

PhysicsByAaryan

CSIR NET · GATE · JEST · BARC – Physics

GATE Physics 2018 — Full Question Paper

Previous Year Questions with Official Answer Key

Inside this PDF

- Every GATE Physics (PH) 2018 question, in order
- Marking scheme + question type (MCQ/MSQ/NAT) on every question
- Subject & topic classification per question
- Official answer key at the end

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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 2018	MCQ	1M
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"When she fell down the ____, she received many ____ but little help."

The words that best fill the blanks in the above sentence are

- (A) stairs, stares
- (B) stairs, stairs
- (C) stares, stairs
- (D) stares, stares

Q2. [Marks: 1 | MCQ]

General Aptitude · English

Gate 2018	MCQ	1M
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"In spite of being warned repeatedly, he failed to correct his ____ behaviour."

The word that best fills the blank in the above sentence is

- (A) Rational
- (B) Reasonable
- (C) Errant
- (D) good

Q3. [Marks: 1 | MCQ]

General Aptitude · Mathematical Analysis

Gate 2018	MCQ	1M
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For $0 \leq x \leq 2\pi$, $\sin x$ and $\cos x$ are both decreasing functions in the interval ____ .

- (A) $\left(0, \frac{\pi}{2}\right)$
- (B) $\left(\frac{\pi}{2}, \pi\right)$
- (C) $\left(\pi, \frac{3\pi}{2}\right)$
- (D) $\left(\frac{3\pi}{2}, 2\pi\right)$

Q4. [Marks: 1 | MCQ]

General Aptitude · Geometry

Gate 2018	MCQ	1M
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The area of an equilateral triangle is $\sqrt{3}$. What is the perimeter of the triangle?

- (A) 2
- (B) 4
- (C) 6
- (D) 8

Q5. [Marks: 1 | MCQ]

General Aptitude · Geometry

Gate 2018	MCQ	1M
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5 Arrange the following three-dimensional objects in the descending order of their volumes:

- (i) A cuboid with dimensions 10 cm, 8 cm and 6 cm
 - (ii) A cube of side 8 cm
 - (iii) A cylinder with base radius 7 cm and height 7 cm
 - (iv) A sphere of radius 7 cm
- (A) (i), (ii), (iii), (iv)
- (B) (ii), (i), (iv), (iii)
- (C) (iii), (ii), (i), (iv)
- (D) (iv), (iii), (ii), (i)

Q6. [Marks: 2 | MCQ]

General Aptitude · Reasoning

Gate 2018	MCQ	2M
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An automobile travels from city A to city B and returns to city A by the same route. The speed of the vehicle during the onward and return journeys were constant at 60 km/h and 90 km/h , respectively. What is the average speed in km/h for the entire journey?

- (A) 72
- (B) 73
- (C) 74
- (D) 75

Q7. [Marks: 2 | MCQ]

General Aptitude · Geometry

Gate 2018	MCQ	2M
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A set of 4 parallel lines intersect with another set of 5 parallel lines. How many parallelograms are formed?

- (A) 20
- (B) 48
- (C) 60
- (D) 72

Q8. [Marks: 2 | MCQ]

General Aptitude · Mathematical Analysis

Gate 2018	MCQ	2M
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To pass a test, a candidate needs to answer at least 2 out of 3 questions correctly. A total of 6,30,000 candidates appeared for the test. Question A was correctly answered by 3,30,000 candidates. Question B was answered correctly by 2,50,000 candidates. Question C was answered correctly by 2,60,000 candidates. Both questions A and B were answered correctly by 1,00,000 candidates. Both questions B and C were answered correctly by 90,000 candidates. Both questions A and C were answered correctly by 80,000 candidates. If the number of students answering all questions correctly is the same as the number answering none, how many candidates failed to clear the test?

- (A) 30,000
- (B) 2,70,000
- (C) 3,90,000
- (D) 4,20,000

Q9. [Marks: 2 | MCQ]

General Aptitude · Mathematical Analysis

Gate 2018	MCQ	2M
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If $x^2 + x - 1 = 0$ what is the value of $x^4 + \frac{1}{x^4}$?

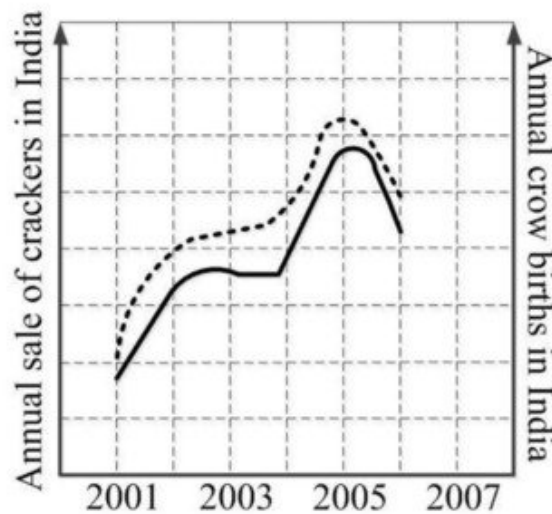
- (A) 1
 - (B) 5
 - (C) 7
 - (D) 9
-

Q10. [Marks: 2 | MCQ]

General Aptitude · Data Analysis

Gate 2018	MCQ	2M
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In a detailed study of annual crow births in India, it was found that there was relatively no growth during the period 2002 to 2004 and a sudden spike from 2004 to 2005. In another unrelated study, it was found that the revenue from cracker sales in India which remained fairly flat from 2002 to 2004, saw a sudden spike in 2005 before declining again in 2006. The solid line in the graph below refers to annual sale of crackers and the dashed line refers to the annual crow births in India. Choose the most appropriate inference from the above data.



- (A) There is a strong correlation between crow birth and cracker sales.
- (B) Cracker usage increases crow birth rate.
- (C) If cracker sale declines, crow birth will decline.
- (D) Increased birth rate of crows will cause an increase in the sale of crackers.

