CUET 2026 May 20 Shift 2 Chemistry

Question Paper (Memory-Based) with Solutions

Conducted by National Testing Agency (NTA)

General Instructions

(i) The examination will be conducted in Computer-Based Test (CBT) mode.

(ii) Each question carries +5 marks for correct answer and -1 mark for wrong answer.

(iii) The total number of questions are 50.

(iv) Duration of the exam is 1 hour (60 minutes).

1. In the actinoid series, which oxidation state is the most stable for most actinoids?

(A) +2

(B) +3

(C) +4

(D) +6

Correct Answer: (B) +3

Solution:

Concept: Actinoids exhibit variable oxidation states because the energies of $5f$, $6d$, and $7s$ orbitals are very close to one another. However, the +3 oxidation state is the most stable and most commonly observed oxidation state for the majority of actinoids.

Step 1: Understanding the electronic configuration of actinoids.

Actinoids belong to the $5f$-series where electrons are progressively filled in the $5f$-orbitals. Since the $5f$, $6d$, and $7s$ orbitals have comparable energies, multiple oxidation states become possible.

Step 2: Formation of the +3 oxidation state.

Most actinoids lose:

$$2 \text{ electrons from } 7s \text{ and } 1 \text{ electron from } 5f/6d$$

leading to the formation of:

$$M^{3+}$$

This state is particularly stable because removal of three electrons gives a comparatively stable electronic arrangement.

Step 3: Examples of stable +3 oxidation state.

Elements like uranium, neptunium, plutonium, and americium commonly form:

$$U^{3+},\ Np^{3+},\ Pu^{3+},\ Am^{3+}$$

Thus, the most stable oxidation state for most actinoids is:

$$\boxed{+3}$$

Quick Tip: Both lanthanoids and actinoids most commonly exhibit the +3 oxidation state due to stability achieved after losing outer electrons.

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2. The magnetic moment of a complex having 3 unpaired electrons is closest to:

$$\mu = \sqrt{n(n+2)}\ \text{BM}$$

(A) 1.73 BM

(B) 2.84 BM

(C) 3.87 BM

(D) 4.90 BM

Correct Answer: (C) 3.87 BM

Solution:

Concept: The spin-only magnetic moment of a coordination complex is calculated using:

$$\mu = \sqrt{n(n+2)}\ \text{BM}$$

where n is the number of unpaired electrons.

Step 1: Identify the number of unpaired electrons.

The complex contains:

$$n = 3$$

unpaired electrons.

Step 2: Substitute the value into the formula.

Using the formula:

$$\mu = \sqrt{n(n+2)}$$

Substituting $n = 3$:

$$\mu = \sqrt{3(3+2)}$$

$$\mu = \sqrt{3 \times 5}$$

$$\mu = \sqrt{15}$$

Step 3: Calculate the numerical value.

$$\sqrt{15} \approx 3.87$$

Therefore:

$$\boxed{\mu \approx 3.87 \text{ BM}}$$

Quick Tip: Common magnetic moments: 1 unpaired electron → 1.73 BM, 2 unpaired electrons → 2.84 BM, 3 unpaired electrons → 3.87 BM.

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3. Semicarbazide is commonly used to identify:

(A) Alcohols

(B) Carboxylic acids

(C) Aldehydes and ketones

(D) Amines

Correct Answer: (C) Aldehydes and ketones

Solution:

Concept: Semicarbazide reacts with carbonyl compounds such as aldehydes and ketones to form semicarbazones, which are crystalline derivatives useful for identification.

Step 1: Understanding semicarbazide.

Semicarbazide has the structure:

$$NH_2NHCONH_2$$

It reacts specifically with the carbonyl group:

$$> C = O$$

Step 2: Reaction with aldehydes and ketones.

Aldehydes and ketones contain carbonyl groups and therefore react with semicarbazide.

For aldehydes:

$$RCHO + NH_2NHCONH_2 \rightarrow RCH = NNHCONH_2$$

For ketones:

$$RCOR' + NH_2NHCONH_2 \rightarrow RC = NNHCONH_2$$

Step 3: Purpose of the reaction.

The semicarbazones formed are crystalline solids with definite melting points. These derivatives help chemists identify unknown aldehydes and ketones.

Hence, semicarbazide is used for identifying:

$$\boxed{\text{Aldehydes and ketones}}$$

Quick Tip: Carbonyl compounds commonly form derivatives such as oximes, hydrazones, and semicarbazones for identification purposes.

