PhysicsByAaryan

CSIR NET · GATE · JEST · BARC – Physics

GATE Physics 2015 — Full Question Paper

Previous Year Questions with Official Answer Key

Inside this PDF

- Every GATE Physics (PH) 2015 question, in order
- Marking scheme + question type (MCQ/MSQ/NAT) on every question
- Subject & topic classification per question
- Official answer key at the end

65 Questions with answer key

Questions taken from official GATE Physics (PH) papers conducted by IITs / IISc.
Compiled by PhysicsByAaryan for free use by aspirants. Answer key at the end of this PDF.

Q1. [Marks: 1 | MCQ] General Aptitude · English

Gate 2015	MCQ	1M

Choose the appropriate word/phrase, out of the four options given below, to complete the following sentence:

Apparent lifelessness ___ dormant life.

(A) harbours
(B) leads to
(C) supports
(D) affects

Q2. [Marks: 1 | MCQ] General Aptitude · English

Gate 2015	MCQ	1M

Fill in the blank with the correct idiom/phrase.

That boy from the town was a ___ in the sleepy village.

(A) dog out of herd
(B) sheep from the heap
(C) fish out of water
(D) bird from the flock

Q3. [Marks: 1 | MCQ] General Aptitude · English

Gate 2015	MCQ	1M

Choose the statement where underlined word is used correctly.

(A) When the teacher eludes to different authors, he is being elusive.

(B) When the thief keeps eluding the police, he is being elusive.

(C) Matters that are difficult to understand, identify or remember are allusive.

(D) Mirages can be allusive, but a better way to express them is illusory.

Q4. [Marks: 1 | MCQ] General Aptitude · Reasoning

Gate 2015	MCQ	1M

Tanya is older than Eric.

Cliff is older than Tanya.

Eric is older than Cliff.

If the first two statements are true, then the third statement is:

(A) True

(B) False

(C) Uncertain

(D) Data insufficient

Q5. [Marks: 1 | MCQ] General Aptitude · Mathematical Analysis

Gate 2015	MCQ	1M

Five teams have to compete in a league, with every team playing every other team exactly once, before going to the next round. How many matches will have to be held to complete the league round of matches?

(A) 20
(B) 10
(C) 8
(D) 5

Q6. [Marks: 2 | MCQ] General Aptitude · English

Gate 2015	MCQ	2M

Select the appropriate option in place of underlined part of the sentence.

Increased productivity necessary reflects greater efforts made by the employees.

(A) Increase in productivity necessary
(B) Increase productivity is necessary
(C) Increase in productivity necessarily
(D) No improvement required

Q7. [Marks: 2 | MCQ] General Aptitude · Reasoning

Gate 2015	MCQ	2M

Given below are two statements followed by two conclusions. Assuming these statements to be true, decide which one logically follows.

Statements:

I. No manager is a leader.

II. All leaders are executives.

Conclusions:

I. No manager is an executive.

II. No executive is a manager.

(A) Only conclusion I follows.

(B) Only conclusion II follows.

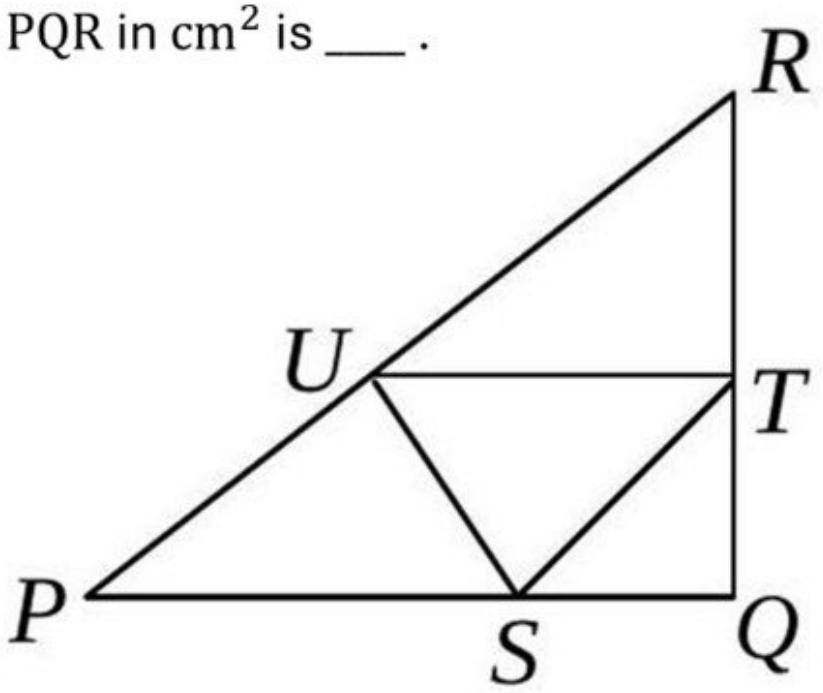
(C) Neither conclusion I nor II follows.

(D) Both conclusions I and II follow.

Q8. [Marks: 2 | NAT] General Aptitude · Geometry

Gate 2015	NAT	2M

In the given figure angle Q is a right angle, $\mathrm{PS:QS} = 3:1, \mathrm{RT:QT} = 5:2$ and $\mathrm{PU:UR} = 1:1$. If area of triangle QTS is $20\,\mathrm{cm}^2$, then the area of triangle PQR in cm^2 is ___ .



Q9. [Marks: 2 | MCQ] General Aptitude · Geometry

Gate 2015	MCQ	2M

Right triangle PQR is to be constructed in the xy -plane so that the right angle is at P and line PR is parallel to the x -axis. The x and y coordinates of $P, Q,$ and R are to be integers that satisfy the inequalities: $-4 \leq x \leq 5$ and $6 \leq y \leq 16$. How many different triangles could be constructed with these properties?

(A) 110
(B) 1,100
(C) 9,900
(D) 10,000

Q10. [Marks: 2 | MCQ] General Aptitude · Mathematical Analysis

Gate 2015	MCQ	2M

A coin is tossed thrice. Let X be the event that head occurs in each of the first two tosses. Let Y be the event that a tail occurs on the third toss. Let Z be the event that two tails occur in three tosses. Based on the above information, which one of the following statements is TRUE?

(A) X and Y are not independent
(B) Y and Z are dependent
(C) Y and Z are independent
(D) X and Z are independent

Q11. [Marks: 1 | MCQ] Classical Mechanics · Central Forces

Gate 2015	MCQ	1M

A satellite is moving in a circular orbit around the Earth. If T, V and E are its average kinetic, average potential and total energies, respectively, then which one of the following options is correct?

