PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

CSIR NET Physics - June 2019 - Full Paper

Complete question paper with answer key

75 questions . Answer key included

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Q1. [June 2019] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2019 June	2M

In a bacterial cell, a protein is synthesized at random location in the cytoplasm. The protein has to reach one pole of the cell for its appropriate function. The protein reaches the pole by

1. chemical attraction
2. random movement
3. enzymatic action
4. attraction between opposite charges

Q2. [June 2019] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2019 June	2M

A precious stone breaks into four pieces having weights in the proportion $1:2:3:4$. The value of such a stone is proportional to the square of its weight. What is the percent loss in the value incurred due to breaking?

1. 0
2. 30
3. 70
4. 90

Q3. [June 2019] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2019 June	2M

Two runners starting together run on a circular path taking 6 and 8 minutes, respectively, to complete one round. How many minutes later do they meet again for the first time on the start line, assuming constant speeds

1. 8
2. 24
3. 32
4. 60

Q4. [June 2019] . 2.0 marks

General Aptitude > Data Analysis

CSIR NET	2019 June	2M

The distribution of grades secured by students in a class is given in the table below.

Grade	Fraction of the Population
A	0.1
B	0.4
C	0.3
D	0.2

What is the least possible population of the class?

1. 2
2. 4
3. 8
4. 10

Q5. [June 2019] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2019 June	2M

The nine numbers $x_1, x_2, x_3 \ldots x_9$, are in ascending order. Their average m is strictly greater than all the first eight numbers. Which of the following is true?

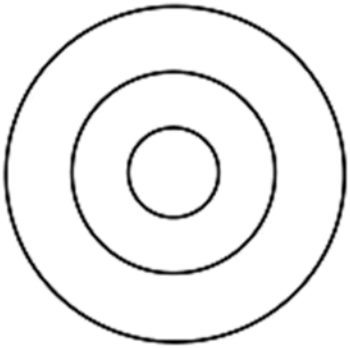
1. Average $(x_1, x_2 \ldots x_9, m) > m$ and Average $(x_2, x_3, \ldots x_9) > m$
2. Average $(x_1, x_2 \ldots x_9, m) < m$ and Average $(x_2, x_3, \ldots x_9) < m$
3. Average $(x_1, x_2 \ldots x_9, m) = m$ and Average $(x_2, x_3, \ldots x_9) > m$
4. Average $(x_1, x_2 \ldots x_9, m) < m$ and Average $(x_2, x_3, \ldots x_9) = m$

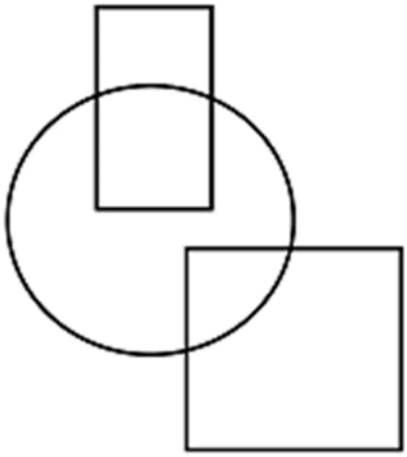
Q6. [June 2019] . 2.0 marks

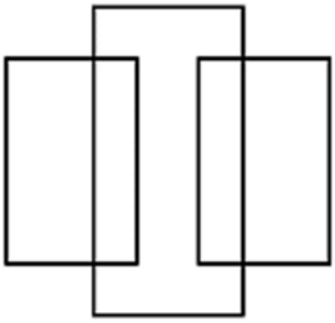
General Aptitude > Reasoning

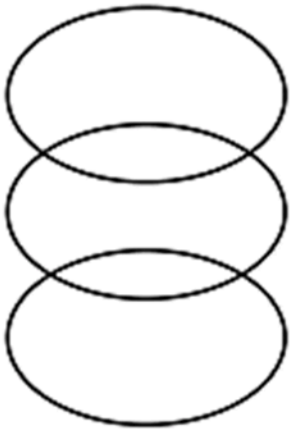
CSIR NET	2019 June	2M

Which among the following diagrams represents women, mothers, human beings?

1. 

2. 

3. 

4. 

Q7. [June 2019] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2019 June	2M

A boy and a girl make the following statements, of which at most one is correct:

The one in a white shirt says: "I am a girl" (statement -I)

The one in a blue shirt says: "I am a boy" (statement - II)

Which of the following is the correct inference?

1. Statement -I is correct but statement -II is incorrect

2. Statement - II is correct but statement - I is incorrect

3. Both statement I and II are incorrect

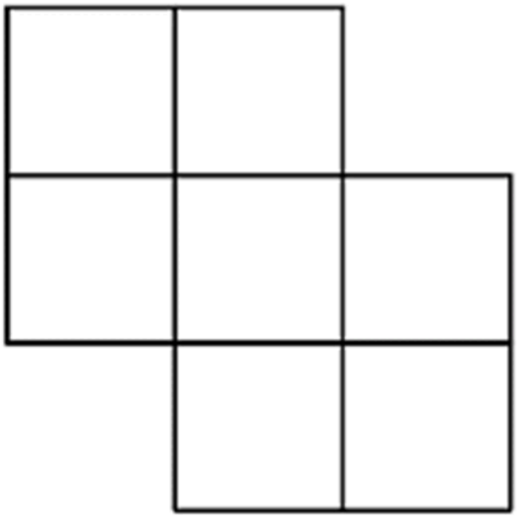
4. The correctness of the statements I and II cannot be ascertained

Q8. [June 2019] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2019 June	2M

How many quadrilaterals does the following figure have?



1. 17
2. 18
3. 19
4. 20

Q9. [June 2019] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2019 June	2M

12 balls, 3 each of the colors red, green, blue and yellow are put in a box and mixed. If 3 balls are picked at random, without replacement, the probability that all 3 balls are of the same color is

1. $\frac{1}{4}$
2. $\frac{1}{12}$
3. $\frac{1}{36}$
4. $\frac{1}{55}$

Q10. [June 2019] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2019 June	2M

Some aliens observe that roosters call before sunrise every day. Having no other information about roosters and sunrises, which of the following inferences would NOT be valid?

1. Rooster-call and sunrise may be independent cyclic events with the same periodicity

2. Both may be triggered by a common cause

3. Rooster-call may be causing the sunrise

4. Sunrise cannot be the cause of rooster call as the rooster-call precedes sunrise

Q11. [June 2019] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2019 June	2M

Twenty-one liters of water in a tank is to be divided into three equal parts using only 5,8 and 12 liter capacity cans. The minimum number of transfers needed to achieve this is

1. 3
2. 4
3. 5
4. 7

Q12. [June 2019] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2019 June	2M

Of four agents Alpha, Beta, Gamma and Delta, three have to be sent together on a mission. If Alpha and Beta cannot go together, Beta and Gamma cannot go together and Gamma and Delta cannot go together, then which of the following holds?

1. Any three agents can be sent.

2. Alpha, Delta and any one out of Beta and Gamma can be sent

3. Beta, Gamma and any one out of Alpha and Delta can be sent

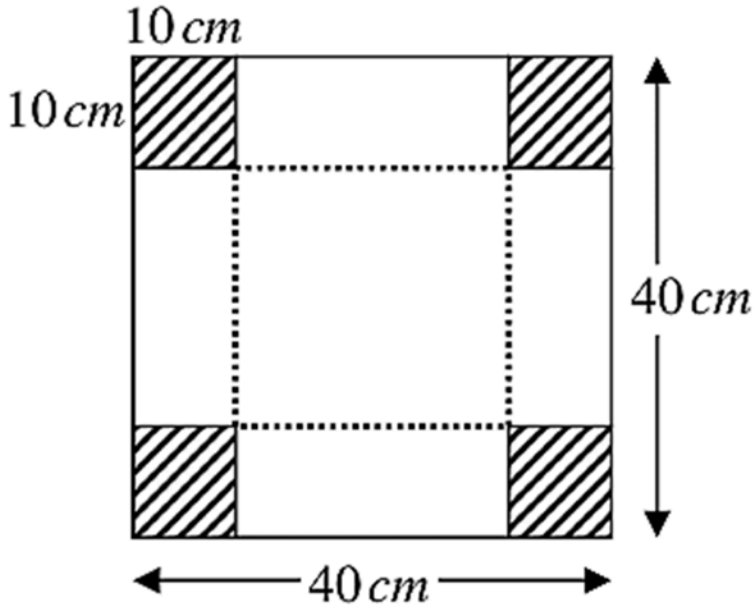
4. The mission is impossible.

Q13. [June 2019] . 2.0 marks

General Aptitude > Geometry

CSIR NET	2019 June	2M

An open rectangular box is made by excluding the four identical corners of a piece of paper as shown in the diagram and folding it along the dotted lines



The capacity of the box (in cm^3) is

1. 8000
2. 1000
3. 4000
4. 6000

Q14. [June 2019] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2019 June	2M

Which of the following is the largest?

$$2^{50}, 3^{40}, 4^{30}, 5^{20}$$

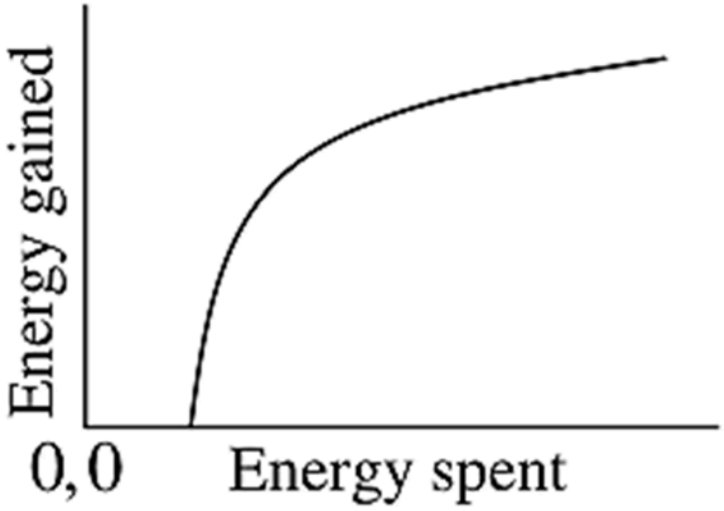
1. 2^{50}
2. 3^{40}
3. 4^{30}
4. 5^{20}

Q15. [June 2019] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2019 June	2M

A monkey climbs a tree to eat fruits. The amount of energy gained from eating fruits and the energy spent in climbing on different branches have a relationship shown in the figure.



