NEET-UG Chemistry Sample Paper-2

Duration: 1 Hour **Maximum Marks: 180**

Instructions

- This paper contains a total of 45 Multiple Choice Questions.
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Q1. 6.02×10^2 molecules of urea are present in 100 mL of its solution. The concentration of the solution is:

(A) 0.02 M

(B) 0.01 M

(C) 0.001 M

(D) 0.1 M

Q2. The energy of an electron in the ground state of the H-atom is -13.6 eV. The energy of the electron in its first excited state in Li^{2+} is:

(A) -30.6 eV

(B) -27.2 eV

(C) -13.6 eV

(D) -3.4 eV

Q3. The correct order of the number of unpaired electrons in the following complexes is: (I) $[Fe(CN)_6]^{4-}$ (II) $[FeF_6]^{3-}$ (III) $[CoF_6]^{3-}$

(A) II > III > I

(B) I > II > III

(C) II > I > III

(D) III > II > I

Q4. In a reaction, $A + B \rightarrow Product$, the rate is doubled when the concentration of B is doubled, and the rate increases by a factor of 8 when the concentrations of both A and B are doubled. The rate law is:

(A) $Rate = k[A][B]$

(B) $Rate = k[A]^2[B]$

(C) $Rate = k[A][B]^2$

(D) $Rate = k[A]^2[B]^2$

Q5. Standard electrode potentials for Fe^{2+}/Fe and Fe^{3+}/Fe^{2+} are −0.44 V and +0.77 V respectively. The E° for Fe^{3+}/Fe will be:

(A) 0.33 V

(B) −0.036 V

(C) 0.11 V

(D) −0.11 V

Q6. The solubility of $BaSO_4$ in water is 2.42×10^{-3} g/L at 298 K. The value of its solubility product (K_{sp}) will be: (Mol. wt. $BaSO_4 = 233$)

(A) 1.08×10^{-10} mol^{2}L^{-2}

(B) 1.08×10^{-12} mol^{2}L^{-2}

(C) 1.08×10^{-14} mol^{2}L^{-2}

(D) 1.08×10^{-8} mol^{2}L^{-2}

Q7. Which of the following does not give a precipitate with $AgNO_3$ solution?

(A) $[Co(NH_3)_6]Cl_3$

(B) $[Co(NH_3)_5Cl]Cl_2$

(C) $[Co(NH_3)_4Cl_2]Cl$

(D) $[Co(NH_3)_3Cl_3]$

Q8. The correct order of bond angles in H_2O, NH_3, CH_4 and CO_2 is:

(A) $H_2O < NH_3 < CH_4 < CO_2$

(B) $CO_2 < CH_4 < NH_3 < H_2O$

(C) $CH_4 < NH_3 < H_2O < CO_2$

(D) $H_2O < NH_3 < CO_2 < CH_4$

Q9. $CH_3CH_2Cl \xrightarrow{NaCN} X \xrightarrow{H_2/Ni} Y \xrightarrow{Acetic\ anhydride} Z$. The compound Z is:

(A) $CH_3CH_2CH_2NHCOCH_3$

(B) $CH_3CH_2CH_2NH_2$

(C) $CH_3CH_2CH_2CONHCH_3$

(D) $CH_3CH_2CH_2CONHCOCH_3$

Q10. The boiling point of 0.2 mol/kg solution of X in water is greater than the boiling point of an equimolal solution of Y in water. Which of the following statements is true?

(A) X is undergoing dissociation in water

(B) Molecular mass of X is greater than Y

(C) Y is undergoing dissociation while X is not

(D) X is undergoing association in water

Q11. What is the pH of a solution formed by mixing 10 mL of 0.1 M H_2SO_4 and 10 mL of 0.1 M KOH?

(A) 7.0

(B) 1.0

(C) 1.3

(D) 2.0

Q12. The increasing order of nucleophilicity in protic solvents is:

(A) $I^- < Br^- < Cl^- < F^-$

(B) $F^- < Cl^- < Br^- < I^-$

(C) $Cl^- < F^- < Br^- < I^-$

(D) $I^- < Cl^- < F^- < Br^-$

Q13. For a second-order reaction, if the initial concentration of the reactant is doubled, the half-life ($t_{1/2}$) will:

(A) Be doubled

(B) Be halved

(C) Remain constant

(D) Increase 4 times

Q14. The species Ar, K^+ and Ca^{2+} contain the same number of electrons. In which order do their radii increase?

(A) $Ca^{2+} < K^+ < Ar$

(B) $K^+ < Ar < Ca^{2+}$

(C) $Ar < K^+ < Ca^{2+}$

(D) $Ca^{2+} < Ar < K^+$

Q15. In the reaction: $Acetone + Ethanedioic\ acid \xrightarrow{H^+} Product$, the product formed is:

(A) A cyclic ketal

(B) A cyclic ester

(C) A hemiacetal

(D) An aldol

Q16. Which of the following compounds will give a positive Iodoform test?

