PhysicsByAaryan

CSIR NET · GATE · JEST · BARC – Physics

GATE Physics 2014 — Full Question Paper

Previous Year Questions with Official Answer Key

Inside this PDF

- Every GATE Physics (PH) 2014 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 2014	MCQ	1M

A student is required to demonstrate a high level of comprehension of the subject, especially in the social sciences.

The word closest in meaning to comprehension is

(A) understanding

(B) meaning

(C) concentration

(D) stability

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

GATE 2014	MCQ	1M

Choose the most appropriate word from the options given below to complete the following sentence.

One of his biggest ___ was his ability to forgive.

(A) vice

(B) virtues

(C) choices

(D) strength

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

GATE 2014	MCQ	1M

Rajan was not happy that Sajan decided to do the project on his own. On observing his unhappiness, Sajan explained to Rajan that he preferred to work independently.

Which one of the statements below is logically valid and can be inferred from the above sentences?

(A) Rajan has decided to work only in a group.

(B) Rajan and Sajan were formed into a group against their wishes.

(C) Sajan had decided to give in to Rajan's request to work with him.

(D) Rajan had believed that Sajan and he would be working together.

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

GATE 2014	MCQ	1M

If $y = 5x^2 + 3$, then the tangent at $x = 0, y = 3$

(A) passes through $x = 0, y = 0$

(B) has a slope of +1

(C) is parallel to the x-axis

(D) has a slope of -1

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

GATE 2014	NAT	1M

A foundry has a fixed daily cost of Rs 50,000 whenever it operates and a variable cost of Rs 800 Q , where Q is the daily production in tonnes. What is the cost of production in Rs per tonne for a daily production of 100 tonnes?

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

GATE 2014	MCQ	2M

Find the odd one in the following group: ALRVX, EPVZB, ITZDF, OYEIK

(A) ALRVX

(B) EPVZB

(C) ITZDF

(D) OYEIK

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

GATE 2014	MCQ	2M

Anuj, Bhola, Chandan, Dilip, Eswar and Faisal live on different floors in a six-storey building (the ground floor is numbered 1 , the floor above it 2 , and so on). Anuj lives on an even-numbered floor. Bhola does not live on an odd numbered floor. Chandan does not live on any of the floors below Faisal's floor. Dilip does not live on floor number 2. Eswar does not live on a floor immediately above or immediately below Bhola. Faisal lives three floors above Dilip. Which of the following floor-person combinations is correct?

	Anuj	Bhola	Chandan	Dilip	Eswar	Faisal
(A)	6	2	5	1	3	4
(B)	2	6	5	1	3	4
(C)	4	2	6	3	1	5
(D)	2	4	6	1	3	5

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

GATE 2014	NAT	2M

The smallest angle of a triangle is equal to two thirds of the smallest angle of a quadrilateral. The ratio between the angles of the quadrilateral is $3:4:5:6$. The largest angle of the triangle is twice its smallest angle. What is the sum, in degrees, of the second largest angle of the triangle and the largest angle of the quadrilateral?

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

GATE 2014	MCQ	2M

One percent of the people of country are taller than 6 ft . Two percent of the people of country are taller than 6 ft . There are thrice as many people in country X as in country Y . Taking both countries together, what is the percentage of people taller than 6 ft ?

(A) 3.0

(B) 2.5

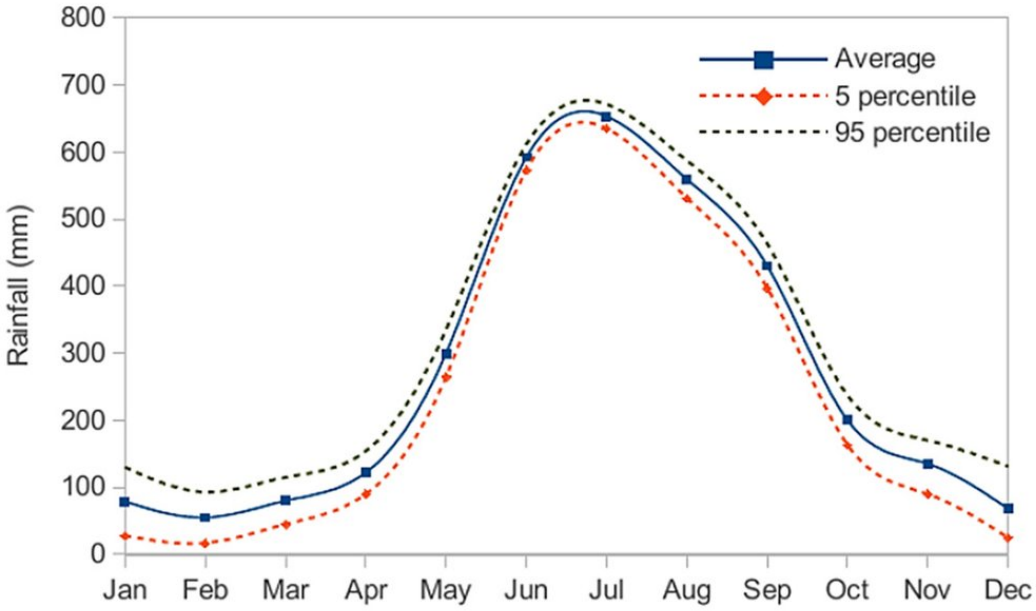
(C) 1.5

(D) 1.25

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

GATE 2014	MCQ	2M

The monthly rainfall chart based on 50 years of rainfall in Agra is shown in the following figure. Which of the following are true? (k percentile is the value such that k percent of the data fall below that value)



(i) On average, it rains more in July than in December
(ii) Every year, the amount of rainfall in August is more than that in January
(iii) July rainfall can be estimated with better confidence than February rainfall
(iv) In August, there is at least 500 mm of rainfall
(A) (i) and (ii)
(B) (i) and (iii)
(C) (ii) and (iii)
(D) (iii) and (iv)

Q11. [Marks: 1 | MCQ] Mathematical Physics · Vector Analysis

GATE 2014	MCQ	1M

The unit vector perpendicular to the surface $x^2 + y^2 + z^2 = 3$ at the point $(1,1,1)$ is

(A) $\frac{\hat{x}+\hat{y}-\hat{z}}{\sqrt{3}}$

(B) $\frac{\hat{x}-\hat{y}-\hat{z}}{\sqrt{3}}$

(C) $\frac{\hat{x}-\hat{y}+\hat{z}}{\sqrt{3}}$

(D) $\frac{\hat{x}+\hat{y}+\hat{z}}{\sqrt{3}}$

Q12. [Marks: 1 | MCQ] Electromagnetism · Relativistic EMT

GATE 2014	MCQ	1M

Which one of the following quantities is invariant under Lorentz transformation?