The ratio of energy gained to energy spent will be the maximum

1. at a point where the slope of the curve is the maximum

2. at a point where the slope of the curve is unity

3. at a point on the curve where the tangent passes through the origin

4. at the highest point on the curve

Q16. [June 2019] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2019 June	2M

The length of a cylinder is measured 10 times yielding 10 distinct values. For this set of values, consider the following statements

A. Five of these values will lie above the mean and five below it

B. Five of these values will lie above median and five below it

C. At least one value will lie above the mean

D. At least one value will lie at the median

Which of the statements are necessarily correct?

1. B and C
2. A and C
3. B and D
4. A,C and D

Q17. [June 2019] . 2.0 marks

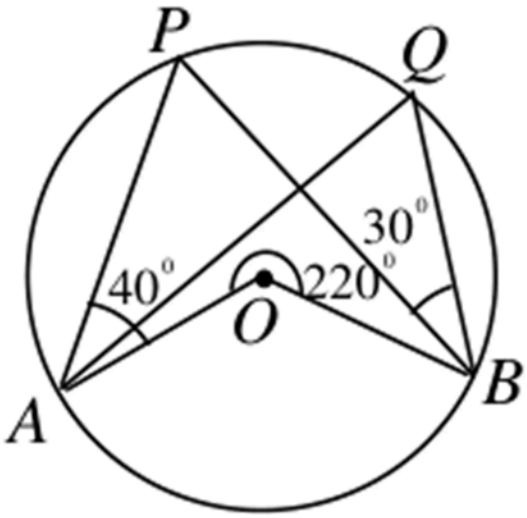
General Aptitude > Geometry

CSIR NET	2019 June	2M

In the given circle, O is the centre, $\angle PAO = 40°, \angle PBQ = 30°$ and outer angle $\angle AOB = 220°$.

Then $\angle AQB$ is

1. $70°$
2. $80°$
3. $60°$
4. $110°$

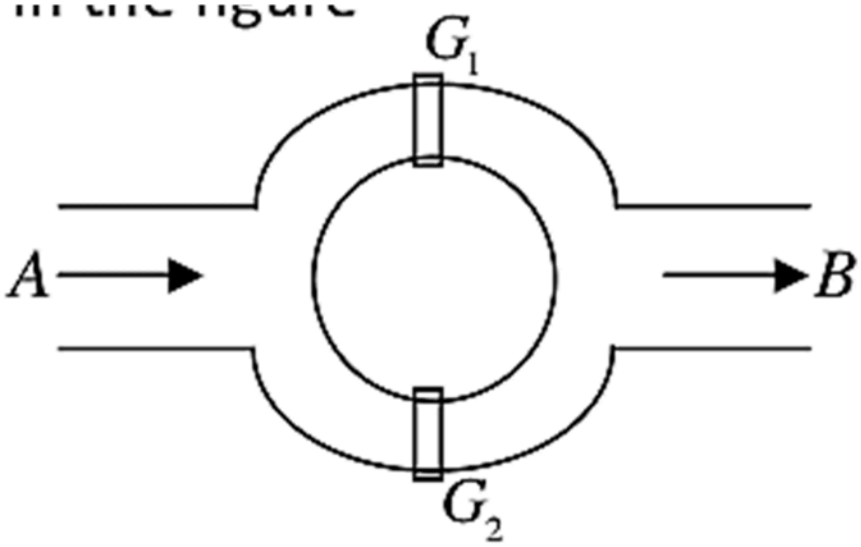


Q18. [June 2019] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2019 June	2M

A canal system is shown in the figure



Water flows from A to B through two channels. Gates G_1 and G_2, are operated independently to regulate the flow. Probability of G_1 to be open is 10% while that of G_2 is 20%. The probability that water will flow from A to B is

1. 10%
2. 20%
3. 28%
4. 30%

Q19. [June 2019] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2019 June	2M

A long ream of paper of thickness t is rolled tightly. As the roll becomes larger, the length of the paper wrapped in one turn exceeds the length in the previous turn by

1. t
2. $2t$
3. πt
4. $2\pi t$

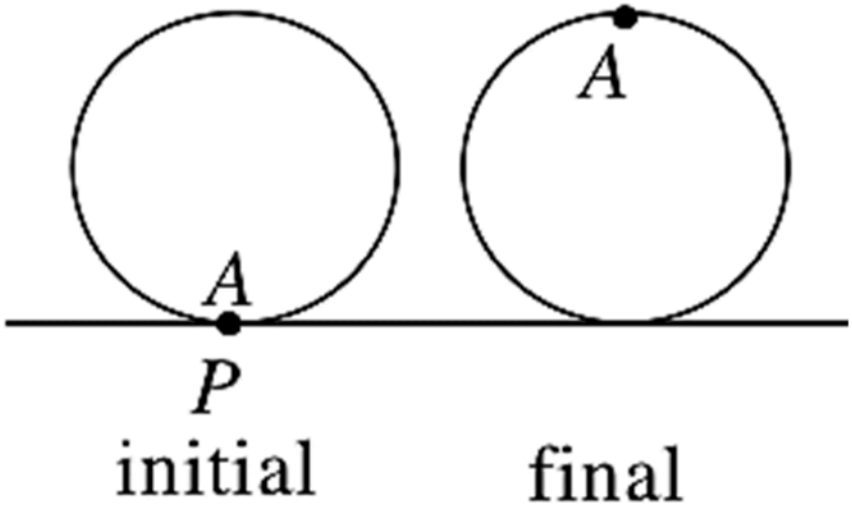
Q20. [June 2019] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2019 June	2M

Point A on a wheel of radius r touches the horizontal plane at point P. It rolls without slipping, till point A is at the highest position in the first turn. What is the final distance AP ?

1. $2r$
2. $r\sqrt{(1+\pi^2)}$
3. $r\sqrt{(4+\pi^2)}$
4. $2r\sqrt{(1+\pi^2)}$



Q21. [June 2019] . 3.5 marks

Classical Mechanics > Basic Mechanics

CSIR NET	2019 June	3.5M

An object is dropped on a cushion from a height $10m$ above it. On being hit, the cushion is depressed by 0.1 m . Assuming that the cushion provides a constant resistive force, the deceleration of the object after hitting the cushion, in terms of the acceleration due to gravity g is

1. 10 g
2. $50g$
3. 100 g
4. g

Q22. [June 2019] . 3.5 marks

Classical Mechanics > Pseudo Forces

CSIR NET	2019 June	3.5M

A turn-table is rotating with a constant angular velocity ω_0. In the rotating frame fixed to the turntable, a particle moves radially outwards at a constant speed v_0. The acceleration of the particle in the $r\theta$ coordinates, as seen from an inertial frame, the origin of which is at the centre of the turntable, is

1. $-r\omega_0^2\hat{r}$
2. $2r\omega_0^2\hat{r} + v_0\omega_0\hat{\theta}$
3. $r\omega_0^2\hat{r} + 2v_0\omega_0\hat{\theta}$
4. $-r\omega_0^2\hat{r} + 2v_0\omega_0\hat{\theta}$

Q23. [June 2019] . 3.5 marks

Classical Mechanics > Central forces

CSIR NET	2019 June	3.5M

Assume that the earth revolves in a circular orbit around the sun. Suppose the gravitational constant G varies slowly as a function of time. In particular, it decreases to half its initial value in the course of one million years. Then during this time the

1. radius of the earth's orbit will increase by a factor of two
2. total energy of the earth remains constant
3. orbital angular momentum of the earth will increase
4. radius of the earth's orbit remains the same.