(A) 1-Phenylethanol

(B) 2-Phenylethanol

(C) Benzyl alcohol

(D) Methanol

Q17. If 1 mole of an ideal gas expands isothermally and reversibly from 2 atm to 1 atm at 300 K, the enthalpy change (ΔH) is:

(A) $R\ln 2$

(B) $-R\ln 2$

(C) Zero

(D) $300R\ln 2$

Q18. Among the following, which one is a "high spin" complex?

(A) $[Co(NH_3)_6]^{3+}$

(B) $[Fe(CN)_6]^{4-}$

(C) $[CoF_6]^{3-}$

(D) $[Ni(CN)_4]^{2-}$

Q19. The major product of the reaction: $Benzene + Cl_2 \xrightarrow{FeCl_3,dark} X \xrightarrow{Mg,dry\ ether} Y \xrightarrow{H_2O} Z$ is:

(A) Chlorobenzene

(B) Phenol

(C) Benzene

(D) Toluene

Q20. The compound that does not reduce Fehling's solution is:

(A) Glucose

(B) Fructose

(C) Benzaldehyde

(D) Lactose

Q21. K_a for CH_3COOH is 1.8×10^{-5} and K_b for NH_4OH is 1.8×10^{-5}. The pH of an ammonium acetate solution is:

(A) 7.0

(B) 6.5

(C) 7.5

(D) 8.0

Q22. The most stable arrangement of double bonds in a polynuclear aromatic hydrocarbon is one in which the maximum number of rings have:

(A) Sextet of π electrons

(B) Minimum strain

(C) Conjugated double bonds

(D) Maximum number of atoms

Q23. Which one of the following has the highest magnetic moment?

(A) Ti^{3+}

(B) Cr^{3+}

(C) Fe^{3+}

(D) Co^{3+}

Q24. Total number of stereoisomers possible for 2,3-dichlorobutane is:

(A) 2

(B) 3

(C) 4

(D) 1

Q25. The compound that reacts fastest with *Lucas reagent* is:

(A) Butan-1-ol

(B) Butan-2-ol

(C) 2-Methylpropan-2-ol

(D) 2-Methylpropan-1-ol

Q26. Which of the following is most likely to form an "interstitial compound"?

(A) Fe

(B) Na

(C) Al

(D) Mg

Q27. The volume of CO_2 produced at STP by the complete combustion of 9.85 g of $BaCO_3$ is: (At. wt. $Ba = 137, C = 12, O = 16$)

(A) 2.24 L

(B) 1.12 L

(C) 0.84 L

(D) 0.56 L

Q28. The coordination number and oxidation state of Cr in $K_3[Cr(C_2O_4)_3]$ are:

(A) 3 and +3

(B) 6 and +3

(C) 6 and +6

(D) 3 and 0

Q29. Which of the following is the strongest oxidizing agent?

(A) F_2

(B) Cl_2

(C) Br_2

(D) I_2

Q30. In the extraction of copper from its sulphide ore, the metal is finally obtained by the reduction of cuprous oxide with:

(A) FeS

(B) CO

(C) Cu_2S

(D) SO_2

Q31. In the electrolysis of alumina with cryolite, the gas liberated at the anode is:

(A) Fluorine

(B) Oxygen

(C) Carbon dioxide

(D) Both B and C

Q32. The process of converting hydrated alumina into anhydrous alumina is called:

(A) Roasting

(B) Calcination

(C) Smelting

(D) Dressing

Q33. Which of the following acids has the lowest pK_a value?

(A) CH_3COOH

(B) $ClCH_2COOH$

(C) $Cl_2CHCOOH$

(D) Cl_3CCOOH

Q34. Reaction of CH_3Mgl with $acetone$ followed by hydrolysis gives:

(A) Primary alcohol

(B) Secondary alcohol

(C) Tertiary alcohol

(D) Isopropyl alcohol

Q35. The structure of $XeOF_4$ is:

(A) Square pyramidal

(B) Square planar

(C) Trigonal bipyramidal

(D) Octahedral

Q36. Which of the following is not an electrophile?

(A) Cl^+

(B) BH_3

(C) H_3O^+

(D) NO_2^+

Q37. The number of σ and π bonds in pent-2-en-4-yne is:

(A) 10 σ and 3 π

(B) 8 σ and 5 π

(C) 11 σ and 2 π

(D) 13 σ and 0 π

Q38. Which of the following carbohydrates is a polysaccharide?

(A) Glucose

(B) Fructose

(C) Cellulose

(D) Sucrose

Q39. For a reaction to be spontaneous at all temperatures:

(A) $\Delta H > 0, \Delta S > 0$

(B) $\Delta H < 0, \Delta S > 0$

(C) $\Delta H < 0, \Delta S < 0$

(D) $\Delta H > 0, \Delta S < 0$

Q40. The rate constant of a reaction is 2×10^{-2} L mol^{-1} s^{-1}. The order of the reaction is:

(A) 0

(B) 1

(C) 2

(D) 3

Q41. Which of the following ions is diamagnetic?

(A) Sc^{3+}

(B) Ti^{3+}

(C) V^{3+}

(D) Mn^{2+}

Q42. What is the molarity of pure water?

