

GATE 2026 CH Question Paper with Solutions

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

Please read the following instructions carefully:

- This question paper is divided into three sections:
 - General Aptitude (GA):** 10 questions (5 questions \times 1 mark + 5 questions \times 2 marks) for a total of 15 marks.
 - Environmental Science and Engineering + Engineering Mathematics:**
 - Part A (Mandatory):** 36 questions (1 questions \times 1 mark + 19 questions \times 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 \times 1 mark + 11 questions \times 2 marks) for a total of 30 marks.
- The total number of questions is **65**, carrying a maximum of **100 marks**.
- The duration of the exam is **3 hours**.
- 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.
- Ensure you attempt questions only from the optional section (Part B1 or Part B2) you have selected.
- Follow the instructions provided during the exam for submitting your answers.

1. For a first-order irreversible reaction carried out in a batch reactor, the rate of reaction is proportional to:

- (A) Square of concentration
- (B) Concentration of reactant
- (C) Inverse of concentration
- (D) Product concentration

Correct Answer: (B) Concentration of reactant

Solution:

Step 1: Understanding the Concept:

In chemical kinetics, the "order" of a reaction defines the power dependency of the reaction rate on the concentration of the reactants.

A first-order reaction is a chemical reaction in which the rate of reaction is linearly dependent on the concentration of only one reactant.

Step 2: Key Formula or Approach:

The rate law for a general reaction $A \rightarrow \text{Product}$ is given by:

$$-r_A = kC_A^n$$

Where:

$-r_A$ is the rate of reaction.

k is the rate constant.

C_A is the concentration of reactant A .

n is the order of the reaction.

Step 3: Detailed Explanation:

For a first-order reaction, the value of n is equal to 1.

Substituting this into the rate law equation:

$$-r_A = kC_A^1 = kC_A$$

This equation clearly shows that the rate of reaction ($-r_A$) is directly proportional to the concentration of the reactant (C_A).

If the concentration is doubled, the rate also doubles; if the concentration is halved, the rate is halved.

Step 4: Final Answer:

Therefore, the rate of a first-order irreversible reaction is proportional to the concentration of the reactant.

Quick Tip

Remember the units of the rate constant k to identify the order:

- Zero order: $\text{mol}/(\text{L} \cdot \text{s})$

- First order: s^{-1}

- Second order: $\text{L}/(\text{mol} \cdot \text{s})$

The unit for a reaction of order n is $(\text{conc})^{1-n}\text{time}^{-1}$.

2. Which law is used to describe steady-state diffusion in gases?

- (A) Henry's law
- (B) Raoult's law
- (C) Fick's first law
- (D) Dalton's law

Correct Answer: (C) Fick's first law

Solution:

Step 1: Understanding the Concept:

Diffusion is the net movement of molecules from a region of higher concentration to a region of lower concentration due to random molecular motion.

Steady-state diffusion occurs when the concentration gradient does not change with time.

Step 2: Key Formula or Approach:

Fick's first law relates the diffusive flux to the concentration under the assumption of steady state.

The mathematical expression is:

$$J = -D \frac{dc}{dx}$$

Where:

J = Diffusion flux (amount of substance per unit area per unit time).

D = Diffusion coefficient or diffusivity.

$\frac{dc}{dx}$ = Concentration gradient.

Step 3: Detailed Explanation:

- **Henry's Law** describes the solubility of a gas in a liquid being proportional to the partial pressure of that gas above the liquid.
- **Raoult's Law** relates the vapor pressure of a solvent in a solution to its mole fraction in the liquid phase.
- **Dalton's Law** states that the total pressure of a mixture of non-reacting gases is equal to the sum of the partial pressures of the individual gases.
- **Fick's First Law** is the fundamental law governing the transport of mass by molecular diffusion under steady-state conditions in gases, liquids, and solids.

Step 4: Final Answer:

Fick's first law is the correct law used to describe steady-state diffusion.

Quick Tip

For non-steady state diffusion (where concentration changes with time), we use Fick's

Second Law: $\frac{\partial c}{\partial t} = D \frac{\partial^2 c}{\partial x^2}$.

Steady state $\implies \frac{dc}{dt} = 0$.

3. Flow is said to be laminar when the Reynolds number is:

- (A) Less than 1000
- (B) Less than 2000
- (C) Between 2000 and 4000
- (D) Greater than 4000

Correct Answer: (B) Less than 2000

Solution:

Step 1: Understanding the Concept:

Fluid flow can be classified based on the nature of the motion of the fluid particles.

Laminar flow (or streamline flow) occurs when fluid particles move in smooth layers or paths, with no mixing between layers.

Step 2: Key Formula or Approach:

The Reynolds number (Re) is a dimensionless quantity used to predict flow patterns.

$$Re = \frac{\rho v D}{\mu}$$

Where:

ρ = density of the fluid.

v = flow velocity.

D = characteristic linear dimension (e.g., pipe diameter).

μ = dynamic viscosity.

Step 3: Detailed Explanation:

For flow through a circular pipe:

1. If $Re < 2000$, the flow is **Laminar**.
2. If $2000 < Re < 4000$, the flow is in a **Transition** region.
3. If $Re > 4000$, the flow is **Turbulent**.

Since the question asks when the flow is laminar, we look for the criteria representing the stable laminar regime. Although the transition starts around 2100-2300, in standard competitive exam contexts, "Less than 2000" is the accepted threshold for purely laminar flow.

Step 4: Final Answer:

Flow is laminar when the Reynolds number is less than 2000.