Q24. [June 2019] . 3.5 marks

Classical Mechanics > Oscillations

CSIR NET	2019 June	3.5M

A particle of mass m moves in One dimension in the potential $V(x) = kx^4, (k > 0)$. at time $t = 0$ the particle starts from rest at $x = A$. For bounded motion, the time period of its motion is

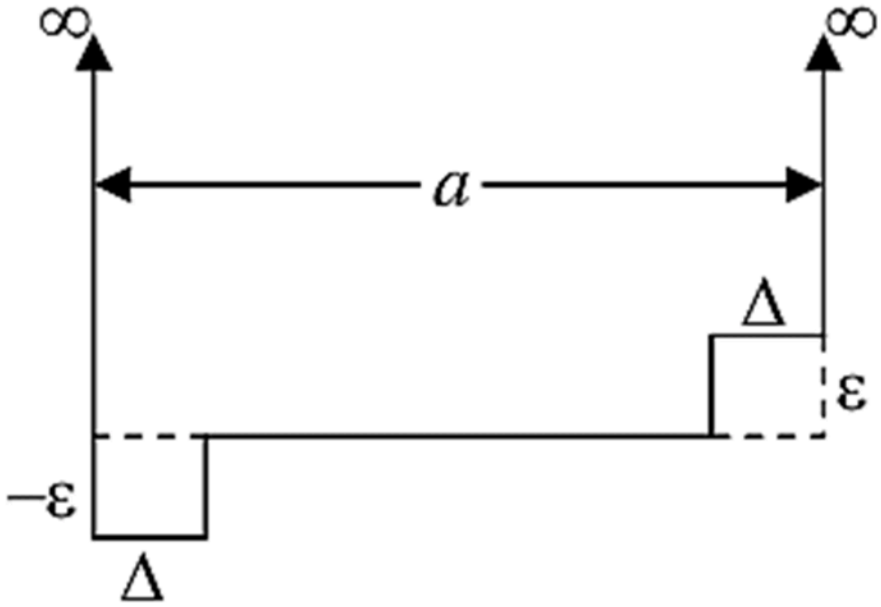
1. proportional to $A^{-1/2}$
2. proportional to A^{-1}
3. independent of A
4. not well-defined (the system is chaotic)

Q25. [June 2019] . 3.5 marks

Quantum Mechanics > Pertubation theory

CSIR NET	2019 June	3.5M

The infinite square-well potential of a particle in a box of size a is modified as shown in the figure below (assume $\Delta \ll a$).



The energy of the ground state, compared to the ground state energy before the perturbation was added

1. increases by a team of order ε
2. decreases by a term of order ε
3. increases by a term of order ε^2
4. decreases by a term of order ε^2

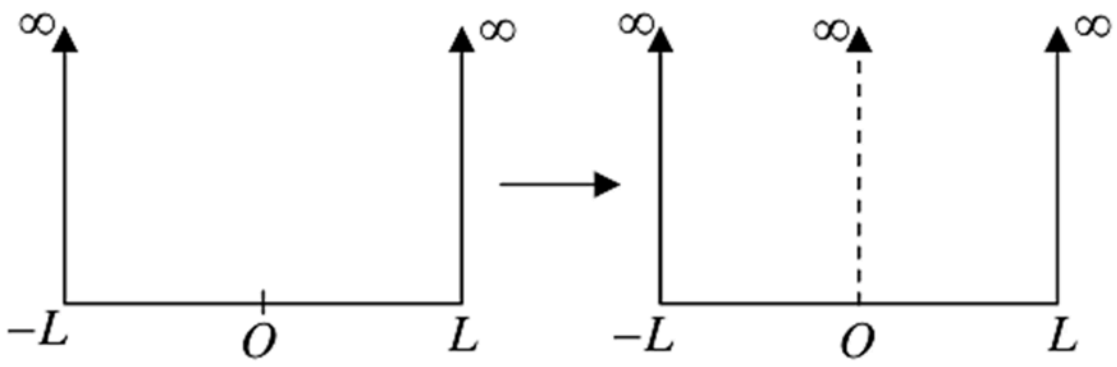
Q26. [June 2019] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2019 June	3.5M

A quantum particle of mass m in one dimension, confined to a rigid box as shown in the figure, is in its ground state. An infinitesimally thin wall is very slowly raised to infinity at the centre of the box, in such a way that the system remains in its ground state at all times. Assuming that no energy is lost in raising the wall, the work done on the system when the wall is fully raised, eventually separating the original box into two compartments, is

1. $\frac{3\pi^2\hbar^2}{8mL^2}$
2. $\frac{\pi^2\hbar^2}{8mL^2}$
3. $\frac{\pi^2\hbar^2}{2mL^2}$
4. 0



Q27. [June 2019] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2019 June	3.5M

The wavefunction of a free particle of mass m, constrained to move in the interval $-L \leq x \leq L$, is $\psi(x) = A(L+x)(L-x)$, where A is the normalization constant. The probability that the particle will be found to have the energy $\frac{\pi^2\hbar^2}{2mL^2}$ is

1. 0
2. $\frac{1}{\sqrt{2}}$
3. $\frac{1}{2\sqrt{3}}$
4. $\frac{1}{\pi}$

Q28. [June 2019] . 3.5 marks

Quantum Mechanics > Orbital angular Momentum and Hydrogen atom

CSIR NET	2019 June	3.5M

A particle moving in a central potential is described by a wave function $\psi(r) = zf(r)$ where $r = (x, y, z)$ is the position vector of the particle and $f(r)$ is a function of $r = |r|$. If L is the total angular momentum of the particle, the value of L^2 must be

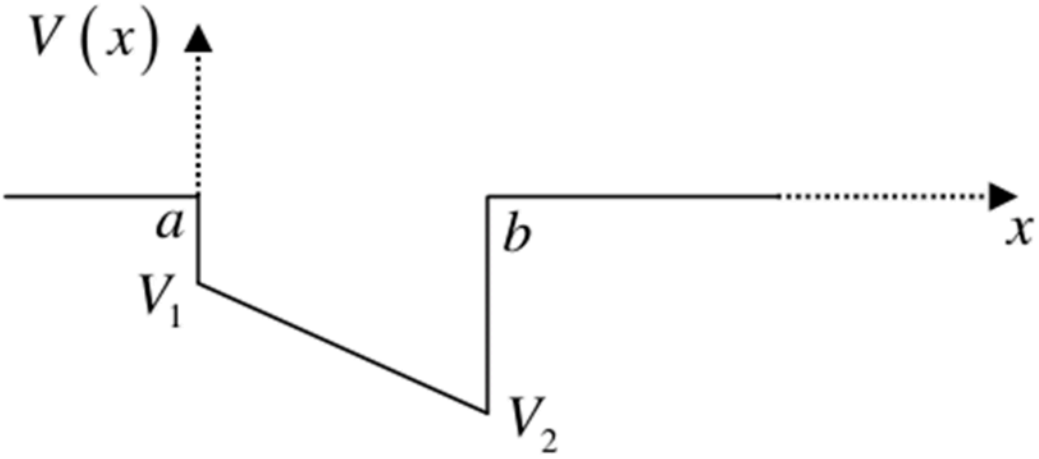
1. $2\hbar^2$
2. $\hbar^2$
3. $4\hbar^2$
4. $\frac{3}{4}\hbar^2$

Q29. [June 2019] . 3.5 marks

Quantum Mechanics > Potential Well

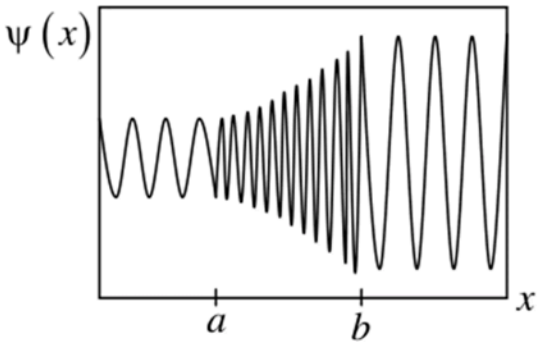
CSIR NET	2019 June	3.5M

A particle of mass in and energy $E > 0$. in one dimension is scattered by the potential below.



If the particle was moving from $x = -\infty$ to $x = \infty$, which of the following graphs gives the best qualitative representation of the wave function of this particle?

1.



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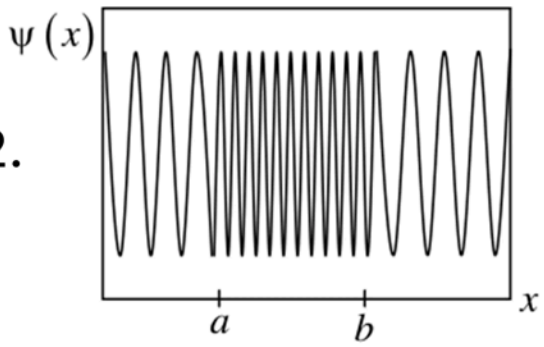
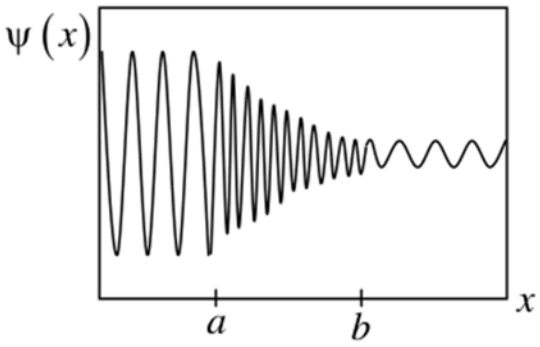
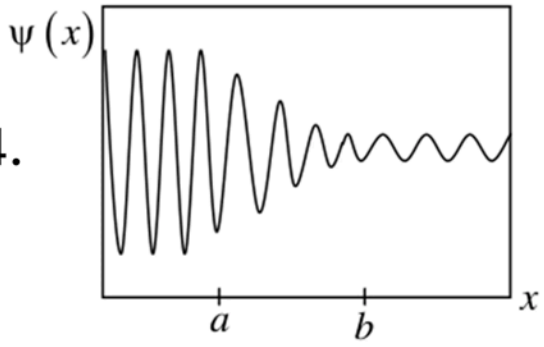


3.



4.



