NEET-UG Chemistry Sample Paper-8

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. What is the mass of the precipitate formed when 50 mL of 16.9% (w/v) solution of $AgNO_3$ is mixed with 50 mL of 5.8% (w/v) NaCl solution? (Ag = 107.8, N = 14, O = 16, Na = 23, Cl = 35.5)

(A) 7.0 g

(B) 14.0 g

(C) 28.0 g

(D) 3.5 g

Q2. The number of angular nodes and radial nodes for a 4d orbital are respectively:

(A) 2 and 1

(B) 1 and 2

(C) 3 and 0

(D) 2 and 2

Q3. For emission line of atomic hydrogen from $n_i = 8$ to $n_f = n$, the plot of wave number ($\bar{\nu}$) against $\frac{1}{n^2}$ will be: (The Rydberg constant, R_H is in wave number unit)

(A) Linear with slope $-R_H$

(B) Linear with intercept $-R_H$

(C) Non-linear

(D) Linear with slope R_H

Q4. Which of the following pairs of species have the same bond order?

(A) O_2, NO^+

(B) CN^-, CO

(C) N_2, O_2^-

(D) CO, NO

Q5. Which of the following molecules represents the order of hybridization sp^2, sp^2, sp, sp from left to right atoms?

(A) $HC \equiv C - C \equiv CH$

(B) $CH_2 = CH - C \equiv CH$

(C) $CH_2 = CH - CH = CH_2$

(D) $CH_3 - CH = CH - CH_3$

Q6. Among the following, the maximum covalent character is shown by the compound:

(A) $FeCl_2$

(B) $SnCl_2$

(C) $AlCl_3$

(D) $MgCl_2$

Q7. Match the type of interaction in Column I with the distance dependence of their interaction energy in Column II:

(I) Ion-ion	(a) $1/r$
(II) Dipole-dipole	(b) $1/r^2$
(III) London dispersion	(c) $1/r^3$
(IV) Ion-dipole	(d) $1/r^6$

(A) I-a, II-c, III-d, IV-b

(B) I-a, II-b, III-c, IV-d

(C) I-b, II-c, III-d, IV-a

(D) I-a, II-d, III-c, IV-b

Q8. For a given reaction, $\Delta H = 35.5$ kJ mol^{-1} and $\Delta S = 83.6$ J K^{-1}mol^{-1}. The reaction is spontaneous at: (Assume that ΔH and ΔS do not vary with temperature)

(A) $T > 425$ K

(B) All temperatures

(C) $T > 298$ K

(D) $T < 425$ K

Q9. The correct thermodynamic conditions for the spontaneous reaction at all temperatures is:

(A) $\Delta H > 0$ and $\Delta S < 0$

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

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

(D) $\Delta H > 0$ and $\Delta S > 0$

Q10. If the molality of the dilute solution is doubled, the value of molal depression constant (K_f) will be:

(A) Halved

(B) Tripled

(C) Unchanged

(D) Doubled

Q11. The freezing point depression constant (K_f) of benzene is 5.12 K kg mol^{-1}. The freezing point depression for the solution of molality 0.078 m containing a non-electrolyte solute in benzene is:

(A) 0.20 K

(B) 0.80 K

(C) 0.40 K

(D) 0.60 K

Q12. The solubility of AgCl (s) with solubility product 1.6×10^{-10} in 0.1 M NaCl solution would be:

(A) 1.26×10^{-5} M

(B) 1.6×10^{-9} M

(C) 1.6×10^{-11} M

(D) 1.26×10^{-15} M

Q13. In which of the following reactions, the equilibrium remains unaffected on addition of small amount of argon at constant volume?

(A) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

(B) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

(C) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

(D) All of the above

Q14. The number of Faradays (F) required to produce 20 g of calcium from molten $CaCl_2$ (Atomic mass of Ca = 40 g mol^{-1}) is:

(A) 1

(B) 2

(C) 3

(D) 4

Q15. Given:

$E^\circ_{Cr^{3+}/Cr} = -0.74$ V; $E^\circ_{MnO_4^-/Mn^{2+}} = 1.51$ V

$E^\circ_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33$ V; $E^\circ_{Cl/Cl^-} = 1.36$ V

Based on the data given above, strongest oxidizing agent is:

(A) Cl

(B) Cr^{3+}

(C) Mn^{2+}

(D) MnO_4^-

Q16. For a first-order reaction $A \rightarrow$ Products, initial concentration of A is 0.1 M, which becomes 0.001 M after 5 minutes. Rate constant for the reaction in min^{-1} is:

(A) 0.9212

(B) 0.4606

(C) 0.2303

(D) 1.3818

Q17. The rate of a reaction quadruples when the temperature changes from 293 K to 313 K. The energy of activation of the reaction assuming that it does not change with temperature is: ($R = 8.314$ J $K^{-1}mol^{-1}$)

(A) 52.8 kJ mol^{-1}

(B) 32.2 kJ mol^{-1}

(C) 42.6 kJ mol^{-1}

(D) 64.4 kJ mol^{-1}

Q18. The correct order of the decreasing ionic radii among the following isoelectronic species is:

(A) $Ca^{2+} > K^+ > S^{2-} > Cl^-$

(B) $Cl^- > S^{2-} > Ca^{2+} > K^+$

(C) $S^{2-} > Cl^- > K^+ > Ca^{2+}$

(D) $K^+ > Ca^{2+} > Cl^- > S^{2-}$

Q19. Identify the incorrect statement related to PCl_5 from the following:

(A) PCl_5 molecule is non-reactive.

(B) Three equatorial P-Cl bonds make an angle of 120° with each other.

(C) Two axial P-Cl bonds make an angle of 180° with each other.

(D) Axial P-Cl bonds are longer than equatorial P-Cl bonds.

Q20. Which of the following oxoacids of phosphorus has reducing property?

(A) H_3PO_4

(B) H_3PO_3

(C) $H_4P_2O_7$

(D) HPO_3

Q21. Noble gases are named because of their inertness towards reactivity. Identify an incorrect statement about them.

(A) Noble gases have very high melting and boiling points.

(B) Noble gases have weak dispersion forces.

