CUET 2026 May 29 Shift 2 Chemistry

Question Paper (Memory-Based) with Solutions

Conducted by National Testing Agency (NTA)

1. In a reaction sequence involving haloalkanes, the compound CH_3CH_2Br is treated with alcoholic KOH followed by ozonolysis. If the final product obtained is methanal, then identify the alkene formed in the intermediate step.

(A) Ethene

(B) Propene

(C) But-1-ene

(D) 2-Methylpropene

Correct Answer: (1) Ethene

Solution:

Concept:

Haloalkanes undergo elimination reactions in the presence of alcoholic KOH to form alkenes. The resulting alkene can further undergo ozonolysis, where the double bond breaks and forms carbonyl compounds. Ozonolysis is an important reaction used to identify the position of double bonds in alkenes.

The key concepts involved are:

- **Dehydrohalogenation:** Removal of HX from haloalkanes using alcoholic KOH.
- **Ozonolysis:** Cleavage of the double bond using ozone followed by reductive workup.
- **Product Identification:** The carbonyl compounds formed help determine the original alkene structure.

Step 1: Formation of alkene from haloalkane.

The given haloalkane is:

$$CH_3CH_2Br$$

When treated with alcoholic KOH, elimination of HBr occurs:

$$CH_3CH_2Br \xrightarrow[\Delta]{alc.\ KOH} CH_2 = CH_2$$

Thus, the alkene formed is ethene.

Step 2: Ozonolysis of the alkene formed.

Ethene undergoes ozonolysis as:

$$CH_2 = CH_2 \xrightarrow[Zn/H_2O]{O_3} 2HCHO$$

The product formed is methanal (formaldehyde).

Step 3: Verification using product analysis.

Since methanal is formed as the only product, the original alkene must contain two terminal hydrogen atoms around the double bond, which is only possible in ethene.
Therefore, the intermediate alkene formed is:

Ethene

Quick Tip: In ozonolysis:

- Terminal alkene carbon having two hydrogens produces methanal.
- Breaking the double bond helps reconstruct the original alkene.
- Alcoholic KOH always favors elimination in haloalkanes.

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2. A compound shows optical isomerism and has molecular formula $C_4H_{10}O$. Which of the following compounds can exhibit chirality?

(A) Butan-1-ol

(B) Butan-2-ol

(C) 2-Methylpropan-2-ol

(D) Methoxypropane

Correct Answer: (2) Butan-2-ol

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Solution:

Concept:

Optical isomerism arises due to the presence of a chiral carbon atom. A carbon atom is said to be chiral when it is attached to four different groups. Such molecules exist as non-superimposable mirror images known as enantiomers.

To determine chirality:

- Identify tetrahedral carbon atoms.
- Check whether all four attached groups are different.
- If yes, the compound is optically active.

Step 1: Examine Butan-1-ol.

Structure:

$$CH_3CH_2CH_2CH_2OH$$

No carbon atom is attached to four different groups.

Hence, it is not chiral.

Step 2: Examine Butan-2-ol.

Structure:

$$CH_3CH(OH)CH_2CH_3$$

The second carbon atom is attached to:

$$CH_3, \quad OH, \quad H, \quad CH_2CH_3$$

All four groups are different.

Therefore, this carbon is chiral.

Hence, Butan-2-ol exhibits optical isomerism.

Step 3: Examine remaining compounds.

For 2-Methylpropan-2-ol:

$$(CH_3)_3COH$$

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The central carbon has three identical methyl groups.

Hence, it is achiral.

For Methoxypropane:

$$CH_3OCH_2CH_2CH_3$$

No chiral center exists.

Therefore, the correct answer is:

$$\boxed{\text{Butan-2-ol}}$$

Quick Tip: A carbon atom becomes chiral only if all four attached groups are different. Molecules containing identical substituents on the same carbon cannot show optical isomerism.

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3. The magnetic moment of a transition metal ion is found to be 5.92 BM. The number of unpaired electrons present in the ion is:

(A) 3

(B) 4

(C) 5

(D) 6

Correct Answer: (3) 5

Solution:

Concept:

The magnetic moment of transition metal ions is calculated using the spin-only formula:

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

where:

- μ = magnetic moment in Bohr Magneton (BM)
- n = number of unpaired electrons

This formula helps determine the electronic configuration and magnetic behavior of coordina-

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tion compounds and transition metal ions.

Step 1: Write the given magnetic moment.

$$\mu = 5.92\,\text{BM}$$

Using:

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

Squaring both sides:

$$(5.92)^2 = n(n+2)$$

$$35.04 \approx n(n+2)$$

Step 2: Find suitable integer value of n.

Check values:

For $n = 5$:

$$5(5+2) = 5 \times 7 = 35$$

$$\sqrt{35} = 5.92$$

This matches the given magnetic moment.

Step 3: Interpretation.

The ion contains:

$$\boxed{\text{5 unpaired electrons}}$$

Hence the ion is strongly paramagnetic.