(A) Charge density

(B) Charge

(C) Current

(D) Electric field

Q13. [Marks: 1 | MCQ] Atomic and Molecular Physics · Effects in atomic physics

GATE 2014	MCQ	1M

The number of normal Zeeman splitting components of $^1P \rightarrow {}^1D$ transition is

(A) 3

(B) 4

(C) 8

(D) 9

Q14. [Marks: 1 | NAT] Classical Mechanics · Special theory of relativity

GATE 2014	NAT	1M

If the half-life of an elementary particle moving with speed $0.9c$ in the laboratory frame is $5 \times 10^{-8}s$, then the proper half-life is ___ $\times 10^{-8}s$. $\left(c = 3 \times 10^8 \text{ m/s}\right)$

Q15. [Marks: 1 | MCQ] Optics · Polarization

GATE 2014	MCQ	1M

An unpolarized light wave is incident from air on a glass surface at the Brewster angle. The angle between the reflected and the refracted wave is

(A) 0^0

(B) $45°$

(C) $90°$

(D) $120°$

Q16. [Marks: 1 | NAT] Classical Mechanics · Small Oscillations

GATE 2014	NAT	1M

Two masses m and $3m$ are attached to the two ends of a massless spring with force constant K. If $m = 100g$ and $K = 0.3\ \mathrm{N/m}$, then the natural angular frequency of oscillation is ___ Hz .

Q17. [Marks: 1 | NAT] Electromagnetism · EM Waves

GATE 2014	NAT	1M

The electric field of a uniform plane wave propagating in a dielectric, non-conducting medium is given by,

$$\vec{E} = \hat{x}10\cos\left(6\pi \times 10^7 t - 0.4\pi z\right)\mathrm{V/m}.$$

The phase velocity of the wave is ___ $\times 10^8\ \mathrm{m/s}$.

Q18. [Marks: 1 | MCQ] Mathematical Physics · Matrices

GATE 2014	MCQ	1M

The matrix

$A = \frac{1}{\sqrt{3}}\begin{bmatrix} 1 & 1+i \\ 1-i & -1 \end{bmatrix}$ is

(A) orthogonal

(B) symmetric

(C) anti-symmetric

(D) unitary

Q19. [Marks: 1 | MCQ] Quantum Mechanics · Basics Quantum Mechanics

GATE 2014	MCQ	1M

The recoil momentum of an atom is p_A when it emits an infrared photon of wavelength $1500nm$, and it is p_B when it emits a photon of visible wavelength $500nm$. The ratio $\frac{p_A}{p_B}$ is

(A) $1:1$

(B) $1:\sqrt{3}$

(C) $1:3$

(D) $3:2$

Q20. [Marks: 1 | MCQ] Thermodynamics · Laws of thermodynamics

GATE 2014	MCQ	1M

For a gas under isothermal conditions, its pressure P varies with volume V as $P \propto V^{-5/3}$. The bulk modulus B is proportional to

(A) $V^{-1/2}$

(B) $V^{-2/3}$

(C) $V^{-3/5}$

(D) $V^{-5/3}$

Q21. [Marks: 1 | MCQ] Nuclear and Particle Physics · Particle Physics

GATE 2014	MCQ	1M

Which one of the following high energy processes is allowed by conservation laws?

(A) $p + \bar{p} \rightarrow \Lambda^0 + \Lambda^0$

(B) $\pi^- + p \rightarrow \pi^0 + n$

(C) $n \rightarrow p + e^- + v_e$

(D) $\mu^+ \rightarrow e^+ + \gamma$

Q22. [Marks: 1 | MCQ] Mathematical Physics · Tensors

GATE 2014	MCQ	1M

The length element ds of an arc is given by,

$(ds)^2 = 2(dx^1)^2 + (dx^2)^2 + \sqrt{3}dx^1dx^2$. The metric tensor g_{ij} is

(A) $\begin{pmatrix} 2 & \sqrt{3} \\ \sqrt{3} & 1 \end{pmatrix}$

(B) $\begin{pmatrix} 2 & \sqrt{\frac{3}{2}} \\ \sqrt{\frac{3}{2}} & 1 \end{pmatrix}$

(C) $\begin{pmatrix} 2 & 1 \\ \sqrt{\frac{3}{2}} & \sqrt{\frac{3}{2}} \end{pmatrix}$

(D) $\begin{pmatrix} 1 & \sqrt{\frac{3}{2}} \\ \sqrt{\frac{3}{2}} & 2 \end{pmatrix}$

Q23. [Marks: 1 | MCQ] Quantum Mechanics · Spin and Total Angular momentum

GATE 2014	MCQ	1M

The ground state and the first excited state wave functions of a one dimensional infinite potential well are ψ_1 and ψ_2, respectively. When two spin-up electrons are placed in this potential, which one of the following, with x_1 and x_2 denoting the position of the two electrons, correctly represents the space part of the ground state wave function of the system?

(A) $\frac{1}{\sqrt{2}}[\psi_1(x_1)\psi_2(x_1) - \psi_1(x_2)\psi_2(x_2)]$

(B) $\frac{1}{\sqrt{2}}[\psi_1(x_1)\psi_2(x_2) + \psi_1(x_2)\psi_2(x_1)]$

(C) $\frac{1}{\sqrt{2}}[\psi_1(x_1)\psi_2(x_1) + \psi_1(x_2)\psi_2(x_2)]$

(D) $\frac{1}{\sqrt{2}}[\psi_1(x_1)\psi_2(x_2) - \psi_1(x_2)\psi_2(x_1)]$

Q24. [Marks: 1 | NAT] Electromagnetism · Potential formulation

GATE 2014	NAT	1M

If the vector potential

$$\vec{A} = \alpha x\hat{x} + 2y\hat{y} - 3z\hat{z},$$

satisfies the Coulomb gauge, the value of the constant α is ____.

Q25. [Marks: 1 | NAT] Thermodynamics · Kinetic theory of gases

GATE 2014	NAT	1M

At a given temperature, T, the average energy per particle of a non-interacting gas of two-dimensional classical harmonic oscillators is ___ k_BT
(k_B is the Boltzmann constant).

Q26. [Marks: 1 | MCQ] Statistical Mechanics · Quantum Statistical Mechanics

GATE 2014	MCQ	1M

Which one of the following is a fermion?
(A) α particle
(B) ${}_4Be^7$ nucleus
(C) Hydrogen atom
(D) Deuteron

Q27. [Marks: 1 | MCQ] Nuclear and Particle Physics · Particle Physics

GATE 2014	MCQ	1M

Which one of the following three-quark states (qqq), denoted by X, CANNOT be a possible baryon? The corresponding electric charge is indicated in the superscript.