Quick Tip

Reynolds number represents the ratio of inertial forces to viscous forces.

High Viscosity \implies Low $Re \implies$ Laminar Flow.

High Velocity \implies High $Re \implies$ Turbulent Flow.

4. Which mode of heat transfer is dominant in vacuum?

- (A) Conduction
- (B) Convection
- (C) Radiation
- (D) All are equal

Correct Answer: (C) Radiation

Solution:

Step 1: Understanding the Concept:

There are three primary modes of heat transfer: conduction, convection, and radiation.

- **Conduction** requires a physical medium (solid, liquid, or gas) and occurs through molecular vibration or free electron movement.
- **Convection** requires a fluid medium (liquid or gas) and occurs through the bulk motion of the fluid.
- **Radiation** occurs via electromagnetic waves and does not require any material medium.

Step 2: Detailed Explanation:

A vacuum is a space devoid of matter.

Since conduction and convection rely on the presence of atoms/molecules to transfer energy, they cannot occur in a vacuum.

Radiation, being electromagnetic in nature (like light), can travel through empty space.

Therefore, in a vacuum environment (such as space or between the walls of a thermos flask), heat can only be transferred effectively via radiation.

Step 3: Final Answer:

Radiation is the only mode of heat transfer that can operate in a vacuum.

Quick Tip

Radiation follows the Stefan-Boltzmann Law: $Q = \sigma AT^4$.

Notice that heat transfer by radiation is highly dependent on the absolute temperature (raised to the power of 4).

5. For an ideal gas, internal energy is a function of:

- (A) Pressure only
- (B) Volume only
- (C) Temperature only
- (D) Pressure and volume

Correct Answer: (C) Temperature only

Solution:

Step 1: Understanding the Concept:

An ideal gas is a theoretical gas composed of many randomly moving point particles that are not subject to inter-particle interactions.

The internal energy (U) of a substance is the sum of the kinetic and potential energies of its molecules.

Step 2: Key Formula or Approach:

According to Joule's Law for an ideal gas:

$$U = f(T)$$

The change in internal energy is given by:

$$dU = mC_v dT$$

Where C_v is the specific heat at constant volume and T is the absolute temperature.

Step 3: Detailed Explanation:

In an ideal gas, there are no intermolecular forces of attraction or repulsion (potential energy is zero).

Thus, the internal energy consists solely of kinetic energy.

According to the kinetic theory of gases, the average kinetic energy of gas molecules is directly proportional to the absolute temperature.

Therefore, the internal energy of an ideal gas does not depend on pressure or volume, but only on temperature.

Step 4: Final Answer:

Internal energy is a function of temperature only for an ideal gas.

Quick Tip

For real gases, internal energy is a function of both temperature and volume $U = f(T, V)$ due to intermolecular forces.

However, for ideal gases, Joule's law holds perfectly.

6. In distillation, relative volatility is a measure of:

- (A) Heat transfer rate
- (B) Ease of separation of components
- (C) Vapor pressure of a mixture
- (D) Column efficiency

Correct Answer: (B) Ease of separation of components

Solution:**Step 1: Understanding the Concept:**

Distillation is a process used to separate components of a liquid mixture based on differences in their boiling points (volatilities).

Relative volatility (α) is a comparison of the vapor pressures of the components in the mixture.

Step 2: Key Formula or Approach:

Relative volatility of component A with respect to component B is defined as:

$$\alpha_{AB} = \frac{y_A/x_A}{y_B/x_B}$$

Where y is the mole fraction in vapor and x is the mole fraction in liquid.

For ideal systems, it can also be expressed as the ratio of vapor pressures:

$$\alpha_{AB} = \frac{P_A^\circ}{P_B^\circ}$$

Step 3: Detailed Explanation:

- If $\alpha = 1$, the components have the same volatility, and they cannot be separated by simple distillation.
- If $\alpha > 1$, component A is more volatile than B.
- The larger the value of α , the greater the difference in boiling points and the easier it is to separate the two components.

Thus, relative volatility acts as a direct indicator of how easily a separation can be achieved in a distillation column.

Step 4: Final Answer:

Relative volatility is a measure of the ease of separation of components.

Quick Tip

The number of theoretical stages required for a separation is inversely related to relative volatility.

High $\alpha \implies$ Fewer stages required.

Low α (close to 1) \implies More stages required.

7. A PID controller consists of:

- (A) Proportional and Integral actions
- (B) Proportional and Derivative actions
- (C) Integral and Derivative actions
- (D) Proportional, Integral and Derivative actions

Solution:

Step 1: Understanding the Concept:

A PID controller is a control loop feedback mechanism widely used in industrial control systems to maintain an output at a desired setpoint.

Step 2: Detailed Explanation:

The acronym PID stands for:

1. **P - Proportional:** Produces an output proportional to the current error value. It provides the bulk of the corrective action but often results in a steady-state offset.
2. **I - Integral:** Accounts for past values of the error and integrates them over time. Its primary role is to eliminate the steady-state offset.
3. **D - Derivative:** Estimates the future trend of the error based on its current rate of change. It provides a damping effect, reducing overshoot and improving stability.

Step 3: Final Answer:

A PID controller combines all three actions: Proportional, Integral, and Derivative.

Quick Tip

- P-only: Fast but has offset.
- PI: No offset, but can be sluggish/oscillatory.
- PID: Fast, no offset, and stable.

Note: Derivative action is sensitive to noise and is often avoided in flow control.