(A) $V = -2T; E = -T$

(B) $V = -T; E = 0$

(C) $V = -T/2; E = T/2$

(D) $V = -3T/2; E = -T/2$

Q12. [Marks: 1 | NAT] Quantum Mechanics · Spin and Total Angular momentum

Gate 2015	NAT	1M

The Pauli matrices for three spin- $1/2$ particles are $\vec{\sigma}_1, \vec{\sigma}_2$, and $\vec{\sigma}_3$, respectively. The dimension of the Hilbert space required to define an operator $\hat{O} = \vec{\sigma}_1 \cdot \vec{\sigma}_2 \times \vec{\sigma}_3$ is ___

Q13. [Marks: 1 | NAT] Nuclear and Particle Physics · Nuclear properties

Gate 2015	NAT	1M

The mean kinetic energy of a nucleon in a nucleus of atomic weight A varies as A^n, where n is ___ (upto two decimal places)

Q14. [Marks: 1 | MCQ] Quantum Mechanics · Orbital angular momentum and hydrogen atom

Gate 2015	MCQ	1M

Let $\vec{L}$ and $\vec{p}$ be the angular and linear momentum operators, respectively, for a particle. The commutator $[L_x, p_y]$ gives

(A) $-i\hbar p_z$

(B) 0

(C) $i\hbar p_x$

(D) $i\hbar p_z$

Q15. [Marks: 1 | MCQ] Nuclear and Particle Physics · Particle Physics

Gate 2015	MCQ	1M

The decay $\mu^+ \rightarrow e^+ + \gamma$ is forbidden, because it violates

(A) momentum and lepton number conservations

(B) baryon and lepton number conservations

(C) angular momentum conservation

(D) lepton number conservation

Q16. [Marks: 1 | MCQ] Quantum Mechanics · Spin and Total Angular momentum

Gate 2015	MCQ	1M

An operator for a spin- $1/2$ particle is given by $\hat{A} = \lambda\vec{\sigma} \cdot \vec{B}$, where $\vec{B} = \frac{B}{\sqrt{2}}(\hat{x} + \hat{y})$, $\vec{\sigma}$ denotes Pauli matrices and λ is a constant. The eigenvalues of $\hat{A}$ are

(A) $\pm\lambda B/\sqrt{2}$

(B) $\pm\lambda B$

(C) $0, \lambda B$

(D) $0, -\lambda B$

Q17. [Marks: 1 | MCQ] Classical Mechanics · Special theory of relativity

Gate 2015	MCQ	1M

In an inertial frame S, two events A and B take place at $(ct_A = 0, \vec{r}_A = 0)$ and $(ct_B = 0, \vec{r}_B = 2\hat{y})$, respectively. The times at which these events take place in a frame S' moving with a velocity $0.6c\,\hat{y}$ with respect to S are given by

(A) $ct'_A = 0; ct'_B = -3/2$

(B) $ct'_A = 0; ct'_B = 0$

(C) $ct'_A = 0; ct'_B = 3/2$

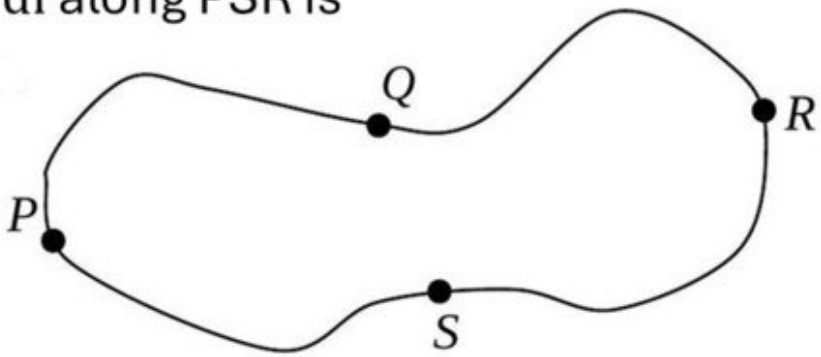
(D) $ct'_A = 0; ct'_B = 1/2$

Q18. [Marks: 1 | MCQ] Electromagnetism · Magnetism

Gate 2015	MCQ	1M

Given that the magnetic flux through the closed loop PQRSP is ϕ. If $\int_P^R \vec{A} \cdot \vec{dl} = \phi_1$ along PQR , the value of $\int_P^R \vec{A} \cdot \vec{dl}$ along PSR is

(A) $\phi - \phi_1$
(B) $\phi_1 - \phi$
(C) $-\phi_1$
(D) ϕ_1



Q19. [Marks: 1 | MCQ] Mathematical Physics · Differential Equations

Gate 2015	MCQ	1M

If $f(x) = e^{-x^2}$ and $g(x) = |x|e^{-x^2}$, then

(A) f and g are differentiable everywhere
(B) f is differentiable everywhere but g is not
(C) g is differentiable everywhere but f is not
(D) g is discontinuous at $x = 0$

Q20. [Marks: 1 | MCQ] Quantum Mechanics · Quantum Statistical Mechanics

Gate 2015	MCQ	1M

In Bose-Einstein condensates, the particles

(A) have strong interparticle attraction

(B) condense in real space

(C) have overlapping wavefuntions

(D) have large and positive chemical potential

Q21. [Marks: 1 | MCQ] Statistical Mechanics · Microcanonical ensemble

Gate 2015	MCQ	1M

Consider a system of N non-interacting spin- 1/2 particles, each having a magnetic moment μ, is in a magnetic field $\vec{B} = B\hat{z}$. If E is the total energy of the system, the number of accessible microstates Ω is given by

(A) $\Omega = \frac{N!}{\frac{1}{2}\left(N-\frac{E}{\mu B}\right)!\frac{1}{2}\left(N+\frac{E}{\mu B}\right)!}$

(B) $\Omega = \frac{\left(N-\frac{E}{\mu B}\right)!}{\left(N+\frac{E}{\mu B}\right)!}$

(C) $\Omega = \frac{1}{2}\left(N-\frac{E}{\mu B}\right)!\ \frac{1}{2}\left(N+\frac{E}{\mu B}\right)!$

(D) $\Omega = \frac{N!}{\left(N+\frac{E}{\mu B}\right)!}$

Q22. [Marks: 1 | MCQ] Statistical Mechanics · Quantum Statistical Mechanics

Gate 2015	MCQ	1M

For a black body radiation in a cavity, photons are created and annihilated freely as a result of emission and absorption by the walls of the cavity. This is because

(A) the chemical potential of the photons is zero

(B) photons obey Pauli exclusion principle

(C) photons are spin-1 particles

(D) the entropy of the photons is very large

Q23. [Marks: 1 | MCQ] Mathematical Physics · Complex Analysis

Gate 2015	MCQ	1M

Consider $w = f(z) = u(x,y) + iv(x,y)$ to be an analytic function in a domain D. Which one of the following options is NOT correct?

