JEE Main Chemistry Sample Paper 01

Total Questions: 25 | **Duration:** 1 Hour

Section A: 20 Multiple Choice Questions | **Section B:** 5 Numerical Questions

Section A: Multiple Choice Questions (1-20)

1. Which of the following lanthanoid ions represents a powerful oxidizing agent in the +4 state?

A. (A) Eu

B. (B) Gd

C. (C) Ce

D. (D) Sm

2. The correct order of basicity for the following amines in aqueous solution is:

A. (A) Aniline < NH3 < Methylamine

B. (B) Methylamine < Aniline < NH3

C. (C) NH3 < Methylamine < Aniline

D. (D) Aniline < Methylamine < NH3

3. The primary product obtained in the Reimer-Tiemann reaction of phenol with chloroform and sodium hydroxide is:

A. (A) Salicylic acid

B. (B) Benzoquinone

C. (C) Salicylaldehyde

D. (D) ortho-Chlorophenol

4. Which of the following carbohydrates is classified as a non-reducing sugar?

A. (A) Lactose

B. (B) Sucrose

C. (C) Maltose

D. (D) Cellobiose

5. In the test for Nitrogen, the formation of Prussian Blue is represented by which formula?

A. (A) $Fe_3[Fe(CN)_6]_4$

B. (B) $Na_4[Fe(CN)_6]$

C. (C) $Fe_4[Fe(CN)_6]_3$

D. (D) $Fe(SCN)_3$

6. Crystal Field Theory fails to explain which of the following characteristics?

A. (A) Color of complexes

B. (B) Magnetic properties

C. (C) Order of ligands in spectrochemical series

D. (D) d-orbital splitting

7. Acidified $K_2Cr_2O_7$ paper changes to green color when it reacts with:

A. (A) CO_2

B. (B) H_2S

C. (C) SO_2

D. (D) SO_3

8. Which of the following molecules lacks an α-hydrogen and therefore cannot undergo Aldol condensation?

A. (A) Acetone

B. (B) Benzaldehyde

C. (C) Acetaldehyde

D. (D) Propanal

9. The dehydrohalogenation of 2-bromobutane with alcoholic KOH yields which major product?

A. (A) But-1-ene

B. (B) trans-But-2-ene

C. (C) cis-But-2-ene

D. (D) Butan-2-ol

10. The transition responsible for the intense purple color of $KMnO_4$ is:

A. (A) d → d transition

B. (B) M → L charge transfer

C. (C) L → M charge transfer

D. (D) π → π* transition

11. Lanthanoid contraction is primarily attributed to:

A. (A) High nuclear charge

B. (B) Poor shielding of 4f electrons

C. (C) Effective shielding of 5d electrons

D. (D) Increasing atomic number

12. Identify the geometry of the Manganese complex Mn2(CO)10:

A. (A) Octahedral

B. (B) Square Pyramidal

C. (C) Trigonal Bipyramidal

D. (D) Tetrahedral

13. D-Glucose pentaacetate does not react with hydroxylamine because:

A. (A) It is too bulky

B. (B) The aldehyde group is not free

C. (C) It is a reducing sugar

D. (D) The ring structure is unstable

14. The de-Broglie wavelength of an electron in the first Bohr orbit of the Hydrogen atom is:

A. (A) 0.529 Å

B. (B) 2π × 0.529 Å

C. (C) 1.058 Å

D. (D) 0.264 Å

15. Which purification technique is based on the principle of differential solubility?

A. (A) Distillation

B. (B) Sublimation

C. (C) Fractional Crystallization

D. (D) Steam Distillation

16. The catalyst used in the Mond's process for the refining of Nickel is:

A. (A) H2

B. (B) CO

C. (C) Cl2

D. (D) N2

17. Adsorption of gases on solids is generally an:

A. (A) Endothermic process
B. (B) Exothermic process
C. (C) Isothermal process
D. (D) Adiabatic process

18. Which of the following species has the highest bond order?

A. (A) O2
B. (B) O2-
C. (C) O2+
D. (D) O2 2-

19. The stability order of carbocations follows the sequence:

A. (A) 3° > 2° > 1°
B. (B) 1° > 2° > 3°
C. (C) 2° > 3° > 1°
D. (D) 3° > 1° > 2°

20. Which gas is commonly used in MRI scans due to its cryogenic properties?

A. (A) Neon
B. (B) Helium
C. (C) Argon
D. (D) Xenon

Section B: Numerical Value Questions (21-25)