(C) Noble gases have large positive values of electron gain enthalpy.

(D) Noble gases are sparingly soluble in water.

Q22. Which of the following statements related to lanthanons is incorrect?

(A) Europium shows +2 oxidation state.

(B) The basicity decreases as the ionic radius decreases from Pr to Lu.

(C) All the lanthanons are much more reactive than aluminium.

(D) Ce^{4+} solutions are widely used as oxidizing agents in volumetric analysis.

Q23. The calculated spin-only magnetic moment of Cr^{2+} ion is:

(A) 3.87 BM

(B) 4.90 BM

(C) 5.92 BM

(D) 2.84 BM

Q24. Interstitial compounds are formed when small atoms are trapped inside the crystal lattice of metals. Which of the following is not the characteristic property of interstitial compounds?

(A) They have high melting points, higher than those of pure metals.

(B) They are very hard.

(C) They retain metallic conductivity.

(D) They are chemically very reactive.

Q25. The crystal field stabilization energy (CFSE) for $[CoCl_6]^{4-}$ is 18000 cm^{-1}. The CFSE for $[CoCl_4]^{2-}$ will be:

(A) 18000 cm^{-1}

(B) 16000 cm^{-1}

(C) 8000 cm^{-1}

(D) 20000 cm^{-1}

Q26. Which of the following complexes is used to be as an anticancer agent?

(A) mer-$[Co(NH_3)_3Cl_3]$

(B) cis-$[PtCl_2(NH_3)_2]$

(C) cis-$K_2[PtCl_2Br_2]$

(D) Na_2CoCl_4

Q27. The correct IUPAC name of $[Pt(NH_3)_2Cl_2]$ is:

(A) Diamminedichloridoplatinum(II)

(B) Diamminedichloridoplatinum(IV)

(C) Diamminedichloridoplatinate(II)

(D) Dichloridodiammineplatinum(II)

Q28. In Dumas' method for estimation of nitrogen, 0.25 g of an organic compound gave 40 mL of nitrogen collected at 300 K temperature and 725 mm pressure. If the aqueous tension at 300 K is 25 mm, the percentage of nitrogen in the compound is:

(A) 16.76

(B) 15.76

(C) 17.36

(D) 18.20

Q29. Which of the following is the most stable carbocation?

(A) $(CH_3)_3C^+$

(B) $CH_2 = CH - CH_2^+$

(C) $C_6H_5 - CH_2^+$

(D) $CH_3 - CH_2^+$

Q30. The correct order of acid strength is:

(A) Phenol < p-cresol < p-nitrophenol < p-chlorophenol

(B) p-cresol < phenol < p-chlorophenol < p-nitrophenol

(C) p-nitrophenol < p-chlorophenol < phenol < p-cresol

(D) Phenol < p-chlorophenol < p-nitrophenol < p-cresol

Q31. The non-aromatic compound among the following is:

(A) Cyclopentadienyl anion

(B) Cycloheptatrienyl cation

(C) Benzene

(D) Cyclopentadienyl cation

Q32. Which of the following reactions will not result in the formation of a carbon-carbon bond?

(A) Reimer-Tiemann reaction

(B) Cannizzaro reaction

(C) Wurtz reaction

(D) Friedel-Crafts acylation

Q33. An alkene "A" on reaction with O_3 and $Zn - H_2O$ gives propanone and ethanal in equimolar ratio. Addition of HCl to alkene "A" gives "B" as the major product. The structure of product "B" is:

(A) 2-Chloro-2-methylbutane

(B) 1-Chloro-2-methylbutane

(C) 2-Chloro-3-methylbutane

(D) 3-Chloro-2-methylbutane

Q34. Compound X on reaction with O_3 followed by Zn/H_2O gives formaldehyde and 2-methyl propanal as products. The compound X is:

(A) 3-Methylbut-1-ene

(B) 2-Methylbut-1-ene

(C) 2-Methylbut-2-ene

(D) Pent-2-ene

Q35. Elimination reaction of 2-Bromopentane to form pent-2-ene is:

(a) β-Elimination reaction

(b) Follows Zaitsev rule

(c) Dehydrohalogenation reaction

(d) Dehydration reaction

(A) (a), (b), (c)

(B) (a), (c), (d)

(C) (b), (c), (d)

(D) (a), (b), (d)

Q36. Which of the following alkyl halides will undergo S_N1 reaction most readily?

(A) $(CH_3)_3C$-F

(B) $(CH_3)_3C$-Cl

(C) $(CH_3)_3C$-Br

(D) $(CH_3)_3C$-I

Q37. Identify the major product formed in the following reaction:
$CH_3 - CH = CH - CH_3 \xrightarrow{KMnO_4/H^+,\Delta}$?

(A) CH_3CHO

(B) CH_3COOH

(C) CO_2 and H_2O

(D) CH_3CH_2COOH

Q38. Reaction between benzaldehyde and acetophenone in presence of dilute NaOH is known as:

(A) Aldol condensation

(B) Cannizzaro's reaction

(C) Cross Cannizzaro's reaction

(D) Cross Aldol condensation

Q39. When vapors of a secondary alcohol is passed over heated copper at 573 K, the product formed is:

(A) A carboxylic acid

(B) An aldehyde

(C) A ketone

(D) An alkene

Q40. The major product of the following reaction is:
Phenol $\xrightarrow{1.NaOH,CO_2,400\ K,4-7\ atm}\xrightarrow{2.H_3O^+} X \xrightarrow{Ac_2O} Y$

(A) Salicylaldehyde

(B) Aspirin

(C) Salicylic acid

(D) Methyl salicylate

Q41. Which of the following amines will give the carbylamine test?

(A) N,N-Dimethylaniline

(B) N-Methylaniline

(C) Aniline

(D) Diethylamine

Q42. The correct increasing order of basic strength for the following compounds is:
(I) Aniline (II) p-Nitroaniline (III) p-Toluidine

(A) II < I < III

(B) III < I < II

(C) III < II < I

(D) I < II < III

Q43. Which of the following statements is not true about glucose?

(A) It is an aldohexose.

(B) On heating with HI, it forms n-hexane.

(C) It is present in furanose form.