Q11. [Marks: 1 | MCQ]

Mathematical Physics · Matrices

Gate 2018	MCQ	1M
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The eigenvalues of a Hermitian matrix are all

- (A) Real
 - (B) Imaginary
 - (C) of modulus one
 - (D) real and positive
-

Q12. [Marks: 1 | MCQ]

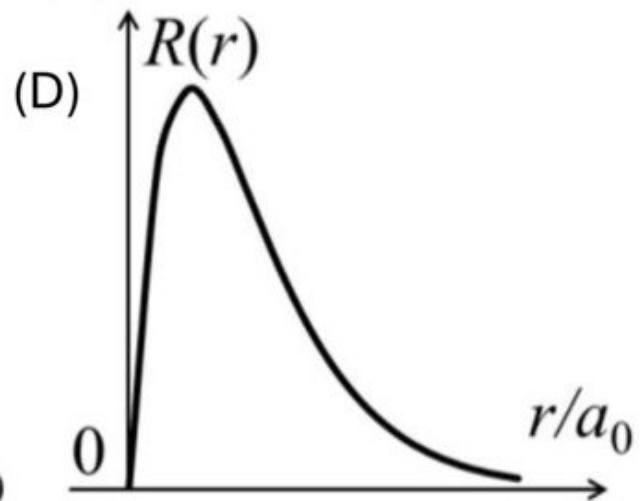
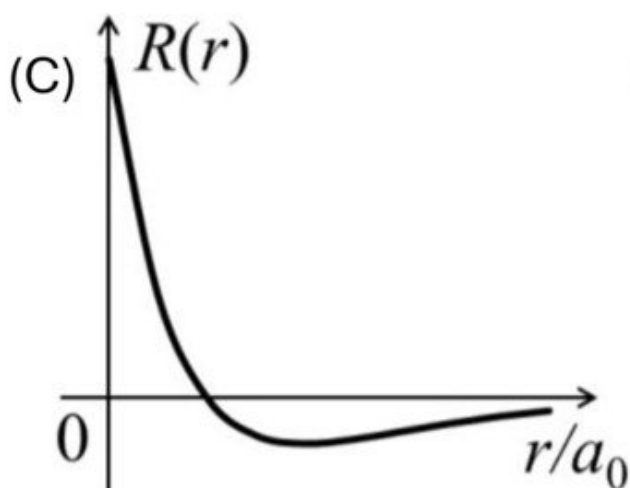
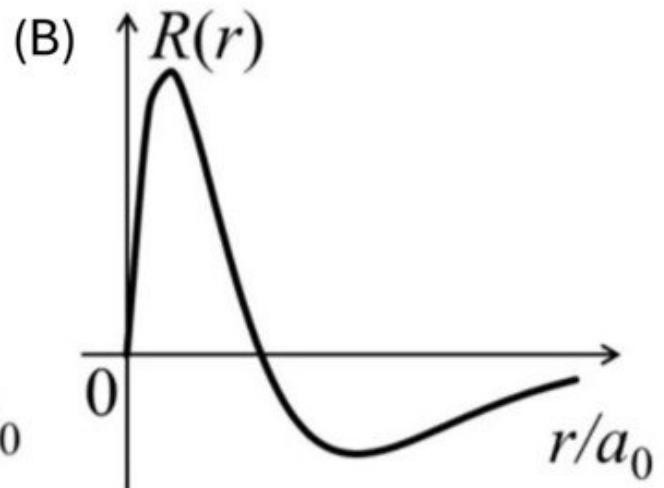
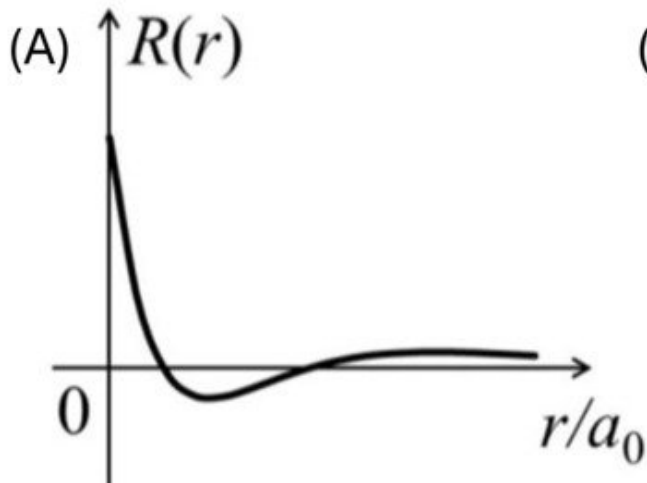
Quantum Mechanics · Orbital angular momentum and hydrogen atom

Gate 2018

MCQ

1M

Which one of the following represents the $3p$ radial wave function of hydrogen atom? (a_0 is the Bohr radius)



Q13. [Marks: 1 | MCQ]

Atomic and Molecular Physics · Effects in atomic physics

Gate 2018	MCQ	1M
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Given the following table,

Group I	Group II
P: Stern-Gerlach experiment	1: Wave nature of particles
Q: Zeeman effect	2: Quantization of energy of electrons in the atoms
R: Frank-Hertz experiment	3: Existence of electron spin
S: Davisson-Germer experiment	4: Space quantization of angular momentum

which one of the following correctly matches the experiments from Group I to their inferences in Group II?

- (A) P-2, Q-3, R-4, S-1
- (B) P-1, Q-3, R-2, S-4
- (C) P-3, Q-4, R-2, S-1
- (D) P-2, Q-1, R-4, S-3

Q14. [Marks: 1 | MCQ]

Mathematical Physics · Vector Analysis

Gate 2018	MCQ	1M
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In spherical polar coordinates (r, θ, ϕ) , the unit vector $\hat{\theta}$ at $(10, \pi/4, \pi/2)$ is

- (A) \hat{k}
- (B) $\frac{1}{\sqrt{2}}(\hat{j} + \hat{k})$
- (C) $\frac{1}{\sqrt{2}}(-\hat{j} + \hat{k})$
- (D) $\frac{1}{\sqrt{2}}(\hat{j} - \hat{k})$

Q15. [Marks: 1 | MCQ]

Mathematical Physics · Tensors

Gate 2018	MCQ	1M
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The scale factors corresponding to the covariant metric tensor g_{ij} in spherical polar coordinates are

- (A) $1, r^2, r^2 \sin^2 \theta$
- (B) $1, r^2, \sin^2 \theta$
- (C) $1, 1, 1$
- (D) $1, r, r \sin \theta$

Q16. [Marks: 1 | MCQ]

Classical Mechanics · Small Oscillations

Gate 2018	MCQ	1M
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In the context of small oscillations, which one of the following does NOT apply to the normal coordinates?