Q30. [June 2019] . 3.5 marks

Electromagnetism > Magetostatics

CSIR NET	2019 June	3.5M

Consider a planar wire loop as an n-sided regular polygon, in which R is the distance from the centre to a vertex. If a steady current I flows through the wire, the magnitude of the magnetic field at the centre of the Loop is

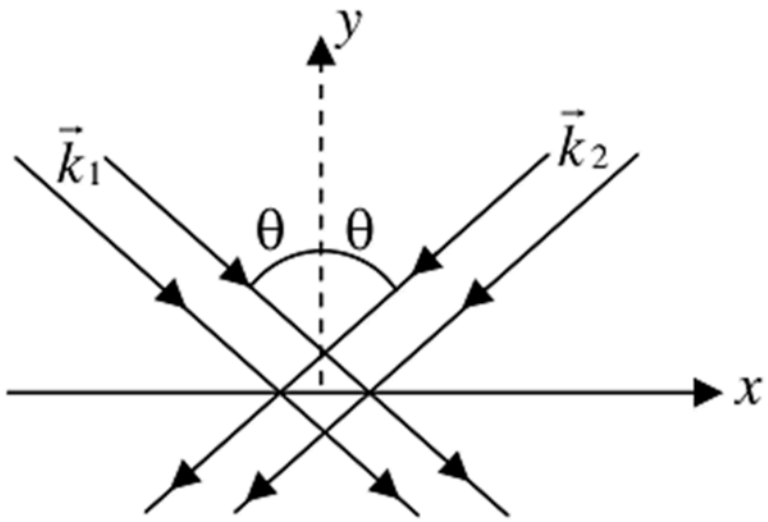
1. $\frac{\mu_0 I}{2R}\sin\left(\frac{2\pi}{n}\right)$
2. $\frac{\mu_0 nI}{4\pi R}\sin\left(\frac{\pi}{n}\right)$
3. $\frac{\mu_0 nI}{2\pi R}\tan\left(\frac{2\pi}{n}\right)$
4. $\frac{\mu_0 nI}{2\pi R}\tan\left(\frac{\pi}{n}\right)$

Q31. [June 2019] . 3.5 marks

Optics > Interference and diffraction

CSIR NET	2019 June	3.5M

Two coherent plane electromagnetic waves of wavelength $0.5\mu m$ (both have the same amplitude and are linearly polarized along the z-direction) fall on the $y = 0$ plane. Their wave vectors k_1 and k_1 are as shown in the figure



If the angle θ is $30°$, the fringe spacing of the interference
pattern produced on the plane is

1. 1.0μ m
2. 0.29μ m
3. 0.58μ m
4. 0.5μ m

Q32. [June 2019] . 3.5 marks

Electromagnetism > Electric field in matter

CSIR NET	2019 June	3.5M

Which of the following is not a correct boundary condition at an interface between two homogeneous dielectric media? (In the following $\hat{n}$ is a unit vector normal to the interface, σ and $\vec{j}_s$, are the surface charge and current densities, respectively.)

1. $\hat{n} \times \left(\vec{D}_1 - \vec{D}_2\right) = 0$
2. $\hat{n} \times \left(\vec{H}_1 - \vec{H}_2\right) = \vec{j}_s$
3. $\hat{n} \cdot \left(\vec{D}_1 - \vec{D}_2\right) = \sigma$
4. $\hat{n} \cdot \left(\vec{B}_1 - \vec{B}_2\right) = 0$

Q33. [June 2019] . 3.5 marks

Optics > Polarization

CSIR NET	2019 June	3.5M

The permittivity tensor of a uniaxial anisotropic medium, in the standard Cartesian basis, is

$\begin{pmatrix} 4\varepsilon_0 & 0 & 0 \\ 0 & 4\varepsilon_0 & 0 \\ 0 & 0 & 9\varepsilon_0 \end{pmatrix}$ where ε_0 is a constant. The wave number of an electromagnetic plane wave polarized along the x-direction, and propagating along the y-direction in this medium (in terms of the wave number k_0 of the wave in vacuum) is

1. $4k_0$
2. $2k_0$
3. $9k_0$
4. $3k_0$

Q34. [June 2019] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2019 June	3.5M

The element of a 3×3 matrix A are the products if its row and column indices $A_{ij} = ij$

(where $i, j = 1,2,3$). The eigenvalues of A are

1. $(7,7,0)$
2. $(7,4,3)$
3. $(14,0,0)$
4. $\left(\frac{14}{3}, \frac{14}{3}, \frac{14}{3}\right)$

Q35. [June 2019] . 3.5 marks

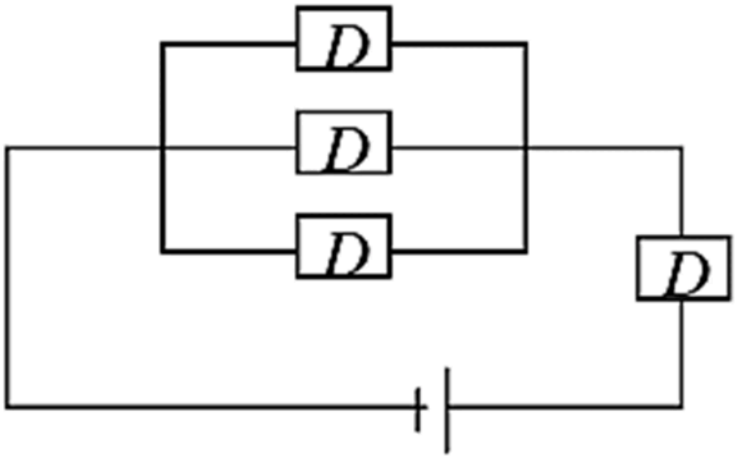
Mathematical Physics > Probability

CSIR NET	2019 June	3.5M

In the following circuit, each device D may be an insulator with probability p or a conductor with probability $(1 - p)$.

The probability that a non-zero current flows through the circuit is

1. $2 - p - p^3$
2. $(1 - p)^4$
3. $(1 - p)^2 p^2$
4. $(1 - p)(1 - p^3)$



Q36. [June 2019] . 3.5 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2019 June	3.5M

The solution of the differential equation

$x\frac{dy}{dx} + (1+x)y = e^{-x}$ with the boundary condition $y(x=1) = 0$, is

1. $\frac{(x-1)}{x}e^{-x}$
2. $\frac{(x-1)}{x^2}e^{-x}$
3. $\frac{(1-x)}{x^2}e^{-x}$
4. $(x-1)^2e^{-x}$

Q37. [June 2019] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2019 June	3.5M

The value of the definite integral $\int_0^{\pi} \frac{d\theta}{5+4\cos\theta}$ is

1. $\frac{4\pi}{3}$
2. $\frac{2\pi}{3}$
3. π
4. $\frac{\pi}{3}$

Q38. [June 2019] . 3.5 marks

Statistical Mechanics > Microstates and Macrostates

CSIR NET	2019 June	3.5M

In a system comprising of approximately 10^{23} distinguishable particles, each particle may occupy any of 20 distinct states. The maximum value of the entropy per particle is nearest to

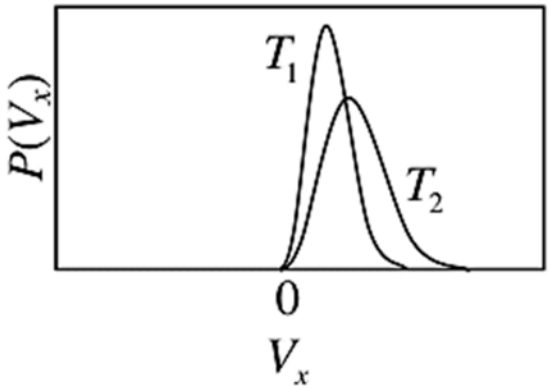
1. $20k_B$
2. $3k_B$
3. $10(\ln 2)k_B$
4. $20(\ln 2)k_B$

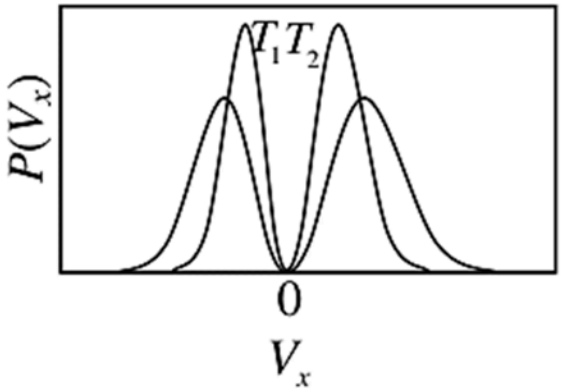
Q39. [June 2019] . 3.5 marks

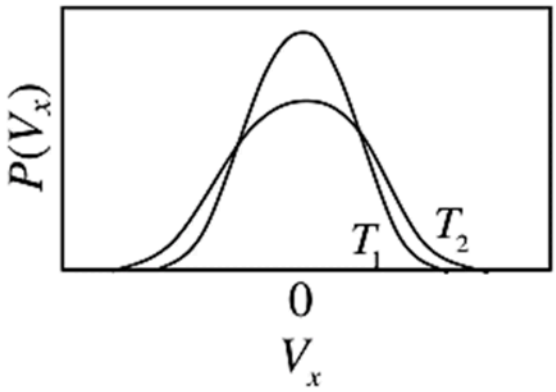
Statistical Mechanics > Black Body Radiations

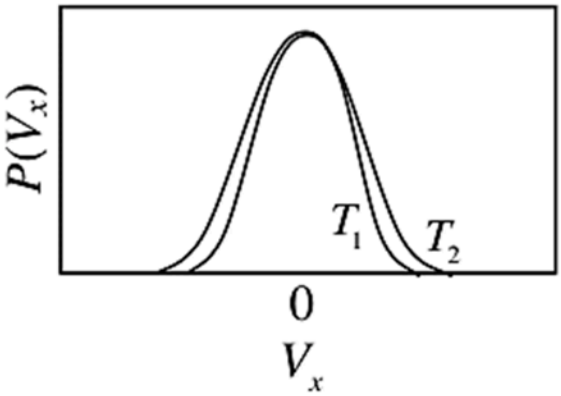
CSIR NET	2019 June	3.5M

Consider a classical gas in thermal equilibrium at temperatures T_1 and T_2 where $T_1 < T_2$. Which of the following graphs correctly represents the qualitative behavior of the probability density function of the x-component of the velocity?

