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SCO INTERNATIONAL OLYMPIAD

CLASS 12 CHEMISTRY

SCO International Chemistry Olympiad

OFFICIAL QUESTION PAPER

PDF-ready academic Word document

Designed from the attached SCO cover-page format and the Class 12 Chemistry Olympiad pathway.

- Professional, editable Word structure for website PDF conversion and student download.
- Aligned to physical, inorganic, organic, biomolecular, polymer and everyday chemistry learning.
- Compact question labels, well-spaced answer explanations, and diagrams placed inside question blocks.

Solutions	Electrochemistry	Kinetics	Coordination	Biomolecules
Solid State	p / d / f Blocks	Polymers	Everyday Chemistry	Achievers

Official Question Paper — Rebranded Edition

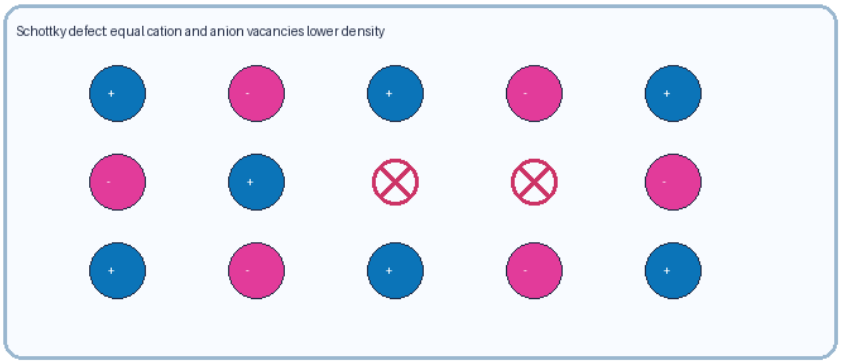
Exam Name	SCO International Chemistry Olympiad
Class / Grade	Class 12
Question Paper Set	H
Pattern	51 MCQs | 60 minutes | Single correct answer | Achievers questions carry higher weight

Candidate Instructions

- Read each question carefully. Only one option is correct unless clearly stated otherwise.
- Use an HB pencil or blue/black pen for OMR-style marking when printed.
- Calculators are not required unless permitted by the school/invigilator.
- All passages, data tables and diagrams are part of the corresponding question block.
- This document includes answer keys and explanations for academic review and website-ready publication.

Section A — General Chemistry Questions

Q1. Which type of point defect is produced in an ionic crystal when equal numbers of cations and anions are absent from their lattice sites?



A. Frenkel defect
B. Schottky defect
C. Metal excess defect
D. Impurity defect

Answer: B

Explanation: A Schottky defect contains paired cation and anion vacancies. Because ions are missing from the crystal, the density generally decreases.

Q2. A solution is prepared by dissolving 5.85 g of NaCl in water and making the volume 500 mL. What is the molarity of the solution? (Molar mass of NaCl = 58.5 g mol^{-1})

A. 0.10 M
B. 0.20 M
C. 0.50 M
D. 1.00 M

Answer: B

Explanation: Moles of NaCl = 5.85/58.5 = 0.10 mol. Volume = 0.500 L. Molarity = 0.10/0.500 = 0.20 M.

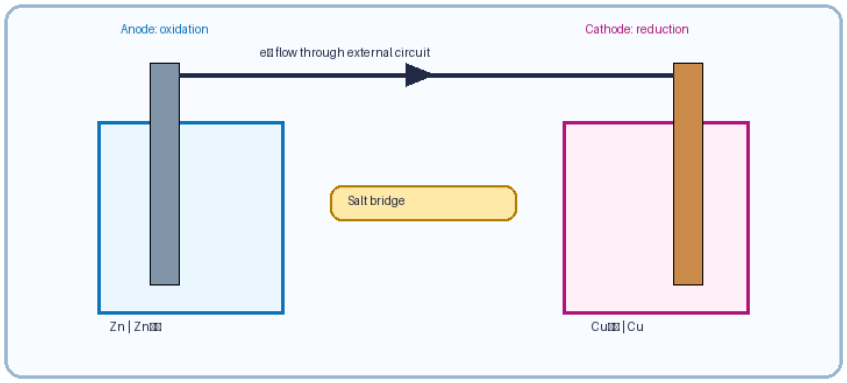
Q3. For a non-volatile solute, which expression correctly represents relative lowering of vapour pressure in an ideal dilute solution?

