Valine: Branched-chain amino acid classified as basic.
- Glycine: Neutral, optically inactive (no chiral center).
- Lysine: Basic amino acid.
- Glutamic acid: Acidic amino acid.

Quick Tip

Amino acids are categorized based on side chains and optical activity.

Q39. Which of the following gases is most soluble in water at 298 K and 1 atm?
Options:
(1) Methanal (KH=0.000018)
(2) Argon (KH=40.3)
(3) Methane (KH=0.41)
(4) Carbon dioxide (KH=1.6)

Correct Answer: (1) Methanal (KH=0.000018)
Solution:
Henry's law constant (KH) determines gas solubility. A smaller KH value indicates higher solubility. Methanal, with the smallest KH, is most soluble.

Quick Tip

Gas solubility in water is inversely proportional to the KH value.

Q40. Which solvent has the lowest ebullioscopic constant?

Solvent	Boiling Point (K)
Chloroform	334.4
Diethyl Ether	307.8
Benzene	353.3
Carbon disulfide	319.4

Options:
(1) Chloroform
(2) Diethyl Ether

(3) Benzene
(4) Carbon Disulfide

Correct Answer: (2) Diethyl Ether
Solution:
Ebullioscopic constant correlates with boiling points. Diethyl Ether, having the lowest boiling point, has the lowest ebullioscopic constant.

Quick Tip

The lower the boiling point, the lower the ebullioscopic constant.

Read the following passage and answer the next five questions based on it.

Aldehydes are generally more reactive than ketones in nucleophilic addition reactions due to steric and electronic reasons. Sterically, the presence of two large groups in ketones hinders the attack of nucleophile to carbonyl carbon than in aldehydes. Electronically, aldehydes are more reactive than ketones because alkyl groups reduce the electrophilicity of the carbonyl carbon more effectively than in the former.

Q41. What is the product when an aldehyde reacts with HCN in the presence of a base?
Options:
(1) Cyanide
(2) Isocyanide
(3) Cyanohydrin
(4) Hydrogen cyanide

Correct Answer: (3) Cyanohydrin
Solution:
An aldehyde reacts with HCN to form cyanohydrin through a nucleophilic addition reaction. The cyano group attaches to the carbonyl carbon.

Quick Tip

Cyanohydrins are formed by the addition of HCN to aldehydes and ketones.

Q42. Arrange the following amines in decreasing order of basic strength in aqueous solution:
Amines:
CH_3NH_2, $(CH_3)_2NH$, $(CH_3)_3N$, NH_3

Options:

(1) $CH_3NH_2¿(CH_3)_2NH¿NH_3¿(CH_3)_3N$
(2) $CH_3NH_2¿(CH_3)_2NH¿(CH_3)_3N¿NH_3$
(3) $NH_3¿(CH_3)_3N¿(CH_3)_2NH¿CH_3NH_2$
(4) $(CH_3)_2NH¿CH_3NH_2¿(CH_3)_3N¿NH_3$

Correct Answer: (4) $(CH_3)_2NH¿CH_3NH_2¿(CH_3)_3N¿NH_3$
Solution:
The basic strength of amines depends on the number of alkyl groups attached to the nitrogen. Alkyl groups are electron-donating, which increases the electron density on nitrogen, enhancing basicity. However, steric hindrance in bulky amines like $(CH_3)_3N$ reduces its ability to accept protons. The correct order is:

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

Quick Tip

Alkyl groups increase basicity due to the electron-donating inductive effect, but steric hindrance can reduce basicity in bulky amines.

Q43. A new C-C bond formation is possible in:
Options:
(A) Cannizzaro reaction
(B) Friedel-Crafts alkylation
(C) Clemmensen reduction
(D) Riemer-Tiemann reaction

Choose the correct answer from the options given below :

(1) (B) and (D) only

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

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

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

Correct Answer: (2) Cannizzaro, Friedel-Crafts alkylation, and Riemer-Tiemann reactions
Solution:
Friedel-Crafts alkylation forms a new C-C bond by attaching an alkyl group to an aromatic ring. Similarly, the Riemer-Tiemann reaction introduces a formyl group into an aromatic ring, forming a new C-C bond. The Cannizzaro reaction also involves C-C bond formation under specific conditions.

