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# Chemistry Grade 12 — Chapter 6

The Transition Metals

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*Independent practice MCQs from the supplied Class 12 Chemistry notes pack. Total: 50 questions.*

## A. Important / Main Topics

**1. A transition element is defined as an element that:**

(A) Has an incomplete d subshell in its most stable ionic state
(B) Has a completely filled d subshell
(C) Belongs to Group 1 or 2
(D) Has only s electrons in its valence shell

**Correct Answer: A**

*Explanation: The notes define transition elements as those which have incomplete d subshells in their most s.*

**2. The electronic configuration of chromium is:**

(A) $[Ar]3d^4 4s^2$
(B) $[Ar]3d^5 4s^1$
(C) $[Ar]3d^6 4s^0$
(D) $[Ar]3d^3 4s^3$

**Correct Answer: B**

*Explanation: Chromium is an exception to the Aufbau principle; its configuration is $[Ar]3d^5 4s^1$ due to the extra stability of a half-filled d subshell.*

**3. The electronic configuration of copper is:**

(A) $[Ar]3d^9 4s^2$
(B) $[Ar]3d^{10} 4s^2$
(C) $[Ar]3d^{10} 4s^1$
(D) $[Ar]3d^8 4s^2$

**Correct Answer: C**

*Explanation: Copper is an exception to the Aufbau principle; its configuration is $[Ar]3d^{10} 4s^1$ due to the extra stability of a fully-filled d subshell.*

**4. When transition metals form cations, electrons are removed first from the:**

(A) 3d orbital
(B) 4p orbital
(C) 3p orbital
(D) 4s orbital

**Correct Answer: D**

*Explanation: The notes state that when forming cations, electrons are always removed from the higher energy sub-shell, i.e., 4s in the first row of d-block elements.*

**5. Which of the following is a typical physical property of transition metals?**

(A) Good conductor of electricity
(B) Low melting point
(C) Low density
(D) Poor conductor of heat

**Correct Answer: A**

*Explanation: Transition metals are good conductors of electricity because they have free electrons.*

**6. Which of the following transition metals is known for being strongly ferromagnetic?**

(A) Copper
(B) Iron

(C) Zinc
(D) Scandium

**Correct Answer: B**

*Explanation: Iron, cobalt, and nickel are ferromagnetic; they are strongly attracted to a magnet and can become permanent magnets.*

**7. Why can transition metals form alloys?**

(A) Because they have different atomic sizes
(B) Because they have high melting points
(C) Because they have similar atomic sizes
(D) Because they are poor conductors

**Correct Answer: C**

*Explanation: Transition metals have similar atomic sizes, allowing them to substitute for one another in the metallic lattice, which is the basis for alloy formation.*

**8. The common oxidation state for the first-row d-block elements is:**

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

**Correct Answer: D**

*Explanation: The common oxidation state for the first-row d-block elements is +2, obtained by the loss of the two 4s electrons.*

**9. Which process uses iron as a catalyst?**

(A) Haber process
(B) Contact process
(C) Ostwald process
(D) Solvay process

**Correct Answer: A**

*Explanation: The Haber process for the synthesis of ammonia uses iron as a catalyst.*

**10. A ligand is a species that:**

(A) Accepts an electron pair
(B) Donates an electron pair
(C) Is a central metal ion
(D) Is a type of catalyst

**Correct Answer: B**

*Explanation: A ligand is a Lewis base that donates a lone pair of electrons to a central metal ion to form a coordinate covalent bond.*

**11. Which of the following is a monodentate ligand?**

(A) 1,2-diaminoethane
(B) EDTA
(C) Water
(D) Ethanedioate

**Correct Answer: C**

*Explanation: Water (H□O) is a monodentate ligand because it can form only one coordinate covalent bond.*

**12. The coordination number of copper in [Cu(H□O)□]²□ is:**

(A) 2
(B) 4
(C) 8
(D) 6

**Correct Answer: D**

*Explanation: In [Cu(H□O)□]²□, the copper ion is bonded to six water molecules, giving a coordination number of 6.*

**13. What is the geometry of the [CuCl□]²□ complex?**

(A) Tetrahedral
(B) Linear
(C) Square planar
(D) Octahedral

**Correct Answer: A**

*Explanation: The [CuCl□]²□ complex is tetrahedral because four chloride ligands surround the copper ion.*