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Quick Tip: Remember common magnetic moments:

$$n = 1 \rightarrow 1.73\,BM$$

$$n = 2 \rightarrow 2.83\,BM$$

$$n = 3 \rightarrow 3.87\,BM$$

$$n = 4 \rightarrow 4.90\,BM$$

$$n = 5 \rightarrow 5.92\,BM$$

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4. The order of basic strength among the following amines is: Aniline, Methylamine, Dimethylamine, and Ammonia.

(A) Dimethylamine > Methylamine > Ammonia > Aniline

(B) Methylamine > Dimethylamine > Ammonia > Aniline

(C) Ammonia > Methylamine > Dimethylamine > Aniline

(D) Aniline > Ammonia > Methylamine > Dimethylamine

Correct Answer: (1) Dimethylamine > Methylamine > Ammonia > Aniline

Solution:

Concept:

Basicity of amines depends upon the availability of the lone pair of electrons on nitrogen for donation.

Factors affecting basicity:

- $+I$ effect of alkyl groups increases electron density on nitrogen.
- Resonance delocalization decreases availability of lone pair.
- Solvation effects also influence stability.

Step 1: Compare aliphatic amines with ammonia.

Alkyl groups donate electrons due to the inductive effect.

Thus:

Dimethylamine > Methylamine > Ammonia

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because dimethylamine has two electron-releasing methyl groups.

Step 2: Analyze aniline.

In aniline:

$$C_6H_5NH_2$$

The lone pair on nitrogen participates in resonance with the benzene ring:

$$\text{N lone pair} \rightarrow \text{benzene ring}$$

Hence the lone pair becomes less available for protonation.
Therefore, aniline is less basic than ammonia.

Step 3: Final order.

Combining all effects:

$$\boxed{\text{Dimethylamine} > \text{Methylamine} > \text{Ammonia} > \text{Aniline}}$$

Quick Tip: Electron donating groups increase basicity, while resonance delocalization decreases basicity because the lone pair becomes less available.

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5. For a first-order reaction, the unit of rate constant is:

(A) mol $L^{-1}s^{-1}$

(B) s^{-1}

(C) L $mol^{-1}s^{-1}$

(D) $mol^{-2}L^2s^{-1}$

Correct Answer: (2) s^{-1}

Solution:

Concept:

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The unit of rate constant depends on the order of reaction.

For a first-order reaction:

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

where:

- Rate has unit mol $L^{-1}s^{-1}$
- Concentration has unit mol L^{-1}

Step 1: Write the rate law.

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

Step 2: Substitute units.

$$\text{mol } L^{-1}s^{-1} = k \times \text{mol } L^{-1}$$

$$k = \frac{\text{mol } L^{-1}s^{-1}}{\text{mol } L^{-1}}$$

$$k = s^{-1}$$

Step 3: Conclusion.

Therefore, the unit of first-order rate constant is:

$$\boxed{s^{-1}}$$

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Quick Tip: For an n^{th}-order reaction:

$$[k] = (\text{concentration})^{1-n}\text{time}^{-1}$$

First-order reactions always have unit:

$$s^{-1}$$

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6. Which of the following complexes is expected to be diamagnetic?

(A) $[Fe(H_2O)_6]^{2+}$

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

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

(D) $[Mn(H_2O)_6]^{2+}$

Correct Answer: (3) $[Ni(CN)_4]^{2-}$

Solution:

Concept:

Diamagnetic substances contain no unpaired electrons. In coordination compounds, magnetic behavior depends on:

- Oxidation state of metal ion
- Strength of ligand field
- Pairing of electrons

Strong field ligands like CN^- cause pairing of electrons.

Step 1: Analyze $[Ni(CN)_4]^{2-}$.

Oxidation state of Ni:

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

$$x = +2$$

Electronic configuration:

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

Since CN^- is a strong field ligand, electrons pair up.

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The complex becomes square planar with all electrons paired.

Hence it is diamagnetic.

Step 2: Analyze remaining complexes.

$$[Fe(H_2O)_6]^{2+}$$

contains weak field ligand H_2O, producing unpaired electrons.

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

contains weak ligand F^-, giving high-spin complex.

$$[Mn(H_2O)_6]^{2+}$$

also contains several unpaired electrons.

Hence all are paramagnetic.

Therefore:

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

is diamagnetic.

Quick Tip: Strong field ligands such as:

$$CN^-,\ CO,\ NH_3$$

favor electron pairing and may produce diamagnetic complexes.

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7. The number of stereoisomers possible for the compound $CH_3CHBrCHBrCH_3$ is:

(A) 2

(B) 3

(C) 4

(D) 5

Correct Answer: (2) 3

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Solution:

Concept:

The number of stereoisomers depends on the number of chiral centers and the presence of symmetry.

Maximum stereoisomers:

$$2^n$$

where n is the number of chiral centers.

However, meso forms reduce the total number.

Step 1: Identify chiral centers.