1. 

2. 

3. 

4. 

Q40. [June 2019] . 3.5 marks

Thermodynamics > Thermodynamic relations and maxwell equations

CSIR NET	2019 June	3.5M

The equation of state of an ideal gas is $pV = RT$. At very low temperatures, the volume expansion coefficient $\frac{1}{V}\frac{\partial V}{\partial T}$ at constant pressure

1. diverges as $\frac{1}{T^2}$
2. diverges as $\frac{1}{T}$
3. vanishes as T
4. is independent of the temperature

Q41. [June 2019] . 3.5 marks

Thermodynamics > Kinetic theory of Gases

CSIR NET	2019 June	3.5M

The Hamiltonian of a classical nonlinear one dimensional oscillator is $H = \frac{1}{2m}p^2 + \lambda x^4$, where $\lambda > 0$ is a constant. The specific heat of a collection of a collection of N independent such oscillators is

1. $\frac{3Nk_B}{2}$
2. $\frac{3Nk_B}{4}$
3. Nk_B
4. $\frac{Nk_B}{2}$

Q42. [June 2019] . 3.5 marks

Electronics > "Errors , curve fitting and data analysis"

CSIR NET	2019 June	3.5M

In an experiment to measure the acceleration due to gravity g using a simple pendulum, the length and time period of the pendulum are measured to three significant figures. The mean value of g and the uncertainty δg of the measurements are then estimated using a calculator from a large number of measurements and found to be $9.82147\ \mathrm{m/s^2}$ and $0.02357\ \mathrm{m/s^2}$, respectively. Which of the following is the most accurate way of presenting the experimentally determined value of g ?

1. $9.82 \pm 0.02\ \mathrm{m/s^2}$
2. $9.8215 \pm 0.02\ \mathrm{m/s^2}$
3. $9.82147 \pm 0.02357\ \mathrm{m/s^2}$
4. $9.82 \pm 0.02357\ \mathrm{m/s^2}$

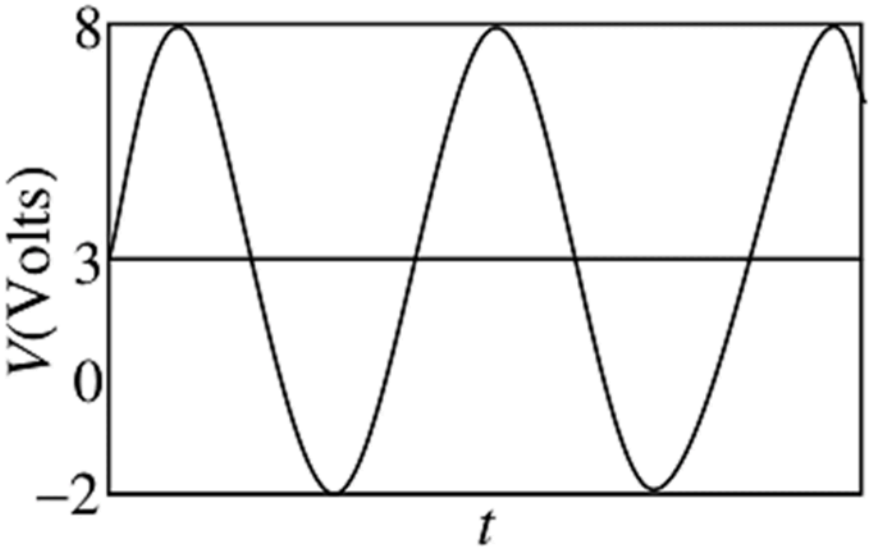
Q43. [June 2019] . 3.5 marks

Electronics > RLC Circuits

CSIR NET	2019 June	3.5M

An ac signal of the type as shown in the figure, is applied across a resistor $R = 1\Omega$. The power dissipated across the resistor is

1. 12.5 W
2. 9 W
3. 25 W
4. 21.5 W

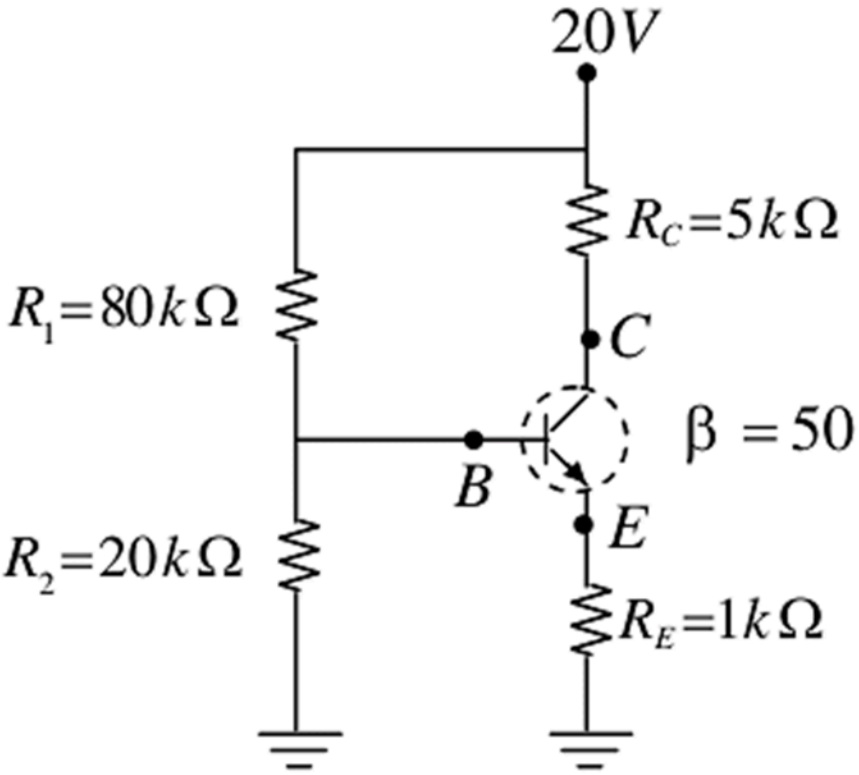


Q44. [June 2019] . 3.5 marks

Electronics > Transistors

CSIR NET	2019 June	3.5M

An npn -transistor is connected in a voltage divider configuration as shown in the figure below.



If the resistor R_2 is disconnected, the voltages V_B at the base and V_C at the collector change as follows.

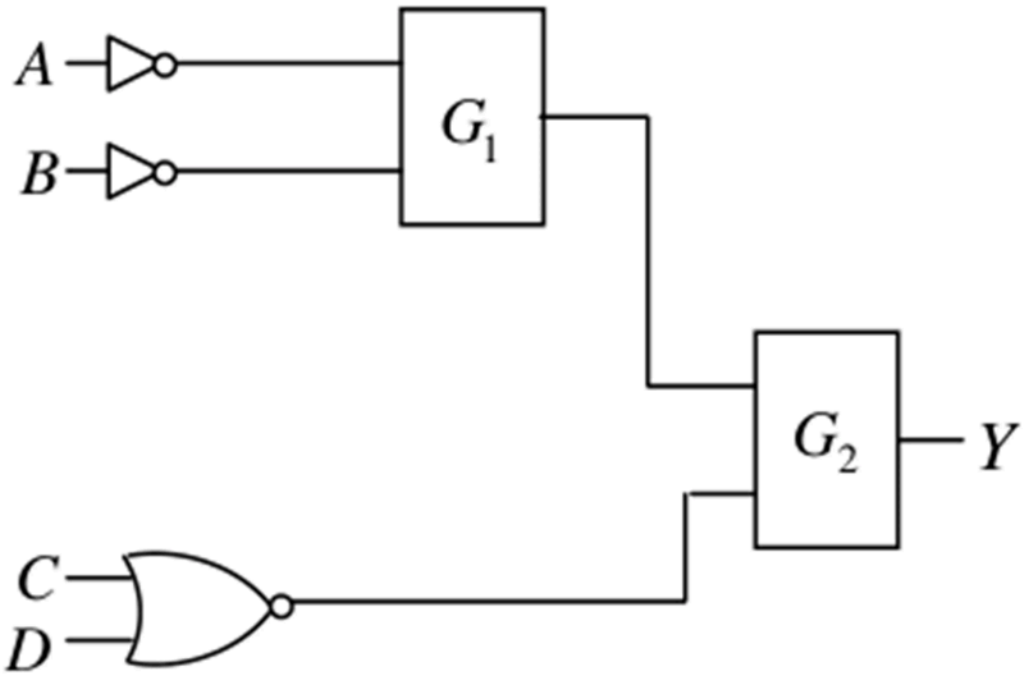
1. both V_B and V_C increase
2. both V_B and V_C decrease
3. V_B decreases, but V_C increases
4. V_B increases, but V_C decreases

Q45. [June 2019] . 3.5 marks

Electronics > Digital Electronics

CSIR NET	2019 June	3.5M

Let Y denote the output in the following logical Circuit.