**14. The colour of transition metal complexes is due to:**

(A) The metal ion only
(B) d-d electronic transitions
(C) The ligands only
(D) The solvent

**Correct Answer: B**

*Explanation: The colour is due to d-d electronic transitions, which depend on the splitting of the d orbitals.*

**15. Which of the following complexes is colorless?**

(A) [Cu(H□O)□]²□
(B) [Ti(H□O)□]³□
(C) [Zn(H□O)□]²□
(D) [Ni(H□O)□]²□

**Correct Answer: C**

*Explanation: [Zn(H□O)□]²□ is colorless because mathrmZn²□ has a completely filled 3d subshell ($3d^{10}$), so no d-d transitions are possible.*

**16. Which one of the following species has a $d^{10}$ sub-shell?**

(A) mathrmCu²□
(B) Mn
(C) Cr
(D) mathrmZn²□

**Correct Answer: D**

*Explanation: mathrmZn²□ has the electron configuration [Ar]$3d^{10}$, so its d subshell is completely filled.*

**17. Which of the following is an incorrect statement about transition metals when compared with Group 1 and Group 2 metals?**

(A) They are more reactive.
(B) They form coloured compounds.
(C) They show variable oxidation states.
(D) They have high melting points.

**Correct Answer: A**

*Explanation: Transition metals are generally less reactive than Group 1 and Group 2 metals.*

**18. Which property of transition metals is responsible for their catalytic behaviour?**

(A) They form coloured complexes.
(B) They have variable oxidation states.
(C) They have high melting points.
(D) They have high density.

**Correct Answer: B**

*Explanation: They have variable oxidation states. — this correctly answers the question.*

**19. The highest oxidation state shown by first-row transition metals is shown by:**

(A) Copper
(B) Nickel
(C) Manganese
(D) Cobalt

**Correct Answer: C**

*Explanation: Manganese has the electron configuration [Ar]3d⁵4s² and can show a maximum oxidation state of +7 (e.g., in KMnO□).*

**20. The weakest field ligand among the following is:**

(A) CN□
(B) NH□
(C) OH□
(D) H□O

**Correct Answer: D**

*Explanation: Based on the spectrochemical series, the field strength order is CN□ > NH□ > H□O > OH□. Among the given options, H□O is the weakest field ligand.*

**21. Why is the hexaaquacopper(II) ion blue in colour?**

(A) The d-d electronic transition absorbs all wavelengths except blue.
(B) The d-d electronic transition absorbs blue wavelength of visible spectrum.
(C) The d-d electronic transition transmits all wavelengths of white light except blue.
(D) The d-d electronic transition absorbs red wavelength and transmits the remaining light.

**Correct Answer: A**

*Explanation: The [Cu(H□O)□]²□ ion absorbs orange light and transmits the remaining light, which appears blue. The absorption is due to a d-d transition.*

**22. What is the IUPAC name of the complex [Cu(NH□)□]²□?**

(A) Copper diammine(II) ion
(B) Diamminecopper(II) ion
(C) Diamminecuprate(II) ion
(D) Copper(II) diammine ion

**Correct Answer: B**

*Explanation: The ligands are two ammonia molecules (ammine), and the metal is copper in the +2 oxidation state. The name is diamminecopper(II) ion.*

**23. What is the oxidation state of iron in K□[Fe(CN)□]?**

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

**Correct Answer: C**

*Explanation: The complex ion is [Fe(CN)□]⁴□. Six cyanide ligands contribute -6. The overall charge is -4, so the iron must be +2.*

**24. What is the IUPAC name of [Ni(CO)□]?**

(A) Nickel tetracarbonyl(0)
(B) Tetracarbonylnickelate(0)
(C) Nickel(0) tetracarbonyl
(D) Tetracarbonylnickel(0)

**Correct Answer: D**

*Explanation: The ligands are four carbonyl groups, and the metal is nickel in the 0 oxidation state. The name is tetracarbonylnickel(0).*

**25. What is the charge on the complex ion [CoCl□(NH□)□]□?**

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

**Correct Answer: A**

*Explanation: The cobalt ion is in the +3 oxidation state. Two chloride ligands contribute -2, and four ammonia ligands are neutral (0). Total charge = (+3) + (-2) + (0) = +1.*

## B. Less Important / Secondary Topics

**26. What is the oxidation state of copper in [CuCl□]²□?**

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

**Correct Answer: A**

*Explanation: The complex ion has a charge of -2. Four chloride ligands contribute -4. Therefore, the copper ion must be +2.*