(A) $u(x,y)$ satisfies Laplace equation in D

(B) $v(x,y)$ satisfies Laplace equation in D

(C) $\int_{z_1}^{z_2} f(z)dz$ is dependent on the choice of the contour between z_1 and z_2 in D

(D) $f(z)$ can be Taylor expanded in D

Q24. [Marks: 1 | NAT] Mathematical Physics · Gamma, Beta and Delta function

Gate 2015	NAT	1M

The value of $\int_0^3 t^2\delta(3t-6)dt$ is ___ (upto one decimal place)

Q25. [Marks: 1 | MCQ] Electronics · Logic Gates

Gate 2015	MCQ	1M

Which one of the following DOES NOT represent an exclusive OR operation for inputs A and B ?

(A) $(A + B)\overline{AB}$

(B) $A\bar{B} + B\bar{A}$

(C) $(A + B)(\bar{A} + \bar{B})$

(D) $(A + B)AB$

Q26. [Marks: 1 | MCQ] Mathematical Physics · Complex Analysis

Gate 2015	MCQ	1M

Consider a complex function $f(z) = \frac{1}{z\left(z+\frac{1}{2}\right)\cos(z\pi)}$.

Which one of the following statements is correct?

(A) $f(z)$ has simple poles at $z = 0$ and $z = -1/2$

(B) $f(z)$ has a second order pole at $z = -1/2$

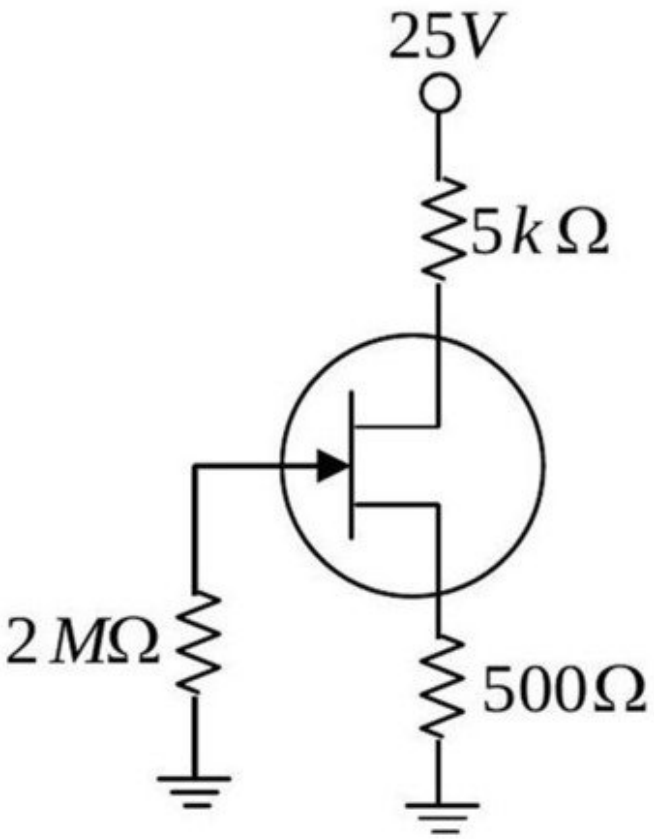
(C) $f(z)$ has infinite number of second order poles

(D) $f(z)$ has all simple poles

Q27. [Marks: 1 | NAT] Electronics · fet

Gate 2015	NAT	1M

In the given circuit, the voltage across the source resistor is 1 V . The drain voltage (in V) is ___



Q28. [Marks: 1 | NAT] Electromagnetism · Image Problem

Gate 2015	NAT	1M

A point charge is placed between two semi-infinite conducting plates which are inclined at an angle of 30° with respect to each other. The number of image charges is ___

Q29. [Marks: 1 | NAT] Atomic and Molecular Physics · Xray spectra

Gate 2015	NAT	1M

A beam of X-ray of intensity I_0 is incident normally on a metal sheet of thickness 2 mm. The intensity of the transmitted beam is $0.025I_0$. The linear absorption coefficient of the metal sheet (in m^{-1}) is ___ (upto one decimal place)

Q30. [Marks: 1 | NAT] Solid State Physics · Crystallography

Gate 2015	NAT	1M

The lattice parameters a, b, c of an orthorhombic crystal are related by $a = 2b = 3c$. In units of a, the interplanar separation between the (110) planes is ___ (upto three decimal places)

Q31. [Marks: 1 | MCQ] Solid State Physics · Hall Effect

Gate 2015	MCQ	1M

In a Hall effect experiment, the Hall voltage for an intrinsic semiconductor is negative. This is because (symbols carry usual meaning)

(A) $n \approx p$

(B) $n > p$

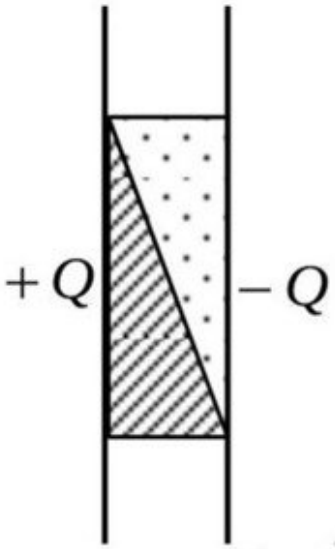
(C) $\mu_e > \mu_h$

(D) $m_e^* > m_h^*$

Q32. [Marks: 1 | MCQ] Electromagnetism · Electric field in matter

Gate 2015	MCQ	1M

The space between two plates of a capacitor carrying charges +Q and -Q is filled with two different dielectric materials, as shown in the figure.



Across the interface of the two dielectric materials, which one of the following statements is correct?

(A) $\vec{E}$ and $\vec{D}$ are continuous

(B) $\vec{E}$ is continuous and $\vec{D}$ is disconitnuous

(C) $\vec{D}$ is continuous and $\vec{E}$ is discontinuous

(D) $\vec{E}$ and $\vec{D}$ are discontinuous

Q33. [Marks: 1 | NAT] Statistical Mechanics · Quantum Statistical Mechanics

Gate 2015	NAT	1M

The energy dependence of the density of states for a two dimensional non-relativistic electron gas is given by, $g(E) = CE^n$, where C is constant. The value of n is ___

Q34. [Marks: 1 | NAT] Solid State Physics · Lattice vibration

Gate 2015	NAT	1M

The dispersion relation for phonons in a one dimensional monatomic Bravais lattice with lattice spacing a and consisting of ions of masses M is given by, $\omega(k) = \sqrt{\frac{2C}{M}[1 - \cos(ka)]}$, where ω is the frequency of oscillation, k is the wavevector and C is the spring constant. For the long wavelength modes ($\lambda \gg a$), the ratio of the phase velocity to the group velocity is ___

Q35. [Marks: 1 | MCQ] Classical Mechanics · Central Forces

Gate 2015	MCQ	1M

Four forces are given below in Cartesian and spherical polar coordinates.