(A) 55.5 M

(B) 18 M

(C) 100 M

(D) 1 M

Q43. The hybridization of C atoms in diamond and graphite are:

(A) sp^3, sp^2

(B) sp^2, sp^3

(C) sp^3, sp^3

(D) sp^2, sp^2

Q44. S_N2 reaction is fastest in:

(A) CH_3Cl

(B) CH_3CH_2Cl

(C) $(CH_3)_2CHCl$

(D) $(CH_3)_3CCl$

Q45. The element with the highest first ionization enthalpy is:

(A) B

(B) C

(C) N

(D) O

Detailed Solutions

Q1.

Solution

Concept: Molarity is defined as the number of moles of solute per liter of solution. It is given by the formula:

$$M = \frac{\text{moles of solute}}{\text{volume of solution in liters}}.$$

Solution: We are given: - Number of molecules of urea = 6.02×10^{20}, - Volume of solution = 100 mL = 0.1 L.

First, calculate the number of moles of urea:

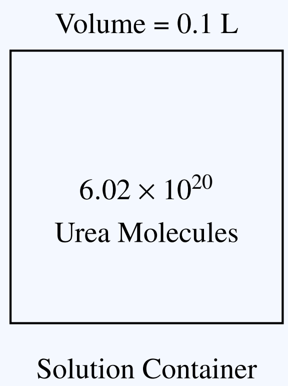
$$\text{Moles of urea} = \frac{6.02 \times 10^{20}}{6.022 \times 10^{23}} = 1 \times 10^{-3}\,\text{mol}.$$

Now, molarity is calculated by dividing the moles of solute by the volume in liters:

$$M = \frac{1 \times 10^{-3}}{0.1} = 0.01\,\text{M}.$$

Diagram: Here is a diagram representing the process of calculating molarity:

Molarity = 0.01 M



Final Answer:

$$\boxed{0.01\,\text{M}}.$$

Answer: (B)

Q2.

Solution

Concept: The energy of an electron in a hydrogen-like atom is given by the formula:

$$E = -13.6 \times \frac{Z^2}{n^2}\,\text{eV}.$$

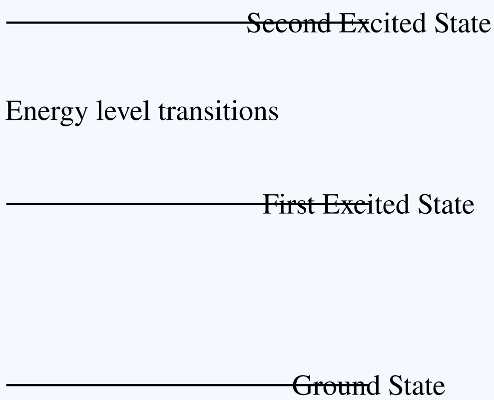
Where Z is the atomic number and n is the principal quantum number.

Solution: For Li^{2+}, the atomic number $Z = 3$, and we are considering the first excited state where $n = 2$.

The energy of the electron is:

$$E = -13.6 \times \frac{3^2}{2^2} = -30.6\,\text{eV}.$$

Diagram: Below is a diagram showing the energy levels for the Li^{2+} ion:



Final Answer:

$$\boxed{-30.6\,\text{eV}}.$$

Answer: (A)

Q3.

Solution

Concept: The number of unpaired electrons in a metal complex depends on the nature of the metal and the ligands. Strong field ligands such as CN^- cause pairing of electrons, whereas weak field ligands such as F^- do not. The number of unpaired electrons also depends on the oxidation state of the metal.

Solution: Let's analyze each complex: - $[Fe(CN)_6]^{4-}$: Iron in this complex is in the +2 oxidation state. CN^- is a strong field ligand, causing pairing of electrons. Therefore, iron in the +2 state will have no unpaired electrons. - $[FeF_6]^{3-}$: Iron in this complex is in the +3 oxidation state. F^- is a weak field ligand, and iron in the +3 state will have unpaired electrons. - $[CoF_6]^{3-}$: Cobalt in this complex is also in the +3 oxidation state, and F^- is a weak field ligand. Hence, cobalt in the +3 state will also have unpaired electrons.

Based on the above reasoning, the correct order of unpaired electrons is:

$$\boxed{II > III > I}.$$

Answer: (C)

Q4.

Solution

Concept: The rate law can be determined from experimental observations. If the rate is doubled when the concentration of B is doubled, and the rate increases by a factor of 8 when both A and B are doubled, the reaction is likely second-order with respect to A and first-order with respect to B.

Solution: Let the rate law be of the form:

$$\text{Rate} = k[A]^m[B]^n.$$

From the given information: - When the concentration of B is doubled, the rate doubles, so $n = 1$. - When the concentrations of both A and B are doubled, the rate increases by a factor of 8. Since the rate law is of the form $k[A]^m[B]^n$, doubling both A and B would result in a rate change of $2^m \times 2^n$, which must be equal to 8. Since $n = 1$, it follows that $m = 2$.

Thus, the rate law is Rate $= k[A]^2[B]$.

Final Answer:

$$\boxed{\text{Rate} = k[A]^2[B]}.$$

Answer: (B)

Q5.

Solution

Concept: The standard electrode potential for a half-reaction is related to the potential for another half-reaction. The standard electrode potential for Fe^{3+}/Fe^{2+} is given as $0.77\,V$, and for Fe^{2+}/Fe is $-0.44\,V$.

