

SECTION B: CHEMISTRY (100 Marks)

Part I: Multiple Choice Questions (MCQs)

20 Questions × 4 Marks = 80 Marks

Instructions:

- Each question has four options (A), (B), (C), and (D)
 - Only ONE option is correct
 - Marking Scheme: +4 for correct answer, -1 for incorrect answer
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26. [BONDING CONCEPTUAL]

Consider the following species: BF_3 , BF_4^- , NH_3 , NH_4^+ . The correct statement regarding bond angles is:

- (A) $\text{NH}_3 > \text{NH}_4^+ = \text{BF}_3 > \text{BF}_4^-$
- (B) $\text{BF}_4^- < \text{BF}_3 < \text{NH}_4^+ < \text{NH}_3$
- (C) $\text{NH}_4^+ = \text{BF}_4^- > \text{BF}_3 > \text{NH}_3$
- (D) $\text{BF}_3 > \text{BF}_4^- = \text{NH}_4^+ > \text{NH}_3$
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27. [MULTI-STEP ORGANIC SYNTHESIS]

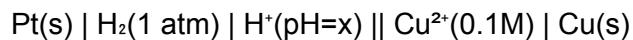
Benzene \rightarrow (i) $\text{CH}_3\text{Cl}/\text{AlCl}_3 \rightarrow \text{A} \rightarrow$ (ii) $\text{KMnO}_4/\text{OH}^-/\Delta \rightarrow \text{B} \rightarrow$ (iii) $\text{H}_3\text{O}^+ \rightarrow \text{C} \rightarrow$ (iv) $\text{SOCl}_2 \rightarrow \text{D} \rightarrow$ (v) $\text{NH}_3 \rightarrow \text{E} \rightarrow$ (vi) $\text{Br}_2/\text{NaOH} \rightarrow \text{F}$

The compound F is:

- (A) Methylamine
- (B) Aniline
- (C) Benzylamine
- (D) N-methylaniline
-

28. [ELECTROCHEMISTRY ADVANCED]

The following electrochemical cell is set up:



If $E^\circ(\text{Cu}^{2+}/\text{Cu}) = +0.34 \text{ V}$ and the measured cell potential is 0.456 V at 298 K , the pH of the solution in the anode compartment is approximately:

- (A) 1
 - (B) 2
 - (C) 3
 - (D) 4
-

29. [STEREOCHEMISTRY TRICKY]

How many stereoisomers are possible for the compound $\text{CH}_3\text{CH}=\text{CH-CHBr-CHCl-CH}_3$?

- (A) 4
 - (B) 6
 - (C) 8
 - (D) 12
-

30. [THERMODYNAMICS CONCEPTUAL]

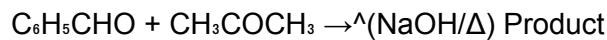
For the reaction: $\text{N}_2\text{(g)} + 3\text{H}_2\text{(g)} \rightleftharpoons 2\text{NH}_3\text{(g)}$, $\Delta H = -92 \text{ kJ}$.

If the reaction is carried out at constant volume instead of constant pressure (both at same temperature), the change in enthalpy would be:

- (A) Greater than -92 kJ
 - (B) Less than -92 kJ
 - (C) Equal to -92 kJ
 - (D) Cannot be determined
-

31. [REACTION MECHANISM - EXPERT]

Consider the reaction:



Which intermediate is MOST stabilized during this aldol condensation?

- (A) $\text{C}_6\text{H}_5\text{CH}=\text{CH-CO-CH}_3$
 - (B) $\text{C}_6\text{H}_5\text{CH(OH)-CH}_2\text{-CO-CH}_3$
 - (C) $\text{^CH}_2\text{-CO-CH}_3$
 - (D) $\text{C}_6\text{H}_5\text{CH}^-\text{-CHO}$
-

32. [KINETICS - COMPLEX]

For a reaction: $2\text{A} + \text{B} \rightarrow \text{products}$, the rate law is $r = k[\text{A}][\text{B}]$.