(A) X^{++}

(B) X^{+}

(C) X^{-}

(D) X^{--}

Q28. [Marks: 1 | MCQ] Classical Mechanics · Canonical Transformation and Poisson bracket

GATE 2014	MCQ	1M

The Hamilton's canonical equations of motion in terms of Poisson Brackets are

(A) $\dot{q} = \{q, H\}; \dot{p} = \{p, H\}$

(B) $\dot{q} = \{H, q\}; \dot{p} = \{H, p\}$

(C) $\dot{q} = \{H, p\}; \dot{p} = \{H, q\}$

(D) $\dot{q} = \{p, H\}; \dot{p} = \{q, H\}$

Q29. [Marks: 1 | MCQ] Solid State Physics · Crystallography

GATE 2014	MCQ	1M

The Miller indices of a plane passing through the three points having coordinates $(0,0,1)$, $(1,0,0)$, $\left(\frac{1}{2},\frac{1}{2},\frac{1}{4}\right)$ are

(A) (212)

(B) (111)

(C) (121)

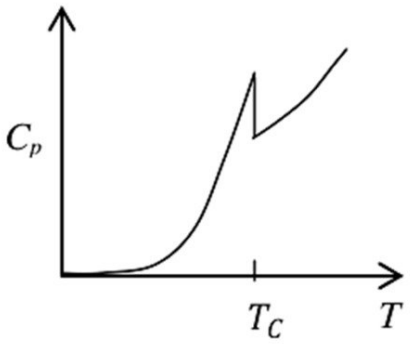
(D) (211)

Q30. [Marks: 1 | MCQ] Solid State Physics · Superconductivity

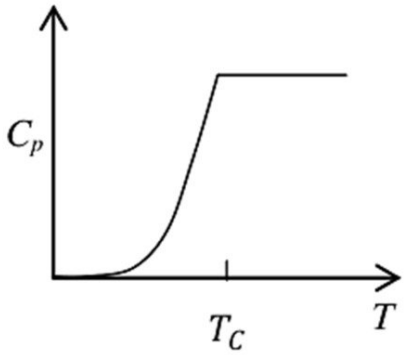
GATE 2014	MCQ	1M

The plot of specific heat versus temperature across the superconducting transition temperature (T_C) is most appropriately represented by

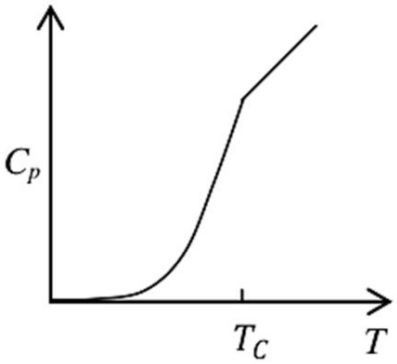
(A)



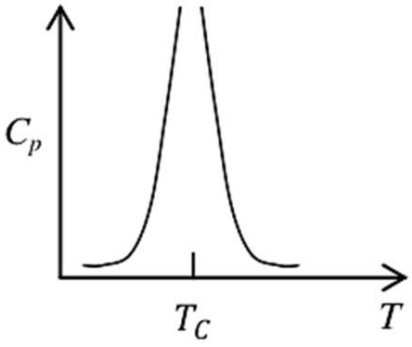
(B)



(C)



(D)



Q31. [Marks: 1 | MCQ] Quantum Mechanics · Spin and Total Angular momentum

GATE 2014	MCQ	1M

If $\vec{L}$ is the orbital angular momentum and $\vec{S}$ is the spin angular momentum, then $\vec{L}.\vec{S}$ does NOT commute with

(A) S_z

(B) L^2

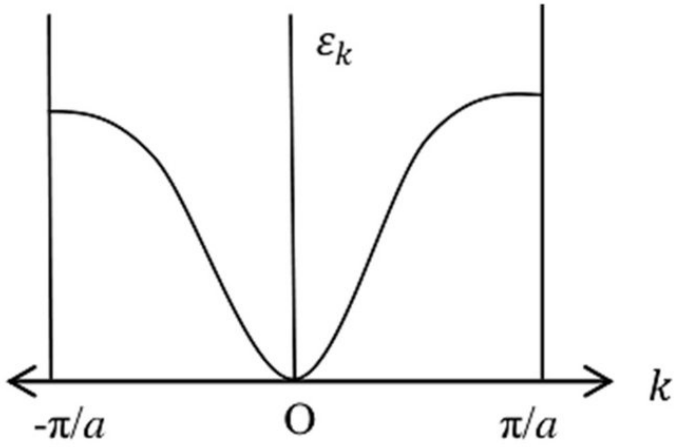
(C) S^2

(D) $(\vec{L}+\vec{S})^2$

Q32. [Marks: 1 | MCQ] Solid State Physics · Tight binding model

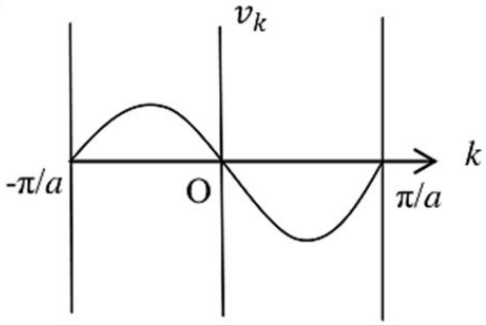
GATE 2014	MCQ	1M

The energy, ε_k for band electrons as a function of the wave vector, k in the first Brillouin zone $(-\pi/a \leq k \leq \pi/a)$ of a one dimensional monatomic lattice is shown as (a is lattice constant)

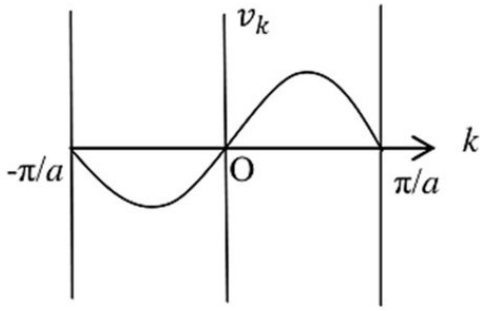


The variation of the group velocity v_k is most appropriately represented by

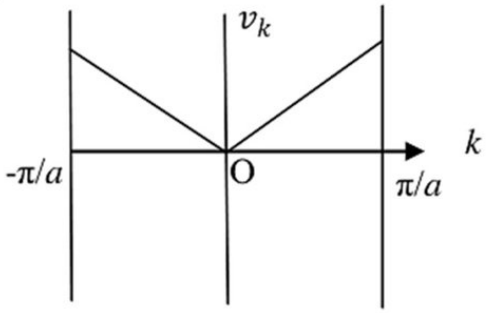
(A)