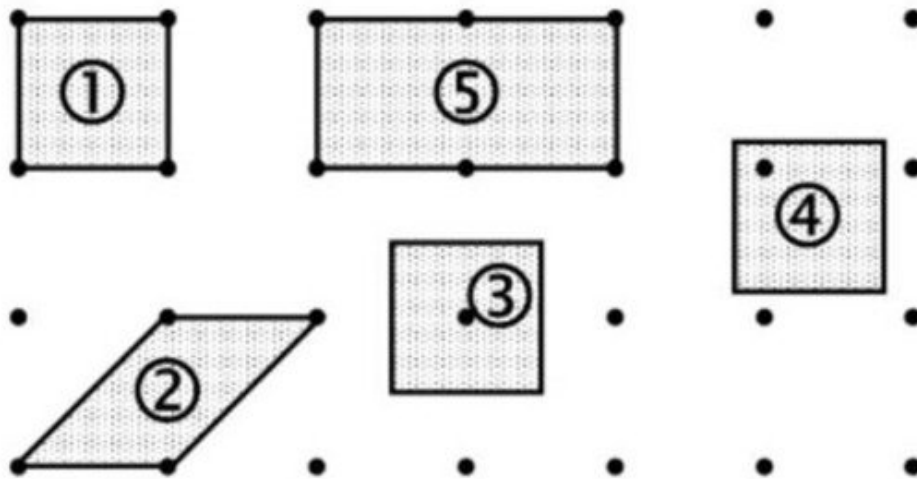
- (A) Each normal coordinate has an eigen-frequency associated with it
- (B) The normal coordinates are orthogonal to one another
- (C) The normal coordinates are all independent
- (D) The potential energy of the system is a sum of squares of the normal coordinates with constant coefficients

Q17. [Marks: 1 | MCQ]

Solid State Physics · Crystallography

Gate 2018	MCQ	1M
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For the given unit cells of a two-dimensional square lattice, which option lists all the primitive cells?



- (A) ① and ②
 (B) ①, ② and ③
 (C) ①, ②, ③ and ④
 (D) ①, ②, ③, ④ and ⑤

Q18. [Marks: 1 | MCQ]

Electromagnetism · Relativistic EMT

Gate 2018	MCQ	1M
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Among electric field (\vec{E}), magnetic field (\vec{B}), angular momentum (\vec{L}), and vector potential (\vec{A}), which is/are odd under parity (space inversion) operation?

- (A) \vec{E} only
- (B) \vec{E} & \vec{A} only
- (C) \vec{E} & \vec{B} only
- (D) \vec{B} & \vec{L} only

Q19. [Marks: 1 | MCQ]

Atomic and Molecular Physics · Molecular Physics

Gate 2018	MCQ	1M
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The expression for the second overtone frequency in the vibrational absorption spectra of a diatomic molecule in terms of the harmonic frequency ω_e and anharmonicity constant x_e is

- (A) $2\omega_e(1 - x_e)$
- (B) $2\omega_e(1 - 3x_e)$
- (C) $3\omega_e(1 - 2x_e)$
- (D) $3\omega_e(1 - 4x_e)$

Q20. [Marks: 1 | MCQ]

Atomic and Molecular Physics · Effects in atomic physics

Gate 2018	MCQ	1M
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Match the physical effects and order of magnitude

of their energy scales given below, where $\alpha = \frac{e^2}{4\pi\epsilon_0\hbar c}$

is fine structure constant; m_e and m_p are electron and proton mass, respectively.

Group I	Group II
P: Lamb shift	1: $\sim \mathcal{O}(\alpha^2 m_e c^2)$
Q: Fine structure	2: $\sim \mathcal{O}(\alpha^4 m_e c^2)$
R: Bohr energy	3: $\sim \mathcal{O}(\alpha^4 m_e^2 c^2 / m_p)$
S: Hyperfine structure	4: $\sim \mathcal{O}(\alpha^5 m_e c^2)$

- (A) P-3, Q-1, R-2, S-4
 (B) P-2, Q-3, R-1, S-4
 (C) P-4, Q-2, R-1, S-3
 (D) P-2, Q-4, R-1, S-3

Q21. [Marks: 1 | MCQ]

Electronics · Logic Gates

Gate 2018	MCQ	1M
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The logic expression $\bar{A}BC + \bar{A}\bar{B}C + AB\bar{C} + A\bar{B}\bar{C}$ can be simplified to

- (A) $A \text{ XOR } C$
- (B) $A \text{ AND } \bar{C}$
- (C) 0
- (D) 1

Q22. [Marks: 1 | MCQ]

Solid State Physics · Lattice vibration

Gate 2018	MCQ	1M
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At low temperatures (T), the specific heat of common metals is described by (with α and β as constants)

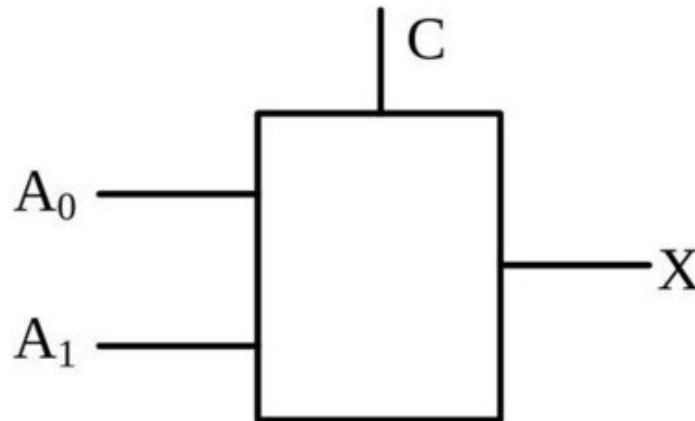
- (A) $\alpha T + \beta T^3$
- (B) βT^3
- (C) $\exp(-\alpha/T)$
- (D) $\alpha T + \beta T^5$

Q23. [Marks: 1 | MCQ]

Electronics · Flip flops

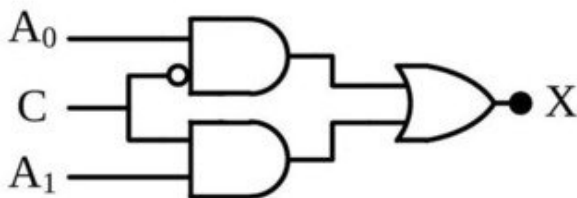
Gate 2018	MCQ	1M
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In a 2-to-1 multiplexer as shown below, the output $X = A_0$ if $C = 0$, and $X = A_1$ if $C = 1$.

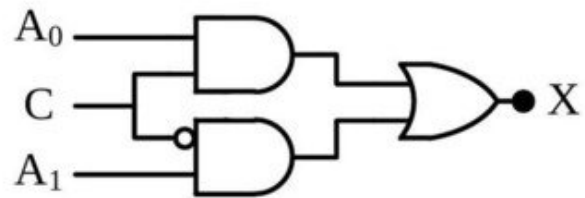


Which one of the following is the correct implementation of this multiplexer?