The reaction is carried out in a container where initial concentration of A is 0.1 M and B is 0.2 M. When half of A is consumed, if we add A to restore its concentration to 0.1 M instantaneously, the rate of reaction at that instant compared to initial rate is:

- (A) Same
 - (B) Half
 - (C) Three-fourth
 - (D) Double
-

33. [INORGANIC CONCEPTUAL]

Among the following complex ions, the one that can exhibit geometrical isomerism but NOT optical isomerism is:

- (A) $[\text{Co}(\text{en})_2\text{Cl}_2]^+$
 - (B) $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$
 - (C) $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$
 - (D) $[\text{Co}(\text{NH}_3)_3(\text{NO}_2)_3]$
-

34. [CFSE CALCULATION]

For the complex ion $[\text{Fe}(\text{H}_2\text{O})_5(\text{NO})]^{2+}$, given that NO acts as a neutral ligand with effectively 3 electrons donated, and assuming strong field, the effective magnetic moment (in B.M.) would be closest to:

- (A) 0

- (B) 1.73
(C) 2.83
(D) 3.87
-

35. [ADVANCED ORGANIC REACTION]

When compound $(\text{CH}_3)_3\text{C}-\text{CH}(\text{OH})-\text{CH}_3$ is heated with concentrated H_2SO_4 , the major product formed is:

- (A) $(\text{CH}_3)_2\text{C}=\text{C}(\text{CH}_3)_2$
(B) $(\text{CH}_3)_3\text{C}-\text{CH}=\text{CH}_2$
(C) $(\text{CH}_3)_2\text{CH}-\text{CH}=\text{CH}-\text{CH}_3$
(D) A mixture of rearranged products
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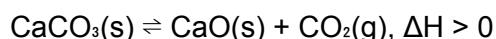
36. [COLLIGATIVE PROPERTY - TRICKY]

A solution of 2 g of a substance X in 100 g of CCl_4 boils at 77.8°C . The boiling point of pure CCl_4 is 76.8°C . If K_b for CCl_4 is 5 K kg mol^{-1} , and the substance X associates in solution forming dimers to the extent of 80%, the molar mass of X is:

- (A) 50 g/mol
(B) 100 g/mol
(C) 125 g/mol
(D) 150 g/mol
-

37. [PHASE DIAGRAM CONCEPTUAL]

For the reaction at equilibrium:



If the temperature is increased at constant volume, which statement is correct?

- (A) Pressure increases, equilibrium shifts right, K_p increases
(B) Pressure increases, equilibrium shifts left, K_p decreases
(C) Pressure decreases, equilibrium shifts right, K_p increases

(D) Pressure constant, equilibrium unaffected, K_p increases

38. [PERIODIC TRENDS ADVANCED]

Among the following, the oxide that can act as both oxidizing and reducing agent is:

- (A) NO_2
 - (B) SO_2
 - (C) CO_2
 - (D) N_2O_5
-

39. [MOLECULAR STRUCTURE]

In XeF_2 , the Xe-F bond order considering three-center four-electron bonding model is:

- (A) 1
 - (B) 0.5
 - (C) 1.5
 - (D) 2
-

40. [CONDUCTANCE COMPLEX]

The equivalent conductance of NaCl , HCl and CH_3COONa at infinite dilution are 126.5, 426.2, and $91.0 \text{ S cm}^2 \text{ equiv}^{-1}$ respectively. The equivalent conductance of CH_3COOH at infinite dilution is:

- (A) 208.7
 - (B) 390.7
 - (C) 543.7
 - (D) 643.7
-

41. [NAME REACTION MECHANISM]

In the Hofmann bromamide degradation reaction, when benzamide is treated with Br_2 in aqueous NaOH , the mechanism involves formation of intermediate X which then undergoes rearrangement. The intermediate X is:

- (A) $\text{C}_6\text{H}_5\text{-CO-NH-Br}$
 - (B) $\text{C}_6\text{H}_5\text{-CO-}\ddot{\text{N}}\text{-Br}$ (with lone pair)
 - (C) $\text{C}_6\text{H}_5\text{-N=C=O}$
 - (D) $\text{C}_6\text{H}_5\text{-NH}_2$
-

42. [ACIDITY CONCEPTUAL]

Arrange the following in increasing order of acidity:

- (I) $\text{CH}_3\text{CH}_2\text{OH}$
- (II) $\text{CH}_3\text{CH}_2\text{COOH}$
- (III) ClCH_2COOH
- (IV) FCH_2COOH

- (A) I < II < III < IV
 - (B) II < I < III < IV
 - (C) I < III < II < IV
 - (D) II < III < I < IV
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43. [ORGANOMETALLIC]

In the Grignard reagent preparation, if water is present as impurity, which of the following reactions does NOT occur?