(D) It does not give 2,4-DNP test.

Q44. The non-essential amino acid among the following is:

(A) Lysine

(B) Valine

(C) Leucine

(D) Alanine

Q45. In the qualitative analysis of Group III cations, NH_4Cl is added to NH_4OH before the addition of the mixture to:

(A) Decrease the concentration of OH^- ions

(B) Increase the concentration of OH^- ions

(C) Prevent the precipitation of group IV cations

(D) Both A and C

Detailed Solutions

Q1.

Solution

Concept: The mass of a precipitate in a reaction is determined by the limiting reagent. First, calculate the mass of solutes from the weight/volume percentage, then convert them to moles.

Formula: 1. Mass $= \frac{\%(w/v) \times \text{Volume (mL)}}{100}$ 2. Moles$(n) = \frac{\text{Mass}}{\text{Molar Mass}}$

Solution: Step 1: Calculate the mass of reactants. Mass of $AgNO_3 = \frac{16.9 \times 50}{100} = 8.45$ g. Mass of NaCl $= \frac{5.8 \times 50}{100} = 2.9$ g.

[Image of precipitation reaction of silver nitrate and sodium chloride]

Step 2: Calculate moles. $n_{AgNO_3} = \frac{8.45}{169.8} = 0.0497$ mol. $n_{NaCl} = \frac{2.9}{58.5} = 0.0495$ mol.

Step 3: Determine mass of precipitate (AgCl). NaCl is the limiting reagent. Moles of AgCl = 0.0495 mol. Mass of AgCl $= 0.0495 \times 143.3 \approx 7.09$ g.

Final Answer:

$$\boxed{7.0 \text{ g}}$$

Answer: (A)

Q2.

Solution

Concept: Nodes are regions of zero electron probability. Angular nodes depend on the azimuthal quantum number (l), and radial nodes depend on $(n - l - 1)$.

Solution: Step 1: Identify quantum numbers for 4d. For a 4d orbital, $n = 4$ and $l = 2$.

Step 2: Calculate Angular Nodes. Angular nodes $= l = 2$.

Step 3: Calculate Radial Nodes. Radial nodes $= n - l - 1 = 4 - 2 - 1 = 1$.

Final Answer:

$$\boxed{2 \text{ and } 1}$$

Answer: (A)

Q3.

Solution

Concept: The wave number ($\bar{\nu}$) for hydrogen emission is given by the Rydberg formula. We arrange it into $y = mx + c$ form.

Formula: $\bar{\nu} = R_H \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$

Solution: Step 1: Substitute $n_i = 8$ and $n_f = n$. $\bar{\nu} = R_H \left(\frac{1}{n^2} - \frac{1}{64} \right)$.

[Image of hydrogen emission spectrum energy levels]

Step 2: Expand the equation. $\bar{\nu} = R_H \left(\frac{1}{n^2} \right) - \frac{R_H}{64}$.

Step 3: Identify slope. In the plot of $\bar{\nu}$ vs $\frac{1}{n^2}$, the coefficient of x is R_H. Thus, slope is R_H.

Final Answer:

$$\boxed{\text{Linear with slope } R_H}$$

Answer: (D)

Q4.

Solution

Concept: Isoelectronic species (same total electrons) usually have the same bond order according to Molecular Orbital Theory.

Solution: Step 1: Count electrons for CN^- and CO. $CN^- = 6+7+1 = 14e^-$. $CO = 6+8 = 14e^-$.

Step 2: Calculate Bond Order. Both have 14 electrons, same as N_2. B.O. $= \frac{10-4}{2} = 3$.

Final Answer:

$$\boxed{CN^-, CO}$$

Answer: (B)

Q5.

Solution

Concept: Hybridization depends on the number of σ bonds. Single bonds are sp^3 (if 4 σ), double bonds are sp^2 (if 3 σ), and triple bonds are sp (if 2 σ).

Solution: Step 1: Analyze $CH_2 = CH - C \equiv CH$. Carbon 1 ($CH_2 =$) has 3 σ bonds $\rightarrow sp^2$.

Step 2: Analyze middle carbons. Carbon 2 ($= CH-$) has 3 σ bonds $\rightarrow sp^2$. Carbon 3 ($-C \equiv$) has 2 σ bonds $\rightarrow sp$.

Step 3: Analyze last carbon. Carbon 4 ($\equiv CH$) has 2 σ bonds $\rightarrow sp$. Sequence: sp^2, sp^2, sp, sp.

Final Answer:

$$\boxed{CH_2 = CH - C \equiv CH}$$

Answer: (B)

Q6.

Solution

Concept: Fajan's Rules determine the covalent character in ionic compounds. Higher charge and smaller size of the cation lead to greater polarization of the anion, increasing covalent character.
Solution: Step 1: Identify the cations and their charges. The cations are Fe^{2+}, Sn^{2+}, Al^{3+}, and Mg^{2+}.
Step 2: Compare the charges. Al^{3+} has the highest positive charge (+3) among the given options.
Step 3: Conclusion. Higher charge results in maximum polarizing power, giving $AlCl_3$ the highest covalent character.
Final Answer:

$$\boxed{AlCl_3}$$

Answer: (C)

Q7.

Solution

Concept: Intermolecular forces have different energy dependencies based on the distance (r) between the interacting species.
Solution: Step 1: Match Ion-Ion interaction. Ion-ion energy follows Coulomb's law: $V \propto 1/r$.
Step 2: Match Dipole-Dipole and Ion-Dipole. Ion-dipole follows $1/r^2$. Stationary dipole-dipole follows $1/r^3$.
Step 3: Match London dispersion. London (dispersion) forces are the weakest and follow $1/r^6$.
Result: I-a, II-c, III-d, IV-b.
Final Answer:

$$\boxed{\text{I-a, II-c, III-d, IV-b}}$$

Answer: (A)

Q8.