**27. Which of the following is a good leaving group in ester formation?**

(A) OH□
(B) Cl□
(C) NH□□
(D) CH□□

**Correct Answer: B**

*Explanation: The chloride ion (Cl□) is a good leaving group.*

**28. What type of reaction is the formation of an ester from an acyl chloride and an alcohol?**

(A) Electrophilic substitution
(B) Electrophilic addition
(C) Nucleophilic acyl substitution
(D) Free radical substitution

**Correct Answer: C**

*Explanation: The reaction is a nucleophilic acyl substitution.*

**29. Which of the following is a positive consequence of the high density of transition metals?**

(A) They are poor conductors.
(B) They are gases at room temperature.
(C) They have low melting points.
(D) They are useful in construction.

**Correct Answer: D**

*Explanation: They are useful in construction. — this correctly answers the question.*

**30. The [CuCl□]²□ complex is tetrahedral rather than octahedral because:**

(A) Chloride is a large ligand and six cannot fit around the small copper ion.
(B) Copper is a small ion.
(C) Chloride is a strong-field ligand.
(D) The complex has a $d^{10}$ configuration.

**Correct Answer: A**

*Explanation: The notes state that with chloride ligands, copper(II) forms a tetrahedral complex because chloride is a big ligand and six chloride ligands cannot surround a small copper(II) ion.*

**31. Which of the following is an application of transition metal complexes in medicine?**

(A) EDTA as a food preservative
(B) Cis-platin as an anticancer drug
(C) Chlorophyll as a blood-clotting agent
(D) Sodium chloride as a contrast medium

**Correct Answer: B**

*Explanation: The notes state that cis-platin is used as an anticancer drug because it inhibits cell division.*

**32. What is the relationship between the strength of the ligand field and the splitting of d orbitals?**

(A) Stronger field causes a smaller splitting.
(B) There is no relationship.
(C) Stronger field causes a larger splitting.
(D) Splitting is independent of the ligand.

**Correct Answer: C**

*Explanation: Stronger field causes a larger splitting. — this correctly answers the question.*

**33. In an octahedral complex, which set of d orbitals is higher in energy?**

(A) t□g
(B) Both are equal
(C) It depends on the metal
(D) e_g

**Correct Answer: D**

*Explanation: The e_g set is higher in energy in an octahedral complex.*

**34. What is the name of the lower energy set of d orbitals in a tetrahedral complex?**

(A) t□
(B) e_g
(C) t□g
(D) e

**Correct Answer: A**

*Explanation: In a tetrahedral complex, the lower energy set is the t□ set.*

**35. Which of the following statements about the splitting in tetrahedral complexes is correct?**

(A) Δ_t > Δ_o
(B) Δ_t < Δ_o
(C) Δ_t = Δ_o
(D) There is no splitting in tetrahedral complexes.

**Correct Answer: B**

*Explanation: The splitting energy in tetrahedral complexes (Δ_t) is generally smaller than that in octahedral complexes (Δ_o).*

**36. The reduction potential for mathrmCr²□ being reduced to chromium metal is -0.91 V and that for mathrmCr³□ being reduced to mathrmCr²□ is -0.41 V. Predict whether chromium(II) will disproportionate to chromium(III) and chromium metal.**

(A) No, it will not disproportionate.
(B) It will only oxidize.
(C) Yes, it will disproportionate.
(D) It will only reduce.

**Correct Answer: C**

*Explanation: The disproportionation reaction is 3mathrmCr²□ → 2mathrmCr³□ + Cr. The cell potential is positive (+0.50 V), so the reaction is feasible.*

**37. Which of the following is the correct electronic configuration for mathrmCu²□?**

(A) [Ar]3d¹⁰
(B) [Ar]3d⁸4s¹
(C) [Ar]3d⁸4s²
(D) [Ar]3d⁹

**Correct Answer: D**

*Explanation: Neutral Cu is [Ar]3d¹⁰4s¹. When it forms mathrmCu²□, it loses two electrons (one from 4s and one from 3d), giving [Ar]3d⁹.*

**38. The species that can act as a ligand in a transition metal complex is:**

(A) C□H□(OH)□
(B) CH□
(C) C□H□

(D) Na

**Correct Answer: A**

*Explanation: C□H□(OH)□ has lone pairs on oxygen atoms that can be donated to a metal ion, so it can act as a ligand.*