- (A) $\text{RMgX} + \text{H}_2\text{O} \rightarrow \text{RH} + \text{Mg(OH)X}$
 - (B) $2\text{RMgX} + \text{H}_2\text{O} \rightarrow \text{R}_2\text{Mg} + \text{Mg(OH)X}$
 - (C) $\text{RMgX} \rightarrow \text{R}_2\text{Mg} + \text{MgX}_2$ (Schlenk equilibrium)
 - (D) $\text{R}_2\text{Mg} + \text{H}_2\text{O} \rightarrow \text{RH} + \text{RMgOH}$
-

44. [KINETICS - ADVANCED]

A first-order reaction has activation energy 50 kJ/mol. The rate constant doubles when temperature is increased from 300 K to 310 K. Using this information, the rate constant at 320 K compared to that at 300 K will be approximately:

- (A) 3 times
 - (B) 4 times
 - (C) 5 times
 - (D) 8 times
-

45. [AMINE BASICITY - TRICKY]

In aqueous solution, the correct order of basicity is:

- (A) $(\text{CH}_3)_2\text{NH} > \text{CH}_3\text{NH}_2 > (\text{CH}_3)_3\text{N} > \text{NH}_3$
 - (B) $\text{CH}_3\text{NH}_2 > (\text{CH}_3)_2\text{NH} > (\text{CH}_3)_3\text{N} > \text{NH}_3$
 - (C) $(\text{CH}_3)_3\text{N} > (\text{CH}_3)_2\text{NH} > \text{CH}_3\text{NH}_2 > \text{NH}_3$
 - (D) $\text{NH}_3 > \text{CH}_3\text{NH}_2 > (\text{CH}_3)_2\text{NH} > (\text{CH}_3)_3\text{N}$
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Part II: Numerical Value Type Questions

5 Questions \times 4 Marks = 20 Marks

Instructions:

- Answer should be a numerical value rounded to the nearest integer (0-9999)
 - Marking Scheme: +4 for correct answer, -1 for incorrect answer
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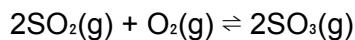
46. [STEREOISOMER COUNTING]

The total number of stereoisomers (including enantiomers and diastereomers) possible for 3-bromo-2-chloro-4-methylhexane is _____.

Answer: _____

47. [COMPLEX EQUILIBRIUM]

At 500 K, the equilibrium constant K_p for the reaction:



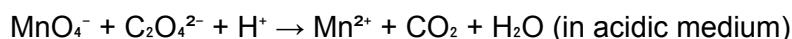
is 2.5×10^{10} Pa⁻¹. If the reaction is started with 2 moles SO₂ and 1 mole O₂ in a 1 L container, and at equilibrium 90% conversion of SO₂ occurs, the equilibrium pressure (in atm) is approximately _____.

(R = 0.082 L atm K⁻¹ mol⁻¹)

Answer: _____

48. [REDOX STOICHIOMETRY]

In the reaction:



When 1.58 g of KMnO₄ (M = 158 g/mol) reacts completely with oxalate, the volume of CO₂ produced at STP (in mL) is _____.

Answer: _____

49. [COMPLEX FREEZING POINT]

A solution is prepared by dissolving 3 g of a mixture of NaCl (50% by mass) and glucose (50% by mass) in 500 g of water. The depression in freezing point (in K × 10²) is _____.

(K_f = 1.86 K kg mol⁻¹, M(NaCl) = 58.5 g/mol, M(glucose) = 180 g/mol)

Answer: _____

50. [OXIDATION STATE CALCULATION]

In the compound Na₄[Fe(CN)₅(NOS)], if the oxidation state of Fe is x and the oxidation state of N in the NOS ligand is y, then |x - y| = _____.

Answer: _____