GATE 2026 CY Question Paper with Solutions

Time Allowed :3 Hour	Maximum Marks :100	Total Questions :65

General Instructions

Please read the following instructions carefully:

1. This question paper is divided into three sections:
   - **General Aptitude (GA):** 10 questions (5 questions × 1 mark + 5 questions × 2 marks) for a total of 15 marks.
   - **Environmental Science and Engineering + Engineering Mathematics:**
     - **Part A (Mandatory):** 36 questions (1 questions × 1 mark + 19 questions × 2 marks) for a total of 55 marks.
     - **Part B (Section 1):** Candidates can choose either Part B1 (Surveying and Mapping) or Part B2 (Section 2). Each part contains 16 questions (8 questions × 1 mark + 11 questions × 2 marks) for a total of 30 marks.
2. The total number of questions is **65**, carrying a maximum of **100 marks**.
3. The duration of the exam is **3 hours**.
4. Marking scheme:
   - For 1-mark MCQs, $\frac{1}{3}$ mark will be deducted for every incorrect response.
   - For 2-mark MCQs, $\frac{2}{3}$ mark will be deducted for every incorrect response.
   - No negative marking for numerical answer type (NAT) questions.
   - No marks will be awarded for unanswered questions.
5. Ensure you attempt questions only from the optional section (Part B1 or Part B2) you have selected.
6. Follow the instructions provided during the exam for submitting your answers.

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1. For an ideal gas, which of the following thermodynamic quantities depends only on temperature?

(A) Enthalpy
(B) Entropy
(C) Gibbs free energy
(D) Pressure

Correct Answer: (A) Enthalpy

Solution:

Step 1: Understanding the Concept:
For an ideal gas, the intermolecular forces of attraction are negligible.
This leads to specific thermodynamic relationships where internal energy and enthalpy become state functions of temperature alone.

Step 2: Key Formula or Approach:
The definition of Enthalpy (H) is:

$$H = U + PV$$

Where U is internal energy, P is pressure, and V is volume.

Step 3: Detailed Explanation:
According to Joule's Law for an ideal gas, the internal energy (U) is a function of temperature only, i.e., $U = f(T)$.
Using the ideal gas equation:

$$PV = nRT$$

Substituting this into the enthalpy equation:

$$H = U(T) + nRT$$

Since both terms on the right side of the equation (U and nRT) are functions of temperature only, enthalpy (H) is also a function of temperature only for an ideal gas.
In contrast, Entropy (S) and Gibbs free energy (G) depend on both temperature and pressure (or volume) as they involve logarithmic terms of P or V.

Step 4: Final Answer:
For an ideal gas, enthalpy is the quantity that depends only on temperature.

> **Quick Tip**
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> Remember that for real gases, enthalpy depends on both pressure and temperature due to intermolecular interactions.
> For ideal gases, always look for U and H as temperature-dependent functions.

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2. Which of the following reagents converts an aldehyde selectively into a primary alcohol?

(A) PCC
(B) $KMnO_4$
(C) $LiAlH_4$
(D) CrO_3

Correct Answer: (C) $LiAlH_4$

Solution:

Step 1: Understanding the Concept:
The conversion of an aldehyde to an alcohol is a reduction process.
An aldehyde ($R-CHO$) contains a carbonyl group that must gain hydrogen to become a primary alcohol ($R-CH_2OH$).

Step 2: Key Formula or Approach:
The reaction can be represented as:

$$R-CHO \xrightarrow{\text{[Reduction]}} R-CH_2OH$$

Step 3: Detailed Explanation:
- **PCC (Pyridinium Chlorochromate):** This is an oxidizing agent. It is used to convert primary alcohols into aldehydes, not the other way around.
- $KMnO_4$ **(Potassium Permanganate):** This is a very strong oxidizing agent. It would oxidize an aldehyde further into a carboxylic acid.
- $LiAlH_4$ **(Lithium Aluminium Hydride):** This is a powerful and selective reducing agent. It provides hydride ions (H^-) that attack the electrophilic carbon of the aldehyde group, reducing it to a primary alcohol.
- CrO_3 **(Chromic anhydride):** This is also an oxidizing agent (often used in Jones reagent) which oxidizes alcohols/aldehydes to carboxylic acids.

Step 4: Final Answer:
Among the given options, $LiAlH_4$ is the reagent that reduces an aldehyde to a primary alcohol.

Quick Tip

While $LiAlH_4$ is strong, $NaBH_4$ (Sodium Borohydride) is a milder alternative that also selectively reduces aldehydes and ketones to alcohols without affecting functional groups like esters or carboxylic acids.

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3. The magnetic behavior of a compound with all electrons paired is:

(A) Paramagnetic
(B) Ferromagnetic
(C) Diamagnetic
(D) Antiferromagnetic

Correct Answer: (C) Diamagnetic

Solution:

Step 1: Understanding the Concept:
Magnetism in materials arises from the orbital and spin motion of electrons.
The way a material reacts to an external magnetic field depends on its electronic configuration.

Step 2: Detailed Explanation:
- **Paramagnetism:** Occurs in compounds with one or more unpaired electrons. These materials are weakly attracted by a magnetic field.
- **Ferromagnetism:** Occurs when domains of unpaired electron spins align in the same direction, resulting in strong permanent magnetism.
- **Diamagnetism:** Occurs in compounds where all electrons are paired. In these atoms, the magnetic moments of the electrons cancel each other out. These materials are weakly repelled by a magnetic field.
- **Antiferromagnetism:** Occurs when adjacent spins point in opposite directions, canceling out the overall magnetic moment.

Step 3: Final Answer:
A compound with all its electrons paired exhibits diamagnetic behavior.