(i) $\vec{F}_1 = K\exp(-r^2/R^2)\hat{r}$

(ii) $\vec{F}_2 = K(x^3\hat{y} - y^3\hat{z})$

(iii) $\vec{F}_3 = K(x^3\hat{x} + y^3\hat{y})$

(iv) $\vec{F}_4 = K(\hat{\phi}/r)$

where K is a constant. Identify the correct option.

(A) (iii) and (iv) are conservative but (i) and (ii) are not

(B) (i) and (ii) are conservative but (iii) and (iv) are not

(C) (ii) and (iii) are conservative but (i) and (iv) are not

(D) (i) and (iii) are conservative but (ii) and (iv) are not

Q36. [Marks: 2 | NAT] Statistical Mechanics · Microstates

Gate 2015	NAT	2M

Consider a system of eight non-interacting, identical quantum particles of spin- $3/2$ in a one dimensional box of length L. The minimum excitation energy of the system, in units of $\frac{\pi^2\hbar^2}{2mL^2}$ is ___

Q37. [Marks: 2 | NAT] Atomic and Molecular Physics · Molecular Physics

Gate 2015	NAT	2M

The excitation wavelength of laser in a Raman effect experiment is 546 nm. If the Stokes' line is observed at 552 nm, then the wavenumber of the anti-Stokes' line (in cm^{-1}) is ___

Q38. [Marks: 2 | NAT] Solid State Physics · Lattice vibration

Gate 2015	NAT	2M

The binding energy per molecule of NaCl (lattice parameter is 0.563 nm) is 7.95 eV. The repulsive term of the potential is of the form $\frac{K}{r^9}$, where K is a constant. The value of the Madelung constant is ____ (upto three decimal places) (Electron charge $e = -1.6 \times 10^{-19} C; \varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}$)

Q39. [Marks: 2 | NAT] Solid State Physics · Free electron model

Gate 2015	NAT	2M

Given that the Fermi energy of gold is 5.54 eV, the number density of electrons is ___ $\times 10^{28}\ m^{-3}$ (upto one decimal place)

(Mass of electron $= 9.11 \times 10^{-31}\ kg;$

$h = 6.626 \times 10^{-34}\ J.s;$

$1eV = 1.6 \times 10^{-19}\ J$)

Q40. [Marks: 2 | NAT] Solid State Physics · Semiconductor Physics

Gate 2015	NAT	2M

The band gap of an intrinsic semiconductor is $E_g = 0.72\,eV$ and $m_h^* = 6m_e^*$. At 300 K, the Fermi level with respect to the edge of the valence band (in eV) is at ___ (upto three decimal places)

$k_B = 1.38 \times 10^{-23} JK^{-1}$

Q41. [Marks: 2 | NAT] Atomic and Molecular Physics · Effects in atomic physics

Gate 2015	NAT	2M

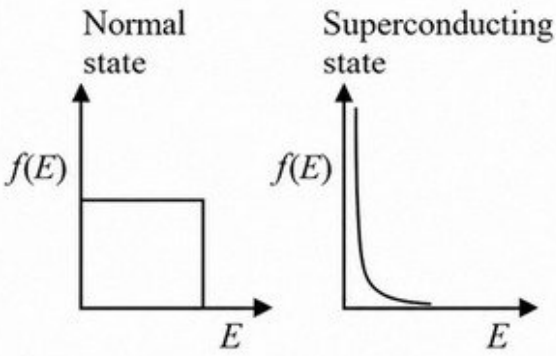
The number of permitted transitions from $^2P_{3/2} \rightarrow {}^2S_{1/2}$ in the presence of a weak magnetic field is ___

Q42. [Marks: 2 | MCQ] Solid State Physics · Superconductivity

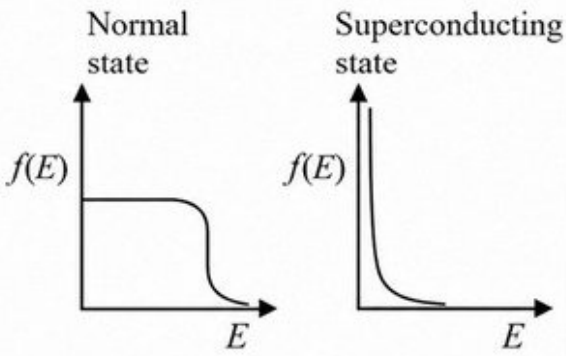
Gate 2015	MCQ	2M

Which one of the following represents the electron occupancy for a superconductor in its normal and superconducting states?

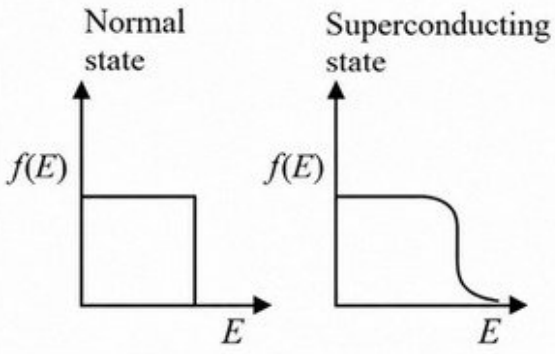
(A)



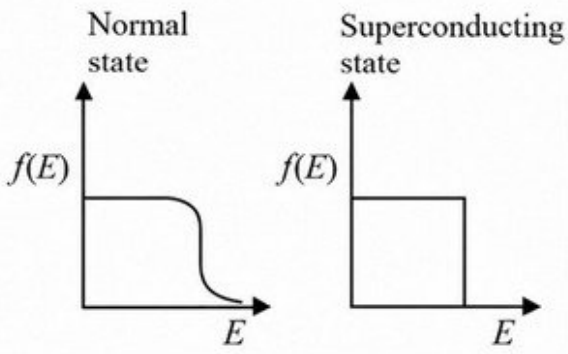
(B)



(C)



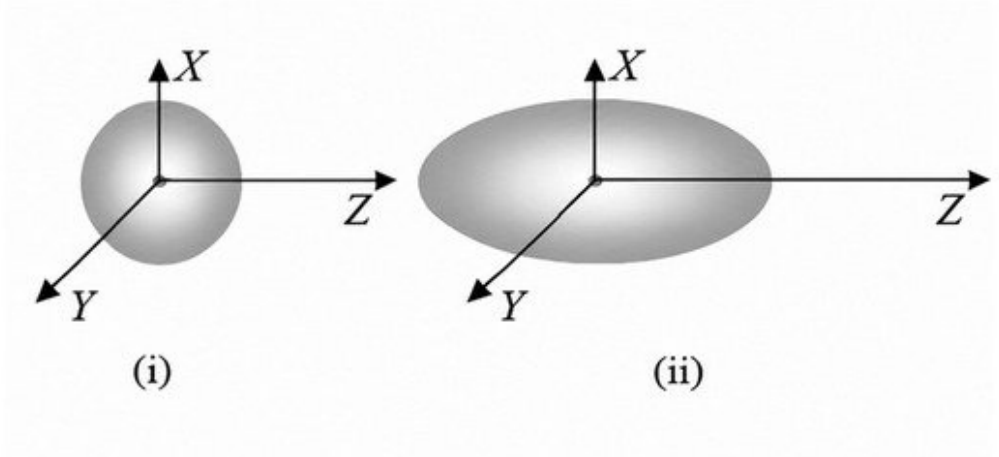
(D)



Q43. [Marks: 2 | MCQ] Electromagnetism · Electrostatics

Gate 2015	MCQ	2M

A charge $-q$ is distributed uniformly over a sphere, with a positive charge q at its center in (i). Also in (ii), a charge $-q$ is distributed uniformly over an ellipsoid with a positive charge q at its center.