Solution

Concept: For a reaction to be spontaneous, the Gibbs Free Energy change (ΔG) must be negative ($\Delta G < 0$).
Formula: $\Delta G = \Delta H - T\Delta S$
Solution: Step 1: Convert units. $\Delta H = 35.5$ kJ $= 35500$ J. $\Delta S = 83.6$ J/K.
Step 2: Set $\Delta G < 0$. $35500 - T(83.6) < 0$.
Step 3: Solve for T. $T > \frac{35500}{83.6} \approx 424.6$ K. Rounding gives $T > 425$ K.
Final Answer:

$$\boxed{T > 425 \text{ K}}$$

Answer: (A)

Q9.

Solution

Concept: Spontaneity at all temperatures requires ΔG to be negative regardless of the value of T.

Solution: Step 1: Analyze the Gibbs equation $\Delta G = \Delta H - T\Delta S$.

Step 2: Identify signs for always negative ΔG. If ΔH is negative (exothermic) and ΔS is positive (increase in entropy), ΔG will always be negative.

Step 3: Final condition. $\Delta H < 0$ and $\Delta S > 0$.

Final Answer:

$$\boxed{\Delta H < 0 \text{ and } \Delta S > 0}$$

Answer: (B)

Q10.

Solution

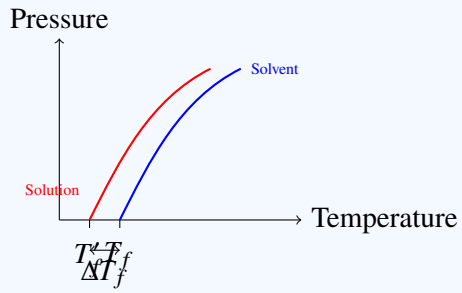
Concept: The depression in freezing point (ΔT_f) is a colligative property that depends on the molality (m) of the solution and the cryoscopic constant (K_f) of the solvent.

Formula: $\Delta T_f = K_f \times m$

Solution: Step 1: Identify given values. The cryoscopic constant $K_f = 5.12$ K kg mol^{-1}. The molality $m = 0.078$ m.

Step 2: Calculate the depression. $\Delta T_f = 5.12 \times 0.078 = 0.39936$ K.

Step 3: Round the result. Approximating to two decimal places, we get 0.40 K.



Final Answer:

$$\boxed{0.40 \text{ K}}$$

Answer: (C)

Q11.

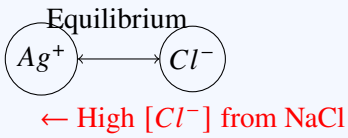
Solution

Concept: The solubility of a sparingly soluble salt decreases in the presence of a common ion. This is known as the Common Ion Effect.

Solution: Step 1: Write the solubility product expression. $K_{sp} = [Ag^+][Cl^-] = 1.6 \times 10^{-10}$.

Step 2: Account for the common ion. In 0.1 M $NaCl$, $[Cl^-] = 0.1$ M (from $NaCl$) $+s$ (from $AgCl$). Since s is very small, $[Cl^-] \approx 0.1$ M.

Step 3: Solve for solubility (s). $1.6 \times 10^{-10} = (s)(0.1) \implies s = 1.6 \times 10^{-9}$ M.



Final Answer:

$$\boxed{1.6 \times 10^{-9} \text{ M}}$$

Answer: (B)

Q12.

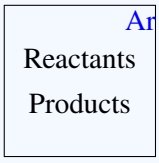
Solution

Concept: According to Le Chatelier's principle, the addition of an inert gas at constant volume does not change the partial pressure or molar concentration of the reactants or products.

Solution: Step 1: Analyze the condition. At constant volume, the total pressure increases, but the relative concentrations (n/V) of the reacting species remain unchanged.

Step 2: Evaluate the equilibrium shift. Since the concentrations do not change, the reaction quotient Q remains equal to K.

Step 3: Conclusion. There is no effect on the equilibrium for any of the given reactions.



Volume is constant (V)

Final Answer:

All of the above

Answer: (D)

Q13.

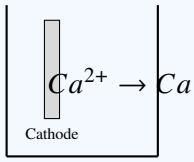
Solution

Concept: According to Faraday's first law of electrolysis, the number of Faradays required is equal to the number of moles of electrons transferred.

Solution: Step 1: Write the reduction half-reaction. $Ca^{2+} + 2e^- \rightarrow Ca(s)$.

Step 2: Calculate moles of Calcium. Molar mass of Ca = 40 g/mol. Moles = $\frac{20\text{ g}}{40\text{ g/mol}} = 0.5$ mol.

Step 3: Calculate Faradays required. $n = 2$ electrons per atom. $Q = 0.5 \text{ mol} \times 2 = 1$ Faraday.



Final Answer:

$$\boxed{1}$$

Answer: (A)

Q14.

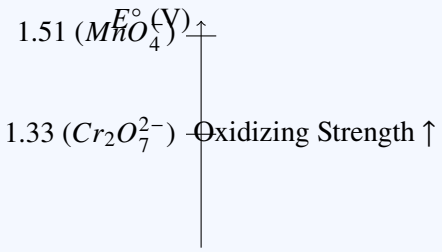
Solution

Concept: The strength of an oxidizing agent is directly proportional to its standard reduction potential (E°). The higher the value, the stronger the oxidizing agent.

Solution: Step 1: Compare the given E° values. $E^\circ_{MnO_4^-/Mn^{2+}} = 1.51$ V $E^\circ_{Cl_2/Cl^-} = 1.36$ V $E^\circ_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33$ V

Step 2: Identify the maximum value. 1.51 V is the highest reduction potential.

Step 3: Conclusion. Permanganate (MnO_4^-) is the strongest oxidizing agent.



Final Answer:

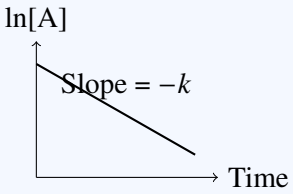
$$\boxed{MnO_4^-}$$

Answer: (D)

Q15.

Solution

Concept: For a first-order reaction, the rate constant k is given by the integrated rate law formula.
Formula: $k = \frac{2.303}{t} \log \frac{[A]_0}{[A]_t}$
Solution: Step 1: Identify given values. $[A]_0 = 0.1$ M, $[A]_t = 0.001$ M, $t = 5$ min.
Step 2: Substitute into the formula. $k = \frac{2.303}{5} \log \frac{0.1}{0.001} = \frac{2.303}{5} \log(100)$.
Step 3: Calculate the value. $k = \frac{2.303}{5} \times 2 = 0.9212$ min^{-1}.