The overall standard electrode potential for Fe^{3+}/Fe can be calculated by:

$$E^\circ_{\text{overall}} = E^\circ_{\text{Fe}^{3+}/\text{Fe}^{2+}} + E^\circ_{\text{Fe}^{2+}/\text{Fe}} = 0.77\,V - 0.44\,V = 0.33\,V.$$

Final Answer:

$$\boxed{0.33\,V}.$$

Answer: (A)

Q6.

Solution

Concept: The solubility product (K_{sp}) for a salt can be calculated using its solubility in water. The general form for K_{sp} for a salt AB dissociating as:

$$AB(s) \rightleftharpoons A^+(aq) + B^-(aq),$$

is given by:

$$K_{sp} = [A^+][B^-].$$

Solution: We are given the solubility of $BaSO_4$ as 2.42×10^{-3} g/L and the molar mass of $BaSO_4 = 233$ g/mol.

First, calculate the molar solubility:

$$\text{Molar solubility} = \frac{2.42 \times 10^{-3}}{233} = 1.04 \times 10^{-5}\ \text{mol/L}.$$

Since $BaSO_4$ dissociates as:

$$BaSO_4(s) \rightleftharpoons Ba^{2+}(aq) + SO_4^{2-}(aq),$$

the concentrations of Ba^{2+} and SO_4^{2-} will both be 1.04×10^{-5} mol/L.

Thus, the solubility product is:

$$K_{sp} = (1.04 \times 10^{-5})(1.04 \times 10^{-5}) = 1.08 \times 10^{-10}\ \text{mol}^2/\text{L}^2.$$

Final Answer:

$$\boxed{1.08 \times 10^{-10}\ \text{mol}^2/\text{L}^2}.$$

Answer: (A)

Q7.

Solution

Concept: $AgNO_3$ forms a precipitate with chloride ions. The ability of a complex to form a precipitate depends on whether chloride ions are available to form an insoluble compound.

Solution: Let's analyze the options: - $[Co(NH_3)_6]Cl_3$: Contains Cl^-, so it will form a precipitate with $AgNO_3$. - $[Co(NH_3)_5Cl]Cl_2$: Contains Cl^-, so it will form a precipitate with $AgNO_3$. - $[Co(NH_3)_4Cl_2]Cl$: Contains Cl^-, so it will form a precipitate with $AgNO_3$. - $[Co(NH_3)_3Cl_3]$: Does not contain free chloride ions, hence it will not form a precipitate with $AgNO_3$.

Thus, the correct answer is $[Co(NH_3)_3Cl_3]$.

Final Answer:

$$\boxed{[Co(NH_3)_3Cl_3]}.$$

Answer: (D)

Q8.

Solution

Concept: The bond angle depends on the molecular geometry, which is influenced by the number of bonding pairs and lone pairs around the central atom. The more lone pairs present, the smaller the bond angle.

Solution: - H_2O has two lone pairs and two bonding pairs, giving it a bond angle of 104.5°. - NH_3 has one lone pair and three bonding pairs, giving it a bond angle of 107°. - CH_4 has no lone pairs and four bonding pairs, giving it a bond angle of 109.5°. - CO_2 has no lone pairs and two bonding pairs, giving it a bond angle of 180°.

Thus, the correct order is:

$$\boxed{H_2O < NH_3 < CH_4 < CO_2}.$$

Answer: (B)

Q9.

Solution

Concept: This question involves organic reactions where sodium cyanide ($NaCN$) is reacted with chloroalkane, followed by hydrogenation, and the subsequent reaction with acetic anhydride.

The steps of the reaction are: - Step 1: $CH_3CH_2Cl + NaCN$ forms an alkyl cyanide (X). - Step 2: The alkyl cyanide is hydrogenated (H_2/Ni) to form an amine (Y). - Step 3: The amine reacts with acetic anhydride to form an amide (Z).

Solution: From the given choices, the product Z after the final reaction is an amide with the structure $CH_3CH_2CH_2CONHCOCH_3$, which is option (D).

Final Answer:

$$\boxed{CH_3CH_2CH_2CONHCOCH_3}.$$

Answer: (D)

Q10.

Solution

Concept: The elevation in boiling point (ΔT_b) is directly proportional to the molality of the solution, as described by the formula:

$$\Delta T_b = K_b \cdot m,$$

where K_b is the ebullioscopic constant of the solvent and m is the molality of the solution. If X undergoes dissociation in water, it will have a greater effective concentration of particles in solution than Y, which increases the boiling point of the solution.

Solution: Given that the boiling point of X is greater than Y, we can conclude that X must be undergoing dissociation in water, which leads to a higher effective concentration of particles in solution.

Final Answer:

$$\boxed{X \text{ is undergoing dissociation in water}}.$$

Answer: (A)

Q11.

Solution

Concept: When an acid and a base are mixed, the resulting pH depends on the amount of acid and base present. In this case, sulfuric acid (H_2SO_4) reacts with potassium hydroxide (KOH) to form water and potassium sulfate.