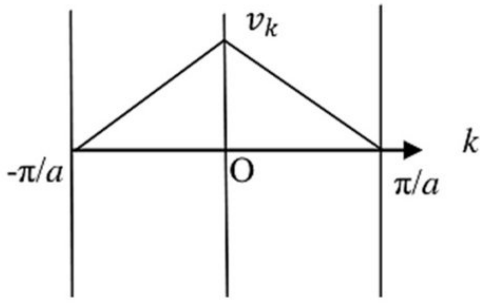
(B)



(C)



(D)

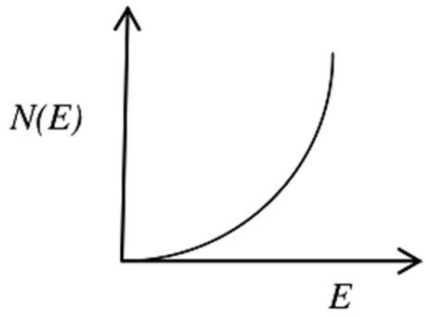


Q33. [Marks: 1 | MCQ] Solid State Physics · Free electron model

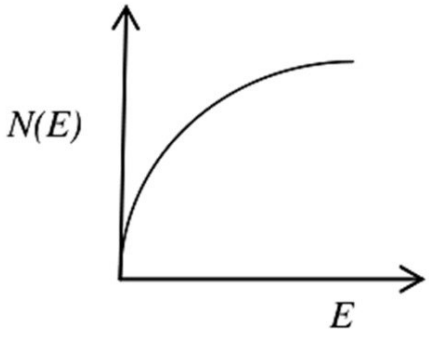
GATE 2014	MCQ	1M

For a free electron gas in two dimensions, the variation of the density of states, N(E) as a function of energy E, is best represented by

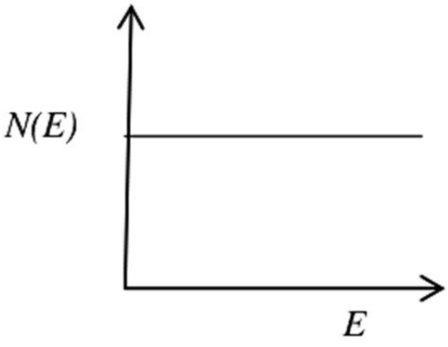
(A)



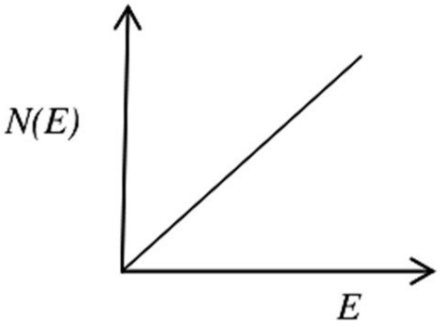
(B)



(C)



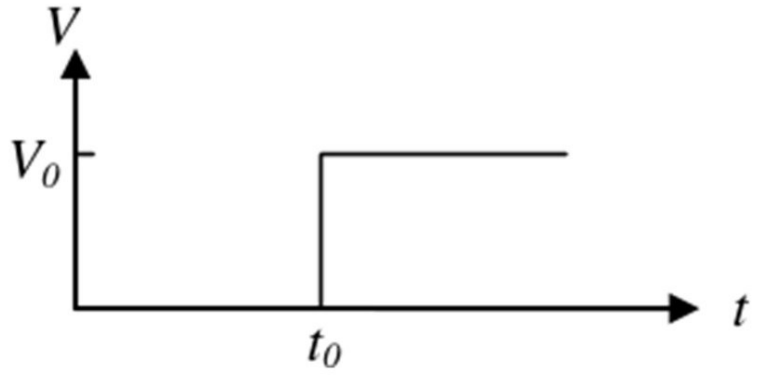
(D)



Q34. [Marks: 1 | MCQ] Electronics · OPAMP

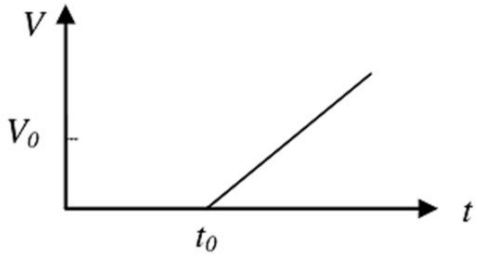
GATE 2014	MCQ	1M

The input given to an ideal OP-AMP integrator circuit is

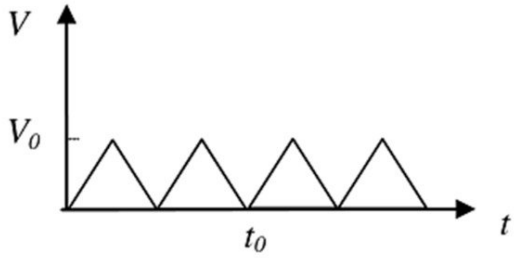


The correct output of the integrator circuit is

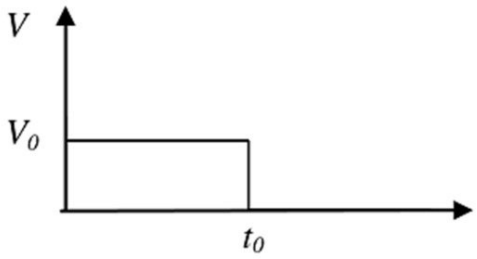
(A)



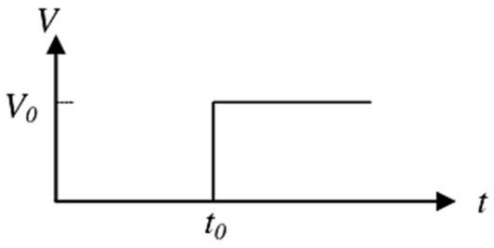
(B)



(C)



(D)



Q35. [Marks: 1 | NAT] Electronics · Flip flops

GATE 2014	NAT	1M

The minimum number of flip-flops required to construct a mod-75 counter is____ .