Final Answer:

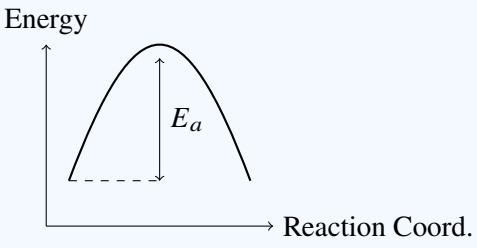
$$\boxed{0.9212}$$

Answer: (A)

Q16.

Solution

Concept: The Arrhenius equation relates the rate constant to temperature and activation energy (E_a).
Formula: $\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left[\frac{T_2 - T_1}{T_1 T_2}\right]$
Solution: Step 1: Identify given values. $k_2 = 4k_1$, $T_1 = 293$ K, $T_2 = 313$ K, $R = 8.314$ J/K/mol.
Step 2: Substitute and solve. $\log 4 = \frac{E_a}{2.303 \times 8.314} \left[\frac{20}{293 \times 313}\right]$.
Step 3: Calculate E_a. $0.602 = \frac{E_a}{19.147} \times 0.000218 \implies E_a \approx 52.8$ kJ/mol.



Final Answer:

$$\boxed{52.8 \text{ kJ mol}^{-1}}$$

Answer: (A)

Q17.

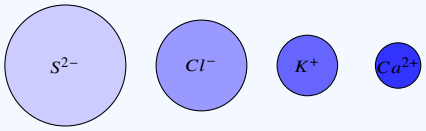
Solution

Concept: For isoelectronic species, the ionic radius decreases as the nuclear charge (atomic number) increases.

Solution: Step 1: List atomic numbers (Z). $S(16)$, $Cl(17)$, $K(19)$, $Ca(20)$.

Step 2: Compare electronic attraction. All have 18 electrons. Ca^{2+} has 20 protons pulling those electrons, while S^{2-} has only 16.

Step 3: Arrange in order. $S^{2-} > Cl^{-} > K^{+} > Ca^{2+}$.



Final Answer:

$$\boxed{S^{2-} > Cl^{-} > K^{+} > Ca^{2+}}$$

Answer: (C)

Q18.

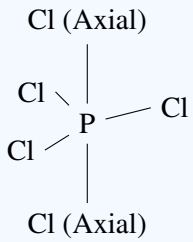
Solution

Concept: PCl_5 has a trigonal bipyramidal structure. The axial bonds are longer and weaker than the equatorial bonds due to greater repulsion.

Solution: Step 1: Identify geometry. sp^3d hybridization results in a trigonal bipyramid.

Step 2: Analyze bond stability. Because the axial bonds are longer and weaker, PCl_5 is very reactive and dissociates into PCl_3 and Cl_2.

Step 3: Conclusion. The statement that PCl_5 is "non-reactive" is incorrect.



Final Answer:

$\boxed{PCl_5 \text{ molecule is non-reactive.}}$

Answer: (A)

Q19.

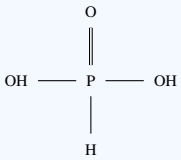
Solution

Concept: The reducing property of phosphorus oxoacids is determined by the presence of $P-H$ bonds in the structure.

Solution: Step 1: Check H_3PO_3 structure. Phosphorous acid contains one $P-H$ bond and two $P-OH$ bonds.

Step 2: Evaluate reducing power. The $P-H$ bond allows the molecule to act as a reducing agent by being oxidized to a higher state.

Step 3: Conclusion. Among the given options, H_3PO_3 is the reducing agent.



Final Answer:

$$\boxed{H_3PO_3}$$

Answer: (B)

Q20.

Solution

Concept: The reducing property of phosphorus oxoacids is due to the presence of P-H bonds.

Solution: Step 1: Check structures. H_3PO_3 (phosphorous acid) has one P-H bond.

Step 2: Mechanism. The hydrogen atom directly attached to phosphorus allows the molecule to act as a reducing agent by being oxidized to a higher state.

Step 3: Conclusion. H_3PO_3 is the oxoacid with reducing properties.

Final Answer:

$$\boxed{H_3PO_3}$$

Answer: (B)

Q21.

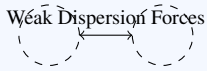
Solution

Concept: Noble gases have completely filled valence shells (ns^2 np), resulting in very weak interatomic attractions (London dispersion forces).

Solution: Step 1: Analyze interatomic forces. Because of their stable octet, noble gases do not form covalent or metallic bonds. They are held together only by weak Van der Waals forces.

Step 2: Evaluate physical properties. Weak forces lead to very low melting and boiling points. Helium, for example, has the lowest boiling point of any element (4.2 K).

Step 3: Conclusion. The statement claiming they have "very high" melting and boiling points is incorrect.



Monoatomic Noble Gas atoms

Final Answer:

Noble gases have very high melting and boiling points.

Answer: (A)

Q22.

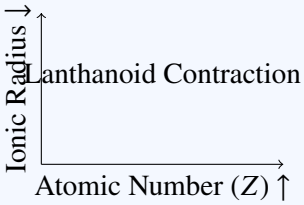
Solution

Concept: The chemistry of Lanthanoids is characterized by the +3 oxidation state and the gradual decrease in ionic radii (Lanthanoid Contraction).

Solution: Step 1: Assess basicity. Due to lanthanoid contraction, the size of Ln^{3+} ions decreases from *La* to *Lu*, which increases the covalent character of their hydroxides, making them less basic.

Step 2: Assess reactivity. Lanthanoids are active metals, but their reactivity is comparable to Aluminium; they are not "much more reactive."

Step 3: Assess Ce^{4+}. Cerium in +4 state is a very common and strong oxidizing agent in aqueous solution.



Final Answer:

All the lanthanons are much more reactive than aluminium.

Answer: (C)

Q23.

Solution

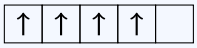
Concept: The spin-only magnetic moment depends on the number of unpaired electrons (n) in the d-orbitals of the transition metal ion.