> Quick Tip
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> A quick check for magnetic properties:
> Count total electrons. If the number is even, it's usually diamagnetic (except for B_2 and O_2 according to MOT).
> If the number is odd, it's always paramagnetic.

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4. In IR spectroscopy, which bond absorbs at the highest wavenumber?

(A) C-C
(B) C=C
(C) C $\equiv$ C
(D) O-H

Correct Answer: (D) O-H

Solution:

Step 1: Understanding the Concept:
The wavenumber ($\bar{\nu}$) of absorption in Infrared (IR) spectroscopy is determined by the strength of the bond and the mass of the atoms involved.

Step 2: Key Formula or Approach:
According to Hooke's Law for bond vibration:

$$\bar{\nu} = \frac{1}{2\pi c}\sqrt{\frac{k}{\mu}}$$

Where:
k is the force constant (bond strength).
μ is the reduced mass ($\frac{m_1 m_2}{m_1+m_2}$).

Step 3: Detailed Explanation:
- **Bond Strength:** Higher bond order (triple > double > single) increases k, which increases wavenumber. So $C \equiv C > C = C > C - C$.
- **Reduced Mass:** As the mass of the atoms decreases, μ decreases, which significantly increases the wavenumber.
- Comparing $C \equiv C$ and $O - H$: Although $C \equiv C$ has a high force constant, the reduced mass of the $O - H$ bond is extremely small because of the Hydrogen atom ($m_H \approx 1$).
- Typically, $O - H$ stretching occurs at $3200 - 3600$ cm^{-1}, while $C \equiv C$ occurs at $2100 - 2250$ cm^{-1}, $C = C$ at $1600 - 1680$ cm^{-1}, and $C - C$ in the fingerprint region (< 1300 cm^{-1}).

Step 4: Final Answer:
The O-H bond absorbs at the highest wavenumber due to the very low reduced mass of Hydrogen.

Quick Tip

Bonds to Hydrogen (X-H) always appear in the high-frequency region ($2500-4000$ cm^{-1}) of the IR spectrum because of the low atomic mass of Hydrogen.

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5. The standard electrode potential of the standard hydrogen electrode (SHE) is:

(A) +1.00 V
(B) -1.00 V
(C) 0.00 V
(D) +0.76 V

Correct Answer: (C) 0.00 V

Solution:

Step 1: Understanding the Concept:
The potential of a single electrode cannot be measured in isolation; only the difference in potential between two electrodes can be measured.
To create a relative scale, a reference electrode is needed.

Step 2: Detailed Explanation:
The Standard Hydrogen Electrode (SHE) is used as the universal reference electrode.
It consists of platinum foil in a 1M acidic solution with pure hydrogen gas bubbled at 1 bar pressure and 298 K temperature.
By convention (IUPAC agreement), the standard electrode potential of SHE is assigned the value of exactly zero volts at all temperatures.

$$2H^+(aq) + 2e^- \rightarrow H_2(g); \quad E^\circ = 0.00 \text{ V}$$

Step 3: Final Answer:
The standard electrode potential of SHE is 0.00 V.

Quick Tip

Any electrode with a positive standard reduction potential relative to SHE is a better oxidizing agent than H^+, while those with negative potentials are better reducing agents than H_2.

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6. Which ligand causes maximum crystal field splitting?

(A) F^-
(B) H_2O
(C) NH_3
(D) CN^-

Correct Answer: (D) CN^-

Solution:

Step 1: Understanding the Concept:
Crystal Field Splitting (Δ) is the energy difference between sets of d-orbitals in a coordination complex.
Different ligands split the d-orbitals to different extents.

Step 2: Key Formula or Approach:
Ligands are arranged in the "Spectrochemical Series" based on their field strength.
A strong field ligand causes a large splitting, while a weak field ligand causes a small splitting.

Step 3: Detailed Explanation:
The order of common ligands in the spectrochemical series is:

$$I^- < Br^- < SCN^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-} < H_2O < NCS^- < edta^{4-} < NH_3 < en < N$$

From the options:
- F^- is a weak field ligand.
- H_2O is a weak field ligand.
- NH_3 is a moderate to strong field ligand.
- CN^- (Cyanide) is a very strong field ligand, appearing near the end of the series.

Because CN^- is a strong pi-acceptor ligand, it causes the greatest crystal field splitting among the choices provided.

Step 4: Final Answer:
The ligand CN^- causes maximum crystal field splitting.

Quick Tip

Strong field ligands (CN^-, CO, NO_2^-) usually lead to "low spin" complexes because the splitting energy is greater than the pairing energy.

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7. 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 L^{-1}

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

Solution:

Step 1: Understanding the Concept:
The rate constant (k) links the reaction rate to the concentrations of reactants.
Its units change depending on the overall order of the reaction.

Step 2: Key Formula or Approach:
The general unit for a rate constant for a reaction of order n is:

$$\text{Units of } k = (\text{concentration})^{1-n} \cdot \text{time}^{-1}$$

Concentration is typically measured in mol/L (or M).

Step 3: Detailed Explanation:
For a first-order reaction, $n = 1$.
Substituting into the general formula:

$$\text{Unit} = (\text{mol L}^{-1})^{1-1} \cdot s^{-1}$$

$$\text{Unit} = (\text{mol L}^{-1})^{0} \cdot s^{-1}$$

$$\text{Unit} = 1 \cdot s^{-1} = s^{-1}$$

Thus, the rate of a first-order reaction depends only on the frequency of the process, and its constant is independent of concentration units.

Step 4: Final Answer:
The unit of the rate constant for a first-order reaction is s^{-1}.

Quick Tip

Zero-order unit: mol $\text{L}^{-1}s^{-1}$
First-order unit: s^{-1}
Second-order unit: L $\text{mol}^{-1}s^{-1}$
Identifying the order from the unit of k is a common exam trick!