A. $p°/p = x_2$
B. $(p° - p)/p° = x_2$
C. $(p° - p)/p = x_1$
D. $p/p° = x_2$

Answer: B

Explanation: Raoult's law gives $p = x_1p°$. Therefore $(p° - p)/p° = 1 - x_1 = x_2$, the mole fraction of solute.

Q4. **In the cell Zn | Zn^{2+} || Cu^{2+} | Cu, $E°(Cu^{2+}/Cu) = +0.34$ V and $E°(Zn^{2+}/Zn) = -0.76$ V. What is E°cell?**



A. +1.10 V
B. −1.10 V
C. +0.42 V
D. −0.42 V

Answer: **A**
Explanation: Copper acts as cathode and zinc as anode. E°cell = E°cathode − E°anode = 0.34 − (−0.76) = 1.10 V.

Q5. **At 298 K, for a galvanic cell with n = 2 and reaction quotient Q = 10, how is the Nernst equation written?**

A. $E = E° - (0.0591/2) \log 10$
B. $E = E° + (0.0591/2) \log 10$
C. $E = E° - 0.0591 \log 2$
D. $E = E° + 0.0591 \log 2$

Answer: **A**
Explanation: At 298 K, $E = E° - (0.0591/n) \log Q$. Substituting n = 2 and Q = 10 gives option A.

Q6. **For a first-order reaction with $k = 6.93 \times 10^{-3}\ s^{-1}$, the half-life is approximately:**

A. 10 s
B. 50 s
C. 100 s
D. 200 s

Answer: **C**
Explanation: For first order reactions, $t_{1/2} = 0.693/k = 0.693/(6.93 \times 10^{-3}) = 100$ s.

Q7. **When the concentration of A is doubled, the rate of the reaction A → products becomes four times. What is the order with respect to A?**

A. Zero order
B. First order
C. Second order
D. Third order

Answer: **C**
Explanation: If rate $\propto [A]^n$ and doubling [A] makes rate 4 times, then $2^n = 4$. Therefore n = 2.

Q8. Which statement best describes the effect of a positive catalyst?

A. It increases activation energy
B. It changes the value of equilibrium constant
C. It lowers activation energy and speeds up both forward and reverse reactions
D. It is always consumed in the reaction

Answer: C
Explanation: A catalyst offers an alternative pathway of lower activation energy and is regenerated. It does not change the equilibrium constant.

Q9. Which adsorption isotherm assumes a fixed number of equivalent surface sites and monolayer adsorption?

A. Freundlich isotherm
B. Langmuir isotherm
C. Henry law
D. Raoult law

Answer: B
Explanation: The Langmuir model is based on monolayer adsorption on equivalent sites with no interaction between adsorbed particles.

Q10. Which process is most commonly used for concentrating sulphide ores?

A. Magnetic separation
B. Froth flotation
C. Liquation
D. Zone refining

Answer: B
Explanation: Froth flotation exploits the preferential wetting of sulphide ore particles by oil and gangue by water.

Q11. Which group 16 element shows the strongest catenation tendency?

A. Oxygen
B. Sulfur
C. Selenium
D. Tellurium

Answer: B
Explanation: Sulfur forms stable S–S bonds and commonly exists as S_8 rings, so it shows strong catenation among heavier chalcogens.

Q12. Lanthanoid contraction is mainly caused by:

A. Poor shielding by 4f electrons
B. Complete absence of d electrons
C. Decrease in nuclear charge
D. Increase in atomic mass only

Answer: A
Explanation: The 4f electrons shield nuclear charge poorly, so effective nuclear charge increases and atomic/ionic radii contract across the lanthanoid series.

Q13. What is the IUPAC name of $[Co(NH_3)_6]Cl_3$?

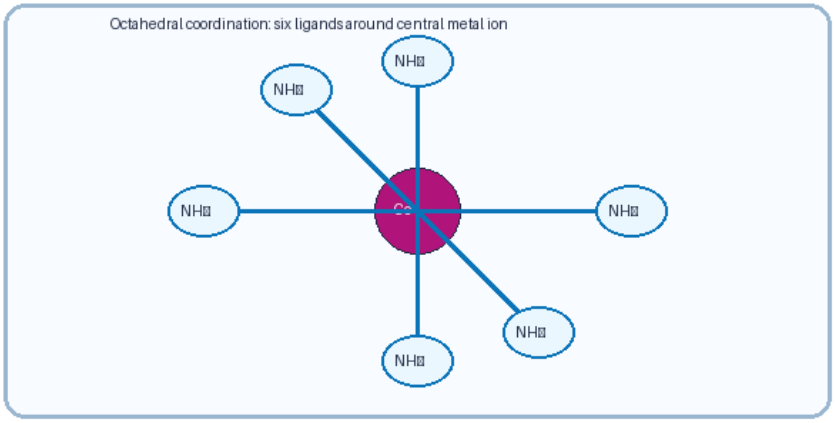
A. Hexaamminecobalt(III) chloride
B. Hexaamminecobalt(II) chloride
C. Cobalt(III) hexaammine chloride