Formula: $\mu = \sqrt{n(n+2)}$ BM

Solution: Step 1: Determine the configuration of Cr^{2+}. Chromium (Z=24): $[Ar]3d^5 4s^1$. Cr^{2+} ion: $[Ar]3d^4$.

Step 2: Count unpaired electrons (n). In a $3d^4$ subshell, all 4 electrons are unpaired according to Hund's Rule.

Step 3: Calculate μ. $\mu = \sqrt{4(4+2)} = \sqrt{24} \approx 4.90$ BM.



$3d^4$ configuration ($n = 4$)

Final Answer:

4.90 BM

Answer: (B)

Q24.

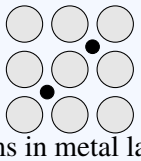
Solution

Concept: Interstitial compounds are formed by transition metals with small atoms like H, C, or N. They are generally non-stoichiometric.

Solution: Step 1: Analyze physical properties. They are very hard (borides approach diamond hardness) and have high melting points.

Step 2: Analyze electrical properties. They retain the metallic conductivity of the parent metal.

Step 3: Analyze chemical properties. Crucially, interstitial compounds are known for being chemically **inert**, not reactive.



Small atoms in metal lattice voids

Final Answer:

They are chemically very reactive.

Answer: (D)

Q25.

Solution

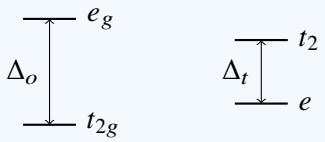
Concept: The crystal field splitting energy in tetrahedral complexes (Δ_t) is smaller than in octahedral complexes (Δ_o).

Formula: $\Delta_t = \frac{4}{9}\Delta_o$

Solution: Step 1: Identify the given Δ_o. For $[CoCl_6]^{4-}$, $\Delta_o = 18000\ \text{cm}^{-1}$.

Step 2: Calculate Δ_t for $[CoCl_4]^{2-}$. $\Delta_t = \frac{4}{9} \times 18000 = 4 \times 2000$.

Step 3: Final result. $\Delta_t = 8000\ \text{cm}^{-1}$.



Final Answer:

$$\boxed{8000\ \text{cm}^{-1}}$$

Answer: (C)

Q26.

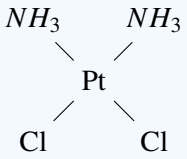
Solution

Concept: Specific coordination compounds are used in medicine. Platinum complexes are particularly important in cancer treatment.

Solution: Step 1: Identify the anticancer agent. The compound *cis*-diamminedichloridoplatinum(II) is widely used in chemotherapy.

Step 2: Identify its common name. This compound is commonly known as **Cisplatin**.

Step 3: Select the formula. Option (B) represents the *cis* isomer: *cis*-$[PtCl_2(NH_3)_2]$.



Cis-platin structure

Final Answer:

$$\boxed{cis\text{-}[PtCl_2(NH_3)_2]}$$

Answer: (B)

Q27.

Solution

Concept: IUPAC naming follows alphabetical order for ligands, the metal name, and the oxidation state in Roman numerals.

Solution: Step 1: Identify ligands and count. Two NH_3 (diammine) and two Cl^- (dichlorido).

Step 2: Determine oxidation state. $x + 2(0) + 2(-1) = 0 \implies x = +2$.

Step 3: Construct the name. "Ammine" comes before "Chlorido" alphabetically. Since the complex is neutral, the metal is named "platinum". Result: Diamminedichloridoplatinum(II).

$$\boxed{[Pt(NH_3)_2Cl_2]}$$

ammine before **chlorido**

Final Answer:

$$\boxed{\text{Diamminedichloridoplatinum(II)}}$$

Answer: (A)

Q28.

Solution

Concept: In Dumas' method, the nitrogen in the organic compound is converted to N_2 gas. The volume is then corrected to STP to find the percentage.

Solution: Step 1: Calculate the pressure of dry nitrogen. $P = P_{\text{total}} - \text{Aqueous tension} = 725 - 25 = 700$ mm Hg.

Step 2: Convert volume to STP. $V_{\text{STP}} = \frac{P_1 V_1 T_0}{P_0 T_1} = \frac{700 \times 40 \times 273}{760 \times 300} \approx 33.52$ mL.

Step 3: Calculate percentage of N. $\%N = \frac{28}{22400} \times \frac{33.52}{0.25} \times 100 \approx 16.76\%$.

$$\boxed{\%N = \frac{28 \times V_{STP} \times 100}{22400 \times m}}$$

Final Answer:

$$\boxed{16.76}$$

Answer: (A)

Q29.

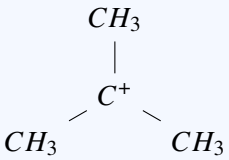
Solution

Concept: The stability of carbocations is determined by inductive effects (+I), hyperconjugation, and resonance.

Solution: Step 1: Identify the type of each carbocation. (A) $(CH_3)_3C^+$ is a 3° carbocation. (B) Allyl is resonance stabilized. (C) Benzyl is resonance stabilized.

Step 2: Compare stability. While benzyl and allyl are stabilized by resonance, the tertiary butyl carbocation has 9 hyperconjugative α-hydrogens and three +I groups, making it extremely stable.

Step 3: Conclusion. In most comparative contexts, $(CH_3)_3C^+$ is the most stable among the given options.



3° Carbocation (9 α-H)

Final Answer:

$$\boxed{(CH_3)_3C^+}$$

Answer: (A)

Q30.

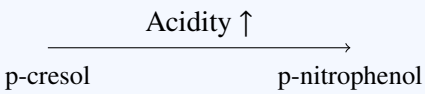
Solution

Concept: Acidity of phenols is increased by electron-withdrawing groups (EWG) and decreased by electron-donating groups (EDG).

Solution: Step 1: Identify the groups. p-nitro (strong EWG), p-chloro (EWG), p-cresol ($-CH_3$, EDG).

Step 2: Determine effect on phenoxide stability. $-NO_2$ stabilizes the negative charge through -R and -I effects. $-CH_3$ destabilizes it via +I and hyperconjugation.