Compound:

$$CH_3CHBrCHBrCH_3$$

Both middle carbons are attached to:

$$H,\ Br,\ CH_3,\ \text{remaining carbon chain}$$

Thus both are chiral centers.

$$n = 2$$

Maximum possible stereoisomers:

$$2^2 = 4$$

Step 2: Check for meso form.

The molecule is symmetrical.

Configurations:

$$(R,R),\ (S,S),\ (R,S)$$

The (R,S) form has an internal plane of symmetry.

Thus it becomes a meso compound.

Step 3: Count distinct stereoisomers.

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Distinct stereoisomers:

- One pair of enantiomers: (R,R) and (S,S)
- One meso form

Total:

$$3$$

Hence:

$$\boxed{3}$$

Quick Tip: For compounds with two identical chiral centers, always check for meso forms because symmetry reduces the total number of stereoisomers.

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8. Which of the following reagents converts aldehydes into primary alcohols?

(A) PCC

(B) $LiAlH_4$

(C) $KMnO_4$

(D) Tollen's reagent

Correct Answer: (2) $LiAlH_4$

Solution:

Concept:

Aldehydes can undergo reduction to form primary alcohols.

Reducing agents commonly used:

- $LiAlH_4$
- $NaBH_4$

Oxidizing agents convert aldehydes into carboxylic acids.

Step 1: Understand the reduction process.

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General reaction:

$$RCHO \xrightarrow{[H]} RCH_2OH$$

Hydrogen is added across the carbonyl group.

Step 2: Analyze each reagent.

$$LiAlH_4$$

is a strong reducing agent.

It converts aldehydes into primary alcohols.

PCC and $KMnO_4$ are oxidizing agents.

Tollen's reagent is used to test aldehydes and oxidizes them.

Thus only:

$$\boxed{LiAlH_4}$$

gives primary alcohols.

Quick Tip:

$LiAlH_4$ and $NaBH_4$

are important reducing agents for converting:

Aldehydes → Primary Alcohols

Ketones → Secondary Alcohols

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9. Which of the following complexes shows the highest crystal field stabilization energy (CFSE) in octahedral geometry?

(A) d^3

(B) d^5 high spin

(C) d^8

(D) d^{10}

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Correct Answer: (1) d^3

Solution:

Concept:

In octahedral complexes, d-orbitals split into:

$$t_{2g} \text{ and } e_g$$

CFSE depends on electron distribution.

Each electron in:

$$t_{2g} \rightarrow -0.4\Delta_o$$

$$e_g \rightarrow +0.6\Delta_o$$

Step 1: Calculate CFSE for each configuration.

For d^3:

$$t_{2g}^3 e_g^0$$

CFSE:

$$3(-0.4\Delta_o) = -1.2\Delta_o$$

For high-spin d^5:

$$t_{2g}^3 e_g^2$$

CFSE:

$$3(-0.4) + 2(+0.6) = 0$$

For d^8:

$$t_{2g}^6 e_g^2$$

CFSE:

$$6(-0.4) + 2(+0.6)$$

$$= -2.4 + 1.2 = -1.2\Delta_o$$

However pairing energy considerations reduce stability comparison.

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For d^{10}:

$$CFSE = 0$$

Step 2: Determine maximum stabilization.

Among common stable octahedral arrangements:

$$d^3$$

shows exceptionally high stability because no electron occupies antibonding e_g orbitals.

Thus:

$$\boxed{d^3}$$

Quick Tip: Configurations with electrons concentrated in lower-energy t_{2g} orbitals show higher crystal field stabilization.

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10. The reagent used in Sandmeyer reaction for converting benzene diazonium chloride into chlorobenzene is:

(A) $CuCl/HCl$

(B) $NaCl$

(C) $Cl_2/FeCl_3$

(D) $SOCl_2$

Correct Answer: (1) $CuCl/HCl$

Solution:

Concept:

Sandmeyer reaction is an important substitution reaction of diazonium salts where the diazonium group is replaced by halogens or cyanide using cuprous salts.

General reaction:

$$ArN_2^+Cl^- \xrightarrow{CuX} ArX$$

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where:

$$X = Cl,\ Br,\ CN$$

Step 1: Write the given transformation.

Benzene diazonium chloride:

$$C_6H_5N_2^+Cl^-$$

must be converted into chlorobenzene:

$$C_6H_5Cl$$

Step 2: Identify appropriate Sandmeyer reagent.

For replacement by chlorine:

$$CuCl/HCl$$

is used.

Reaction:

$$C_6H_5N_2^+Cl^- \xrightarrow{CuCl/HCl} C_6H_5Cl + N_2$$

Nitrogen gas escapes, driving the reaction forward.

Step 3: Analyze incorrect options.

- $NaCl$ cannot replace diazonium group.
- $Cl_2/FeCl_3$ is used for electrophilic chlorination.
- $SOCl_2$ converts alcohols into alkyl chlorides.

Therefore the correct reagent is:

$$\boxed{CuCl/HCl}$$

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Quick Tip: Sandmeyer reactions use cuprous salts:

$$CuCl,\ CuBr,\ CuCN$$

to replace diazonium groups with halogens or cyanide.

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