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4. Aldol condensation is shown by compounds containing:

(A) Only carbonyl group

(B) α-hydrogen and carbonyl group

(C) Triple bond

(D) Ether linkage

Correct Answer: (B) α-hydrogen and carbonyl group

Solution:

Concept: Aldol condensation is shown by aldehydes or ketones that contain at least one α-hydrogen atom.

Step 1: Understanding the requirement of aldol condensation.

In aldol condensation, one molecule forms an enolate ion using an α-hydrogen atom.

This enolate ion attacks another molecule containing a carbonyl group.

Step 2: Necessary conditions for the reaction.

The compound must contain:

$$\text{(i) A carbonyl group}$$

and

$$\text{(ii) At least one } \alpha\text{-hydrogen}$$

Without α-hydrogen, enolate ion formation cannot occur.

Step 3: Example of aldol condensation.

Acetaldehyde undergoes aldol condensation:

$$2CH_3CHO \rightarrow CH_3CH(OH)CH_2CHO$$

Thus, compounds containing both carbonyl group and α-hydrogen undergo aldol condensation.

Therefore, the correct answer is:

$$\boxed{\alpha\text{-hydrogen and carbonyl group}}$$

Quick Tip: Formaldehyde and benzaldehyde do not undergo aldol condensation because they do not contain α-hydrogen atoms.

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5. Match the following reaction orders with their units of rate constant:

Reaction Order	Units of k
(A) Zero order	$(I)\ L\,mol^{-1}s^{-1}$
(B) First order	$(II)\ mol\,L^{-1}s^{-1}$
(C) Second order	$(III)\ s^{-1}$

Choose the correct option:

(A) A–II, B–III, C–I

(B) A–III, B–II, C–I

(C) A–I, B–II, C–III

(D) A–II, B–I, C–III

Correct Answer: (A) A–II, B–III, C–I

Solution:

Concept: The units of rate constant depend on the order of reaction.

Step 1: Write the general rate equation.

$$\text{Rate} = k[A]^n$$

Units of rate are:

$$mol\,L^{-1}s^{-1}$$

Step 2: Find units for zero-order reaction.

For zero-order:

$$\text{Rate} = k$$

Thus:

$$[k] = mol\,L^{-1}s^{-1}$$

Hence:

$$A \rightarrow II$$

Step 3: Find units for first-order reaction.

For first-order:

$$k = \frac{\text{Rate}}{[A]}$$

Units become:

$$s^{-1}$$

Thus:

$$B \rightarrow III$$

Step 4: Find units for second-order reaction.

For second-order:

$$k = \frac{\text{Rate}}{[A]^2}$$

Units become:

$$L\,mol^{-1}s^{-1}$$

Thus:

$$C \rightarrow I$$

Therefore, the correct matching is:

$$\boxed{A-II,\ B-III,\ C-I}$$

Quick Tip: The unit of rate constant for first-order reactions is always s^{-1}, independent of concentration units.

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6. For a first-order reaction, the half-life is given by $t_{1/2} = \frac{0.693}{k}$. Which conclusion is correct?

(A) Depends on initial concentration

(B) Is inversely proportional to k

(C) Is directly proportional to concentration

(D) Increases with time

Correct Answer: (B) Is inversely proportional to k

Solution:

Concept: For a first-order reaction, the half-life expression is:

$$t_{1/2} = \frac{0.693}{k}$$

where k is the rate constant.

Step 1: Understanding the formula.

From the formula:

$$t_{1/2} \propto \frac{1}{k}$$

This means the half-life decreases if the rate constant increases.

Step 2: Checking dependence on concentration.

The formula contains only the rate constant k and no concentration term. Therefore, half-life of a first-order reaction is independent of initial concentration.

Step 3: Final conclusion.

Since half-life varies inversely with k, the correct statement is:

$$\boxed{\text{(B) Is inversely proportional to } k}$$

Quick Tip: Only first-order reactions have half-life independent of initial concentration. This is one of their most important properties.

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7. Which of the following complexes is diamagnetic?

(A) $[Fe(H_2O)_6]^{3+}$

(B) $[CoF_6]^{3-}$

(C) $[Ni(CN)_4]^{2-}$

(D) $[MnCl_4]^{2-}$

Correct Answer: (C) $[Ni(CN)_4]^{2-}$

Solution:

Concept: A diamagnetic complex contains no unpaired electrons. Strong field ligands can pair electrons and produce diamagnetism.

Step 1: Analyzing option (A).

In $[Fe(H_2O)_6]^{3+}$:

$$Fe^{3+} : 3d^5$$

H_2O is a weak field ligand. Thus, electrons remain unpaired. Hence, the complex is paramagnetic.