Q36. [Marks: 2 | MCQ] Classical Mechanics · Lagrangian and Hamiltonian

GATE 2014	MCQ	2M

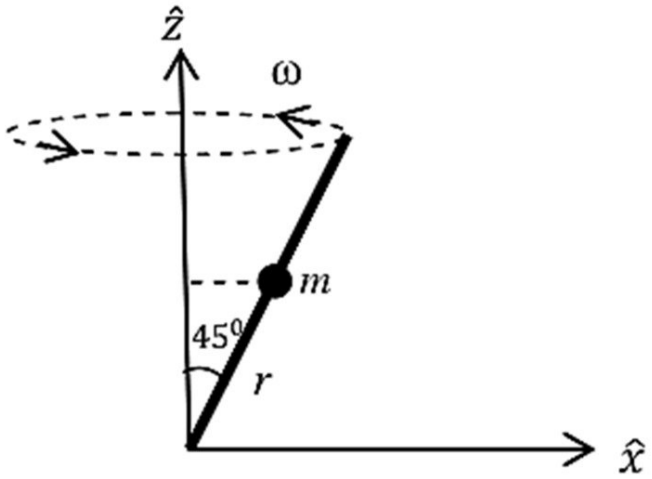
A bead of mass m can slide without friction along a massless rod kept at 45^0 with the vertical as shown in the figure. The rod is rotating about the vertical axis with a constant angular speed ω. At any instant, r is the distance of the bead from the origin. The momentum conjugate to r is

(A) $m\dot{r}$

(B) $\frac{1}{\sqrt{2}}m\dot{r}$

(C) $\frac{1}{2}m\dot{r}$

(D) $\sqrt{2}m\dot{r}$



Q37. [Marks: 2 | MCQ] Quantum Mechanics · Orbital angular momentum and hydrogen atom

GATE 2014	MCQ	2M

An electron in the ground state of the hydrogen atom has the wave function

$$\Psi(\vec{r}) = \frac{1}{\sqrt{\pi a_0^3}} e^{-(r/a_0)}$$

where a_0 is constant. The expectation value of the operator $\hat{Q} = z^2 - r^2$, where $z = r\cos\theta$ is (Hint: $\int_0^\infty e^{-\alpha r} r^n dr = \frac{\Gamma(n)}{\alpha^{n+1}} = \frac{(n-1)!}{\alpha^{n+1}}$)

(A) $-a_0^2/2$

(B) $-a_0^2$

(C) $-3a_0^2/2$

(D) $-2a_0^2$

Q38. [Marks: 2 | NAT] Solid State Physics · Magnetic properties of solids

GATE 2014	NAT	2M

For Nickel, the number density is 8×10^{23} atoms/cm^3 and electronic configuration is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$. The value of the saturation magnetization of Nickel in its ferromagnetic state is ___ $\times 10^9$ A/m.
(Given the value of Bohr magneton $\mu_B = 9.21 \times 10^{-21} \mathrm{Am}^2$)

Q39. [Marks: 2 | MCQ] Classical Mechanics · Small Oscillations

GATE 2014	MCQ	2M

A particle of mass m is in a potential given by

$$V(r) = -\frac{a}{r} + \frac{ar_0^2}{3r^3},$$

where a and r_0 are positive constants. When disturbed slightly from its stable equilibrium position, it undergoes a simple harmonic oscillation. The time period of oscillation is

(A) $2\pi\sqrt{\frac{mr_0^3}{2a}}$

(B) $2\pi\sqrt{\frac{mr_0^3}{a}}$

(C) $2\pi\sqrt{\frac{2mr_0^3}{a}}$

(D) $4\pi\sqrt{\frac{mr_0^3}{a}}$

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

GATE 2014	NAT	2M

The donor concentration in a sample of n-type silicon is increased by a factor of 100 . The shift in the position of the Fermi level at 300 K , assuming the sample to be non degenerate is ___ meV.

$$(k_B T = 25\text{meV at } 300\text{ K})$$

Q41. [Marks: 2 | NAT] Quantum Mechanics · Quantum Harmonic Oscillator

GATE 2014	NAT	2M

A particle of mass m is subjected to a potential,

$$V(x,y) = \frac{1}{2}m\omega^2\left(x^2 + y^2\right), -\infty \leq x \leq \infty, -\infty \leq y \leq \infty$$

The state with energy $4\hbar\omega$ is g-fold degenerate. The value of g is ____.

Q42. [Marks: 2 | NAT] Quantum Mechanics · Orbital angular momentum and hydrogen atom

GATE 2014	NAT	2M

A hydrogen atom is in the state

$$\Psi = \sqrt{\frac{8}{21}}\psi_{200} - \sqrt{\frac{3}{7}}\psi_{310} + \sqrt{\frac{4}{21}}\psi_{321},$$

where n, l, m in ψ_{nlm} denote the principal, orbital and magnetic quantum numbers, respectively. If $\vec{L}$ is the angular momentum operator, the average value of L^2 is ___ $\hbar^2$.

Q43. [Marks: 2 | MCQ] Classical Mechanics · Central Forces

GATE 2014	MCQ	2M

A planet of mass m moves in a circular orbit of radius r_0 in the gravitational potential $V(r) = -\frac{k}{r}$, where k is a positive constant. The orbital angular momentum of the planet is

(A) $2r_0km$

(B) $\sqrt{2r_0km}$

(C) r_0 km

(D) $\sqrt{r_0km}$

Q44. [Marks: 2 | MCQ] Atomic and Molecular Physics · Molecular Physics

GATE 2014	MCQ	2M

The moment of inertia of a rigid diatomic molecule A is 6 times that of another rigid diatomic molecule B. If the rotational energies of the two molecules are equal, then the corresponding values of the rotational quantum numbers J_A and J_B are