With respect to the origin of the coordinate system, which one of the following statements is correct?

(A) The dipole moment is zero in both (i) and (ii)

(B) The dipole moment is non-zero in (i) but zero in (ii)

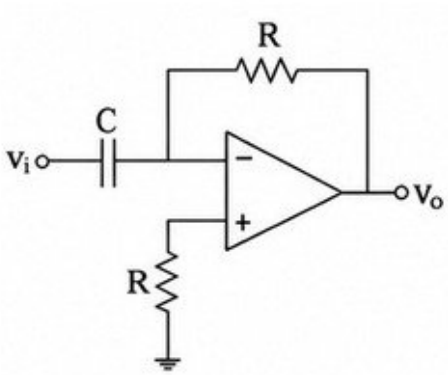
(C) The dipole moment is zero in (i) but non-zero in (ii)

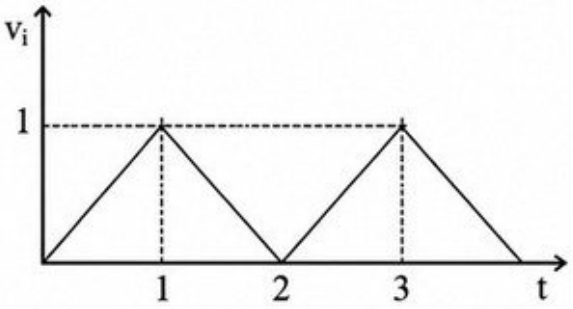
(D) The dipole moment is non-zero in both (i) and (ii)

Q44. [Marks: 2 | MCQ] Electronics · OPAMP

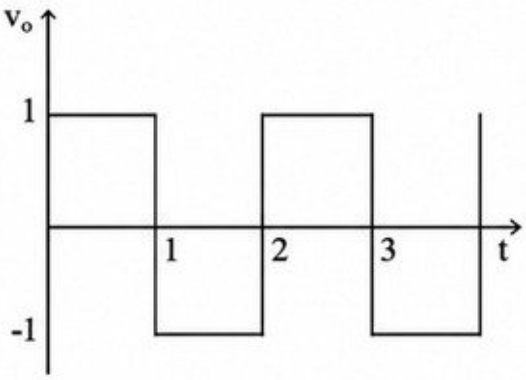
Gate 2015	MCQ	2M

Consider the circuit shown in the figure, where $RC = 1$. For an input signal V_i shown below, choose the correct V_0 from the options:

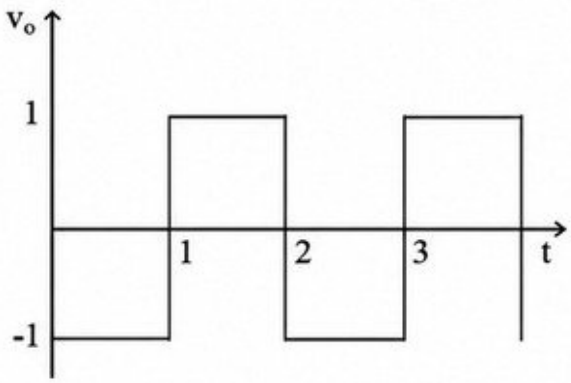




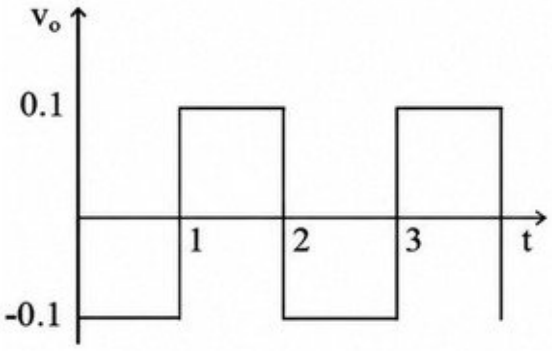
(A)



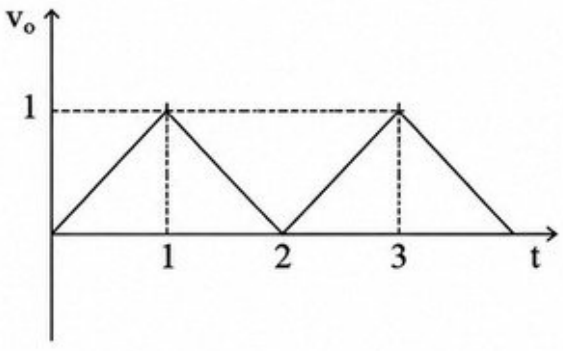
(B)



(C)



(D)



Q45. [Marks: 2 | MCQ] Electromagnetism · Electrodynamics

Gate 2015	MCQ	2M

A long solenoid is embedded in a conducting medium and is insulated from the medium. If the current through the solenoid is increased at a constant rate, the induced current in the medium as a function of the radial distance r from the axis of the solenoid is proportional to

(A) r^2 inside the solenoid and $\frac{1}{r}$ outside

(B) r inside the solenoid and $\frac{1}{r^2}$ outside

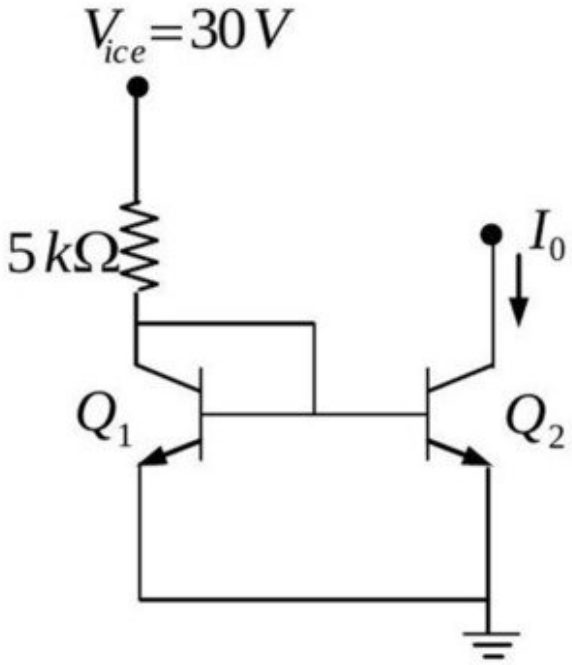
(C) r^2 inside the solenoid and $\frac{1}{r^2}$ outside

(D) r inside the solenoid and $\frac{1}{r}$ outside

Q46. [Marks: 2 | NAT] Electronics · Transistors

Gate 2015	NAT	2M

In the simple current source shown in the figure, Q_1 and Q_2 are identical transistors with current gain $\beta = 100$ and $V_{BE} = 0.7\ V$



The current I_0 (in mA) is ___ (upto two decimal places)

Q47. [Marks: 2 | MCQ] Atomic and Molecular Physics · ESR/EPR/NMR

Gate 2015	MCQ	2M

Match the phrases in Group I and Group II and identify the correct option.

