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

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

Q1. Which of the following ions will be coloured 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)

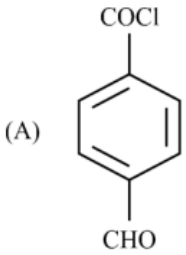
Correct Answer: (3) (A) and (B) only
Solution:
The color of aqueous solutions arises due to $d-d$ electronic transitions. Let us analyze each option:

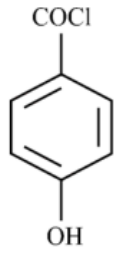
1. Ti^{3+}: The configuration $[Ar]\,3d^1$ allows for $d-d$ transitions, leading to a colored solution.
2. Nb^{3+}: The configuration $[Kr]\,4d^2$ also supports $d-d$ transitions.
3. Cu^{+}: Fully filled $[Ar]\,3d^{10}$ orbitals prevent transitions, making it colorless.
4. Y^{3+}: No d-electrons result in no transitions, hence colorless.

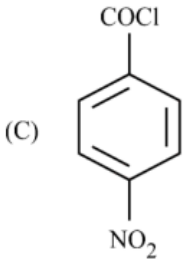
Quick Tip

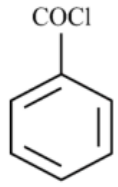
Transition metal ions with unpaired d-electrons are usually colored due to $d-d$ transitions.

Q2. Arrange the following compounds in the increasing order of rate of hydrolysis:
Options:
(A) C_6H_5CHO
(B) C_6H_5OH
(C) $C_6H_5NO_2$
(D) C_6H_5COCl
Arrange these compounds in the increasing order of rate of hydrolysis:

(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 the electronic effects of substituents. More electron-withdrawing groups enhance reactivity.

Quick Tip

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

Q3. The correct statement/statements from the options given below is/are:
(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 $+R$-effect of $-NH_2$ 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, and aniline reacts in Friedel-Crafts due to resonance effects.

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

Q4. 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)

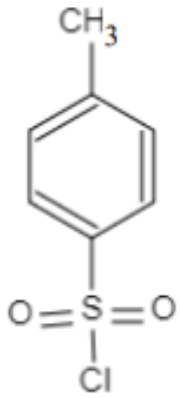
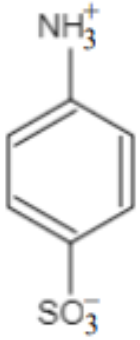
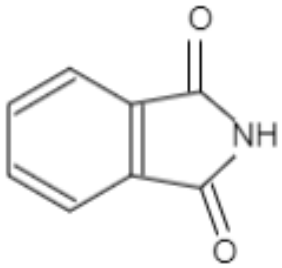
(3) (A) - (IV), (B) - (III), (C) - (I), (D) - (II)

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

Correct Answer: (1) (A) - (I), (B) - (III), (C) - (IV), (D) - (II)
Solution:
- Mn^{2+} is associated with pyrolusite ore (I).
- Spin-only magnetic moment corresponds to the formula $\mu_s = \sqrt{n(n+2)}$ BM (III).
- MnO_2 corresponds to the highest oxidation states of manganese (II).
- Misch metal is an alloy of 4f metals and other elements like iron, sulfur, and carbon (IV).

> Quick Tip
>
> Misch metal is a mix of rare earth elements used in flints.

Q5. 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) $COCl_2$ (phosgene) is a poisonous gas and is used in reactions to distinguish between primary, secondary, and tertiary amines. So, (A) corresponds to (II).
- (B) $C_6H_5SO_2Cl$ (benzenesulfonyl chloride) is used to distinguish between different amines, which corresponds to (I).
- (C) $C_6H_4NH_3^+$ (aniline) is used in the synthesis of primary amines, which corresponds to (III).
- (D) C_6H_5COOH (benzoic acid) can form a zwitterion in water, which corresponds to (IV).

Quick Tip

Zwitterions form when compounds have both positive and negative charges in the same molecule.

Q6. Which of the following is/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

Correct Answer: (3) (A), (C), and (D) only
Solution:
The bases of DNA are Adenine (A), Thymine (T), Cytosine (C), and Guanine (G). Uracil (U) is a base found in RNA, not in DNA.