(A) $J_A = 2, J_B = 1$

(B) $J_A = 3, J_B = 1$

(C) $J_A = 5, J_B = 0$

(D) $J_A = 6, J_B = 1$

Q45. [Marks: 2 | MCQ] Mathematical Physics · Complex Analysis

GATE 2014	MCQ	2M

The value of the integral

$$\oint_C \frac{z^2}{e^z + 1} dz$$

where C is the circle $|z| = 4$, is

(A) $2\pi i$

(B) $2\pi^2 i$

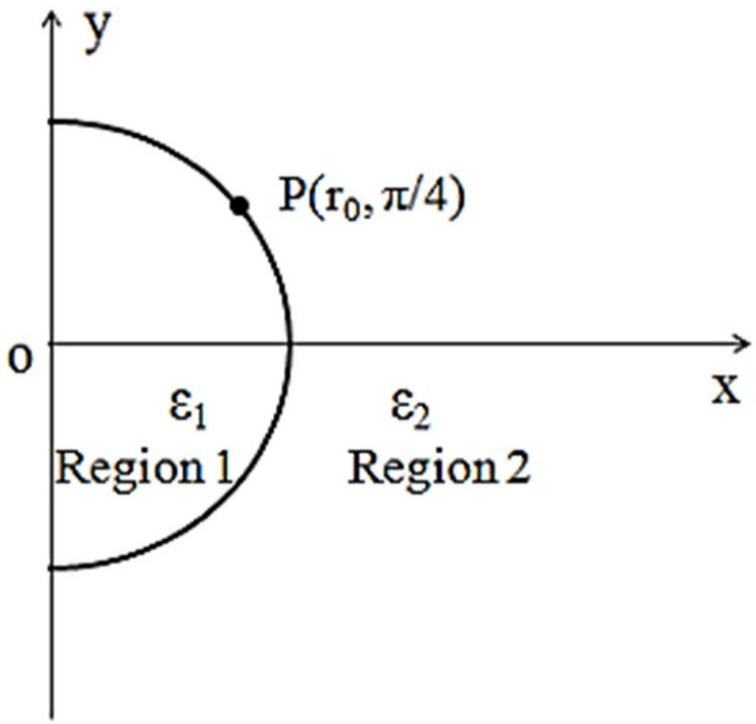
(C) $4\pi^3 i$

(D) $4\pi^2 i$

Q46. [Marks: 2 | NAT] Electromagnetism · Electric field in matter

GATE 2014	NAT	2M

A ray of light inside Region 1 in the xy-plane is incident at the semicircular boundary that carries no free charges. The electric field at the point $P(r_0, \pi/4)$ in plane polar coordinates is $\vec{E}_1 = 7\hat{e}_r - 3\hat{e}_\varphi$, where $\hat{e}_r$ and $\hat{e}_\varphi$ are the unit vectors. The emerging ray in Region 2 has the electric field $\vec{E}_2$ parallel to x - axis. If ε_1 and ε_2 are the dielectric constants of Region 1 and Region 2 respectively, then $\frac{\varepsilon_2}{\varepsilon_1}$ is ____.



Q47. [Marks: 2 | MCQ] Mathematical Physics · Differential Equations

GATE 2014	MCQ	2M

The solution of the differential equation

$$\frac{d^2y}{dt^2} - y = 0,$$

subject to the boundary conditions $y(0) = 1$ and $y(\infty) = 0$, is

(A) $\cos t + \sin t$

(B) $\cosh t + \sinh t$

(C) $\cos t - \sin t$

(D) $\cosh t - \sinh t$

Q48. [Marks: 2 | NAT] Classical Mechanics · Canonical Transformation and Poisson bracket

GATE 2014	NAT	2M

Given that the linear transformation of a generalized coordinate q and the corresponding momentum p,

$$Q = q + 4ap$$
$$P = q + 2p$$

is canonical, the value of the constant a is ___.

Q49. [Marks: 2 | NAT] Electromagnetism · Magnetism

GATE 2014	NAT	2M

The value of the magnetic field required to maintain non-relativistic protons of energy 1 MeV in a circular orbit of radius 100 mm is ___ Tesla.
(Given: $m_p = 1.67 \times 10^{-27}$ kg, $e = 1.6 \times 10^{-19}$C)

Q50. [Marks: 2 | MCQ] Statistical Mechanics · Canonical ensemble

GATE 2014	MCQ	2M

For a system of two bosons, each of which can occupy any of the two energy levels 0 and ε, the mean energy of the system at a temperature T with $\beta = \frac{1}{k_B T}$ is given by

(A) $\frac{\varepsilon e^{-\beta\varepsilon} + 2\varepsilon e^{-2\beta\varepsilon}}{1 + 2e^{-\beta\varepsilon} + e^{-2\beta\varepsilon}}$

(B) $\frac{1 + \varepsilon e^{-\beta\varepsilon}}{2e^{-\beta\varepsilon} + e^{-2\beta\varepsilon}}$

(C) $\frac{2\varepsilon e^{-\beta\varepsilon} + \varepsilon e^{-2\beta\varepsilon}}{2 + e^{-\beta\varepsilon} + e^{-2\beta\varepsilon}}$

(D) $\frac{\varepsilon e^{-\beta\varepsilon} + 2\varepsilon e^{-2\beta\varepsilon}}{2 + e^{-\beta\varepsilon} + e^{-2\beta\varepsilon}}$

Q51. [Marks: 2 | MCQ] Optics · Interference and Diffraction

GATE 2014	MCQ	2M

In an interference pattern formed by two coherent sources, the maximum and the minimum of the intensities are $9I_0$ and I_0, respectively. The intensities of the individual waves are

(A) $3I_0$ and I_0

(B) $4I_0$ and I_0

(C) $5I_0$ and $4I_0$

(D) $9I_0$ and I_0

Q52. [Marks: 2 | NAT] Quantum Mechanics · Spin and Total Angular momentum

GATE 2014	NAT	2M

ψ_1 and ψ_2 are two orthogonal states of a spin $\frac{1}{2}$ system. It is given that

$$\psi_1 = \frac{1}{\sqrt{3}}\begin{pmatrix}1\\0\end{pmatrix} + \sqrt{\frac{2}{3}}\begin{pmatrix}0\\1\end{pmatrix},$$

where $\begin{pmatrix}1\\0\end{pmatrix}$ and $\begin{pmatrix}0\\1\end{pmatrix}$ represent the spin-up and spin-down states, respectively. When the system is in the state ψ_2, its probability to be in the spin-up state is ___.

Q53. [Marks: 2 | NAT] Solid State Physics · Xray diffraction

GATE 2014	NAT	2M

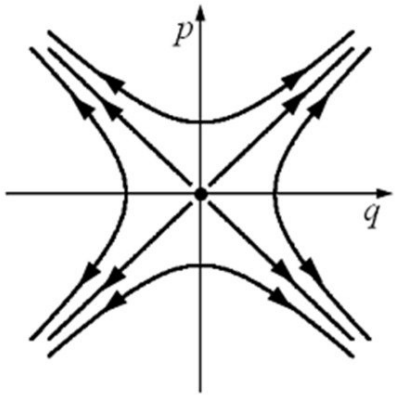
Neutrons moving with speed 10^3 m/s are used for the determination of crystal structure. If the Bragg angle for the first order diffraction is 30^0, the interplanar spacing of the crystal is ___ Å.
(Given: $m_n = 1.675 \times 10^{-27}$ kg, $h = 6.626 \times 10^{-34}$ J. s)

Q54. [Marks: 2 | MCQ] Classical Mechanics · Phase diagram

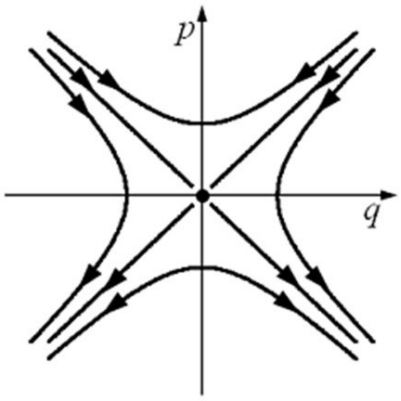
GATE 2014	MCQ	2M

The Hamiltonian of a particle of mass m is given by $H = \frac{p^2}{2m} - \frac{\alpha q^2}{2}$. Which one of the following figures describes the motion of the particle in phase space?