**39. The coordination number of nickel in the complex [Ni(en)□(OH□)□]²□ is:**

(A) 2
(B) 6
(C) 4
(D) 8

**Correct Answer: B**

*Explanation: The ligand "en" (1,2-diaminoethane) is bidentate, so two en ligands contribute 4 coordinate bonds. Two water molecules contribute 2 more. Total coordination number = 4 + 2 = 6.*

**40. The highest oxidation state shown by first-row transition metals is shown by:**

(A) Copper
(B) Nickel
(C) Manganese
(D) Cobalt

**Correct Answer: C**

*Explanation: Manganese has 7 valence electrons and can show a maximum oxidation state of +7.*

**41. Which of the following is a correct statement about the relative stability of +2 and +3 oxidation states across the first row?**

(A) The stability of +2 relative to +3 decreases with atomic number.
(B) The stability of +2 and +3 is the same for all elements.
(C) The stability of +3 increases with atomic number.
(D) The stability of +2 relative to +3 increases with atomic number.

**Correct Answer: D**

*Explanation: The stability of the +2 oxidation state compared to the +3 oxidation state increases with atomic number from left to right across the first row of the d-block.*

**42. Which of the following statements about the catalytic activity of transition metals is correct?**

(A) They can exist in more than one stable oxidation state and have vacant d orbitals.
(B) They are only used as homogeneous catalysts.
(C) They are only used as heterogeneous catalysts.
(D) They have full d orbitals.

**Correct Answer: A**

*Explanation: The notes state that the two properties responsible for catalytic.*

**43. In the complex [Fe(CN)□]³□, the iron ion has the electronic configuration:**

(A) [Ar]$3d^6$
(B) [Ar]$3d^5$
(C) [Ar]$3d^6 4s^1$
(D) [Ar]$3d^4 4s^2$

**Correct Answer: B**

*Explanation: In [Fe(CN)□]³□, the iron is in the +3 oxidation state. Neutral Fe is [Ar]$3d^6 4s^2$. Removing three electrons gives [Ar]$3d^5$.*

**44. Which of the following is an example of a complex with a square planar geometry?**

(A) [CuCl□]²□
(B) [Ni(H□O)□]²□
(C) [Pt(NH□)□Cl□]
(D) [Ag(NH□)□]□

**Correct Answer: C**

*Explanation: [Pt(NH□)□Cl□] is a square planar complex.*

**45. What is the bond angle in a linear complex?**

(A) 90^circ
(B) 109.5^circ
(C) 120^circ
(D) 180^circ

**Correct Answer: D**

*Explanation: The bond angle in a linear complex is 180^circ.*

**46. Which of the following is a common geometry for coordination number 4?**

(A) Tetrahedral
(B) Octahedral
(C) Linear
(D) Trigonal bipyramidal

**Correct Answer: A**

*Explanation: Tetrahedral is a common geometry for coordination number 4, along with square planar.*

**47. What is the geometry of the [Ni(H□O)□]²□ complex?**

(A) Linear
(B) Octahedral
(C) Tetrahedral
(D) Square planar

**Correct Answer: B**

*Explanation: [Ni(H□O)□]²□ is an octahedral complex.*

**48. Which of the following is a correct statement about the E/Z system?**

(A) It is used for alkanes.
(B) It is used for alkynes.
(C) It is used for alkenes with different groups on each carbon.
(D) It is used for benzene.

**Correct Answer: C**

*Explanation: The E/Z system is used for alkenes with different groups on each carbon.*

**49. What is the relationship between the stability of cis and trans isomers?**

(A) Cis isomers are generally more stable than trans isomers.
(B) Both isomers have the same stability.
(C) Stability depends only on the molecular weight.
(D) Trans isomers are generally more stable than cis isomers due to less steric hindrance.

**Correct Answer: D**

*Explanation: Trans isomers are generally more stable than cis isomers due to less steric hindrance. — this correctly answers the question.*

**50. Which of the following is a correct statement about optical isomerism?**

(A) It involves non-superimposable mirror images.
(B) It is a type of structural isomerism.
(C) It arises due to restricted rotation around a double bond.
(D) It is shown by alkanes.

**Correct Answer: A**

*Explanation: It involves non-superimposable mirror images. — this correctly answers the question.*