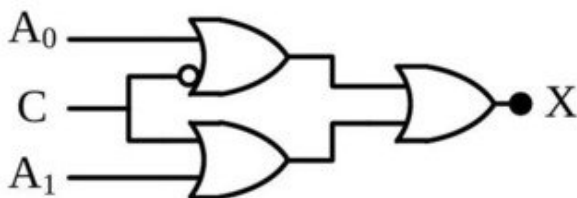
(A)



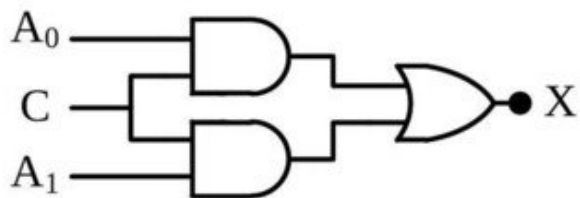
(B)



(C)



(D)



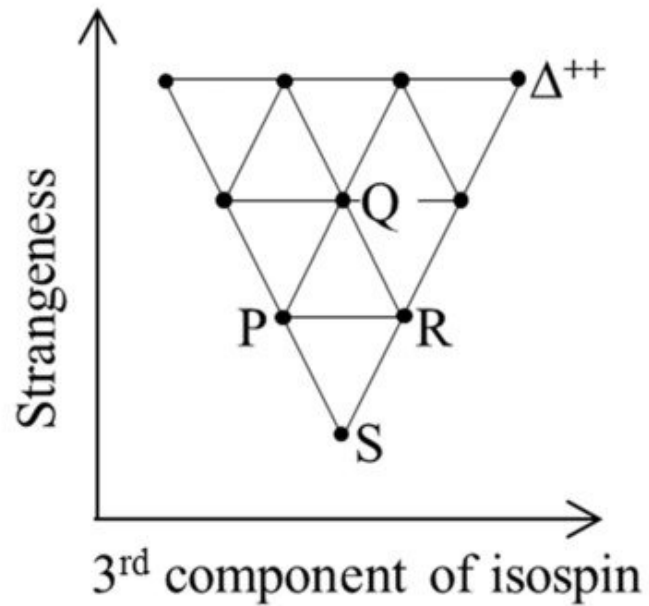
Q24. [Marks: 1 | MCQ]

Nuclear and Particle Physics · Particle Physics

Gate 2018	MCQ	1M
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The elementary particle Ξ^0 is placed in the baryon decuplet, shown below, at

- (A) P
- (B) Q
- (C) R
- (D) S



Q25. [Marks: 1 | MCQ]

Atomic and Molecular Physics · Effects in atomic physics

Gate 2018	MCQ	1M
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The intrinsic/permanent electric dipole moment in the ground state of hydrogen atom is (a_0 is the Bohr radius)

- (A) $-3ea_0$
- (B) Zero
- (C) ea_0
- (D) $3ea_0$

Q26. [Marks: 1 | MCQ]

Solid State Physics · Magnetic properties of solids

Gate 2018	MCQ	1M
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The high temperature magnetic susceptibility of solids having ions with magnetic moments can be described by $\chi \propto \frac{1}{T+\theta}$ with T as absolute temperature and θ as constant. The three behaviors i.e. paramagnetic, ferromagnetic and anti-ferromagnetic are described, respectively, by

- (A) $\theta < 0, \theta > 0, \theta = 0$
- (B) $\theta > 0, \theta < 0, \theta = 0$
- (C) $\theta = 0, \theta < 0, \theta > 0$
- (D) $\theta = 0, \theta > 0, \theta < 0$

Q27. [Marks: 1 | MCQ]

Atomic and Molecular Physics · Effects in atomic physics

Gate 2018	MCQ	1M
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Which one of the following is an allowed electric dipole transition?

- (A) $^1S_0 \rightarrow ^3S_1$
- (B) $^2P_{3/2} \rightarrow ^2D_{5/2}$
- (C) $^2D_{5/2} \rightarrow ^2P_{1/2}$
- (D) $^3P_0 \rightarrow ^5D_0$

Q28. [Marks: 1 | MCQ]

Nuclear and Particle Physics · Particle Physics

Gate 2018	MCQ	1M
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In the decay, $\mu^+ \rightarrow e^+ + \nu_e + X$, what is X ?

- (A) γ
- (B) $\bar{\nu}_e$
- (C) ν_μ
- (D) $\bar{\nu}_\mu$

Q29. [Marks: 1 | NAT]

Classical Mechanics · Special theory of relativity

Gate 2018	NAT	1M
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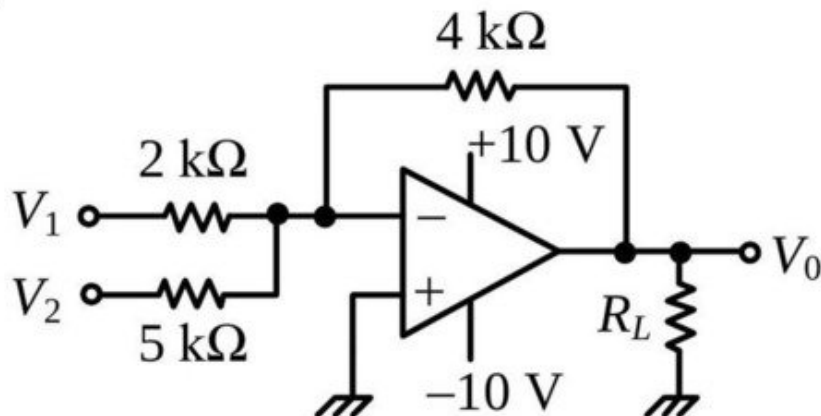
A spaceship is travelling with a velocity of $0.7c$ away from a space station. The spaceship ejects a probe with a velocity $0.59c$ opposite to its own velocity. A person in the space station would see the probe moving at a speed Xc , where the value of X is ___ (up to three decimal places).

Q30. [Marks: 1 | NAT]

Electronics · OPAMP

Gate 2018	NAT	1M
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For an operational amplifier (ideal) circuit shown below,



if $V_1 = 1\text{ V}$ and $V_2 = 2\text{ V}$, the value of V_0 is ___ V (up to one decimal place).

Q31. [Marks: 1 | NAT]

Electromagnetism · Magnetism

Gate 2018	NAT	1M
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An infinitely long straight wire is carrying a steady current I . The ratio of magnetic energy density at distance r_1 to that at $r_2 (= 2r_1)$ from the wire is ____ .

Q32. [Marks: 1 | NAT]

Electromagnetism · EM Waves

Gate 2018	NAT	1M
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A light beam of intensity I_0 is falling normally on a surface. The surface absorbs 20% of the intensity and the rest is reflected. The radiation pressure on the surface is given by $X I_0/c$, where X is ____ (up to one decimal place). Here c is the speed of light.

Q33. [Marks: 1 | NAT]

Electromagnetism · Relativistic EMT

Gate 2018	NAT	1M
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The number of independent components of a general electromagnetic field tensor is ____ .

Q34. [Marks: 1 | NAT]

Statistical Mechanics · Quantum Statistical Mechanics

Gate 2018	NAT	1M
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If X is the dimensionality of a free electron gas, the energy (E) dependence of density of states is given by $E^{\frac{1}{2}X-Y}$, where Y is ____ .