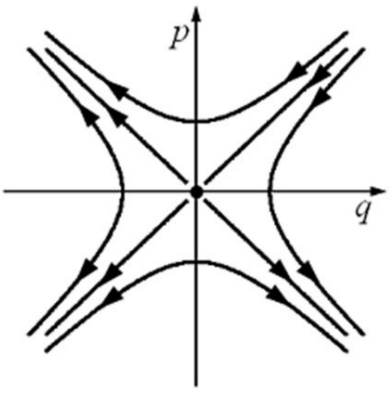
(A)



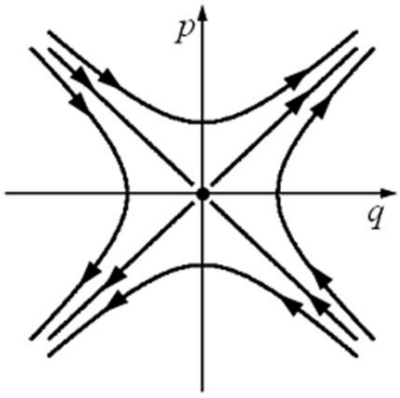
(B)



(C)



(D)



Q55. [Marks: 2 | NAT] Electromagnetism · EM Waves

GATE 2014	NAT	2M

The intensity of a laser in free space is $150\ \mathrm{mW/m^2}$. The corresponding amplitude of the electric field of the laser is ___ V/m.

$$\left(\varepsilon_0 = 8.854 \times 10^{-12} C^2/N.m^2\right)$$

Q56. [Marks: 2 | MCQ] Atomic and Molecular Physics · Lasers

GATE 2014	MCQ	2M

The emission wavelength for the transition $^1D_2 \rightarrow {}^1F_3$ is 3122Å. The ratio of populations of the final to the initial states at a temperature 5000 K is

$\left(h = 6.626 \times 10^{-34}\ \mathrm{J.s}, c = 3 \times 10^8\ \mathrm{m/s},\right.$
$\left.k_B = 1.380 \times 10^{-23}\ \mathrm{J/K}\right)$

(A) 2.03×10^{-5}

(B) 4.02×10^{-5}

(C) 7.02×10^{-5}

(D) 9.83×10^{-5}

Q57. [Marks: 2 | MCQ] Statistical Mechanics · Microstates

GATE 2014	MCQ	2M

Consider a system of 3 fermions, which can occupy any of the 4 available energy states with equal probability. The entropy of the system is

(A) $k_B \ln 2$

(B) $2k_B \ln 2$

(C) $2k_B \ln 4$

(D) $3k_B \ln 4$

Q58. [Marks: 2 | MCQ] Quantum Mechanics · Perturbation Theory

GATE 2014	MCQ	2M

A particle is confined to a one dimensional potential box with the potential

$$V(x) = 0, 0 < x < a$$
$$= \infty, \text{ otherwise}$$

If the particle is subjected to a perturbation, within the box, $W = \beta x$, where β is a small constant, the first order correction to the ground state energy is

(A) 0

(B) $a\beta/4$

(C) $a\beta/2$

(D) $a\beta$

Q59. [Marks: 2 | NAT] Nuclear and Particle Physics · Radioactivity

GATE 2014	NAT	2M

Consider the process $\mu^+ + \mu^- \rightarrow \pi^+ + \pi^-$. The minimum kinetic energy of the muons (μ) in the centre of mass frame required to produce the pion (π) pairs at rest is ___ MeV .

(Given: $m_\mu = 105\text{MeV/c}^2, m_\pi = 140\text{MeV/c}^2$).

Q60. [Marks: 2 | NAT] Quantum Mechanics · Quantum Harmonic Oscillator

GATE 2014	NAT	2M

A one dimensional harmonic oscillator is in the superposition of number states, $|n\rangle$, given by

$$|\psi\rangle = \frac{1}{2}|2\rangle + \frac{\sqrt{3}}{2}|3\rangle.$$

The average energy of the oscillator in the given state is ____ $\hbar\omega$.

Q61. [Marks: 2 | MCQ] Nuclear and Particle Physics · Radioactivity

GATE 2014	MCQ	2M

A nucleus X undergoes a first forbidden β-decay to a nucleus Y. If the angular momentum (I) and parity (P), denoted by I^P as $\frac{7^-}{2}$ for X, which of the following is a possible I^P value for Y ?

(A) $\frac{1^+}{2}$

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

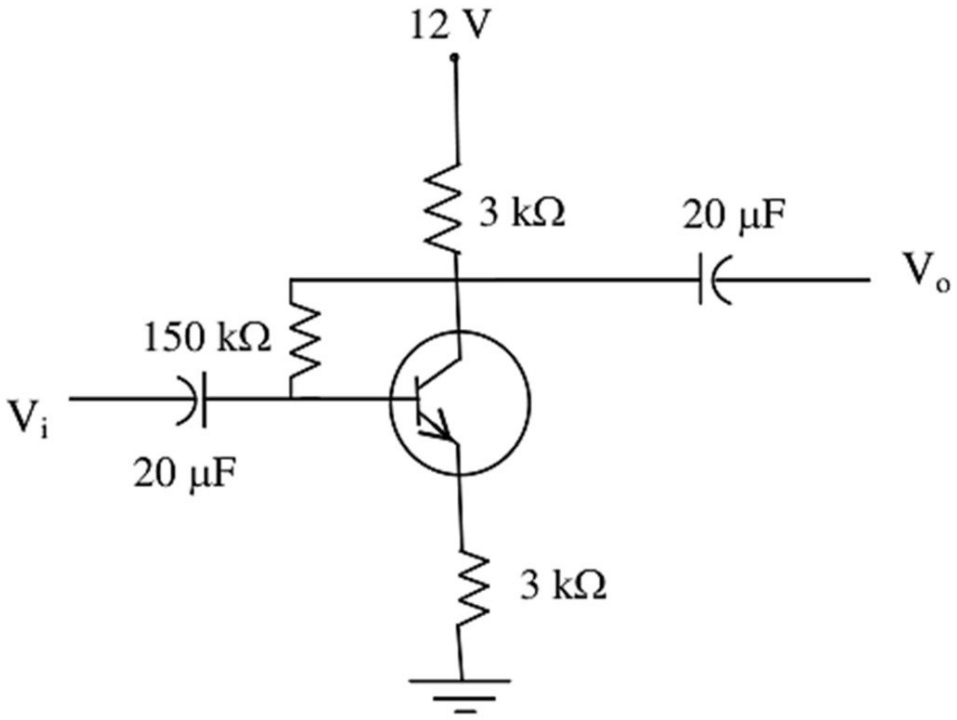
(C) $\frac{3^+}{2}$

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

Q62. [Marks: 2 | NAT] Electronics · Transistors

GATE 2014	NAT	2M

The current gain of the transistor in the following circuit is $\beta_{dc} = 100$. The value of collector current I_c is ___ mA.



