

JEE Main Chemistry Sample Paper 04

Subject: Chemistry

Structure: 20 Shuffled MCQs + 5 Pure Chemistry Numericals

Marking Scheme: Correct (+4) | Incorrect MCQ (-1) | Incorrect NVT (0)

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 < NH ₃ < Methylamine | B. (B) Methylamine < Aniline < NH ₃ |
| C. (C) NH ₃ < Methylamine < Aniline | D. (D) Aniline < Methylamine < NH ₃ |

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) $\text{Fe}_3[\text{Fe}(\text{CN})_6]_4$ | B. (B) $\text{Na}_4[\text{Fe}(\text{CN})_6]$ |
| C. (C) $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ | D. (D) $\text{Fe}(\text{SCN})_3$ |
-

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 $\text{K}_2\text{Cr}_2\text{O}_7$ 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 according to Saytzeff's rule?

- | | |
|------------------|------------------------|
| 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) $d \rightarrow d$ transition

B. (B) $M \rightarrow L$ charge transfer

C. (C) $L \rightarrow M$ charge transfer

D. (D) $\pi \rightarrow \pi^*$ 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 $\text{Mn}_2(\text{CO})_{10}$:

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) $0.529 \text{ \AA}$

B. (B) $2\pi \times 0.529 \text{ \AA}$

C. (C) $1.058 \text{ \AA}$

D. (D) $0.264 \text{ \AA}$

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) H_2

B. (B) CO

C. (C) Cl_2

D. (D) N_2

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) O_2

B. (B) O_2^-

C. (C) O_2^+

D. (D) O_2^{2-}

19. The stability order of carbocations follows the sequence:

A. (A) $3^\circ > 2^\circ > 1^\circ$

B. (B) $1^\circ > 2^\circ > 3^\circ$

C. (C) $2^\circ > 3^\circ > 1^\circ$

D. (D) $3^\circ > 1^\circ > 2^\circ$

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 K_f value for 1g solute (MW 256), 50g solvent, $\Delta T_f = 0.4$: _____

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 in aqueous solution: Methylamine > NH_3 > Aniline. Aliphatic amines are more basic than ammonia due to +I effect; aromatic amines are least basic due to resonance.

3. [C] The Reimer-Tiemann reaction primarily yields Salicylaldehyde (o-hydroxybenzaldehyde).

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

5. [C] Prussian Blue formula in the nitrogen test is Ferric Ferrocyanide: $Fe_4[Fe(CN)_6]_3$.

6. [C] CFT fails to explain the covalent nature of bonding and the specific order of ligands in the spectrochemical series.

7. [C] SO_2 reduces orange $K_2Cr_2O_7$ to green $Cr_2(SO_4)_3$.

8. [B] Benzaldehyde lacks α -hydrogens and therefore cannot form an enolate to undergo Aldol condensation.
9. [B] trans-But-2-ene is the more substituted and thus major product according to Saytzeff's rule.
10. [C] The intense color of KMnO_4 is due to Charge Transfer ($L \rightarrow M$) from Oxygen ligands to Manganese.
11. [B] Poor shielding of 4f electrons allows the nuclear charge to pull outer electrons more strongly.
12. [B] $\text{Mn}_2(\text{CO})_{10}$ consists of two units with Square Pyramidal geometry.
13. [B] Acetylation hides the aldehyde group, preventing it from reacting with hydroxylamine.
14. [B] For the first Bohr orbit, $2\pi r = n\lambda$. With $n=1$ and $r=0.529 \text{ \AA}$, $\lambda = 2\pi \times 0.529 \text{ \AA}$.
15. [C] Fractional crystallization separates components based on solubility at various temperatures.
16. [B] Mond's process uses CO to form volatile nickel tetracarbonyl.
17. [B] Adsorption is generally exothermic as residual forces on the surface decrease.
18. [C] Bond order: O_2^+ (2.5) > O_2 (2.0) > O_2^- (1.5). Highest is O_2^+ .
19. [A] Stability order: $3^\circ > 2^\circ > 1^\circ$ due to hyperconjugation and inductive effects.

20. [B] Liquid Helium is used as a cryogenic coolant for MRI magnets.

21. [12] Empirical Formula is CH_2 (mass 14). $n = 84/14 = 6$. Molecular formula C_6H_{12} . H atoms = 12.

22. [8] Peroxodisulphuric acid (4) + Pyrosulphuric acid (4) = 8 pi bonds.

23. [4] ppm, M, mass%, and m are units. Mole is a quantity. Count = 4.

24. [5.12] $0.4 = K_f * (1/256) / (50/1000)$. Solving gives $K_f = 5.12$.

25. [8] $2^3 = 8$ possible unique tripeptide combinations.