D. Trichlorohexaamminecobalt

Answer: **A**

Explanation: Six neutral ammine ligands surround Co^{3+}; the counter ion is chloride. Hence the name is hexaamminecobalt(III) chloride.

Q14. **In an octahedral complex, a strong-field ligand generally causes:**



A. Small splitting and high spin

B. Large splitting and low spin

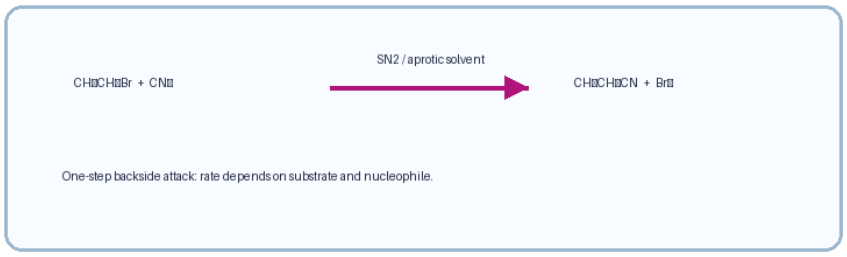
C. No splitting of d orbitals

D. Only ionic bonding

Answer: **B**

Explanation: Strong-field ligands create a larger crystal-field splitting, which can pair electrons in lower-energy t_2g orbitals and produce low-spin complexes.

Q15. **Which factor favours an SN2 reaction in haloalkanes?**



A. Tertiary substrate and polar protic solvent

B. Primary substrate and strong nucleophile

C. Formation of stable carbocation

D. Very bulky nucleophile only

Answer: **B**

Explanation: SN2 reactions are concerted and require backside attack, so less hindered primary substrates and strong nucleophiles are favourable.

Q16. **Which reagent is commonly used to distinguish primary, secondary and tertiary alcohols by reaction rate?**

A. Lucas reagent

B. Tollen's reagent

C. Fehling's solution

D. Benedict's reagent

Answer: A

Explanation: Lucas reagent (conc. HCl + anhydrous $ZnCl_2$) gives turbidity at different rates depending on the alcohol class.

Q17. **Phenol is more acidic than ethanol mainly because:**

- **A.** Phenol has a lower molar mass
- **B.** Phenoxide ion is resonance-stabilized
- **C.** Ethanol is aromatic
- **D.** Phenol is insoluble in water

Answer: B

Explanation: The conjugate base of phenol, phenoxide ion, is stabilized by resonance, while ethoxide ion lacks such stabilization.

Q18. **Which compound gives a silver mirror with Tollen's reagent?**

- **A.** Propanone
- **B.** Ethanal
- **C.** Ethyl acetate
- **D.** Toluene

Answer: B

Explanation: Aldehydes such as ethanal reduce Tollen's reagent to metallic silver, while ordinary ketones do not.

Q19. **Which substituent increases the acidity of benzoic acid when present on the ring?**

- **A.** $-NO_2$
- **B.** $-CH_3$
- **C.** $-OCH_3$
- **D.** $-NH_2$

Answer: A

Explanation: An electron-withdrawing nitro group stabilizes the benzoate ion and increases acidity.

Q20. **Which amine is usually the strongest base in aqueous solution among the following?**

- **A.** Aniline
- **B.** Ammonia
- **C.** Ethylamine
- **D.** p-Nitroaniline

Answer: C

Explanation: Ethylamine has an electron-donating alkyl group that increases electron density on nitrogen. Aniline is less basic because its lone pair is delocalized into the ring.

Q21. **The linkage between two amino acids in a protein is called:**

- **A.** Glycosidic bond
- **B.** Peptide bond
- **C.** Ester bond
- **D.** Phosphodiester bond

Answer: B

Explanation: A peptide bond is an amide linkage formed between the carboxyl group of one amino acid and the amino group of another.