Q63. [Marks: 2 | NAT] Electronics · AD/DA coversion

GATE 2014	NAT	2M

In order to measure a maximum of $1V$ with a resolution of $1mV$ using a n-bit A/D converter, working under the principle of ladder network, the minimum value of n is ___ .

Q64. [Marks: 2 | NAT] Quantum Mechanics · Orbital angular momentum and hydrogen atom

GATE 2014	NAT	2M

If L_+ and L_- are the angular momentum ladder operators, then, the expectation value of $(L_+L_- + L_-L_+)$, in the state $|l = 1, m = 1\rangle$ of an atom is ___ $\hbar^2$.

Q65. [Marks: 2 | MCQ] Electronics · Filters

GATE 2014	MCQ	2M

A low pass filter is formed by a resistance R and a capacitance C. At the cut-off angular frequency $\omega_c = \frac{1}{RC}$, the voltage gain and the phase of the output voltage relative to the input voltage respectively, are

(A) 0.71 and $45°$

(B) 0.71 and $-45°$

(C) 0.5 and $-90°$

(D) 0.5 and $90°$

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	**B**
Q3	General Aptitude	Reasoning	MCQ	1	**D**
Q4	General Aptitude	Mathematical Analysis	MCQ	1	**C**
Q5	General Aptitude	Mathematical Analysis	NAT	1	**1300 to 1300**
Q6	General Aptitude	Reasoning	MCQ	2	**D**
Q7	General Aptitude	Reasoning	MCQ	2	**B**
Q8	General Aptitude	Geometry	NAT	2	**180 to 180**
Q9	General Aptitude	Mathematical Analysis	MCQ	2	**D**
Q10	General Aptitude	Data Analysis	MCQ	2	**B**
Q11	Mathematical Physics	Vector Analysis	MCQ	1	**D**
Q12	Electromagnetism	Relativistic EMT	MCQ	1	**B**
Q13	Atomic and Molecular Ph…	Effects in atomic physics	MCQ	1	**A**
Q14	Classical Mechanics	Special theory of relativity	NAT	1	**2.1 to 2.3**
Q15	Optics	Polarization	MCQ	1	**C**
Q16	Classical Mechanics	Small Oscillations	NAT	1	**1.99 to 2.01**
Q17	Electromagnetism	EM Waves	NAT	1	**1.49 to 1.51**
Q18	Mathematical Physics	Matrices	MCQ	1	**D**
Q19	Quantum Mechanics	Basics Quantum Mechanics	MCQ	1	**C**
Q20	Thermodynamics	Laws of thermodynamics	MCQ	1	**D**
Q21	Nuclear and Particle Phy…	Particle Physics	MCQ	1	**B**
Q22	Mathematical Physics	Tensors	MCQ	1	**B**
Q23	Quantum Mechanics	Spin and Total Angular momentum	MCQ	1	**D**
Q24	Electromagnetism	Potential formulation	NAT	1	**0.99 to 1.01**
Q25	Thermodynamics	Kinetic theory of gases	NAT	1	**1.99 to 2.01**
Q26	Statistical Mechanics	Quantum Statistical Mechanics	MCQ	1	**B**
Q27	Nuclear and Particle Phy…	Particle Physics	MCQ	1	**D**
Q28	Classical Mechanics	Canonical Transformation and Poiss…	MCQ	1	**A**
Q29	Solid State Physics	Crystallography	MCQ	1	**C**
Q30	Solid State Physics	Superconductivity	MCQ	1	**A**
Q31	Quantum Mechanics	Spin and Total Angular momentum	MCQ	1	**A**
Q32	Solid State Physics	Tight binding model	MCQ	1	**B**
Q33	Solid State Physics	Free electron model	MCQ	1	**C**
Q34	Electronics	OPAMP	MCQ	1	**A**
Q35	Electronics	Flip flops	NAT	1	**6.99 to 7.01**
Q36	Classical Mechanics	Lagrangian and Hamiltonian	MCQ	2	**A**

Answer Key

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

Q.No	Subject	Topic	Type	Marks	Answer
Q37	Quantum Mechanics	Orbital angular momentum and hydr…	MCQ	2	**D**
Q38	Solid State Physics	Magnetic properties of solids	NAT	2	**40 to 43**
Q39	Classical Mechanics	Small Oscillations	MCQ	2	**A**
Q40	Solid State Physics	Semiconductor Physics	NAT	2	**114 to 117**
Q41	Quantum Mechanics	Quantum Harmonic Oscillator	NAT	2	**3.99 to 4.01**
Q42	Quantum Mechanics	Orbital angular momentum and hydr…	NAT	2	**1.99 to 2.01**
Q43	Classical Mechanics	Central Forces	MCQ	2	**D**
Q44	Atomic and Molecular Ph…	Molecular Physics	MCQ	2	**B**
Q45	Mathematical Physics	Complex Analysis	MCQ	2	**C**
Q46	Electromagnetism	Electric field in matter	NAT	2	**2.3 to 2.4**
Q47	Mathematical Physics	Differential Equations	MCQ	2	**D**
Q48	Classical Mechanics	Canonical Transformation and Poiss…	NAT	2	**0.24 to 0.26**
Q49	Electromagnetism	Magnetism	NAT	2	**1.41 to 1.47**
Q50	Statistical Mechanics	Canonical ensemble	MCQ	2	**A**
Q51	Optics	Interference and Diffraction	MCQ	2	**B**
Q52	Quantum Mechanics	Spin and Total Angular momentum	NAT	2	**0.66 to 0.68**
Q53	Solid State Physics	Xray diffraction	NAT	2	**3.91 to 4.15**
Q54	Classical Mechanics	Phase diagram	MCQ	2	**D**
Q55	Electromagnetism	EM Waves	NAT	2	**10.58 to 10.70**
Q56	Atomic and Molecular Ph…	Lasers	MCQ	2	**C**
Q57	Statistical Mechanics	Microstates	MCQ	2	**B**
Q58	Quantum Mechanics	Perturbation Theory	MCQ	2	**C**
Q59	Nuclear and Particle Phy…	Radioactivity	NAT	2	**34.9 to 35.1**
Q60	Quantum Mechanics	Quantum Harmonic Oscillator	NAT	2	**3.2 to 3.3**
Q61	Nuclear and Particle Phy…	Radioactivity	MCQ	2	**C**
Q62	Electronics	Transistors	NAT	2	**1.4 to 1.7**
Q63	Electronics	AD/DA coversion	NAT	2	**9.99 to 10.01**
Q64	Quantum Mechanics	Orbital angular momentum and hydr…	NAT	2	**1.99 to 2.01**
Q65	Electronics	Filters	MCQ	2	**B**