If $Y = AB + \bar{C}D$, the gates G_1 and G_2 must, respectively, be

1. OR and NAND
2. NOR and OR
3. AND and NAND
4. NAND and OR

Q46. [June 2019] . 5.0 marks

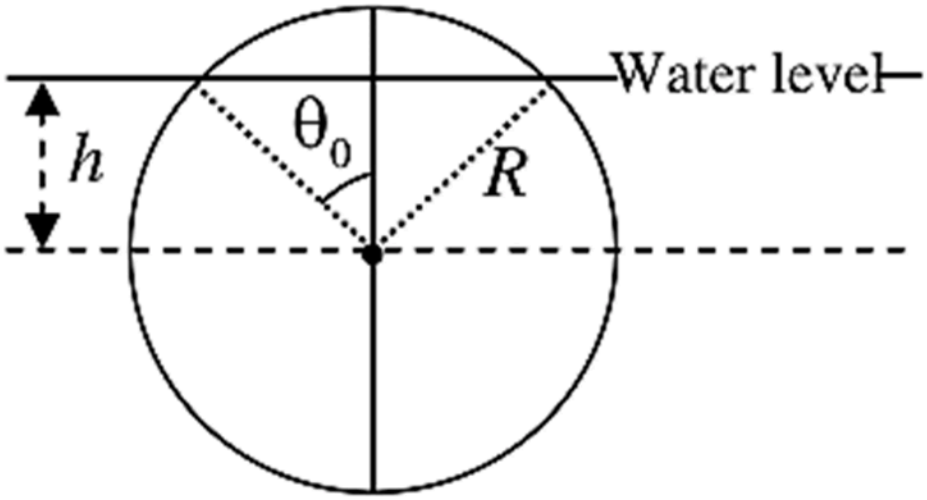
Classical Mechanics > Basic Mechanics

CSIR NET	2019 June	5M

A solid spherical Cork of radius R and specific gravity 0.5 floats on water. The cork is pushed down so that its centre of mass is at a distance h (where $0 < h < R$) below the surface of water, and Then released. The volume of the part of the cork above water level is $\pi R^3 \left(\frac{2}{3} - \cos\theta_0 + \frac{1}{3}\cos^3\theta_0\right)$ where θ_0 is the angle as shown in the figure.

At the moment of release, the dependence of the upward force on the cork on h is

1. $\frac{h}{R} - \frac{1}{3}\left(\frac{h}{R}\right)^3$
2. $\frac{h}{R} + \frac{1}{3}\left(\frac{h}{R}\right)^3$
3. $\frac{h}{R} - \frac{2}{3}\left(\frac{h}{R}\right)^3$
4. $\frac{h}{R} + \frac{2}{3}\left(\frac{h}{R}\right)^3$



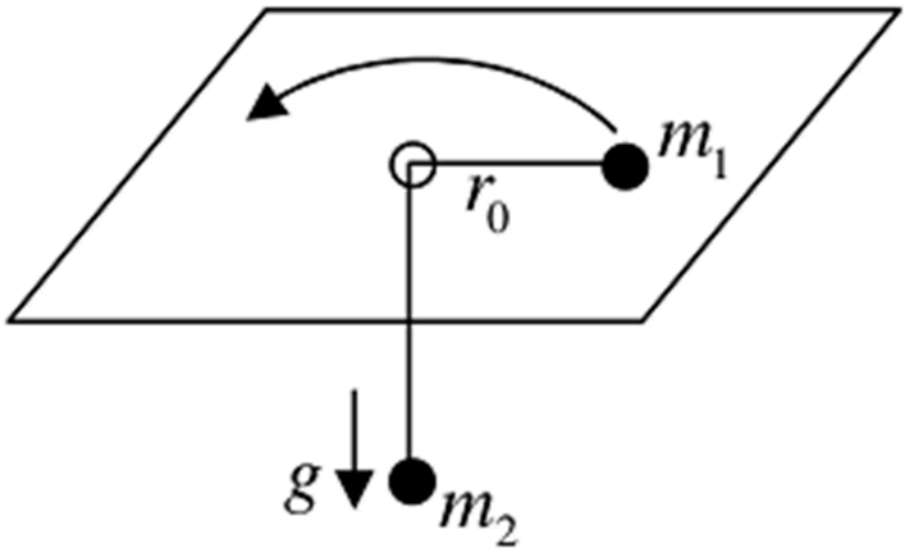
Q47. [June 2019] . 5.0 marks

Classical Mechanics > Lagrangian and Hamiltonian

CSIR NET	2019 June	5M

Two particles of masses m_1 and m_2 are connected by a mass less thread of length l as shown in figure.

The particle of mass in on the plane undergoes a circular motion with radius r_0 and angular momentum L. When a small radial displacement $\in$ (whew $\in \ll r_0$) is applied, its radial coordinate is found to found to oscillate about r_0. The frequency of the oscillations is



1. $\sqrt{\frac{7m_2g}{\left(m_1+\frac{m_2}{2}\right)r_0}}$
2. $\sqrt{\frac{7m_2g}{(m_1+m_2)r_0}}$
3. $\sqrt{\frac{3m_2g}{\left(m_1+\frac{m_2}{2}\right)r_0}}$
4. $\sqrt{\frac{3m_2g}{(m_1+m_2)r_0}}$

Q48. [June 2019] . 5.0 marks

Classical Mechanics > Basic Mechanics

CSIR NET	2019 June	5M

The time evolution of a coordinate x of a particle is described by the equation

$$\frac{d^2x}{dt^4} + 2\Omega^2\frac{d^2x}{dt^2} + (\Omega^4 - A^4)x = 0$$

For $\Omega > A$, the particle will

1. eventually come to rest at the origin
2. eventually drift to infinity ($|x| \to \infty$)
3. oscillate about the origin
4. eventually come to rest at $\frac{\Omega}{A}$ or $-\frac{\Omega}{A}$

Q49. [June 2019] . 5.0 marks

Quantum Mechanics > WKB Approximation

CSIR NET	2019 June	5M

The Hamiltonian of A quantum particle of mass m is $H = \frac{p^2}{2m} + \alpha|x|^r$, where α and r are positive constants. The energy E_n of the n^{th} level for large n, depends on n as

1. n^{2r}
2. n^{r+2}
3. $n^{1/(r+2)}$
4. $n^{2r/(r+2)}$

Q50. [June 2019] . 5.0 marks

Quantum Mechanics > Scattering theory

CSIR NET	2019 June	5M

In the partial wave expansion, the differential scattering cross-section is given by

$$\frac{d\sigma}{d(\cos\theta)} = \left|\sum_l (2l+1)e^{i\delta_i}\sin\delta_l P_l(\cos\theta)\right|^2$$

where θ is the scattering angle. For a certain neutron-nucleus scattering. it is found that the two lowest phase shifts δ_0 and δ_1 corresponding to s-wave and p-wave, respectively, satisfy $\delta_1 \approx \frac{\delta_0}{2}$. Assuming that the other phase shifts are negligibly small, the differential cross-section reaches its minimum for $\cos\theta$ equal to

1. 0
2. ± 1
3. $-\frac{2}{3}\cos^2\delta_1$
4. $\frac{1}{3}\cos^2\delta_1$

Q51. [June 2019] . 5.0 marks

Quantum Mechanics > Pertubation theory

CSIR NET	2019 June	5M

A charged, spin-less particle of mass m is subjected to an attractive potential

$V(x,y,z) = \frac{1}{2}k\left(x^2 + y^2 + z^2\right)$, where k is a positive constant. Now a perturbation in the form of a weak magnetic field $B = B_0\hat{k}$ (where B_0 is a constant is switched on. Into how many distinct levels will the second excited state of the unperturbed Hamiltonian split?

1. 5
2. 4
3. 2
4. 1

Q52. [June 2019] . 5.0 marks

Quantum Mechanics > Scattering theory

CSIR NET	2019 June	5M

The elastic scattering of a charged particle of mass m off an atom can be approximated by the potential $V(r) = \frac{\alpha}{r} e^{-r/R}$ where α and R are positive constants. If the wave number of the incoming particle is k and the scattering angle is 2θ, the differential cross-section in the Born approximation is

(a) $\frac{m^2\alpha^2R^4}{4\hbar^4\left(1+k^3R^2\sin^2\theta\right)}$

(b) $\frac{m^2\alpha^2R^4}{\hbar^4\left(2k^2R^2\sin^2\theta\right)^2}$

(c) $\frac{2m^2\alpha^2R^4}{\hbar^4\left(2k^2R^2 2\sin^2\theta\right)}$

(d) $\frac{4m^2\alpha^2R^4}{\hbar^4\left(1+4k^2R^2\sin^2\theta\right)^2}$

Q53. [June 2019] . 5.0 marks

Quantum Mechanics > Basic Quantum Mechanics

CSIR NET	2019 June	5M

The wave number k and the angular frequency ω of a wave are related by the dispersion relation $\omega^2 = \alpha k + \beta k^3$ where α and β are positive constants. The wave number for which the phase velocity equals the group velocity, is

1. $3\sqrt{\frac{\alpha}{\beta}}$
2. $\sqrt{\frac{\alpha}{\beta}}$
3. $\frac{1}{2}\sqrt{\frac{\alpha}{\beta}}$
4. $\frac{1}{3}\sqrt{\frac{\alpha}{\beta}}$

Q54. [June 2019] . 5.0 marks

Electromagnetism > Relativistic electromagnetism

CSIR NET	2019 June	5M

A inertial observer A at rest measures the electric and magnetic field $E = (\alpha, 0,0)$ and $B = (\alpha, 0,2\alpha)$ in a region, where a is a constant. Another inertial observer B, moving with a constant velocity with respect to A, measures the fields as $E' = (E'_x, \alpha, 0)$ and $B' = (\alpha, B'_y, \alpha)$. Then in units $c = 1, E'_x$ and B'_y are given, respectively, by