21. A hydrocarbon contains 85.8% Carbon. Molar mass is 84. Find number of Hydrogen atoms: _____

22. Sum of π-bonds in Peroxodisulphuric acid and Pyrosulphuric acid: _____

23. Find number of concentration units in list: ppm, M, Mole, mass%, m: _____

24. Calculate Kf value for 1g solute (MW 256), 50g solvent, ΔTf = 0.4: _____

25. Tripeptides possible from mixing valine and proline: _____

Answer Key & Detailed Explanation

1. [C] Cerium in the +4 state (Ce^{4+}) is a powerful oxidizing agent as it strongly tends to reach the stable +3 state by gaining an electron.

2. [A] Basicity order: Aliphatic amines > Ammonia > Aromatic amines. Methylamine is more basic than Aniline due to the +I effect and resonance in Aniline.

3. [C] The Reimer-Tiemann reaction of phenol with $CHCl_3$ and NaOH primarily yields Salicylaldehyde (ortho-hydroxybenzaldehyde).

4. [B] Sucrose is non-reducing because its reducing groups (anomeric carbons) are involved in the glycosidic linkage.

5. [C] Prussian Blue is formed in the nitrogen test as Ferric Ferrocyanide, with the chemical formula $Fe_4[Fe(CN)_6]_3$.

6. [C] Crystal Field Theory (CFT) is an electrostatic model; it fails to explain the specific order of ligands in the spectrochemical series.

7. [C] SO_2 reduces orange $K_2Cr_2O_7$ to green $Cr_2(SO_4)_3$. This reaction is a characteristic test for sulfur dioxide gas.

8. [B] Benzaldehyde lacks alpha-hydrogens on the carbon adjacent to the carbonyl group and therefore cannot form an enolate to undergo Aldol condensation.

9. [B] According to Saytzeff's rule, the more substituted alkene (trans-but-2-ene) is the major product in dehydrohalogenation.

10. [C] $KMnO_4$ has Mn in +7 (d0). The intense purple color is due to Charge Transfer (L → M) from Oxygen ligands to the Manganese center.

11. [B] Lanthanoid contraction is caused by the poor shielding effect of 4f electrons, which allows the nuclear charge to pull outer electrons more strongly.

12. [B] $Mn_2(CO)_{10}$ consists of two $Mn(CO)_5$ units. Each Mn center has a Square Pyramidal geometry.

13. [B] Acetylation of glucose hides the aldehyde group; hence the pentaacetate cannot revert to the open-chain form to react with NH_2OH.

14. [B] For the first Bohr orbit, $2\pi r = n\lambda$. With n=1 and r=0.529 Å, $\lambda = 2\pi \times 0.529$ Å.

15. [C] Fractional crystallization separates components based on their different solubilities in a given solvent at various temperatures.

16. [B] The Mond process uses Carbon Monoxide (CO) to form a volatile complex $[Ni(CO)_4]$ for refining Nickel.

17. [B] Adsorption is generally exothermic ($\Delta H < 0$) because the residual forces on the surface of the adsorbent decrease upon bond formation.

18. [C] Bond order: O_2^+(2.5) > O_2(2.0) > O_2^-(1.5) > O_2^{2-}(1.0). Therefore, O_2^+ has the

highest bond order.

19. [A] Stability order: 3° > 2° > 1° due to hyperconjugation and the inductive effect (+I) from alkyl groups.

20. [B] Liquid Helium is used in MRI machines as a coolant for superconducting magnets due to its extremely low boiling point.

21. [12] Empirical formula is CH2. Empirical mass = 14. n = 84/14 = 6. Molecular formula is C6H12. H atoms = 12.

22. [8] H2S2O8 has 4 S=O bonds (4 pi); H2S2O7 has 4 S=O bonds (4 pi). Total sum = 8.

23. [4] Concentration units are ppm, M, mass%, and m. 'Mole' is a unit of quantity, not concentration. Count = 4.

24. [5.12] $\Delta T_f = K_f \times m$. $0.4 = K_f \times [(1/256) / (50/1000)]$. Solving gives $K_f = 5.12$.

25. [8] Mixing 2 amino acids for a tripeptide sequence allows 2^3 = 8 unique combinations.