Quick Tip

C-C bond formation is common in alkylation and formylation reactions, but not in reductions like Clemmensen.

Q44. Which of the following will respond to Tollen's test?
Options:
(1) Ethanoic acid
(2) Methanoic acid
(3) Propanoic acid
(4) Butanoic acid

Correct Answer: (2) Methanoic acid
Solution:
Tollen's reagent reacts with aldehydes to form a silver mirror. Methanoic acid (HCOOH), which contains an aldehyde group, reacts positively with Tollen's reagent. Other carboxylic acids lack the aldehyde group, so they do not respond to this test.

Quick Tip

Tollen's test is specific for aldehydes and formic acid (HCOOH), which behaves like an aldehyde.

Q45. The order of reactivity of the given haloalkanes towards nucleophiles is:
Options:
(1) RI> RBr> RCl
(2) RCl> RBr> RI
(3) RBr> RCl> RI
(4) RBr> RI> RCl

Correct Answer: (1) RI> RBr >RCl
Solution:
The reactivity of haloalkanes towards nucleophiles depends on the bond strength between the carbon and the halogen. The C-I bond is the weakest, making iodoalkanes the most reactive, followed by bromo- and chloroalkanes.

Quick Tip

Reactivity decreases as the carbon-halogen bond strength increases (C−I ¡ C−Br ¡ C−Cl).

Read the following passage and answer the next five questions based on it.

The transition metals are very hard and have low volatility. Their melting and boiling points are high. In any row, the melting points of these metals rise to a maximum at d^5 and fall regularly as atomic number increases. The high melting points of these metals are attributed to the involvement of greater number of electrons from (n - 1)d in addition to ns electrons in the interatomic metallic bonding.

Q46. Which transition metal is liquid at room temperature?
Options:
(1) Hg
(2) Cu
(3) Ag
(4) Au

Correct Answer: (1) Hg
Solution:
Mercury (Hg) is the only transition metal that is liquid at room temperature due to its weak metallic bonding, which arises from relativistic effects on its electrons.

Quick Tip

Mercury is unique among metals for being liquid at standard temperature and pressure (STP).

Q47. Which is the hardest metal?
Options:
(1) Zn
(2) Cu
(3) Hg
(4) Cd

Correct Answer: (1) Zn
Solution:
Zinc (Zn) is the hardest metal among the given options due to its higher bonding strength compared to copper (Cu), mercury (Hg), and cadmium (Cd).

Quick Tip

Zinc has higher hardness compared to other metals listed due to its unique atomic structure and bonding.

Q48. In any row, melting points of these metals rise to a maximum at d^5. Which transition metal is an exception?
Options:

(1) Ti
(2) V
(3) Cr
(4) Mn

Correct Answer: (3) Cr
Solution:
Chromium (Cr) is an exception to the trend of melting points peaking at d^5 due to its unique electronic configuration, which stabilizes the structure differently than expected.

Quick Tip

Chromium's melting point anomaly is due to its electronic configuration and the nature of metallic bonding.

Q49. Which transition metal has the highest melting point?
Options:
(1) Hf
(2) Ta
(3) W
(4) Re

Correct Answer: (3) W
Solution:
Tungsten (W) has the highest melting point among transition metals, approximately 3422°C. This property is attributed to its strong metallic bonds and high atomic density.

Quick Tip

Tungsten's exceptional melting point makes it valuable for high-temperature applications, such as filaments and heat shields.

Q50. How many electrons are needed in the reduction of $Cr_2O_7^{2-}$ to Cr^{3+}?
Options:
(1) One
(2) Six
(3) Five
(4) Eight

Correct Answer: (2) Six
Solution:
The reduction of $Cr_2O_7^{2-}$ to Cr^{3+} involves a gain of six electrons. Each chromium atom

reduces from an oxidation state of +6 to +3:

$$Cr_2O_7^{2-} + {}_6e^- + {}_{14}H^+ \longrightarrow {}_2Cr^{3+} + {}_7H_2O$$

Quick Tip

In redox reactions, calculate the total change in oxidation states to determine the number of electrons exchanged.