Step 3: Arrange in order. p-cresol (least acidic) < phenol < p-chlorophenol < p-nitrophenol (most acidic).



Final Answer:

$$\boxed{\text{p-cresol} < \text{phenol} < \text{p-chlorophenol} < \text{p-nitrophenol}}$$

Answer: (B)

Q31.

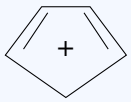
Solution

Concept: According to Huckel's Rule, a compound is aromatic if it is cyclic, planar, fully conjugated, and contains $(4n + 2)\pi$ electrons. If it contains $4n\pi$ electrons, it is anti-aromatic.

Solution: Step 1: Analyze Benzene and Cycloheptatrienyl cation. Both have 6π electrons ($n = 1$), satisfying Huckel's rule for aromaticity.

Step 2: Analyze Cyclopentadienyl anion. It has 6π electrons (including the lone pair), making it aromatic.

Step 3: Analyze Cyclopentadienyl cation. It has only 4π electrons, which follows the $4n$ rule ($n = 1$), making it anti-aromatic (non-aromatic).



$4\pi\ e^-$ (Non-aromatic)

Final Answer:

Cyclopentadienyl cation

Answer: (D)

Q32.

Solution

Concept: Carbon-carbon ($C - C$) bond formation is a key feature of coupling and alkylation reactions.

Solution: Step 1: Evaluate Reimer-Tiemann and Wurtz reactions. Reimer-Tiemann introduces a $-CHO$ group to phenol ($C - C$ bond). Wurtz reaction couples two alkyl halides ($C - C$ bond).

Step 2: Evaluate Friedel-Crafts acylation. An acyl group is attached to the benzene ring, forming a new $C - C$ bond.

Step 3: Evaluate Cannizzaro reaction. This is a disproportionation of an aldehyde into an alcohol and a carboxylic acid salt. No new $C - C$ bond is created.

$$2RCHO \xrightarrow{\text{NaOH}} RCH_2OH + RCOO^-$$

Redox change, no $C - C$ coupling

Final Answer:

Cannizzaro reaction

Answer: (B)

Q33.

Solution

Concept: Ozonolysis products help reconstruct the original alkene. Markovnikov's rule then determines the major product of HCl addition.

Solution: Step 1: Reconstruct Alkene "A". The products are propanone (CH_3COCH_3) and ethanal (CH_3CHO). Joining them at the carbonyl carbons gives 2-methylbut-2-ene.

Step 2: Add HCl to Alkene "A". According to Markovnikov's rule, H^+ adds to the carbon with more hydrogens ($C3$), and Cl^- adds to the more substituted tertiary carbon ($C2$).

Step 3: Identify Product "B". The resulting structure is 2-chloro-2-methylbutane.

$$(CH_3)_2C = CHCH_3 \xrightarrow{\text{HCl}} (CH_3)_2C(Cl)CH_2CH_3$$

Final Answer:

2-Chloro-2-methylbutane

Answer: (A)

Q34.

Solution

Concept: Reductive ozonolysis breaks the double bond and forms two carbonyl compounds. We can find the reactant by "removing" the oxygens.

Solution: Step 1: Identify products. Formaldehyde ($CH_2 = O$) and 2-methylpropanal ($(CH_3)_2CH - CH = O$).

Step 2: Connect the fragments. Removing the oxygens and forming a double bond between the two carbonyl carbons gives $CH_2 = CH - CH(CH_3)_2$.

Step 3: Name Compound X. The IUPAC name for this structure is 3-methylbut-1-ene.

$$CH_2 = CH - CH(CH_3)_2 \xrightarrow{O_3, Zn/H_2O} HCHO + (CH_3)_2CHCHO$$

Final Answer:

3-Methylbut-1-ene

Answer: (A)

Q35.

Solution

Concept: Elimination of alkyl halides involves removing a hydrogen from the β-carbon and the halogen from the α-carbon.

Solution: Step 1: Identify the reaction type. It is a β-elimination because the hydrogen is removed from the β-carbon. It is also a dehydrohalogenation (HBr is removed).

Step 2: Apply Zaitsev's rule. The reaction forms pent-2-ene (more substituted) as the major product, consistent with Zaitsev's rule.

Step 3: Evaluate dehydration. Dehydration specifically refers to the loss of water (from alcohols), so statement (d) is incorrect.

$$CH_3CH(Br)CH_2CH_2CH_3 \xrightarrow{\text{alc. KOH}} CH_3CH = CHCH_2CH_3$$

Final Answer:

$$\boxed{\text{(a), (b), (c)}}$$

Answer: (A)

Q36.

Solution

Concept: In S_N1 reactions, the rate-determining step is the formation of a carbocation. This depends on the stability of the cation and the leaving group's ability.

Solution: Step 1: Compare carbocations. All four options yield the tertiary butyl carbocation ($(CH_3)_3C^+$), which is highly stable.

Step 2: Compare leaving groups. Iodide (I^-) is the best leaving group among the halides because the $C - I$ bond is the weakest due to the large size of Iodine.

Step 3: Conclusion. Tertiary butyl iodide reacts most readily.

$$\text{Reactivity: } R - I > R - Br > R - Cl > R - F$$
$$\xrightarrow[\text{Leaving group ability increases}]{}$$

Final Answer:

$$\boxed{(CH_3)_3C - I}$$

Answer: (D)

Q37.

Solution

Concept: Hot acidic $KMnO_4$ is a strong oxidizing agent that causes oxidative cleavage of the $C = C$ double bond.

Solution: Step 1: Analyze the reactant. The reactant is But-2-ene ($CH_3 - CH = CH - CH_3$).

Step 2: Apply oxidative cleavage. The double bond breaks, and the $= CH-$ groups are oxidized to $-COOH$ groups.

Step 3: Final Product. Two molecules of ethanoic acid (CH_3COOH) are formed.

$$CH_3CH = CHCH_3 \xrightarrow{KMnO_4/H^+} 2CH_3COOH$$

Final Answer:

$$\boxed{CH_3COOH}$$

Answer: (B)

Q38.

Solution

Concept: Aldol condensation occurs between two carbonyl compounds where at least one has an α-hydrogen. If the reactants are different, it is a "cross" reaction.