1. -2α and α
2. 2α and $-\alpha$
3. α and -2α
4. $-\alpha$ and 2α

Q55. [June 2019] . 5.0 marks

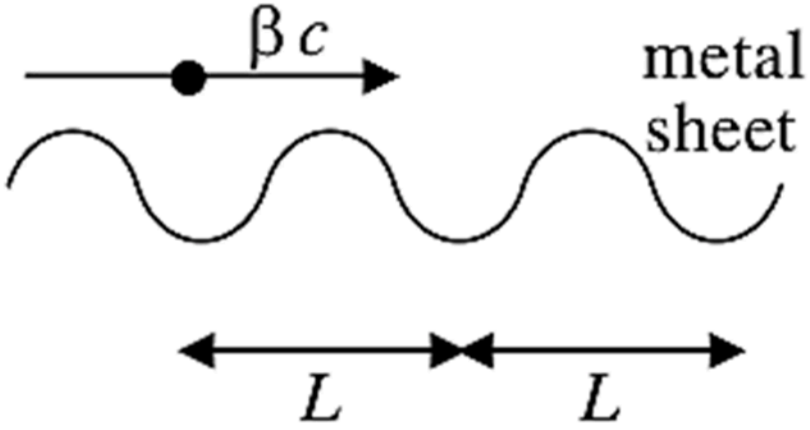
Classical Mechanics > Special theory of relativity

CSIR NET	2019 June	5M

A point charge is moving with a uniform velocity βC along the positive x-direction, parallel to and very close to a corrugated metal sheet (see the figure).

The wavelength of the electromagnetic radiation received by an observer along the direction of motion is

1. $\frac{1}{\beta}\sqrt{1-\beta^2}$
2. $L\sqrt{1-\beta^2}$
3. $L\beta\sqrt{1-\beta^2}$
4. L



Q56. [June 2019] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2019 June	5M

If the Newton-Raphson method is used to find the positive root of the equation $x = 2\sin x$, the iteration equation is

1. $x_{n+1} = \frac{2x_n - 2(\sin x_n + x_n \cos x_n)}{1 - 2\cos x_n}$
2. $x_{n+1} = \frac{2(\sin x_n - x_n \cos x_n)}{1 - 2\cos x_n}$
3. $x_{n+1} = \frac{x_n^2 - 1 + 2(\cos x_n - x_n \sin x_n)}{x_n - 2\sin x_n}$
4. $x_{n+1} = \frac{x_n^2 - 1 - 2(\cos x_n + \sin x_n)}{x_n - 2\sin x_n}$

Q57. [June 2019] . 5.0 marks

Classical Mechanics > Oscillations

CSIR NET	2019 June	5M

The equation of motion of a forced simple harmonic oscillator is $\ddot{x} + \omega^2 x = A\cos\Omega t$, where A is a constant. At resonance $\Omega = \omega$ the amplitude of oscillations at large times

1. saturates to a finite value
2. increases with time as $\sqrt{t}$
3. increases linearly with time
4. increases exponentially with time

Q58. [June 2019] . 5.0 marks

Quantum Mechanics > Basic Quantum Mechanics

CSIR NET	2019 June	5M

The operator A has a matrix representation $\begin{pmatrix} 2 & 1 \\ 1 & 2 \end{pmatrix}$ in the basis spanned by $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$. In another basis spanned by $\frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ 1 \end{pmatrix}$ and $\frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ -1 \end{pmatrix}$, the matrix representation of A is

1. $\begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$
2. $\begin{pmatrix} 3 & 0 \\ 0 & 1 \end{pmatrix}$
3. $\begin{pmatrix} 3 & 1 \\ 0 & 1 \end{pmatrix}$
4. $\begin{pmatrix} 3 & 0 \\ 1 & 1 \end{pmatrix}$

Q59. [June 2019] . 5.0 marks

Quantum Mechanics > Basic Quantum Mechanics

CSIR NET	2019 June	5M

The operator $x\frac{d}{dx}\delta(x)$, where $\delta(x)$ is the Dirac delta function, acts on the space of real valued square-integrable functions on the real line. This operator is equivalent to

1. $-\delta(x)$
2. $\delta(x)$
3. x
4. 0

Q60. [June 2019] . 5.0 marks

Statistical Mechanics > Random Walk/Brownian motion/Diffusion

CSIR NET	2019 June	5M

At each time step, a random walker in one dimension either remains at the same point with probability $\frac{1}{4}$, or moves by a distance Δ to the right or left with probabilities $\frac{3}{8}$ each. After N time steps, its root mean squared displacement is

1. $\Delta\sqrt{N}$
2. $\Delta\sqrt{\frac{9N}{16}}$
3. $\Delta\sqrt{\frac{3N}{4}}$
4. $\Delta\sqrt{\frac{3N}{8}}$

Q61. [June 2019] . 5.0 marks

Statistical Mechanics > Ising model

CSIR NET	2019 June	5M

The Hamiltonian of three Ising spins S_1, S_2 and S_3, each taking values ± 1, is

$H = -J(S_1S_2 + S_2S_3) - hS_1$, where J and h are positive constants. The mean value of S_3 in equilibrium at a temperature $T = 1/(k_B\beta)$, is

1. $\tanh^3(\beta J)$
2. $\tan(\beta h)\tanh^2(\beta J)$
3. $\sinh(\beta h)\sinh^2(\beta J)$
4. 0

Q62. [June 2019] . 5.0 marks

Thermodynamics > Phase transitions

CSIR NET	2019 June	5M

The free energy of a magnetic system, as a function of its magnetization m, is $F = \frac{1}{2}am^2 - \frac{1}{4}bm^4 + \frac{1}{6}m^6$. where a and b are positive constants.

At a fixed value of a, the critical value of b, above which the minimum of F will be at a nonzero value of magnetization, is

1. $\sqrt{\frac{10a}{3}}$
2. $\sqrt{\frac{16a}{3}}$
3. $\frac{10}{3}\sqrt{a}$
4. $\frac{16}{3}\sqrt{a}$

Q63. [June 2019] . 5.0 marks

Electronics > OPAMP

CSIR NET	2019 June	5M

For optimal performance of an op-amp based current-to-voltage converter circuit, the input and output impedance should be

1. Low input impedance and high output impedance
2. low input impedance and low output impedance
3. high input impedance and high output impedance
4. high input impedance and low output impedance

Q64. [June 2019] . 5.0 marks

Electronics > Diodes

CSIR NET	2019 June	5M

The forward diode current is given by

$I = kT^{\alpha}e^{-E_g/k_BT}(\exp(eV/k_BT) - 1)$, where E_g is the band gap of the semiconductor, V is the voltage drop across the diode, T is the temperature of the diode operating near room temperature and, α and K are constants. A diode is used as a thermal sensor in the circuit shown below.

If V is measured using an ideal voltmeter to estimate T, the variation of the voltage V as a function of T is best approximated by (in the following a and b are constants)

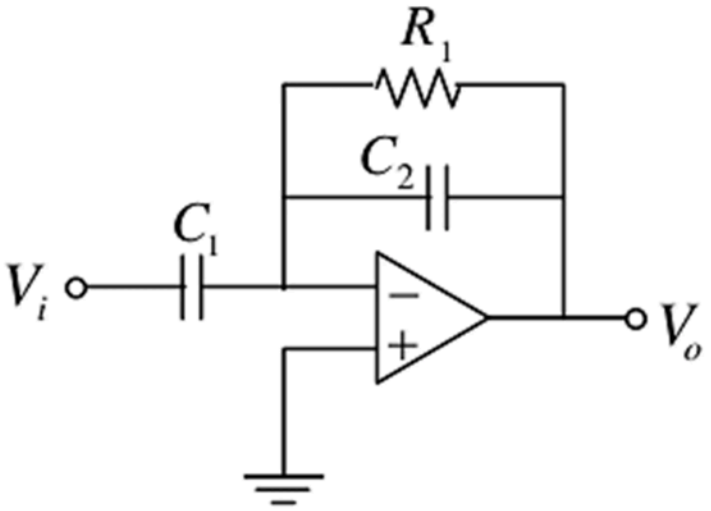
1. $aT^2 + b$
2. $aT + b$
3. $aT^3 + b$
4. $aT + bT^2$

Q65. [June 2019] . 5.0 marks

Electronics > OPAMP

CSIR NET	2019 June	5M

A circuit constructed using op-amp, resistor $R_1 = 1k\Omega$ and capacitors $C_1 = 1\mu F$ and $C_2 = 0.1\mu F$ is shown in the figure below.



This circuit will act as a

1. high pass filter
2. low pass filter
3. band pass filter
4. band reject filter

Q66. [June 2019] . 5.0 marks

Solid State Physics > Crystallography

CSIR NET	2019 June	5M

The third-nearest neighbor distance in a BCC (Body Centered Cubic) crystal with lattice constant a_0 is

1. a_0
2. $\frac{3a_0}{2}$
3. $\sqrt{3}a_0$
4. $\sqrt{2}a_0$

Q67. [June 2019] . 5.0 marks

Solid State Physics > Semiconductor Physics

CSIR NET	2019 June	5M

A bound electron and hole pair interacting via Coulomb interaction in a semiconductor is called an exciton. The effective masses of an electron and a hole are about $0.1m_e$ and $0.5m_e$ respectively, where m_e is the rest mass of the electron. The dielectric constant of the semiconductor is 10 . Assuming that the energy levels of the excitons are hydrogen- like, the binding energy of an exciton (in units of the Rydberg constant) is closest to

1. 2×10^{-3}
2. 2×10^{-4}
3. 8×10^{-4}
4. 3×10^{-3}

Q68. [June 2019] . 5.0 marks

Solid State Physics > Tight binding model

CSIR NET	2019 June	5M

Consider an array of atoms in one dimension with an ensemble averaged periodic density distribution as shown in the figure.