Q35. [Marks: 1 | NAT]

Nuclear and Particle Physics · Collective Model

Gate 2018	NAT	1M
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For nucleus ^{164}Er , a $J^\pi = 2^+$ state is at 90 keV . Assuming ^{164}Er to be a rigid rotor, the energy of its 4^+ state is ____ keV (up to one decimal place).

Q36. [Marks: 2 | MCQ]

Mathematical Physics · Vector Analysis

Gate 2018	MCQ	2M
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Given $\vec{V}_1 = \hat{i} - \hat{j}$ and $\vec{V}_2 = -2\hat{i} + 3\hat{j} + 2\hat{k}$, which one of the following \vec{V}_3 makes $(\vec{V}_1, \vec{V}_2, \vec{V}_3)$ a complete set for a three-dimensional real linear vector space?

- (A) $\vec{V}_3 = \hat{i} + \hat{j} + 4\hat{k}$
- (B) $\vec{V}_3 = 2\hat{i} - \hat{j} + 2\hat{k}$
- (C) $\vec{V}_3 = \hat{i} + 2\hat{j} + 6\hat{k}$
- (D) $\vec{V}_3 = 2\hat{i} + \hat{j} + 4\hat{k}$

Q37. [Marks: 2 | MCQ]

Classical Mechanics · Central Forces

Gate 2018	MCQ	2M
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An interstellar object has speed v at the point of its shortest distance R from a star of much larger mass M . Given $v^2 = 2GM/R$, the trajectory of the object is

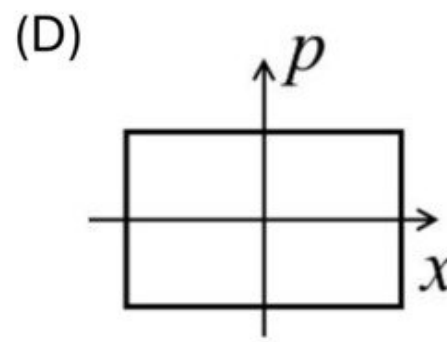
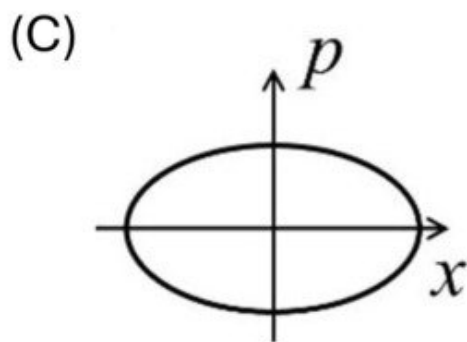
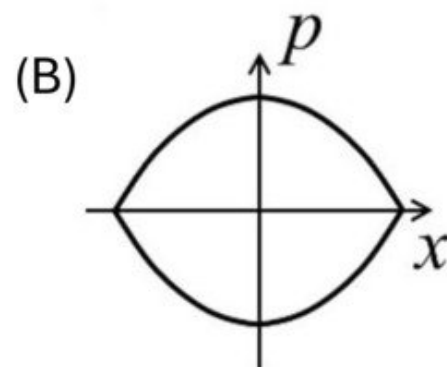
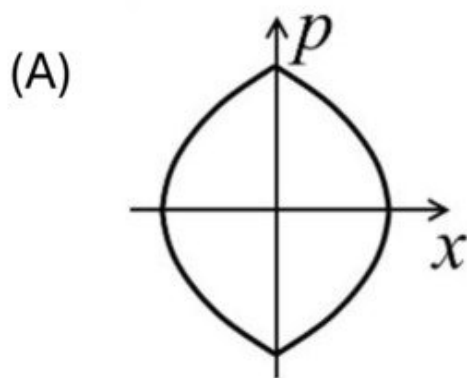
- (A) Circle
 - (B) Ellipse
 - (C) Parabola
 - (D) hyperbola
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Q38. [Marks: 2 | MCQ]

Classical Mechanics · Phase diagram

Gate 2018	MCQ	2M
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A particle moves in one dimension under a potential $V(x) = \alpha|x|$ with some non-zero total energy. Which one of the following best describes the particle trajectory in the phase space?



Q39. [Marks: 2 | MCQ]

Electromagnetism · Electrodynamics

Gate 2018	MCQ	2M
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Consider an infinitely long solenoid with N turns per unit length, radius R and carrying a current $I(t) = \alpha \cos \omega t$, where α is a constant and ω is the angular frequency. The magnitude of electric field at the surface of the solenoid is

- (A) $\frac{1}{2} \mu_0 N R \omega \alpha \sin \omega t$
- (B) $\frac{1}{2} \mu_0 \omega N R \cos \omega t$
- (C) $\mu_0 N R \omega \alpha \sin \omega t$
- (D) $\mu_0 \omega N R \cos \omega t$

Q40. [Marks: 2 | MCQ]

Electromagnetism · Relativistic EMT

Gate 2018	MCQ	2M
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A constant and uniform magnetic field $\vec{B} = B_0 \hat{k}$ pervades all space. Which one of the following is the correct choice for the vector potential in Coulomb gauge?

- (A) $-B_0(x + y)\hat{i}$
- (B) $B_0(x + y)\hat{j}$
- (C) $B_0x\hat{j}$
- (D) $-\frac{1}{2}B_0(x\hat{i} - y\hat{j})$

Q41. [Marks: 2 | MCQ]

Quantum Mechanics · Basics Quantum Mechanics

Gate 2018	MCQ	2M
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If H is the Hamiltonian for a free particle with mass m , the commutator $[x, [x, H]]$ is

- (A) \hbar^2/m
- (B) $-\hbar^2/m$
- (C) $-\hbar^2/(2m)$
- (D) $\hbar^2/(2m)$

Q42. [Marks: 2 | MCQ]

Electromagnetism · EM Waves

Gate 2018	MCQ	2M
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A long straight wire, having radius a and resistance per unit length r , carries a current I . The magnitude and direction of the Poynting vector on the surface of the wire is

- (A) $I^2 r / 2\pi a$, perpendicular to axis of the wire and pointing inwards
- (B) $I^2 r / 2\pi a$, perpendicular to axis of the wire and pointing outwards
- (C) $I^2 r / \pi a$, perpendicular to axis of the wire and pointing inwards
- (D) $I^2 r / \pi a$, perpendicular to axis of the wire and pointing outwards

Q43. [Marks: 2 | MCQ]

Statistical Mechanics · Microstates

Gate 2018	MCQ	2M
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Three particles are to be distributed in four non-degenerate energy levels. The possible number of ways of distribution: (i) for distinguishable particles, and (ii) for identical Bosons, respectively, is

