

GATE 2026 PH 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 particle executing simple harmonic motion, the restoring force is proportional to:

- (A) Velocity of the particle
- (B) Square of displacement
- (C) Displacement from mean position
- (D) Acceleration of the particle

Correct Answer: (C) Displacement from mean position

Solution:

Step 1: Understanding the Concept:

Simple Harmonic Motion (SHM) is a special type of periodic motion where the restoring force on the moving object is directly proportional to the magnitude of the object's displacement and acts towards the object's equilibrium position.

Step 2: Key Formula or Approach:

The mathematical expression for the restoring force F in SHM is given by Hooke's Law:

$$F = -kx$$

Where:

k is the force constant (or spring constant).

x is the displacement of the particle from its mean (equilibrium) position.

The negative sign indicates that the force is always directed opposite to the displacement.

Step 3: Detailed Explanation:

In SHM, as the particle moves away from the mean position, the restoring force increases linearly with the distance x .

If we double the displacement, the restoring force required to bring the particle back to the center also doubles.

Option (A) is incorrect because the force is related to acceleration, not directly to velocity.

Option (B) describes a non-linear relationship which does not characterize SHM.

Option (D) is related because $F = ma$, so acceleration is also proportional to displacement, but the fundamental definition of the "restoring force" is based on the displacement itself.

Step 4: Final Answer:

Thus, the restoring force is proportional to the displacement from the mean position.

Quick Tip

Always remember the "linear" nature of SHM.

Restoring Force $\propto -x$ and Acceleration $\propto -x$.

If the force were proportional to x^2 , the motion would be periodic but not "Simple Harmonic".

2. The eigenvalues of the Hamiltonian operator represent the:

- (A) Momentum of the system
- (B) Energy of the system
- (C) Position of the particle
- (D) Probability density

Correct Answer: (B) Energy of the system

Solution:

Step 1: Understanding the Concept:

In Quantum Mechanics, physical observables are represented by linear operators. When an operator acts on its eigenfunction, the resulting scalar value is called an eigenvalue, which represents the measurable value of that observable.

Step 2: Key Formula or Approach:

The time-independent Schrödinger equation is an eigenvalue equation for the Hamiltonian operator \hat{H} :

$$\hat{H}\psi = E\psi$$

Where:

\hat{H} is the Hamiltonian operator (Total Energy operator).

ψ is the wave function (eigenfunction).

E is the eigenvalue.

Step 3: Detailed Explanation:

The Hamiltonian operator \hat{H} corresponds to the total energy of the system, consisting of kinetic energy and potential energy components:

$$\hat{H} = -\frac{\hbar^2}{2m}\nabla^2 + \hat{V}$$

The solution to the eigenvalue equation yields a set of allowed energy levels E .

Therefore, measuring the Hamiltonian of a system in a state ψ will return one of these energy eigenvalues.

Step 4: Final Answer:

The eigenvalues of the Hamiltonian operator represent the total energy of the system.

Quick Tip

Remember the operator-observable pairs:

Hamiltonian \rightarrow Energy.

Momentum operator \rightarrow Momentum.

Position operator \rightarrow Position.

3. The solution of Laplace's equation satisfies which condition?

- (A) It has a maximum inside the domain
- (B) It has a minimum inside the domain

- (C) It satisfies the maximum–minimum principle
- (D) It diverges at the boundary

Correct Answer: (C) It satisfies the maximum–minimum principle

Solution:

Step 1: Understanding the Concept:

Laplace’s equation is a second-order partial differential equation given by $\nabla^2\phi = 0$. Solutions to this equation are called ”harmonic functions”.

Step 2: Detailed Explanation:

Harmonic functions possess unique properties:

1. **Mean Value Property:** The value of the function at a point is the average of its values on a surrounding circle or sphere.

2. **Maximum-Minimum Principle:** A non-constant harmonic function cannot have a local maximum or minimum at any point inside the domain where it is defined.

This means the extreme values (maximum and minimum) must occur on the boundaries of the domain.

If a solution had a local maximum inside, the second derivative would have to be negative in all directions, making the Laplacian $\nabla^2\phi < 0$, which contradicts $\nabla^2\phi = 0$.

Step 3: Final Answer:

Since the solution cannot have local extrema inside the domain, it must satisfy the maximum–minimum principle.

Quick Tip

A physical interpretation: If you have a steady-state temperature distribution (which follows Laplace’s eq), the hottest and coldest points must be on the edges/surface, not in the middle of the object.

4. Which of the following Maxwell’s equations represents Faraday’s law of electromagnetic induction?

- (A) $\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0}$
- (B) $\nabla \cdot \mathbf{B} = 0$
- (C) $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$
- (D) $\nabla \times \mathbf{B} = \mu_0 \mathbf{J}$

Correct Answer: (C) $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$

Solution:

Step 1: Understanding the Concept:

Faraday's Law states that a time-varying magnetic field induces an electromotive force (EMF), which in turn creates a circulating electric field.