Group I	Group II
(P) Electron spin resonance (ESR)	(i) radio frequency
(Q) Nuclear magnetic resonance (NMR)	(ii) visible range frequency
(R) Transition between vibrational states of a molecule	(iii) microwave frequency
(S) Electronic transition	(iv) far-infrared range

(A) (P-i), (Q-ii), (R-iii), (S-iv)

(B) (P-ii), (Q-i), (R-iv), (S-iii)

(C) (P-iii), (Q-iv), (R-i), (S-ii)

(D) (P-iii), (Q-i), (R-iv), (S-ii)

Q48. [Marks: 2 | MCQ] Classical Mechanics · Coriolis Force

Gate 2015	MCQ	2M

Consider the motion of the Sun with respect to the rotation of the Earth about its axis. If $\vec{F}_c$ and $\vec{F}_{Co}$ denote the centrifugal and the Coriolis forces, respectively, acting on the Sun, then

(A) $\vec{F}_c$ is radially outward and $\vec{F}_{C_o} = \vec{F}_c$

(B) $\vec{F}_c$ is radially inward and $\vec{F}_{Co} = -2\vec{F}_c$

(C) $\vec{F}_c$ is radially outward and $\vec{F}_{Co} = -2\vec{F}_c$

(D) $\vec{F}_c$ is radially outward and $\vec{F}_{C_o} = 2\vec{F}_c$

Q49. [Marks: 2 | NAT] Atomic and Molecular Physics · Molecular Physics

Gate 2015	NAT	2M

In a rigid-rotator of mass M, if the energy of the first excited state is 1 meV , then the fourth excited state energy (in meV) is ___

Q50. [Marks: 2 | MCQ] Optics · Polarization

Gate 2015	MCQ	2M

A plane wave $(\hat{x} + i\hat{y})E_0 \exp[i(kz - \omega t)]$ after passing through an optical element emerges as $(\hat{x} - i\hat{y})E_0 \exp[i(kz - \omega t)]$, where k and ω are the wavevector and the angular frequency, respectively. The optical element is a

(A) quarter wave plate

(B) half wave plate

(C) polarizer

(D) Faraday rotator

Q51. [Marks: 2 | MCQ] Classical Mechanics · Lagrangian and Hamiltonian

Gate 2015	MCQ	2M

The Lagrangian for a particle of mass m at a position $\vec{r}$ moving with a velocity $\vec{v}$ is given by $L = \frac{m}{2}\vec{v}^2 + C\vec{r}\cdot\vec{v} - V(r)$, where $V(r)$ is a potential and C is a constant. If $\vec{p}_c$ is the canonical momentum, then its Hamiltonian is given by

(A) $\frac{1}{2m}(\vec{p}_c + C\vec{r})^2 + V(r)$

(B) $\frac{1}{2m}(\vec{p}_c - C\vec{r})^2 + V(r)$

(C) $\frac{p_c^2}{2m} + V(r)$

(D) $\frac{1}{2m}p_c^2 + C^2r^2 + V(r)$

Q52. [Marks: 2 | MCQ] Classical Mechanics · Lagrangian and Hamiltonian

Gate 2015	MCQ	2M

The Hamiltonian for a system of two particles of masses m_1 and m_2 at $\vec{r}_1$ and $\vec{r}_2$ having velocities $\vec{v}_1$ and $\vec{v}_2$ is given by

$$H = \frac{1}{2}m_1 v_1^2 + \frac{1}{2}m_2 v_2^2 + \frac{C}{(\vec{r}_1 - \vec{r}_2)^2}\hat{z} \cdot (\vec{r}_1 \times \vec{r}_2),$$

where C is a constant. Which one of the following statements is correct?

(A) The total energy and total momentum are conserved

(B) Only the total energy is conserved

(C) The total energy and the z - component of the total angular momentum are conserved

(D) The total energy and total angular momentum are conserved

Q53. [Marks: 2 | NAT] Classical Mechanics · Basic Mechanics

Gate 2015	NAT	2M

A particle of mass 0.01 kg falls freely in the earth's gravitational field with an initial velocity $v(0) = 10\,ms^{-1}$. If the air exerts a frictional force of the form, $f = -kv$, then for $k = 0.05Nm^{-1}s$, the velocity (in $m\,s^{-1}$) at time $t = 0.2s$ is ___ (upto two decimal places) (use $g = 10\,ms^{-2}$ and $e = 2.72$)

Q54. [Marks: 2 | MCQ] Nuclear and Particle Physics · Shell Model

Gate 2015	MCQ	2M

In the nuclear shell model, the potential is modeled as $V(r) = \frac{1}{2}m\omega^2 r^2 - \lambda\vec{L}\cdot\vec{S}, \lambda > 0$. The correct spin-parity and isospin assignments for the ground state of ^{13}C is

(A) $\frac{1^-}{2}; \frac{-1}{2}$

(B) $\frac{1^+}{2}; \frac{-1}{2}$

(C) $\frac{3^+}{2}; \frac{1}{2}$

(D) $\frac{3^-}{2}; \frac{-1}{2}$

Q55. [Marks: 2 | MCQ] Quantum Mechanics · Perturbation Theory

Gate 2015	MCQ	2M

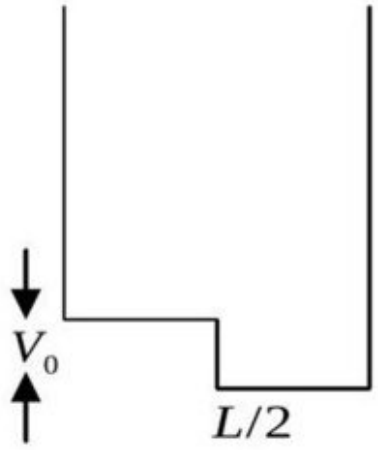
A particle is confined in a box of length L as shown below. If the potential V_0 is treated as a perturbation, including the first order correction, the ground state energy is