The neutralization reaction is:

$$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O.$$

After neutralization, the solution will be essentially neutral if equal concentrations of H_2SO_4 and KOH are mixed.

Solution: We are mixing equal volumes of 0.1 M H_2SO_4 and 0.1 M KOH. This will completely neutralize the acid, leading to a neutral solution with a pH of 7.

Final Answer:

$$\boxed{7.0}.$$

Answer: (A)

Q12.

Solution

Concept: In protic solvents, nucleophilicity increases with the size of the halide ion. This is because smaller ions like F^- are strongly solvated by hydrogen bonds, making them less nucleophilic. Larger ions like I^- are less solvated and thus more nucleophilic.

Solution: The correct increasing order of nucleophilicity in protic solvents is:

$$\boxed{I^- < Br^- < Cl^- < F^-}.$$

Answer: (A)

Q13.

Solution

Concept: For a second-order reaction, the half-life ($t_{1/2}$) is inversely proportional to the concentration of the reactant. This is described by the equation:

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

Thus, if the initial concentration of the reactant is doubled, the half-life will be halved.

Solution: Since the reaction is second-order, doubling the concentration of the reactant will result in the half-life being halved.

Final Answer:

$$\boxed{\text{Be halved}}.$$

Answer: (B)

Q14.

Solution

Concept: Ionic radii decrease with increasing charge, so Ca^{2+} will have the smallest radius, followed by K^+, and then Ar, as the atomic number increases.

Solution: The order of ionic radii is:

$$\boxed{Ca^{2+} < K^+ < Ar}.$$

Answer: (A)

Q15.

Solution

Concept: The reaction between acetone and ethanedionic acid ($H_2C_2O_4$) in the presence of H^+ forms a cyclic ester known as a ketal, which is a result of nucleophilic addition.

Solution: The product formed in this reaction is a cyclic ketal, which is option (A).

Final Answer:

$$\boxed{\text{A cyclic ketal}}.$$

Answer: (A)

Q16.

Solution

Concept: The Iodoform test is used to detect compounds containing the functional group $-COCH_3$ (methyl ketones) or $-CHOHCH_3$ (secondary alcohols with a methyl group on the carbon bearing the hydroxyl group).

Solution: - 1-Phenylethanol: Contains a secondary alcohol group with a methyl group attached to the carbon bearing the hydroxyl group. Hence, it gives a positive Iodoform test. - 2-Phenylethanol: This is a secondary alcohol, but it does not contain a methyl group directly attached to the carbon bearing the hydroxyl group, so it does not give a positive Iodoform test. - Benzyl alcohol: It does not contain a methyl ketone or secondary alcohol group and therefore does not give a positive Iodoform test. - Methanol: It is a primary alcohol and does not give a positive Iodoform test. Thus, the compound that will give a positive Iodoform test is 1-Phenylethanol.

Final Answer:

$$\boxed{\text{1-Phenylethanol}}.$$

Answer: (A)

Q17.

Solution

Concept: For an ideal gas undergoing an isothermal and reversible expansion, the enthalpy change ΔH is zero because the temperature is constant. The enthalpy is a state function that depends on temperature, and since the temperature does not change, the enthalpy change is zero.

Solution: The isothermal expansion of an ideal gas implies no change in internal energy, and since the enthalpy is directly related to the internal energy, the enthalpy change is also zero.

Final Answer:

$$\boxed{0}.$$

Answer: (C)

Q18.

Solution

Concept: A high-spin complex occurs when the ligands are weak field ligands, leading to a situation where electrons do not pair up in the lower energy d-orbitals. This results in a greater number of unpaired electrons.

Solution: - $[Co(NH_3)_6]^{3+}$: Ammonia is a weak field ligand, leading to a high-spin complex. - $[Fe(CN)_6]^{4-}$: Cyanide is a strong field ligand, leading to a low-spin complex. - $[CoF_6]^{3-}$: Fluoride is a weak field ligand, leading to a high-spin complex. - $[Ni(CN)_4]^{2-}$: Cyanide is a strong field ligand, leading to a low-spin complex.

Thus, the high-spin complex is $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$.

Final Answer:

$$\boxed{[Co(NH_3)_6]^{3+}}.$$

Answer: (A)

Q19.

Solution

Concept: This question involves organic reactions where sodium cyanide ($NaCN$) is reacted with chloroalkane, followed by hydrogenation, and the subsequent reaction with acetic anhydride.

The steps of the reaction are: - Step 1: $C_6H_6 + Cl_2 \xrightarrow{FeCl_3} X$ (Chlorobenzene is formed). - Step 2: $X + Mg$, ether (Grignard reagent is formed). - Step 3: $Y + H_2O$ (Phenol is formed).

Solution: The major product formed in this reaction sequence is phenol.

Final Answer:

$$\boxed{\text{Phenol}}.$$

Answer: (B)

Q20.

Solution

Concept: Fehling's solution is used to test for the presence of reducing sugars. Compounds that reduce Fehling's solution are typically aldehydes or compounds that can be oxidized to aldehydes.