Quick Tip

Remember: In DNA, Uracil is replaced by Thymine, while in RNA, Uracil is present instead of Thymine.

Q7. 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: A branched-chain amino acid categorized as basic (*I*).
- Glycine: Neutral, but optically inactive due to the absence of a chiral center (*II*).
- Lysine: Contains an amino group, making it basic (*III*).
- Glutamic acid: An acidic amino acid (*IV*).

Quick Tip

Amino acids are classified based on their side chains. Optically inactive amino acids like Glycine lack chiral centers.

Q8. Which of the following gases at 298 K and 1 atm pressure is most soluble in water?
Options:
(1) Methanal ($K_H = 0.000018$)
(2) Argon ($K_H = 40.3$)
(3) Methane ($K_H = 0.41$)
(4) Carbon dioxide ($K_H = 1.6$)

Correct Answer: (1) Methanal ($K_H = 0.000018$)
Solution:
The Henry's law constant (K_H) determines the solubility of gases in water. A lower K_H value indicates higher solubility. Methanal, with the lowest K_H, is the most soluble.

Quick Tip

The solubility of gases in water is inversely proportional to their K_H value.

Q9. Which of the following solvents 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 the boiling point. Diethyl Ether, having the lowest boiling point, has the lowest ebullioscopic constant.

Quick Tip

The lower the boiling point of a solvent, the lower its 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.

Q10. Which compound is formed 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.

Q11. Arrange the following amines in decreasing order of basic strength in aqueous solution:

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

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: (2) $CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N > NH_3$
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, making it more basic. However, steric hindrance in bulky amines like $(CH_3)_3N$ reduces its ability to accept protons. The decreasing order of basic strength is:

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

Quick Tip

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

Q12. 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: (1) (B) and (D) only
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, resulting in a new C-C bond.

Quick Tip

C-C bond formation is common in Friedel-Crafts and Riemer-Tiemann reactions but not in Clemmensen reduction.

Q13. 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 (formic acid) contains an aldehyde group and reacts positively with Tollen's reagent, while other carboxylic acids do not.

Quick Tip

Only aldehydes will reduce Tollen's reagent, forming a silver mirror.

Q14. The order of reactivity of the given haloalkanes towards nucleophile 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 halogen. The C-I bond is the weakest, making iodoalkanes the most reactive, followed by bromo- and chloroalkanes.

Quick Tip

Reactivity decreases as the 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.

Q15. 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.

Q16. 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.

Quick Tip

Zinc is harder than copper, mercury, and cadmium, making it the hardest among these metals.

Q17. 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 the exception where the melting point does not follow the expected trend based on the d^5 configuration.

Quick Tip

Chromium is an exception in the trend of melting points, due to its unique electronic configuration.

Q18. 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 the transition metals.

Quick Tip

Tungsten has the highest melting point of any metal, making it useful for high-temperature applications.

Q19. 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+} requires the gain of six electrons.

Quick Tip

In the reduction of $Cr_2O_7^{2-}$ to Cr^{3+}, each chromium atom gains three electrons, so two chromium atoms require six electrons in total.

Q20. 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 shows a metal excess defect due to anionic vacancy. This occurs because oxygen ions are missing, and this creates a charge imbalance, which is compensated by the excess zinc ions.

Quick Tip

In metal excess defects, there is an excess of metal cations due to the loss of anions.

Q21. 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 also known as the ebullioscopic constant, which is used in determining the elevation of boiling point.

Quick Tip

Ebullioscopic constant is used to measure the change in boiling point when a solute is dissolved in a solvent.

Q22. What is the overall order of the reaction?

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

Options:
(1) 2
(2) 0

(3) 1
(4) 0.5

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

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

Quick Tip

To find the order of a reaction, sum the exponents of the concentrations in the rate law expression.

Q23. 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 when its concentration approaches zero, at which point the ions in the solution are free to move without hindrance.

Quick Tip

Limiting molar conductivity is the conductivity of an electrolyte when it is in a dilute solution with an infinitesimally small concentration.

Q24. Kohlrausch law is related to which of the following term?
Options:
(1) Osmosis
(2) Diffusion
(3) Effusion
(4) Migration of ions

Correct Answer: (4) Migration of ions
Solution:
Kohlrausch's law is related to the migration of ions in an electrolyte, describing the

limiting molar conductivity of an electrolyte at infinite dilution.