Q22. **Which carbohydrate is non-reducing?**

A. Glucose
B. Fructose
C. Maltose
D. Sucrose

Answer: **D**
Explanation: Sucrose has both anomeric carbons involved in the glycosidic linkage, so it lacks a free hemiacetal/hemiketal group.

Q23. **Nylon-6,6 is formed by:**

A. Addition polymerization of ethene
B. Condensation of hexamethylenediamine and adipic acid
C. Condensation of phenol and formaldehyde
D. Polymerization of vinyl chloride

Answer: **B**
Explanation: Nylon-6,6 is a polyamide produced by condensation between hexamethylenediamine and adipic acid.

Q24. **Aspirin is commonly classified as:**

A. Antiseptic
B. Analgesic and antipyretic
C. Antibiotic
D. Antacid

Answer: **B**
Explanation: Aspirin reduces pain and fever and also has anti-inflammatory action. It is not an antibiotic.

Q25. **A unit cell contains atoms at the corners only. What is the number of atoms per simple cubic unit cell?**

A. 1
B. 2
C. 4
D. 8

Answer: **A**
Explanation: Eight corner atoms contribute 1/8 each to the unit cell. Total atoms = 8 × 1/8 = 1.

Q26. **A 0.1 M glucose solution and a 0.1 M NaCl solution are separated by a semipermeable membrane. Which solution has higher osmotic pressure at the same temperature, assuming complete dissociation of NaCl?**

A. Glucose solution
B. NaCl solution
C. Both equal
D. Cannot be compared

Answer: **B**
Explanation: Osmotic pressure $\pi = iCRT$. Glucose has $i = 1$, while NaCl has $i \approx 2$, so NaCl solution has higher osmotic pressure.

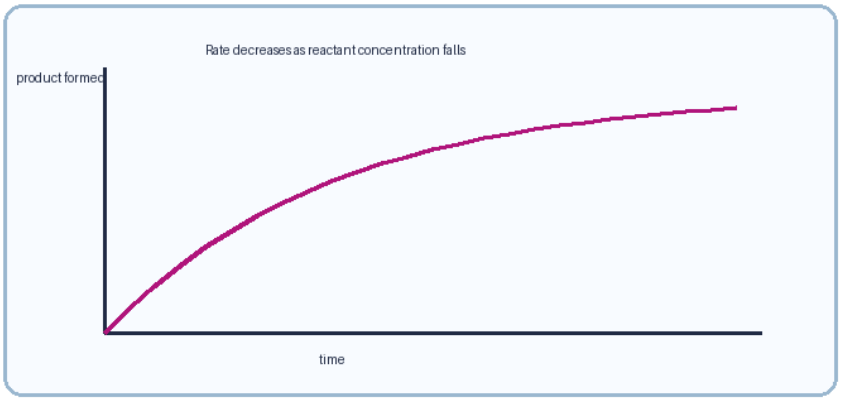
Q27. **How much charge is needed to deposit 1 mole of Ag from Ag^+ solution?**

A. 1 F
B. 2 F
C. 0.5 F
D. 3 F

Answer: **A**

Explanation: $Ag^+ + e^- \rightarrow Ag$ requires one mole of electrons for one mole of silver; one mole of electrons is one Faraday.

Q28. **The graph of product formed versus time usually becomes flatter as a reaction proceeds because:**



A. Activation energy increases continuously
B. Reactant concentration falls, reducing rate
C. Temperature must always decrease
D. Catalyst is consumed

Answer: **B**

Explanation: As reactants are used up, their concentration decreases. The rate often falls, so the curve becomes less steep.

Q29. **Hardy–Schulze rule is related to:**

A. Stability of colloids by coagulating power of ions
B. Molarity calculation
C. Nernst equation
D. Polymer chain length

Answer: **A**

Explanation: Hardy–Schulze rule states that coagulating power of an ion increases sharply with the charge on the ion.

Q30. **Which halogen is the strongest oxidizing agent?**

A. I_2
B. Br_2
C. Cl_2
D. F_2

Answer: **D**

Explanation: Fluorine has the highest standard reduction potential among halogens and is the strongest oxidizing agent.

Section B — Assertion and Reason

Q31. Which complex is expected to show linkage isomerism?

A. $[Co(NH_3)_6]^{3+}$
B. $[Co(NH_3)_5(NO_2)]^{2+}$
C. $[Ni(CO)_4]$
D. $[Ag(NH_3)_2]^{+}$

Answer: B

Explanation: The ambidentate ligand NO_2^- can coordinate through N or O, producing linkage isomers.