Step 2: Analyzing option (B).

In $[CoF_6]^{3-}$:

$$Co^{3+} : 3d^6$$

F^- is a weak field ligand. The complex is high-spin with unpaired electrons. Therefore, it is paramagnetic.

Step 3: Analyzing option (C).

In $[Ni(CN)_4]^{2-}$:

$$Ni^{2+} : 3d^8$$

CN^- is a strong field ligand. Electrons pair up and form a square planar complex. All electrons become paired. Therefore, the complex is diamagnetic.

Step 4: Analyzing option (D).

In $[MnCl_4]^{2-}$:

$$Mn^{2+} : 3d^5$$

Cl^- is a weak field ligand. The complex contains several unpaired electrons. Hence, it is paramagnetic.

Step 5: Final conclusion.

Only $[Ni(CN)_4]^{2-}$ is diamagnetic.

$$\boxed{[Ni(CN)_4]^{2-}}$$

Quick Tip: Strong field ligands like CN^- often produce low-spin complexes with paired electrons, leading to diamagnetism.

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8. The shape of $[Ni(CN)_4]^{2-}$ is:

(A) Tetrahedral

(B) Square planar

(C) Octahedral

(D) Trigonal bipyramidal

Correct Answer: (B) Square planar

Solution:

Concept: The geometry of coordination compounds depends upon the metal ion, electronic configuration, and ligand strength.

Step 1: Finding oxidation state of nickel.

In $[Ni(CN)_4]^{2-}$:

$$x + 4(-1) = -2$$

$$x - 4 = -2$$

$$x = +2$$

Thus, nickel is in +2 oxidation state.

Step 2: Finding electronic configuration.

$$Ni^{2+} : 3d^8$$

Step 3: Effect of ligand CN^-.

CN^- is a strong field ligand. It causes pairing of electrons in d-orbitals.

Step 4: Determining hybridization and shape.

For d^8 configuration with strong field ligands:

$$dsp^2 \text{ hybridization occurs}$$

This leads to square planar geometry.

Step 5: Final answer.

Hence, the shape is:

$$\boxed{\text{Square planar}}$$

Quick Tip: Most d^8 metal ions with strong field ligands form square planar complexes.

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9. The rate of a reaction doubles when concentration of reactant is doubled. The order of reaction is:

(A) Zero order

(B) First order

(C) Second order

(D) Third order

Correct Answer: (B) First order

Solution:

Concept: For a reaction:

$$Rate = k[A]^n$$

where n is the order of reaction.

Step 1: Writing the rate law.

Suppose initial rate is:

$$R_1 = k[A]^n$$

When concentration is doubled:

$$R_2 = k(2[A])^n$$

$$R_2 = 2^n k[A]^n$$

$$R_2 = 2^n R_1$$

Step 2: Using given condition.

The rate doubles:

$$R_2 = 2R_1$$

Thus:

$$2^n R_1 = 2R_1$$

$$2^n = 2$$

$$n = 1$$

Step 3: Final conclusion.

The reaction is first order.

$$\boxed{\text{First order}}$$

Quick Tip: If doubling concentration doubles rate, the reaction is first order. If rate becomes four times, it is second order.

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10. Which statement about physical chemistry numericals in CUET is generally correct?

(A) Mostly lengthy derivations

(B) Assertion-reason type only

(C) Direct formula-based numericals

(D) Only graph-based questions

Correct Answer: (C) Direct formula-based numericals

Solution:

Concept: CUET physical chemistry questions are generally objective and formula-oriented. Most numericals test direct application of standard equations.

Step 1: Analyzing option (A).

CUET questions are usually not based on lengthy derivations. Hence, this statement is incorrect.

Step 2: Analyzing option (B).

Assertion-reason questions may appear occasionally, but physical chemistry numericals are not limited to this pattern. Hence, incorrect.

Step 3: Analyzing option (C).

Most questions involve direct use of formulas such as:

$$M_1V_1 = M_2V_2$$

$$PV = nRT$$

$$t_{1/2} = \frac{0.693}{k}$$

Thus, CUET numericals are mainly formula-based.

Step 4: Analyzing option (D).

Graph-based questions are not the only type asked. Hence, incorrect.

Step 5: Final conclusion.

The correct statement is:

$$\boxed{\text{Direct formula-based numericals}}$$

Quick Tip: For CUET physical chemistry, memorize standard formulas and practice quick substitutions because most questions are application-based.