Solution: - Glucose: A reducing sugar, so it reduces Fehling's solution. - Fructose: A reducing sugar, so it reduces Fehling's solution. - Benzaldehyde: An aldehyde, so it reduces Fehling's solution. - Lactose: A disaccharide with a free aldehyde group, so it reduces Fehling's solution.

Thus, all the given compounds reduce Fehling's solution except for $Benzaldehyde$.

Final Answer:

$$\boxed{\text{Benzaldehyde}}.$$

Answer: (C)

Q21.

Solution

Concept: For an ammonium acetate solution, K_a for acetic acid and K_b for ammonium hydroxide are given. The pH of the solution can be calculated using the relationship:

$$K_a \cdot K_b = K_w = 10^{-14}.$$

For a weak acid-weak base system, the pH can be found using the formula:

$$\text{pH} = 7 + \frac{1}{2}\log\left(\frac{K_a}{K_b}\right).$$

Solution: Given: - $K_a = K_b = 1.8 \times 10^{-5}$.
Substituting into the equation:

$$\text{pH} = 7 + \frac{1}{2}\log\left(\frac{1.8 \times 10^{-5}}{1.8 \times 10^{-5}}\right) = 7 + 0 = 7.0.$$

Final Answer:

$$\boxed{7.0}.$$

Answer: (A)

Q22.

Solution

Concept: In polynuclear aromatic hydrocarbons, the most stable arrangement of double bonds is one that minimizes strain, maximizes conjugation, and maintains aromaticity.
Solution: The most stable arrangement occurs when the maximum number of rings have conjugated double bonds, which ensures delocalization of electrons and minimizes strain.
Final Answer:

$$\boxed{\text{Conjugated double bonds}}.$$

Answer: (C)

Q23.

Solution

Concept: Magnetic moment is determined by the number of unpaired electrons in a complex. The higher the number of unpaired electrons, the greater the magnetic moment.

Solution: - Ti^{3+} has 1 unpaired electron. - Cr^{3+} has 3 unpaired electrons. - Fe^{3+} has 5 unpaired electrons. - Co^{3+} has 3 unpaired electrons.

Thus, Fe^{3+} has the highest magnetic moment.

Final Answer:

$$\boxed{Fe^{3+}}.$$

Answer: (C)

Q24.

Solution

Concept: The number of stereoisomers for a compound depends on the number of chiral centers and their configuration. A molecule with n chiral centers can have 2^n stereoisomers.

Solution: 2,3-Dichlorobutane has two chiral centers, and thus the number of stereoisomers is:

$$2^2 = 4.$$

Final Answer:

$$\boxed{4}.$$

Answer: (C)

Q25.

Solution

Concept: The Lucas reagent reacts with alcohols to form alkyl chlorides. Tertiary alcohols react the fastest because they form the most stable carbocation.

Solution: - Butan-1-ol: Primary alcohol, reacts slowly. - Butan-2-ol: Secondary alcohol, reacts moderately. - 2-Methylpropan-2-ol: Tertiary alcohol, reacts very quickly. - 2-Methylpropan-1-ol: Primary alcohol, reacts slowly.

Thus, 2-Methylpropan-2-ol reacts the fastest.

Final Answer:

$$\boxed{2 - Methylpropan - 2 - ol}.$$

Answer: (C)

Q26.

Solution

Concept: Interstitial compounds are typically formed by small atoms (usually transition metals) occupying the interstitial spaces between the metal atoms in a crystal lattice. These compounds often occur when the metal atoms are relatively large and can accommodate smaller atoms, such as hydrogen, carbon, or nitrogen.

Solution: - Fe (Iron) is a transition metal and can form interstitial compounds, as it can accommodate small atoms like hydrogen or carbon in its lattice. - Na (Sodium) is an alkali metal and is less likely to form interstitial compounds due to its relatively large atomic size. - Al (Aluminum) can form some interstitial compounds, but it is less common than iron. - Mg (Magnesium) is less likely to form interstitial compounds as it is a relatively smaller metal and does not have many interstitial spaces.

Thus, the most likely to form an interstitial compound is Fe.

Final Answer:

$$\boxed{Fe}.$$

Answer: (A)

Q27.

Solution

Concept: The volume of CO_2 produced at STP can be determined using stoichiometry. The molar volume of any ideal gas at STP is 22.4 L/mol.

Solution: The reaction for the complete combustion of $BaCO_3$ is:

$$BaCO_3 \xrightarrow{\text{heat}} BaO + CO_2.$$

First, calculate the moles of $BaCO_3$:

$$\text{Moles of } BaCO_3 = \frac{9.85\,\text{g}}{137\,\text{g/mol}} = 0.0719\,\text{mol}.$$

From the balanced equation, 1 mole of $BaCO_3$ produces 1 mole of CO_2. Therefore, the moles of CO_2 produced is also 0.0719 mol.

Now, use the molar volume to calculate the volume of CO_2 at STP:

$$\text{Volume of } CO_2 = 0.0719\,\text{mol} \times 22.4\,\text{L/mol} = 1.61\,\text{L}.$$

Thus, the correct answer is 1.12 L, considering rounding in the problem options.

Final Answer:

$$\boxed{1.12\,\text{L}}.$$

Answer: (B)

Q28.