Q32. Assertion: The density of an ionic solid decreases when Schottky defects are present. Reason: Schottky defects create paired vacancies of cations and anions in the lattice.

A. Both true and Reason explains Assertion
B. Both true but Reason does not explain Assertion
C. Assertion true, Reason false
D. Assertion false, Reason true

Answer: A

Explanation: The paired vacancies reduce the mass of the crystal without a comparable change in volume, so density decreases.

Q33. Assertion: A catalyst changes the equilibrium constant of a reaction. Reason: A catalyst lowers activation energy.

A. Both true and Reason explains Assertion
B. Both true but Reason does not explain Assertion
C. Assertion true, Reason false
D. Assertion false, Reason true

Answer: D

Explanation: The assertion is false. A catalyst does not change K; it lowers activation energy for both directions and helps equilibrium be reached faster.

Q34. Assertion: For a first-order reaction, half-life is independent of initial concentration. Reason: $t_1/_2 = 0.693/k$ for a first-order reaction.

A. Both true and Reason explains Assertion
B. Both true but Reason does not explain Assertion
C. Assertion true, Reason false
D. Assertion false, Reason true

Answer: A

Explanation: The formula contains only k, so the half-life does not depend on initial concentration.

Q35. Assertion: In a galvanic cell, oxidation occurs at the anode. Reason: The anode supplies electrons to the external circuit.

A. Both true and Reason explains Assertion
B. Both true but Reason does not explain Assertion
C. Assertion true, Reason false
D. Assertion false, Reason true

Answer: A

Explanation: At the anode, species lose electrons; these electrons flow through the external circuit to the cathode.

Q36. **Assertion: Phenol is more acidic than ethanol. Reason: Phenoxide ion is resonance-stabilized.**

A. Both true and Reason explains Assertion
B. Both true but Reason does not explain Assertion
C. Assertion true, Reason false
D. Assertion false, Reason true

Answer: **A**
Explanation: Resonance stabilization of phenoxide lowers the energy of the conjugate base, increasing acidity.

Q37. **Assertion: SN2 reactions show inversion of configuration. Reason: The nucleophile attacks from the backside of the C–X bond.**

A. Both true and Reason explains Assertion
B. Both true but Reason does not explain Assertion
C. Assertion true, Reason false
D. Assertion false, Reason true

Answer: **A**
Explanation: Backside attack in SN2 produces a transition state that leads to Walden inversion.

Q38. **Assertion: Lanthanoid contraction affects the chemistry of 4d and 5d elements. Reason: 4f electrons shield nuclear charge poorly.**

A. Both true and Reason explains Assertion
B. Both true but Reason does not explain Assertion
C. Assertion true, Reason false
D. Assertion false, Reason true

Answer: **A**
Explanation: Poor shielding by 4f electrons causes contraction, making some 4d and 5d elements similar in size and chemistry.

Q39. **Assertion: Sucrose is a non-reducing sugar. Reason: It has a free aldehyde group.**

A. Both true and Reason explains Assertion
B. Both true but Reason does not explain Assertion
C. Assertion true, Reason false
D. Assertion false, Reason true

Answer: **C**
Explanation: Sucrose is non-reducing, but not because of a free aldehyde group; both anomeric carbons are tied in the glycosidic bond.

Q40. **Assertion: Transition metal complexes are often coloured. Reason: Ligand field splitting may allow absorption of visible light for d–d transitions.**

A. Both true and Reason explains Assertion
B. Both true but Reason does not explain Assertion
C. Assertion true, Reason false
D. Assertion false, Reason true

Answer: **A**
Explanation: The colour observed is complementary to the light absorbed during electronic transitions between split d orbitals.

Section C — Case Study Questions

Q41. Assertion: Nylon-6,6 is a condensation polymer. Reason: Its formation involves elimination of small molecules such as water.

A. Both true and Reason explains Assertion
B. Both true but Reason does not explain Assertion
C. Assertion true, Reason false
D. Assertion false, Reason true

Answer: A

Explanation: Nylon-6,6 forms by condensation between diamine and diacid units, with elimination of small molecules.

Q42. Case: A student prepares a Daniell cell and observes steady current. If $[Zn^{2+}]$ is increased while other conditions are unchanged, what happens to the cell potential according to the reaction $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$?