Solution: Step 1: Identify α-hydrogens. Benzaldehyde (C_6H_5CHO) has no α-hydrogen. Acetophenone ($C_6H_5COCH_3$) has α-hydrogens on the methyl group.

Step 2: Identify reaction type. Since the two carbonyl compounds are different, the reaction is a Cross Aldol condensation.

Step 3: Conclusion. Option D is correct.

$$PhCHO + CH_3COPh \xrightarrow{\text{dil. NaOH}} PhCH = CHCOPh$$

Final Answer:

$$\boxed{\text{Cross Aldol condensation}}$$

Answer: (D)

Q39.

Solution

Concept: Passing alcohol vapors over heated copper at 573 K leads to dehydrogenation. The product depends on the degree of the alcohol.

Solution: Step 1: Primary alcohols. They lose H_2 to form aldehydes ($RCHO$).

Step 2: Secondary alcohols. They lose H_2 to form ketones ($RCOR$).

Step 3: Tertiary alcohols. They undergo dehydration (loss of H_2O) to form alkenes. Since the question asks for a secondary alcohol, the product is a ketone.

$$R - CH(OH) - R \xrightarrow{\text{Cu / 573 K}} R - CO - R + H_2$$

Final Answer:

A ketone

Answer: (C)

Q40.

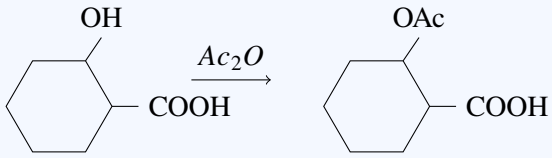
Solution

Concept: This is a sequence of Kolbe's reaction followed by acetylation to synthesize a common medicine.

Solution: Step 1: Formation of X. Phenol with $NaOH$ and CO_2 followed by acidification gives Salicylic acid.

Step 2: Formation of Y. Salicylic acid reacts with acetic anhydride (Ac_2O) to acetylate the hydroxyl group.

Step 3: Identify Y. The final product is acetylsalicylic acid, known as Aspirin.



Final Answer:

Aspirin

Answer: (B)

Q41.

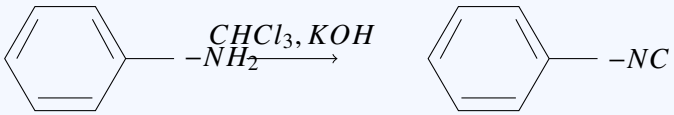
Solution

Concept: The carbylamine test (isocyanide test) is a specific test for primary (1°) amines. Both aliphatic and aromatic primary amines react with chloroform and ethanolic KOH to form foul-smelling isocyanides.

Solution: Step 1: Identify the amine types in the options. (A) N,N-Dimethylaniline (3°), (B) N-Methylaniline (2°), and (D) Diethylamine (2°) do not give this test.

Step 2: Identify the primary amine. Aniline ($C_6H_5NH_2$) is a primary aromatic amine.

Step 3: Chemical Reaction. The reaction is: $R-NH_2+CHCl_3+3KOH \xrightarrow{\Delta} R-NC+3KCl+3H_2O$.



Final Answer:

Aniline

Answer: (C)

Q42.

Solution

Concept: Basic strength in aromatic amines increases with electron-donating groups (EDG) and decreases with electron-withdrawing groups (EWG).

Solution: Step 1: Identify substituent effects. p-Nitroaniline has $-NO_2$ (EWG), which decreases the electron density on Nitrogen.

Step 2: Compare with Aniline and p-Toluidine. Aniline is neutral. p-Toluidine has $-CH_3$ (EDG), which increases electron density via +I and hyperconjugation.

Step 3: Arrange in increasing order. p-Nitroaniline (weakest) < Aniline < p-Toluidine (strongest).

Basicity $\propto$ EDG ← H ← EWG

(Increasing Order)

Final Answer:

II < I < III

Answer: (A)

Q43.

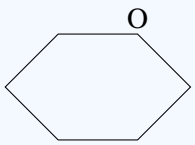
Solution

Concept: Glucose is an aldohexose. Its structure involves a six-membered cyclic hemiacetal ring.

Solution: Step 1: Analyze statements. Heating with HI gives n-hexane (True). It is an aldohexose (True). It doesn't give 2,4-DNP test due to cyclic structure (True).

Step 2: Identify the ring type. A six-membered ring is called a **pyranose**. A five-membered ring is a furanose.

Step 3: Conclusion. Glucose is a pyranose, not a furanose.



Pyranose (6-membered)

Final Answer:

It is present in furanose form.

Answer: (C)

Q44.

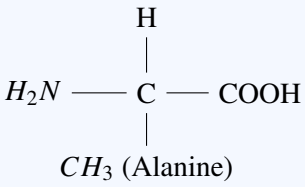
Solution

Concept: Non-essential amino acids are those that the body can produce itself and are not strictly required through diet.

Solution: Step 1: Categorize the options. Lysine, Valine, and Leucine are essential amino acids.

Step 2: Identify the non-essential one. Alanine is a non-essential amino acid synthesized from pyruvate.

Step 3: Conclusion. Alanine is the correct answer.



(Alanine)

Final Answer:

Alanine

Answer: (D)

Q45.

Solution

Concept: In qualitative analysis, NH_4Cl is used to provide a common ion (NH_4^+) to suppress the dissociation of NH_4OH.

Solution: Step 1: Explain the Common Ion Effect. $NH_4Cl \rightarrow NH_4^+ + Cl^-$. The excess NH_4^+ shifts the equilibrium $NH_4OH \rightleftharpoons NH_4^+ + OH^-$ to the left.

Step 2: Impact on precipitation. This decreases $[OH^-]$ so that only Group III hydroxides precipitate (having lower K_{sp}).

Step 3: Selective separation. This prevents Group IV cations from precipitating as hydroxides. Thus, both A and C are correct.

$$NH_4OH \rightleftharpoons NH_4^+ + OH^-$$
$$\xleftarrow{\text{Common Ion } NH_4^+ \text{ added}}$$

Final Answer:

Both A and C

Answer: (D)

Answer Key

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