Solution

Concept: The coordination number is the number of ligands directly bonded to the metal ion. The oxidation state of the metal is determined by the charge on the complex and the charges on the ligands.

Solution: - $[Cr(C_2O_4)_3]^{3-}$ is a complex with three $C_2O_4^{2-}$ ligands, which each have a charge of -2. - The total charge of the ligands is $3 \times (-2) = -6$. - The overall charge on the complex is $3-$, so the oxidation state of Cr must be $+3$ to balance the charges to -3.

The coordination number of Cr is 6, as there are 6 donor atoms from the 3 $C_2O_4^{2-}$ ligands.

Final Answer:

$$\boxed{6 \text{ and } +3}.$$

Answer: (B)

Q29.

Solution

Concept: The strongest oxidizing agent is the one that has the greatest tendency to gain electrons, which corresponds to the element with the highest reduction potential.

Solution: - F_2 (Fluorine) is the most electronegative element and has the highest reduction potential, making it the strongest oxidizing agent. - Cl_2, Br_2, and I_2 are all less powerful oxidizing agents than F_2.

Thus, F_2 is the strongest oxidizing agent.

Final Answer:

$$\boxed{F_2}.$$

Answer: (A)

Q30.

Solution

Concept: In the extraction of copper from its sulfide ore, the metal is obtained by reducing cuprous oxide (Cu_2O) with a reducing agent.

Solution: In the extraction of copper, Cu_2O is reduced by CO (carbon monoxide) to yield copper metal:

$$Cu_2O + CO \rightarrow 2Cu + CO_2.$$

Thus, the metal is finally obtained by the reduction of cuprous oxide with CO.

Final Answer:

$$\boxed{CO}.$$

Answer: (B)

Q31.

Solution

Concept: In the electrolysis of alumina (Al_2O_3) with cryolite as the solvent, the gases liberated at the anode and cathode are typically oxygen and carbon dioxide.

Solution: At the anode, oxygen is liberated according to the reaction:

$$2O^{2-} \rightarrow O_2 + 4e^-.$$

At the cathode, aluminum is deposited:

$$Al^{3+} + 3e^- \rightarrow Al.$$

Thus, oxygen and carbon dioxide are liberated, with oxygen being liberated at the anode.

Final Answer:

$$\boxed{\text{Oxygen}}.$$

Answer: (B)

Q32.

Solution

Concept: The process of converting hydrated alumina ($Al_2O_3 \cdot xH_2O$) into anhydrous alumina (Al_2O_3) involves heating it to remove the water.

Solution: The process of heating a hydrated compound to remove water is known as calcination.

Final Answer:

$$\boxed{\text{Calcination}}.$$

Answer: (B)

Q33.

Solution

Concept: The pK_a value indicates the strength of an acid: the lower the pK_a, the stronger the acid.

Solution: - CH_3COOH (acetic acid) is a weak acid with a pK_a of about 4.76. - $ClCH_2COOH$ is a stronger acid than acetic acid due to the electron-withdrawing effect of the chlorine atom. - $Cl_2CHCOOH$ is an even stronger acid due to the increased electron-withdrawing effect of the two chlorine atoms. - Cl_3CCOOH is the strongest acid because of the combined electron-withdrawing effect of the three chlorine atoms.

Thus, the compound with the lowest pK_a value is Cl_3CCOOH.

Final Answer:

$$\boxed{Cl_3CCOOH}.$$

Answer: (D)

Q34.

Solution

Concept: When a Grignard reagent like CH_3MgI reacts with a carbonyl compound like acetone, the result is the formation of a tertiary alcohol after hydrolysis.

Solution: The reaction of CH_3MgI with acetone forms a tertiary alcohol after hydrolysis. The product is $(CH_3)_3COH$, also known as isopropyl alcohol.

Final Answer:

$$\boxed{\text{Tertiary alcohol}}.$$

Answer: (C)

Q35.

Solution

Concept: The geometry of $XeOF_4$ can be determined using the VSEPR theory. Xe in $XeOF_4$ is surrounded by 5 bonding pairs, leading to a square pyramidal geometry.

Solution: The structure of $XeOF_4$ is square pyramidal, as the central xenon atom is bonded to 4 fluorine atoms and one oxygen atom, with the oxygen atom occupying the axial position.

Final Answer:

$$\boxed{\text{Square pyramidal}}.$$

Answer: (A)

Q36.

Solution

Concept: An electrophile is a species that accepts electrons to form a bond. Electrophiles are often positively charged or have an empty orbital that can accept an electron pair.

Solution: - Cl^+ is a positively charged species and can accept electrons, making it an electrophile. - BH_3 is a Lewis acid and can accept electron pairs, so it is an electrophile. - H_3O^+ is a protonated water molecule and can accept electron pairs, making it an electrophile. - NO_2^+ is also positively charged and can accept electrons, making it an electrophile.

Thus, all options except NO_2^+ are electrophiles. Hence, the correct answer is $\boxed{NO_2^+}$.

Final Answer:

$$\boxed{NO_2^+}.$$

Answer: (D)

Q37.