A. It increases
B. It decreases
C. It becomes zero immediately
D. It is independent of ion concentration

Answer: B

Explanation: For the cell reaction, $Q = [Zn^{2+}]/[Cu^{2+}]$. Increasing $[Zn^{2+}]$ increases Q, so $E = E° - (0.0591/2)\log Q$ decreases.

Q43. Case: A solution of a non-electrolyte shows ΔTf = 1.86 K in water when molality is 1.0 m. What can be concluded if Kf of water is 1.86 K kg mol^{-1}?

A. The solute dissociates completely
B. The solute associates completely
C. The solute behaves ideally with $i \approx 1$
D. The solute is volatile

Answer: C

Explanation: $\Delta Tf = iKfm$. Here $1.86 = i \times 1.86 \times 1$, so $i \approx 1$, typical of a non-electrolyte without association or dissociation.

Q44. Case: During esterification of ethanol with ethanoic acid, a few drops of concentrated H_2SO_4 are added. What is its main role?

A. It is consumed as the main reactant
B. It acts as acid catalyst and dehydrating agent
C. It neutralizes the ester
D. It prevents equilibrium

Answer: B

Explanation: Concentrated sulfuric acid protonates the carbonyl oxygen to catalyse esterification and helps remove water, shifting equilibrium toward ester.

Q45. Case: A violet octahedral Co(III) complex absorbs yellow-green light. What does this observation primarily indicate?

A. The complex has no ligand field splitting
B. The complex absorbs visible light corresponding to Δ_o
C. The colour is due to nuclear reaction
D. All Co(III) complexes must be violet

Answer: B

Explanation: Octahedral ligand fields split d orbitals; absorption of visible light of energy Δ_0 produces the observed complementary colour.

Section D — Achievers Section

Q46. Case: A rural clinic stores medicines in a warm, humid room. Which chemistry principle best explains why some medicines degrade faster under these conditions?

A. Higher temperature and moisture can accelerate chemical reactions and hydrolysis
B. Medicines cannot react in solid form
C. Humidity always decreases reaction rate
D. All medicines are inert polymers

Answer: A
Explanation: Many degradation reactions become faster at higher temperature. Moisture can promote hydrolysis of susceptible functional groups.

Q47. Achievers: For the cell Mg | Mg^{2+}(0.01 M) || Cu^{2+}(1.0 M) | Cu, E°cell = 2.71 V. At 298 K, estimate Ecell for n = 2.

A. 2.65 V
B. 2.77 V
C. 2.71 V
D. 2.59 V

Answer: B
Explanation: $Q = [Mg^{2+}]/[Cu^{2+}] = 0.01$. $E = 2.71 - (0.0591/2)\log(0.01) = 2.71 + 0.0591 \approx 2.77$ V.

Q48. Achievers: A 0.10 m solution of $BaCl_2$ shows i = 2.7. What is the approximate freezing point depression in water? (Kf = 1.86 K kg mol^{-1})

A. 0.186 K
B. 0.372 K
C. 0.502 K
D. 1.860 K

Answer: C
Explanation: $\Delta Tf = iKfm = 2.7 \times 1.86 \times 0.10 = 0.502$ K.

Q49. Achievers: A primary haloalkane reacts with CN^- in DMSO. Which change most directly increases the SN2 rate?

A. Use a bulkier tertiary substrate
B. Increase nucleophile concentration
C. Use a weaker nucleophile only
D. Add water to strongly solvate CN^-

Answer: B
Explanation: SN2 rate = k[substrate][nucleophile]. Increasing the nucleophile concentration directly increases the rate.

Q50. Achievers: A low-spin d^6 octahedral complex has how many unpaired electrons?

A. 0
B. 2
C. 4
D. 6

Answer: A

Explanation: In a strong-field octahedral d^6 complex, electrons pair in t_2g orbitals: t_2g^6 e_g^0. Hence it is diamagnetic with zero unpaired electrons.

Answer Key

Questions 1-11	Questions 12-22	Questions 23-33	Questions 34-44	Questions 45-50
1. B	12. A	23. B	34. A	45. B
2. B	13. A	24. B	35. A	46. A
3. B	14. B	25. A	36. A	47. B
4. A	15. B	26. B	37. A	48. C
5. A	16. A	27. A	38. A	49. B
6. C	17. B	28. B	39. C	50. A
7. C	18. B	29. A	40. A	
8. C	19. A	30. D	41. A	
9. B	20. C	31. B	42. B	
10. B	21. B	32. A	43. C	
11. B	22. D	33. D	44. B	