If k is the wave number and $S(k,\Delta)$ denotes the Fourier transform of the density-density correlation function, the ratio $\frac{S(k,\Delta)}{S(k,0)}$ is

1. $\cos\left(\frac{k\Delta}{2}\right)$
2. $\cos^2\left(\frac{k\Delta}{2}\right)$
3. $\frac{2}{k\Delta}\sin\left(\frac{k\Delta}{2}\right)$
4. $\frac{4}{k^2\Delta^2}\sin^2\left(\frac{k\Delta}{2}\right)$

Q69. [June 2019] . 5.0 marks

Atomic and Molecular Physics > Angular momentum in Atomic Physics

CSIR NET	2019 June	5M

A doubly charged ion in the angular momentum state $(J = 2, J_3 = 1)$ meets a gas of polarized electrons $\left(S_3 = \frac{1}{2}\right)$ and gets neutralized. If the orbital angular momentum transferred in the process is zero, the probability that the neutral atom is in the $(J = 2, J_3 = 2)$ state is

1. $\frac{2}{5}$
2. $\frac{2}{3}$
3. $\frac{1}{5}$
4. $\frac{1}{3}$

Q70. [June 2019] . 5.0 marks

Quantum Mechanics > Scattering theory

CSIR NET	2019 June	5M

The range of the inter-atomic potential in gaseous hydrogen is approximately 5Å . In thermal equilibrium, the maximum temperature for which the atom-atom scattering is dominantly s wave, is

1. 500 K
2. 100 K
3. 1 K
4. 1 mK

Q71. [June 2019] . 5.0 marks

Atomic and Molecular Physics > Molecular physics

CSIR NET	2019 June	5M

The energy levels corresponding to the rotational motion of a molecule are $E_J = BJ(J+1)cm^{-1}$ where $J = 0,1,2,$ ..., and B is a constant. Pure rotational Raman transitions follow the selection rule $\Delta J = 0, \pm 2$. When the molecule is irradiated, the separation between the closest Stokes and anti-Stokes lines (in cm^{-1}) is

1. $6B$
2. $12B$
3. $4B$
4. $8B$

Q72. [June 2019] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2019 June	5M

The cavity of a He-Ne laser emitting at 632.8 nm , consists of two mirrors separated by a distance of 35 cm . If the oscillations in the laser cavity occur at frequencies within the gain bandwidth of 1.3 GHz , the number of longitudinal modes allowed in the cavity is

1. 1
2. 2
3. 3
4. 4

Q73. [June 2019] . 5.0 marks

Nuclear and Particle Physics > Radioactivity

CSIR NET	2019 June	5M

An excited state of a $^{8}_{4}\mathrm{Be}$ nucleus decays into two α-particles which are in a spin-parity 0^{+} state. If the mean life-time of this decay is $10^{-22}s$, the spin-parity of the excited state of the nucleus is

1. 2^{+}
2. 3^{+}
3. 0^{-}
4. 4^{-}

Q74. [June 2019] . 5.0 marks

Nuclear and Particle Physics > Nuclear forces and Scattering

CSIR NET	2019 June	5M

The elastic scattering of a neutrino v_e by an electron e^{-}, i.e. the reaction $v_e + e^{-} \rightarrow v_e + e^{-}$ can be described by the interaction Hamiltonian

$$H_{\mathrm{int}} = \frac{1}{\sqrt{2}} G_F \int d^3x (\bar{\psi}_e(x)\gamma^{\mu}\psi_{ve}(x))\left(\bar{\psi}_{ve}(x)\gamma_{\mu}\psi_e(x)\right)$$

The cross-section of the above process depends on the centre of mass energy E, as

1. $\frac{1}{E^2}$
2. E^2
3. E
4. $\sqrt{E}$

Q75. [June 2019] . 5.0 marks

Nuclear and Particle Physics > Particle physics

CSIR NET	2019 June	5M

The mean life-time of the following decays:

$\rho_0 \to \pi^+ + \pi^-, \pi^0 \to \gamma + \gamma, \mu^- \to e^- + \bar{\nu}_e + \nu_\mu$, are τ_ρ, τ_π and τ_μ respectively.

They satisfy

1. $\tau_\pi < \tau_\rho < \tau_\mu$
2. $\tau_\mu < \tau_\rho < \tau_\pi$
3. $\tau_\rho < \tau_\pi < \tau_\mu$
4. $\tau_\rho < \tau_\mu < \tau_\pi$

Answer Key

75 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	General Aptitude	Basic Physics	**2**
Q2	General Aptitude	Mathematical Analysis	**3**
Q3	General Aptitude	Basic Physics	**2**
Q4	General Aptitude	Data Analysis	**4**
Q5	General Aptitude	Mathematical Analysis	**3**
Q6	General Aptitude	Reasoning	**1**
Q7	General Aptitude	Reasoning	**3**
Q8	General Aptitude	Reasoning	**3**
Q9	General Aptitude	Mathematical Analysis	**4**
Q10	General Aptitude	Reasoning	**4**
Q11	General Aptitude	Reasoning	**4**
Q12	General Aptitude	Reasoning	**4**
Q13	General Aptitude	Geometry	**3**
Q14	General Aptitude	Mathematical Analysis	**2**
Q15	General Aptitude	Basic Physics	**3**
Q16	General Aptitude	Mathematical Analysis	**1**
Q17	General Aptitude	Geometry	**1**
Q18	General Aptitude	Mathematical Analysis	**3**
Q19	General Aptitude	Basic Physics	**4**
Q20	General Aptitude	Basic Physics	**3**
Q21	Classical Mechanics	Basic Mechanics	**3**
Q22	Classical Mechanics	Pseudo Forces	**4**
Q23	Classical Mechanics	Central forces	**1**
Q24	Classical Mechanics	Oscillations	**2**
Q25	Quantum Mechanics	Pertubation theory	**4**
Q26	Quantum Mechanics	Potential Well	**1**
Q27	Quantum Mechanics	Potential Well	**1**
Q28	Quantum Mechanics	Orbital angular Momentum and Hydrogen atom	**1**
Q29	Quantum Mechanics	Potential Well	**3**
Q30	Electromagnetism	Magetostatics	**4**
Q31	Optics	Interference and diffraction	**4**
Q32	Electromagnetism	Electric field in matter	**1**
Q33	Optics	Polarization	**2**
Q34	Mathematical Physics	Matrices and Linear Algebra	**3**
Q35	Mathematical Physics	Probability	**4**
Q36	Mathematical Physics	Ordinary Differential Equations	**1**
Q37	Mathematical Physics	Complex analysis	**4**
Q38	Statistical Mechanics	Microstates and Macrostates	**2**
Q39	Statistical Mechanics	Black Body Radiations	**3**
Q40	Thermodynamics	Thermodynamic relations and maxwell equations	**2**

Answer Key (cont.)

Q. No	Subject	Topic	Answer
Q41	Thermodynamics	Kinetic theory of Gases	**2**
Q42	Electronics	"Errors , curve fitting and data analysis"	**4**
Q43	Electronics	RLC Circuits	**4**
Q44	Electronics	Transistors	**4**
Q45	Electronics	Digital Electronics	**2**
Q46	Classical Mechanics	Basic Mechanics	**1**
Q47	Classical Mechanics	Lagrangian and Hamiltonian	**4**
Q48	Classical Mechanics	Basic Mechanics	**3**
Q49	Quantum Mechanics	WKB Approximation	**4**
Q50	Quantum Mechanics	Scattering theory	**3**
Q51	Quantum Mechanics	Pertubation theory	**1**
Q52	Quantum Mechanics	Scattering theory	**4**
Q53	Quantum Mechanics	Basic Quantum Mechanics	**2**
Q54	Electromagnetism	Relativistic electromagnetism	**3**
Q55	Classical Mechanics	Special theory of relativity	**1**
Q56	Mathematical Physics	Numerical Methods	**2**
Q57	Classical Mechanics	Oscillations	**3**
Q58	Quantum Mechanics	Basic Quantum Mechanics	**2**
Q59	Quantum Mechanics	Basic Quantum Mechanics	**1**
Q60	Statistical Mechanics	Random Walk/Brownian motion/Diffusion	**3**
Q61	Statistical Mechanics	Ising model	**2**
Q62	Thermodynamics	Phase transitions	**2**
Q63	Electronics	OPAMP	**2**
Q64	Electronics	Diodes	**2**
Q65	Electronics	OPAMP	**1**
Q66	Solid State Physics	Crystallography	**4**
Q67	Solid State Physics	Semiconductor Physics	**3**
Q68	Solid State Physics	Tight binding model	**3**
Q69	Atomic and Molecular Physics	Angular momentum in Atomic Physics	**4**
Q70	Quantum Mechanics	Scattering theory	**3**
Q71	Atomic and Molecular Physics	Molecular physics	**2**
Q72	Atomic and Molecular Physics	Lasers	**3**
Q73	Nuclear and Particle Physics	Radioactivity	**1**
Q74	Nuclear and Particle Physics	Nuclear forces and Scattering	**2**
Q75	Nuclear and Particle Physics	Particle physics	**3**

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