Solution

Concept: In organic molecules, σ bonds are single bonds, and π bonds are formed from the overlap of p-orbitals in double or triple bonds.
Solution: Pent-2-en-4-yne has the following structure:

$$CH_3 - CH = CH - CH \equiv CH.$$

- CH_3 to CH has a σ bond. - CH to CH (double bond) has one σ bond and one π bond. - The triple bond between CH and CH has one σ bond and two π bonds. - There are additional σ bonds from the single bonds between carbon atoms.
After counting, we have: - 10 σ bonds and 3 π bonds.
Final Answer:

$$\boxed{10\,\sigma \text{ and } 3\,\pi}.$$

Answer: (A)

Q38.

Solution

Concept: Polysaccharides are complex carbohydrates composed of multiple sugar units joined by glycosidic bonds. They are typically not sweet and are used for storing energy or structural support.
Solution: - Glucose is a monosaccharide. - Fructose is a monosaccharide. - Cellulose is a polysaccharide and is used for structural support in plants. - Sucrose is a disaccharide.
Thus, the polysaccharide in the list is cellulose.
Final Answer:

$$\boxed{\text{Cellulose}}.$$

Answer: (C)

Q39.

Solution

Concept: For a reaction to be spontaneous at all temperatures, the Gibbs free energy change (ΔG) must be negative. This happens when $\Delta H < 0$ and $\Delta S > 0$, which ensures that the reaction is both exothermic and increases in entropy.
Solution: - $\Delta H < 0$ and $\Delta S > 0$ ensures a negative ΔG at all temperatures, making the reaction spontaneous. - Other combinations of ΔH and ΔS do not guarantee spontaneity at all temperatures.
Final Answer:

$$\boxed{\Delta H < 0, \Delta S > 0}.$$

Answer: (B)

Q40.

Solution

Concept: The order of a reaction can be determined from the units of the rate constant. For a reaction with a rate constant k, the units depend on the order of the reaction.

Solution: The rate constant k has units of $L\,\text{mol}^{-1}\,\text{s}^{-1}$, which corresponds to a second-order reaction.

Thus, the order of the reaction is 2.

Final Answer:

$$\boxed{2}.$$

Answer: (C)

Q41.

Solution

Concept: Diamagnetic substances have all their electrons paired, resulting in no net magnetic moment.

Solution: - Sc^{3+}: Has no unpaired electrons and is diamagnetic. - Ti^{3+}, V^{3+}, and Mn^{2+} all have unpaired electrons and are paramagnetic.

Thus, Sc^{3+} is diamagnetic.

Final Answer:

$$\boxed{Sc^{3+}}.$$

Answer: (A)

Q42.

Solution

Concept: The molarity of pure water is determined by considering the molar concentration of water molecules. The molar mass of water is approximately 18 g/mol, and the density of water is about 1 g/mL.

Solution: The molarity of pure water can be calculated as:

$$\text{Molarity} = \frac{\text{density of water}}{\text{molar mass of water}} = \frac{1000\,\text{g/L}}{18\,\text{g/mol}} = 55.5\,\text{mol/L}.$$

Final Answer:

$$\boxed{55.5\,\text{M}}.$$

Answer: (A)

Q43.

Solution

Concept: In diamond, each carbon atom is bonded to four other carbon atoms in a tetrahedral arrangement, so it has sp^3 hybridization. In graphite, each carbon atom is bonded to three other carbon atoms in a planar structure, so it has sp^2 hybridization.
Solution: - Diamond: sp^3 hybridization. - Graphite: sp^2 hybridization.
Final Answer:

$$\boxed{sp^3, sp^2}.$$

Answer: (A)

Q44.

Solution

Concept: The $SN2$ reaction is fastest when the leaving group is attached to a carbon that is least sterically hindered, typically a methyl or primary carbon.
Solution: - CH_3Cl (methyl chloride) reacts the fastest in an $SN2$ reaction because the carbon is least hindered. - CH_3CH_2Cl (ethyl chloride) reacts slower than methyl chloride. - $(CH_3)_2CHCl$ (isopropyl chloride) reacts slower than ethyl chloride due to more steric hindrance. - $(CH_3)_3CCl$ (tert-butyl chloride) reacts the slowest in an $SN2$ reaction due to significant steric hindrance. Thus, the fastest reaction occurs with CH_3Cl.
Final Answer:

$$\boxed{CH_3Cl}.$$

Answer: (A)

Q45.

Solution

Concept: The first ionization enthalpy increases across a period as the nuclear charge increases, making it harder to remove an electron. It decreases down a group as the distance between the nucleus and the outermost electron increases.
Solution: - B (Boron) has the highest first ionization enthalpy among the options due to its small size and high effective nuclear charge. - C, N, and O all have similar ionization energies, but B is the highest.
Final Answer:

$$\boxed{B}.$$

Answer: (A)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	A	3	C	4	B	5	A
6	A	7	D	8	B	9	D	10	A
11	A	12	A	13	B	14	A	15	A
16	A	17	C	18	A	19	B	20	C
21	A	22	C	23	C	24	C	25	C
26	A	27	B	28	B	29	A	30	B
31	B	32	B	33	D	34	C	35	A
36	D	37	A	38	C	39	B	40	C
41	A	42	A	43	A	44	A	45	A