- (A) (i) 24, (ii) 4
- (B) (i) 24, (ii) 20
- (C) (i) 64, (ii) 20
- (D) (i) 64, (ii) 16

Q44. [Marks: 2 | MCQ]

Atomic and Molecular Physics · Effects in atomic physics

Gate 2018	MCQ	2M
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The term symbol for the electronic ground state of oxygen atom is

- (A) 1S_0
- (B) 1D_2
- (C) 3P_0
- (D) 3P_2

Q45. [Marks: 2 | MCQ]

Solid State Physics · Tight binding model

Gate 2018	MCQ	2M
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The energy dispersion for electrons in one-dimensional lattice with lattice parameter a is given by

$$E(k) = E_0 - \frac{1}{2}W \cos ka,$$

where W and E_0 are constants. The effective mass of the electron near the bottom of the band is

- (A) $\frac{2\hbar^2}{Wa^2}$
- (B) $\frac{\hbar^2}{Wa^2}$
- (C) $\frac{\hbar^2}{2Wa^2}$
- (D) $\frac{\hbar^2}{4Wa^2}$

Q46. [Marks: 2 | MCQ]

Solid State Physics · Superconductivity

Gate 2018	MCQ	2M
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Amongst electrical resistivity (ρ), thermal conductivity (κ), specific heat (C), Young's modulus (Y), and magnetic susceptibility (χ), which quantities show a sharp change at the superconducting transition temperature?

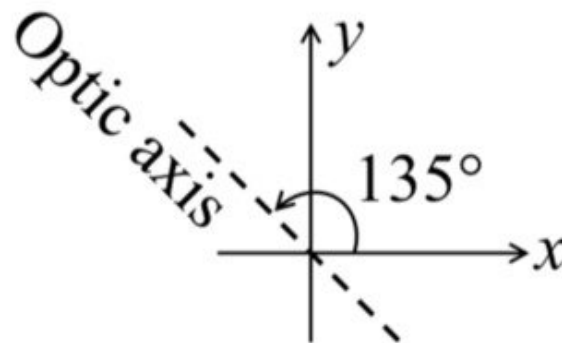
- (A) ρ, κ, C, Y
- (B) ρ, C, χ
- (C) ρ, κ, C, χ
- (D) κ, Y, χ

Q47. [Marks: 2 | MCQ]

Optics · Polarization

Gate 2018	MCQ	2M
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A quarter wave plate introduces a path difference of $\lambda/4$ between the two components of polarization parallel and perpendicular to the optic axis. An electromagnetic wave with $\vec{E} = (\hat{x} + \hat{y})E_0 e^{i(kz - \omega t)}$ is incident normally on a quarter wave plate which has its optic axis making an angle 135° with the x -axis as shown.



The emergent electromagnetic wave would be

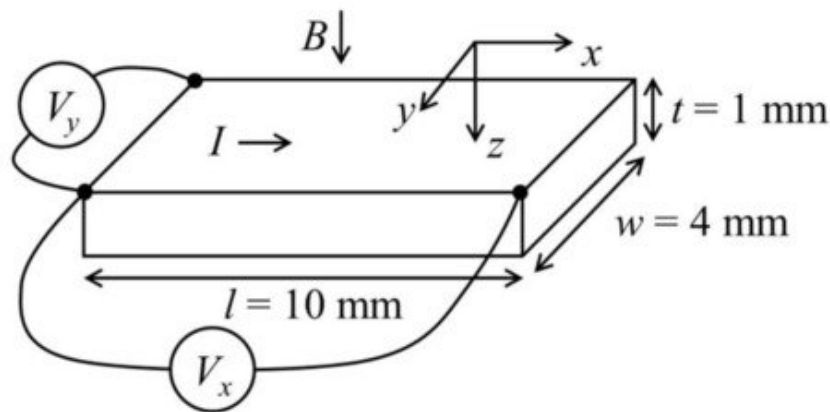
- (A) elliptically polarized
- (B) circularly polarized
- (C) linearly polarized with polarization as that of incident wave
- (D) linearly polarized but with polarization at 90° to that of the incident wave

Q48. [Marks: 2 | NAT]

Solid State Physics · Hall Effect

Gate 2018	NAT	2M
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A p -doped semiconductor slab carries a current $I = 100 \text{ mA}$ in a magnetic field $B = 0.2 \text{ T}$ as shown. One measures $V_y = 0.25 \text{ mV}$ and $V_x = 2 \text{ mV}$. The mobility of holes in the semiconductor is ___ $\text{m}^2 \text{ V}^{-1} \text{ s}^{-1}$ (up to two decimal places).

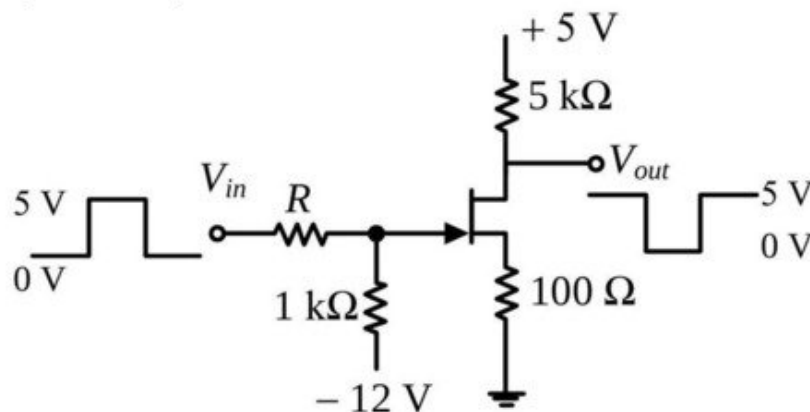


Q49. [Marks: 2 | NAT]

Electronics · fet

Gate 2018	NAT	2M
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An n-channel FET having Gate-Source switch-off voltage $V_{GS(OFF)} = -2 \text{ V}$ is used to invert a $0 - 5 \text{ V}$ square-wave signal as shown. The maximum allowed value of R would be ___ $\text{k}\Omega$ (up to two decimal places).



Q50. [Marks: 2 | NAT]

Nuclear and Particle Physics · Collective Model

Gate 2018	NAT	2M
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Inside a large nucleus, a nucleon with mass $939 \text{ MeV}c^{-2}$ has Fermi momentum 1.40 fm^{-1} at absolute zero temperature. Its velocity is Xc , where the value of X is ___ (up to two decimal places). ($\hbar c = 197 \text{ MeV} - \text{fm}$)

Q51. [Marks: 2 | NAT]

Nuclear and Particle Physics · Radioactivity

Gate 2018	NAT	2M
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4 MeV γ -rays emitted by the de-excitation of ^{19}F are attributed, assuming spherical symmetry, to the transition of protons from $1d_{3/2}$ state to $1d_{5/2}$ state. If the contribution of spin-orbit term to the total energy is written as $C\langle\vec{l} \cdot \vec{s}\rangle$, the magnitude of C is ___ MeV (up to one decimal place).