(A) $E = \frac{\hbar^2\pi^2}{2mL^2} + V_0$

(B) $E = \frac{\hbar^2\pi^2}{2mL^2} - \frac{V_0}{2}$

(C) $E = \frac{\hbar^2\pi^2}{2mL^2} + \frac{V_0}{4}$

(D) $E = \frac{\hbar^2\pi^2}{2mL^2} + \frac{V_0}{2}$



Q56. [Marks: 2 | NAT] Quantum Mechanics · Basics Quantum Mechanics

Gate 2015	NAT	2M

Suppose a linear harmonic oscillator of frequency ω and mass m is in the state

$$|\psi\rangle = \frac{1}{\sqrt{2}}\left[|\psi_0\rangle + e^{i\frac{\pi}{2}}|\psi_1\rangle\right]$$

at $t = 0$ where $|\psi_0\rangle$ and $|\psi_1\rangle$ are the ground and the first excited states, respectively. The value of $\langle\psi|x|\psi\rangle$ in the units of $\sqrt{\frac{\hbar}{m\omega}}$ at $t = 0$ is ___

Q57. [Marks: 2 | MCQ] Classical Mechanics · Special theory of relativity

Gate 2015	MCQ	2M

A particle with rest mass M is at rest and decays into two particles of equal rest masses $\frac{3}{10}$M which move along the z axis. Their velocities are given by

(A) $\vec{v}_1 = \vec{v}_2 = (0.8c)\hat{z}$

(B) $\vec{v}_1 = -\vec{v}_2 = (0.8c)\hat{z}$

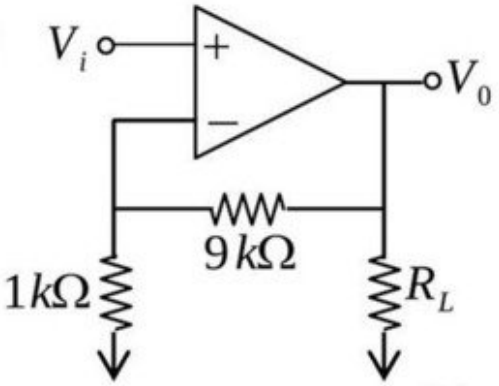
(C) $\vec{v}_1 = -\vec{v}_2 = (0.6c)\hat{z}$

(D) $\vec{v}_1 = (0.6c)\hat{z};\ \vec{v}_2 = (-0.8c)\hat{z}$

Q58. [Marks: 2 | MCQ] Electronics · OPAMP

Gate 2015	MCQ	2M

In the given circuit, if the open loop gain $A = 10^5$, the feedback configuration and the closed loop gain A_f are



(A) series-shunt, $A_f = 9$

(B) series-series, $A_f = 10$

(C) series-shunt, $A_f = 10$

(D) shunt-shunt, $A_f = 10$

Q59. [Marks: 2 | MCQ] Mathematical Physics · Differential Equations

Gate 2015	MCQ	2M

A function $y(z)$ satisfies the ordinary differential equation $y'' + \frac{1}{z}y' - \frac{m^2}{z^2}y = 0$, where $m = 0,1,2,3,....$ Consider the four statements P, Q, R, S as given below.

P: z^m and z^{-m} are linearly independent solutions for all values of m

Q: z^m and z^{-m} are linearly independent solutions for all values of $m > 0$

R: $\ln z$ and 1 are linearly independent solutions for $m = 0$

S: z^m and $\ln z$ are linearly independent solutions for all values of m

The correct option for the combination of valid statements is

(A) P, R and S only
(B) P and R only
(C) Q and R only
(D) R and S only

Q60. [Marks: 2 | MCQ] Statistical Mechanics · Microcanonical ensemble

Gate 2015	MCQ	2M

The entropy of a gas containing N particles enclosed in a volume V is given by $S = Nk_B \ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right)$, where E is the total energy, a is a constant and k_B is the Boltzmann constant. The chemical potential μ of the system at a temperature T is given by

(A) $\mu = -k_B T\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right) - \frac{5}{2}\right]$

(B) $\mu = -k_B T\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right) - \frac{3}{2}\right]$

(C) $\mu = -k_B T\left[\ln\left(\frac{aVE^{3/2}}{N^{3/2}}\right) - \frac{5}{2}\right]$

(D) $\mu = -k_B T\left[\ln\left(\frac{aVE^{3/2}}{N^{3/2}}\right) - \frac{3}{2}\right]$

Q61. [Marks: 2 | NAT] Quantum Mechanics · Spin and Total Angular momentum

Gate 2015	NAT	2M

Let the Hamiltonian for two spin- $1/2$ particles of equal masses m, momenta $\vec{p}_1$ and $\vec{p}_2$ and positions $\vec{r}_1$ and $\vec{r}_2$ be

$$H = \frac{1}{2m}p_1^2 + \frac{1}{2m}p_2^2 + \frac{1}{2}m\omega^2(r_1^2 + r_2^2) + k\vec{\sigma}_1 \cdot \vec{\sigma}_2,$$

where $\vec{\sigma}_1$ and $\vec{\sigma}_2$ denote the corresponding Pauli matrices, $\hbar\omega = 0.1$ eV and $k = 0.2$ eV. If the ground state has net spin zero, then the energy (in eV) is ___

Q62. [Marks: 2 | MCQ] Statistical Mechanics · Canonical ensemble

Gate 2015	MCQ	2M

The average energy U of a one dimensional quantum oscillator of frequency ω and in contact with a heat bath at temperature T is given by

(A) $U = \frac{1}{2}\hbar\omega\coth\left(\frac{1}{2}\beta\hbar\omega\right)$

(B) $U = \frac{1}{2}\hbar\omega\sinh\left(\frac{1}{2}\beta\hbar\omega\right)$

(C) $U = \frac{1}{2}\hbar\omega\tanh\left(\frac{1}{2}\beta\hbar\omega\right)$

(D) $U = \frac{1}{2}\hbar\omega\cosh\left(\frac{1}{2}\beta\hbar\omega\right)$

Q63. [Marks: 2 | NAT] Optics · Interference and Diffraction

Gate 2015	NAT	2M

A monochromatic plane wave (wavelength = 600 nm) $E_0 \exp[i(kz - \omega t)]$ is incident normally on a diffraction grating giving rise to a plane wave $E_1 \exp\left[i\left(\vec{k}_1 \cdot \vec{r} - \omega t\right)\right]$ in the first order of diffraction. Here $E_1 < E_0$ and $\vec{k}_1 = \left|\vec{k}_1\right| \left[\frac{1}{2}\hat{x} + \frac{\sqrt{3}}{2}\hat{z}\right]$. The period (in μm) of the diffraction grating is ___ (upto one decimal place)

Q64. [Marks: 2 | MCQ] Mathematical Physics · Fourier and Laplace transform

Gate 2015	MCQ	2M

The Heaviside function is defined as

$$H(t) = \begin{cases} +1 & \text{for } t > 0 \\ -1 & \text{for } t < 0 \end{cases}$$

and its Fourier transform is given by $-2i/\omega$. The Fourier transform of $\frac{1}{2}[H(t + 1/2) - H(t - 1/2)]$ is