Step 2: Key Formula or Approach:

The integral form is $\oint \mathbf{E} \cdot d\mathbf{l} = -\frac{d\Phi_B}{dt}$.

Using Stokes' Theorem, this is converted into the differential form used in Maxwell's equations.

Step 3: Detailed Explanation:

Let's look at the options:

- (A) $\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0}$ is Gauss's Law for Electricity.
- (B) $\nabla \cdot \mathbf{B} = 0$ is Gauss's Law for Magnetism (no monopoles).
- (C) $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$ relates the curl of the electric field to the time rate of change of the magnetic field. This is the differential form of Faraday's Law.
- (D) $\nabla \times \mathbf{B} = \mu_0 \mathbf{J}$ (ignoring displacement current) is Ampere's Circuital Law.

Step 4: Final Answer:

The equation $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$ represents Faraday's law.

Quick Tip

The negative sign in Faraday's Law represents **Lenz's Law**, which states that the induced effect opposes the cause that produced it.

5. For an ideal gas undergoing an adiabatic process, which quantity remains constant?

- (A) Temperature
- (B) Pressure
- (C) PV^γ
- (D) Volume

Correct Answer: (C) PV^γ

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

An adiabatic process is a thermodynamic process in which there is no exchange of heat ($dQ = 0$) between the system and its surroundings.

Step 2: Key Formula or Approach:

For a reversible adiabatic process involving an ideal gas, the relationship between pressure (P) and volume (V) follows the Poisson's law:

$$PV^\gamma = \text{constant}$$

Where γ (gamma) is the adiabatic index, defined as the ratio of specific heats C_p/C_v .

Step 3: Detailed Explanation:

During an adiabatic expansion, the gas does work at the expense of its internal energy, causing the temperature to drop.

Similarly, during adiabatic compression, the temperature rises.

Thus, T , P , and V all change during the process.

However, the specific combination PV^γ remains invariant throughout the process for an ideal gas.

Other constant relations include:

- $TV^{\gamma-1} = \text{constant}$
- $P^{1-\gamma}T^\gamma = \text{constant}$

Step 4: Final Answer:

In an adiabatic process, the quantity PV^γ remains constant.

Quick Tip

For a **monatomic** ideal gas, $\gamma = 5/3 \approx 1.67$.

For a **diatomic** ideal gas, $\gamma = 7/5 = 1.4$.

The adiabatic curve on a P-V diagram is steeper than the isothermal curve.

6. Which of the following solids has a completely filled valence band and a large band gap?

- (A) Conductor
- (B) Semiconductor
- (C) Insulator
- (D) Superconductor

Correct Answer: (C) Insulator

Solution:

Step 1: Understanding the Concept:

Solid materials are classified into conductors, semiconductors, and insulators based on their energy band structure, specifically the gap between the valence band and the conduction band.

Step 2: Detailed Explanation:

- **Conductors:** The valence and conduction bands overlap, or the valence band is partially

filled. Electrons move freely.

- **Semiconductors:** There is a small energy gap (typically < 3 eV) between a filled valence band and an empty conduction band. Thermal energy can excite some electrons across the gap.

- **Insulators:** The valence band is completely filled, and there is a very large energy gap (typically > 3 to 5 eV) to the conduction band. Electrons cannot easily jump to the conduction band at room temperature, resulting in very low conductivity.

Step 3: Final Answer:

An insulator is characterized by a completely filled valence band and a large band gap.

Quick Tip

Conductivity of semiconductors increases with temperature (as more electrons jump the gap), while the conductivity of metals (conductors) decreases with temperature due to increased lattice vibrations.

7. Which particle is emitted during beta-minus decay?

- (A) Proton
- (B) Neutron
- (C) Positron
- (D) Electron

Correct Answer: (D) Electron

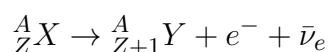
Solution:

Step 1: Understanding the Concept:

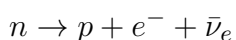
Beta decay is a type of radioactive decay in which a beta particle is emitted from an atomic nucleus. There are two types: beta-minus (β^-) and beta-plus (β^+).

Step 2: Key Formula or Approach:

The nuclear reaction for β^- decay is:



Where:



A neutron transforms into a proton, an electron, and an anti-neutrino.

Step 3: Detailed Explanation:

In β^- decay, the nucleus has too many neutrons. To achieve stability, a neutron is converted

into a proton. During this process, a high-energy electron (called a beta particle) and an electron antineutrino are ejected from the nucleus.

Note that the electron is not one of the orbital electrons; it is created and ejected directly from the nucleus.

In contrast, β^+ decay emits a positron.

Step 4: Final Answer:

The particle emitted during beta-minus decay is an electron.

Quick Tip

In β^- decay, the Atomic Number (Z) increases by 1, but the Mass Number (A) remains the same.

In β^+ decay, the Atomic Number (Z) decreases by 1.