Q52. [Marks: 2 | NAT]

Nuclear and Particle Physics · Liquid Drop Model

Gate 2018	NAT	2M
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An α particle is emitted by a $^{230}_{90}\text{Th}$ nucleus. Assuming the potential to be purely Coulombic beyond the point of separation, the height of the Coulomb barrier is ___ MeV (up to two decimal places).

$$\left(\frac{e^2}{4\pi\epsilon_0} = 1.44\text{MeV} - \text{fm}, r_0 = 1.30\text{fm} \right)$$

Q53. [Marks: 2 | NAT]

Classical Mechanics · Canonical Transformation and Poisson bracket

Gate 2018	NAT	2M
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For the transformation

$$Q = \sqrt{2q}e^{-1+2\alpha}\cos p, P = \sqrt{2q}e^{-\alpha-1}\sin p$$

(where α is a constant) to be canonical, the value of α is ____ .

Q54. [Marks: 2 | NAT]

Mathematical Physics · Differential Equations

Gate 2018	NAT	2M
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Given

$$\frac{d^2f(x)}{dx^2} - 2\frac{df(x)}{dx} + f(x) = 0$$

and boundary conditions $f(0) = 1$ and $f(1) = 0$, the value of $f(0.5)$ is ____ (up to two decimal places).

Q55. [Marks: 2 | NAT]

Mathematical Physics · Complex Analysis

Gate 2018	NAT	2M
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The absolute value of the integral

$$\int \frac{5z^3 + 3z^2}{z^2 - 4} dz$$

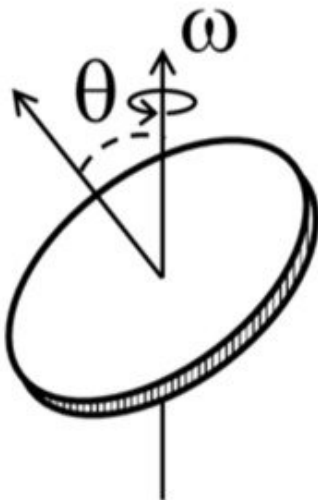
over the circle $|z - 1.5| = 1$ in complex plane, is
___ (up to two decimal places).

Q56. [Marks: 2 | NAT]

Classical Mechanics · Basic Mechanics

Gate 2018	NAT	2M
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A uniform circular disc of mass m and radius R is rotating with angular speed ω about an axis passing through its center and making an angle $\theta = 30^\circ$ with the axis of the disc. If the kinetic energy of the disc is $\alpha m \omega^2 R^2$, the value of α is ___ (up to 2 decimal places).

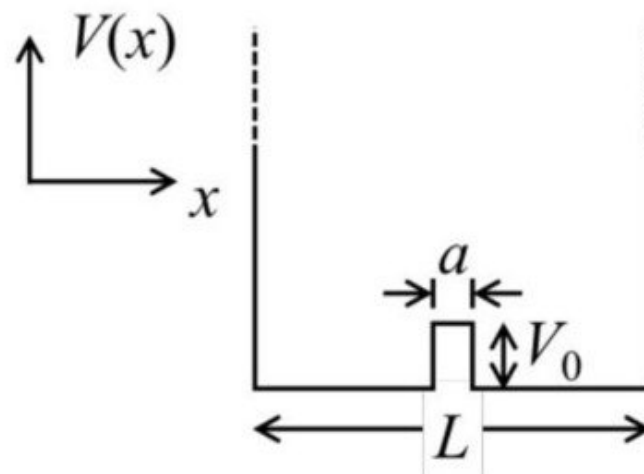


Q57. [Marks: 2 | NAT]

Quantum Mechanics · Perturbation Theory

Gate 2018	NAT	2M
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The ground state energy of a particle of mass m in an infinite potential well is E_0 . It changes to $E_0(1 + \alpha \times 10^{-3})$, when there is a small potential bump of height $V_0 = \frac{\pi^2 \hbar^2}{50mL^2}$ and width $a = L/100$, as shown in the figure. The value of α is ___ (up to two decimal places).



Q58. [Marks: 2 | NAT]

Electromagnetism · EM Waves

Gate 2018	NAT	2M
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An electromagnetic plane wave is propagating with an intensity $I = 1.0 \times 10^5 \text{ Wm}^{-2}$ in a medium with $\epsilon = 3\epsilon_0$ and $\mu = \mu_0$. The amplitude of the electric field inside the medium is ___ $\times 10^3 \text{ Vm}^{-1}$ (up to one decimal place).

$$\left(\begin{array}{l} \epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}, \\ \mu_0 = 4\pi \times 10^{-7} \text{ NA}^{-2}, c = 3 \times 10^8 \text{ ms}^{-1} \end{array} \right)$$

Q59. [Marks: 2 | NAT]

Statistical Mechanics · Microstates

Gate 2018	NAT	2M
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A microcanonical ensemble consists of 12 atoms with each taking either energy 0 state, or energy ϵ state. Both states are non-degenerate. If the total energy of this ensemble is 4ϵ , its entropy will be ___ k_B (up to one decimal place), where k_B is the Boltzmann constant.

Q60. [Marks: 2 | NAT]

Quantum Mechanics · Basics Quantum Mechanics

Gate 2018	NAT	2M
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A two-state quantum system has energy eigenvalues $\pm\epsilon$ corresponding to the normalized states $|\psi_{\pm}\rangle$. At time $t = 0$, the system is in quantum state $\frac{1}{\sqrt{2}} [|\psi_{+}\rangle + |\psi_{-}\rangle]$. The probability that the system will be in the same state at $t = h/(6\epsilon)$ is ___ (up to two decimal places).

Q61. [Marks: 2 | NAT]

Thermodynamics · Carnot Cycle

Gate 2018	NAT	2M
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An air-conditioner maintains the room temperature at 27°C while the outside temperature is 47°C . The heat conducted through the walls of the room from outside to inside due to temperature difference is 7000 W . The minimum work done by the compressor of the air conditioner per unit time is ___ W.

Q62. [Marks: 2 | NAT]

Quantum Mechanics · Quantum Statistical Mechanics

Gate 2018	NAT	2M
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Two solid spheres A and B have same emissivity. The radius of A is four times the radius of B , and temperature of A is twice the temperature of B . The ratio of the rate of heat radiated from A to that from B is ____.