(A) $\frac{\sin\left(\frac{\omega}{2}\right)}{\omega/2}$

(B) $\frac{\cos\left(\frac{\omega}{2}\right)}{\omega/2}$

(C) $\sin\left(\frac{\omega}{2}\right)$

(D) 0

Q65. [Marks: 2 | NAT] Nuclear and Particle Physics · Radioactivity

Gate 2015	NAT	2M

The atomic masses of $^{152}_{63}\mathrm{Eu}$, $^{152}_{62}\mathrm{Sm}$, $^{1}_{1}\mathrm{H}$ and neutron are 151.921749, 151.919756, 1.007825 and 1.008665 in atomic mass units (amu), respectively. Using the above information, the Q-value of the reaction $^{152}_{63}\mathrm{Eu} + \mathrm{n} \rightarrow {}^{152}_{62}\mathrm{Sm} + \mathrm{p}$ is ____ $\times 10^{-3}$amu (upto three decimal places)

Answer Key

65 questions · Subject & topic for quick revision · Official keys (IIT/IISc)

Q.No	Subject	Topic	Type	Marks	Answer
Q1	General Aptitude	English	MCQ	1	**A**
Q2	General Aptitude	English	MCQ	1	**C**
Q3	General Aptitude	English	MCQ	1	**B**
Q4	General Aptitude	Reasoning	MCQ	1	**B**
Q5	General Aptitude	Mathematical Analysis	MCQ	1	**B**
Q6	General Aptitude	English	MCQ	2	**C**
Q7	General Aptitude	Reasoning	MCQ	2	**C**
Q8	General Aptitude	Geometry	NAT	2	**280**
Q9	General Aptitude	Geometry	MCQ	2	**C**
Q10	General Aptitude	Mathematical Analysis	MCQ	2	**B**
Q11	Classical Mechanics	Central Forces	MCQ	1	**A**
Q12	Quantum Mechanics	Spin and Total Angular momentum	NAT	1	**8**
Q13	Nuclear and Particle Phy…	Nuclear properties	NAT	1	**-0.67 to -0.66**
Q14	Quantum Mechanics	Orbital angular momentum and hydr…	MCQ	1	**C**
Q15	Nuclear and Particle Phy…	Particle Physics	MCQ	1	**D**
Q16	Quantum Mechanics	Spin and Total Angular momentum	MCQ	1	**B**
Q17	Classical Mechanics	Special theory of relativity	MCQ	1	**A**
Q18	Electromagnetism	Magnetism	MCQ	1	**B**
Q19	Mathematical Physics	Differential Equations	MCQ	1	**B**
Q20	Quantum Mechanics	Quantum Statistical Mechanics	MCQ	1	**C**
Q21	Statistical Mechanics	Microcanonical ensemble	MCQ	1	**A**
Q22	Statistical Mechanics	Quantum Statistical Mechanics	MCQ	1	**A**
Q23	Mathematical Physics	Complex Analysis	MCQ	1	**C**
Q24	Mathematical Physics	Gamma, Beta and Delta function	NAT	1	**1.3**
Q25	Electronics	Logic Gates	MCQ	1	**D**
Q26	Mathematical Physics	Complex Analysis	MCQ	1	**B**
Q27	Electronics	fet	NAT	1	**15**
Q28	Electromagnetism	Image Problem	NAT	1	**11**
Q29	Atomic and Molecular Ph…	Xray spectra	NAT	1	**1844.3 to 1844.5**
Q30	Solid State Physics	Crystallography	NAT	1	**0.445 to 0.450**
Q31	Solid State Physics	Hall Effect	MCQ	1	**C**
Q32	Electromagnetism	Electric field in matter	MCQ	1	**C**
Q33	Statistical Mechanics	Quantum Statistical Mechanics	NAT	1	**0**
Q34	Solid State Physics	Lattice vibration	NAT	1	**1**
Q35	Classical Mechanics	Central Forces	MCQ	1	**D**
Q36	Statistical Mechanics	Microstates	NAT	2	**5**

Answer Key

65 questions · Subject & topic for quick revision · Official keys (IIT/IISc)

Q.No	Subject	Topic	Type	Marks	Answer
Q37	Atomic and Molecular Ph…	Molecular Physics	NAT	2	**18513 to 18519**
Q38	Solid State Physics	Lattice vibration	NAT	2	**1.745 to 1.751**
Q39	Solid State Physics	Free electron model	NAT	2	**5.9 to 6.0**
Q40	Solid State Physics	Semiconductor Physics	NAT	2	**0.394 to 0.395**
Q41	Atomic and Molecular Ph…	Effects in atomic physics	NAT	2	**6**
Q42	Solid State Physics	Superconductivity	MCQ	2	**B**
Q43	Electromagnetism	Electrostatics	MCQ	2	**A**
Q44	Electronics	OPAMP	MCQ	2	**B**
Q45	Electromagnetism	Electrodynamics	MCQ	2	**D**
Q46	Electronics	Transistors	NAT	2	**5.74 to 5.75**
Q47	Atomic and Molecular Ph…	ESR/EPR/NMR	MCQ	2	**D**
Q48	Classical Mechanics	Coriolis Force	MCQ	2	**C**
Q49	Atomic and Molecular Ph…	Molecular Physics	NAT	2	**10**
Q50	Optics	Polarization	MCQ	2	**B**
Q51	Classical Mechanics	Lagrangian and Hamiltonian	MCQ	2	**B**
Q52	Classical Mechanics	Lagrangian and Hamiltonian	MCQ	2	**C**
Q53	Classical Mechanics	Basic Mechanics	NAT	2	**4.93 to 4.98**
Q54	Nuclear and Particle Phy…	Shell Model	MCQ	2	**A**
Q55	Quantum Mechanics	Perturbation Theory	MCQ	2	**D**
Q56	Quantum Mechanics	Basics Quantum Mechanics	NAT	2	**0**
Q57	Classical Mechanics	Special theory of relativity	MCQ	2	**B**
Q58	Electronics	OPAMP	MCQ	2	**C**
Q59	Mathematical Physics	Differential Equations	MCQ	2	**C**
Q60	Statistical Mechanics	Microcanonical ensemble	MCQ	2	**A**
Q61	Quantum Mechanics	Spin and Total Angular momentum	NAT	2	**-0.3**
Q62	Statistical Mechanics	Canonical ensemble	MCQ	2	**A**
Q63	Optics	Interference and Diffraction	NAT	2	**1.2**
Q64	Mathematical Physics	Fourier and Laplace transform	MCQ	2	**A**
Q65	Nuclear and Particle Phy…	Radioactivity	NAT	2	**2.830 to 2.835**