Quick Tip

Kohlrausch's law provides a way to calculate the limiting molar conductivity of electrolytes based on ion migration.

Q25. 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) $e^{-E_a/RT}$

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

Quick Tip

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

Q26. What is another term used for 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.

Q27. 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.

Q28. 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.

Q29. The central atoms/ions in the coordination compounds are referred to as _____.
Options:
(1) Lewis base
(2) Lewis acid

(3) Brønsted acid
(4) Brønsted 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.

Q30. What is the IUPAC name of $[Pt(NH_3)_2Cl(NO_2)]$?
Options:
(1) Diamminechloridonitrito-N-platinum(II)
(2) Diamminechloridonitrito-O-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 (chloride) 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. Therefore, the correct name is Diamminechloridonitrito-N-platinum(II).

Quick Tip

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

Q31. What product is obtained when chloroform reacts with oxygen in the 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.

Q32. 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.

Hence, glycerol is the correct answer.

Quick Tip

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

Q33. 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:

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

Aspirin is a widely used drug with anti-inflammatory and analgesic properties.

Quick Tip

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

Q34. 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.

Q35. 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.

Q36. 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:
- $Cr_2O_7^{2-}$: The oxidation state of chromium is $+6$.
- MnO_4^-: The oxidation state of manganese is $+7$.
- VO_3^-: The oxidation state of vanadium is $+5$.
- FeF_6^{3-}: The 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.

Q37. 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.

Q38. 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.

Q39. 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 ($R{-}NC$).

Quick Tip

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

Q40. 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.

Q41. Arrange the following in increasing order of their pH values:
Options:
(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) < (C) < (D)
(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, which increases the electron density on the phenolic oxygen, reducing acidity.

Quick Tip

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

Q42. 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 biodegradable.

Quick Tip

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

Q43. 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.

Q44. 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.

Q45. 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 half-life formula:

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

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

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

Quick Tip

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

Q46. For SN2 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) $(CH_3)_2CHCH_2Br$

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 SN2 reactions, the reactivity decreases with increasing steric hindrance. Primary alkyl halides react faster than secondary halides, and tertiary halides react the slowest due to steric hindrance.

Quick Tip

Steric hindrance plays a crucial role in SN2 reactions. Smaller, less hindered substrates react faster.

Q47. 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.

Q48. 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:

$$\pi = \frac{nRT}{V}$$

Calculating the molarity for each case: - (D): $\frac{0.2}{0.05} = 4\,\text{mol/L}$ - (A): $\frac{0.5}{1} = 0.5\,\text{mol/L}$ - (B): $\frac{0.25}{1} = 0.25\,\text{mol/L}$ - (C): $\frac{0.1}{0.01} = 10\,\text{mol/L}$

Quick Tip

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

Q49. Arrange the following rate constant units in increasing order of their order of reaction:
Options:
(A) sec^{-1}
(B) $\text{mol L}^{-1}\text{sec}^{-1}$
(C) $\text{mol}^{-1}\text{L sec}^{-1}$
(D) $\text{mol}^{-2}\text{L}^{2}\text{sec}^{-1}$

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: (1) (C) < (A) < (B) < (D)
Solution:
The units of the rate constant depend on the reaction order:

- For zero-order: $\text{mol L}^{-1}\text{sec}^{-1}$
- For first-order: sec^{-1}
- For second-order: $\text{mol}^{-1}\text{L sec}^{-1}$

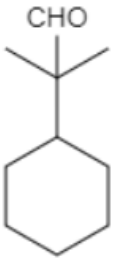
- For third-order: $mol^{-2}L^2sec^{-1}$

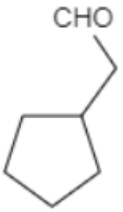
The correct order is (C) < (A) < (B) < (D).

Quick Tip

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

Q50. 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. Analyzing each compound:

- (A): Contains α-hydrogen, so it undergoes Aldol condensation.
- (B): Lacks α-hydrogen, so it does not undergo Aldol condensation.
- (C): Contains α-hydrogen, so it undergoes Aldol condensation.
- (D): Formaldehyde (HCHO) can participate in Aldol condensation.

Quick Tip

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