Q63. [Marks: 2 | NAT]

Statistical Mechanics · Canonical ensemble

Gate 2018	NAT	2M
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The partition function of an ensemble at a temperature T is

$$Z = \left(2 \cosh \frac{\varepsilon}{k_B T} \right)^N$$

where k_B is the Boltzmann constant. The heat capacity of this ensemble at $T = \frac{\varepsilon}{k_B}$ is XNk_B , where the value of X is ____ (up to two decimal places).

Q64. [Marks: 2 | NAT]

Atomic and Molecular Physics · Effects in atomic physics

Gate 2018	NAT	2M
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An atom in its singlet state is subjected to a magnetic field. The Zeeman splitting of its 650 nm spectral line is 0.03 nm . The magnitude of the field is ___ Tesla (up to two decimal places).

$$\left(\begin{array}{l} e = 1.60 \times 10^{-19} \text{C}, m_e = 9.11 \times 10^{-31} \text{ kg}, \\ c = 3.0 \times 10^8 \text{ ms}^{-1} \end{array} \right)$$

Q65. [Marks: 2 | NAT]

Statistical Mechanics · Quantum Statistical Mechanics

Gate 2018	NAT	2M
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The quantum effects in an ideal gas become important below a certain temperature T_Q when de Broglie wavelength corresponding to the root mean square thermal speed becomes equal to the inter-atomic separation. For such a gas of atoms of mass 2×10^{-26} kg and number density $6.4 \times 10^{25} \text{ m}^{-3}$, $T_Q = ___ \times 10^{-3}$ K (up to one decimal place).

$$(k_B = 1.38 \times 10^{-23} \text{ J/K}, h = 6.6 \times 10^{-34} \text{ J-s})$$

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	Mathematical Analysis	MCQ	1	B
Q4	General Aptitude	Geometry	MCQ	1	C
Q5	General Aptitude	Geometry	MCQ	1	D
Q6	General Aptitude	Reasoning	MCQ	2	A
Q7	General Aptitude	Geometry	MCQ	2	C
Q8	General Aptitude	Mathematical Analysis	MCQ	2	D
Q9	General Aptitude	Mathematical Analysis	MCQ	2	C
Q10	General Aptitude	Data Analysis	MCQ	2	A
Q11	Mathematical Physics	Matrices	MCQ	1	A
Q12	Quantum Mechanics	Orbital angular momentum and hydr...	MCQ	1	B
Q13	Atomic and Molecular Ph...	Effects in atomic physics	MCQ	1	C
Q14	Mathematical Physics	Vector Analysis	MCQ	1	D
Q15	Mathematical Physics	Tensors	MCQ	1	D
Q16	Classical Mechanics	Small Oscillations	MCQ	1	B
Q17	Solid State Physics	Crystallography	MCQ	1	C
Q18	Electromagnetism	Relativistic EMT	MCQ	1	B
Q19	Atomic and Molecular Ph...	Molecular Physics	MCQ	1	D
Q20	Atomic and Molecular Ph...	Effects in atomic physics	MCQ	1	C
Q21	Electronics	Logic Gates	MCQ	1	A
Q22	Solid State Physics	Lattice vibration	MCQ	1	A
Q23	Electronics	Flip flops	MCQ	1	A
Q24	Nuclear and Particle Phy...	Particle Physics	MCQ	1	C
Q25	Atomic and Molecular Ph...	Effects in atomic physics	MCQ	1	B
Q26	Solid State Physics	Magnetic properties of solids	MCQ	1	C
Q27	Atomic and Molecular Ph...	Effects in atomic physics	MCQ	1	B
Q28	Nuclear and Particle Phy...	Particle Physics	MCQ	1	D
Q29	Classical Mechanics	Special theory of relativity	NAT	1	0.185 to 0.189
Q30	Electronics	OPAMP	NAT	1	-3.7 to -3.5
Q31	Electromagnetism	Magnetism	NAT	1	4 to 4
Q32	Electromagnetism	EM Waves	NAT	1	1.8 to 1.8
Q33	Electromagnetism	Relativistic EMT	NAT	1	6 to 6
Q34	Statistical Mechanics	Quantum Statistical Mechanics	NAT	1	1 to 1
Q35	Nuclear and Particle Phy...	Collective Model	NAT	1	297.0 to 300.1
Q36	Mathematical Physics	Vector Analysis	MCQ	2	D

Answer Key

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

Q.No	Subject	Topic	Type	Marks	Answer
Q37	Classical Mechanics	Central Forces	MCQ	2	C
Q38	Classical Mechanics	Phase diagram	MCQ	2	A
Q39	Electromagnetism	Electrodynamics	MCQ	2	A
Q40	Electromagnetism	Relativistic EMT	MCQ	2	C
Q41	Quantum Mechanics	Basics Quantum Mechanics	MCQ	2	B
Q42	Electromagnetism	EM Waves	MCQ	2	A
Q43	Statistical Mechanics	Microstates	MCQ	2	C
Q44	Atomic and Molecular Ph...	Effects in atomic physics	MCQ	2	D
Q45	Solid State Physics	Tight binding model	MCQ	2	A
Q46	Solid State Physics	Superconductivity	MCQ	2	B
Q47	Optics	Polarization	MCQ	2	C
Q48	Solid State Physics	Hall Effect	NAT	2	1.55 to 1.58
Q49	Electronics	fet	NAT	2	0.70 to 0.73
Q50	Nuclear and Particle Phy...	Collective Model	NAT	2	0.28 to 0.31
Q51	Nuclear and Particle Phy...	Radioactivity	NAT	2	1.6 to 1.6
Q52	Nuclear and Particle Phy...	Liquid Drop Model	NAT	2	24.4 to 27.6
Q53	Classical Mechanics	Canonical Transformation and Poiss...	NAT	2	2 to 2
Q54	Mathematical Physics	Differential Equations	NAT	2	0.81 to 0.84
Q55	Mathematical Physics	Complex Analysis	NAT	2	81.60 to 81.80
Q56	Classical Mechanics	Basic Mechanics	NAT	2	0.21 to 0.23
Q57	Quantum Mechanics	Perturbation Theory	NAT	2	0.78 to 0.82
Q58	Electromagnetism	EM Waves	NAT	2	6.5 to 6.7
Q59	Statistical Mechanics	Microstates	NAT	2	6.1 to 6.3
Q60	Quantum Mechanics	Basics Quantum Mechanics	NAT	2	0.25 to 0.25
Q61	Thermodynamics	Carnot Cycle	NAT	2	466 to 467
Q62	Quantum Mechanics	Quantum Statistical Mechanics	NAT	2	256 to 256
Q63	Statistical Mechanics	Canonical ensemble	NAT	2	0.41 to 0.43
Q64	Atomic and Molecular Ph...	Effects in atomic physics	NAT	2	1.51 to 1.53
Q65	Statistical Mechanics	Quantum Statistical Mechanics	NAT	2	78 to 90