PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

CSIR NET Physics - Dec 2024 - Full Paper

Complete question paper with answer key

75 questions . Answer key included

www.physicsbyaaryan.com . www.csirnetphysics.com
Contact: 9501976811

Q1. [Dec 2024] . 2.0 marks

General Aptitude > Geometry

CSIR NET	2024 Dec	2M

A chocolate bar of 5 cm length and 4 cm width has to be cut into $1\,\text{cm} \times 1\,\text{cm}$ pieces. How many minimum cuts would be required, if pieces are to be taken one-by-one? (One can start by cutting along either length or width, before removing $1\,\text{cm} \times 1\,\text{cm}$ pieces one by one)

1. 20
2. 19
3. 18
4. 10

Q2. [Dec 2024] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2024 Dec	2M

The square of the geometric mean of two positive integers is 30 . The smallest possible sum of the two integers is

1. 10
2. 11
3. 13
4. 17

Q3. [Dec 2024] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2024 Dec	2M

Two fair dice are thrown at random independently. What is the probability that the average of the values on their upper faces is 4 ?

1. $5/36$
2. $1/6$
3. $7/36$
4. $2/9$

Q4. [Dec 2024] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2024 Dec	2M

Ramesh is taller than Rajesh but not taller than Rupesh. Suresh's height is the average of the heights of Naresh and Rajesh. If Rajesh is taller than Naresh then who is the shortest among them?

1. Suresh
2. Naresh
3. Rupesh
4. Cannot be determined

Q5. [Dec 2024] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2024 Dec	2M

Cube root of 0.0125% is closest to

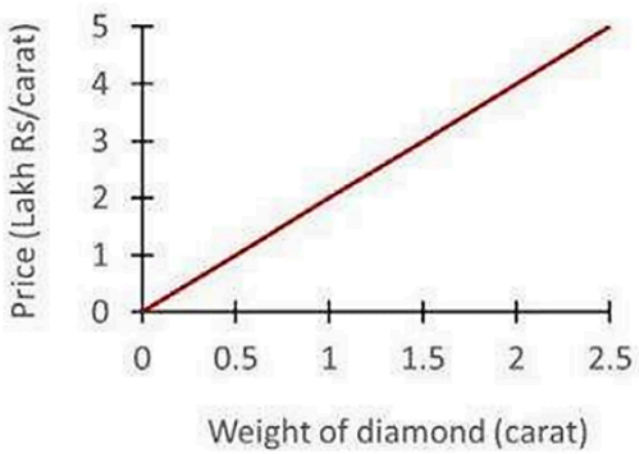
1. 0.005%
2. 0.05%
3. 0.5%
4. 5%

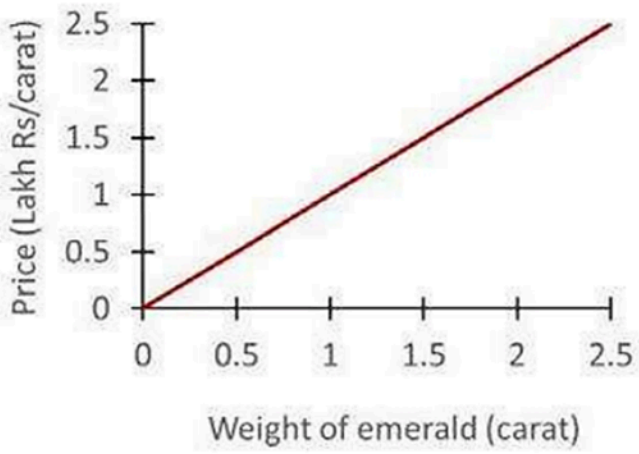
Q6. [Dec 2024] . 2.0 marks

General Aptitude > Data Analysis

CSIR NET	2024 Dec	2M

The diagrams show the rates of diamond and emerald in a range of sizes. A person wants to buy a diamond and an emerald of identical size for a total of Rs. $6,75,000/-$. What is that size?





1. 1 carat
2. 1.5 carat
3. 2 carat
4. 2.5 carat

Q7. [Dec 2024] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2024 Dec	2M

Ten litre (L) milk contains 10% water. How much water should be added to increase its proportion to 20% ?

1. 1 L

2. 1.25 L

3. 2 L

4. 2.25 L

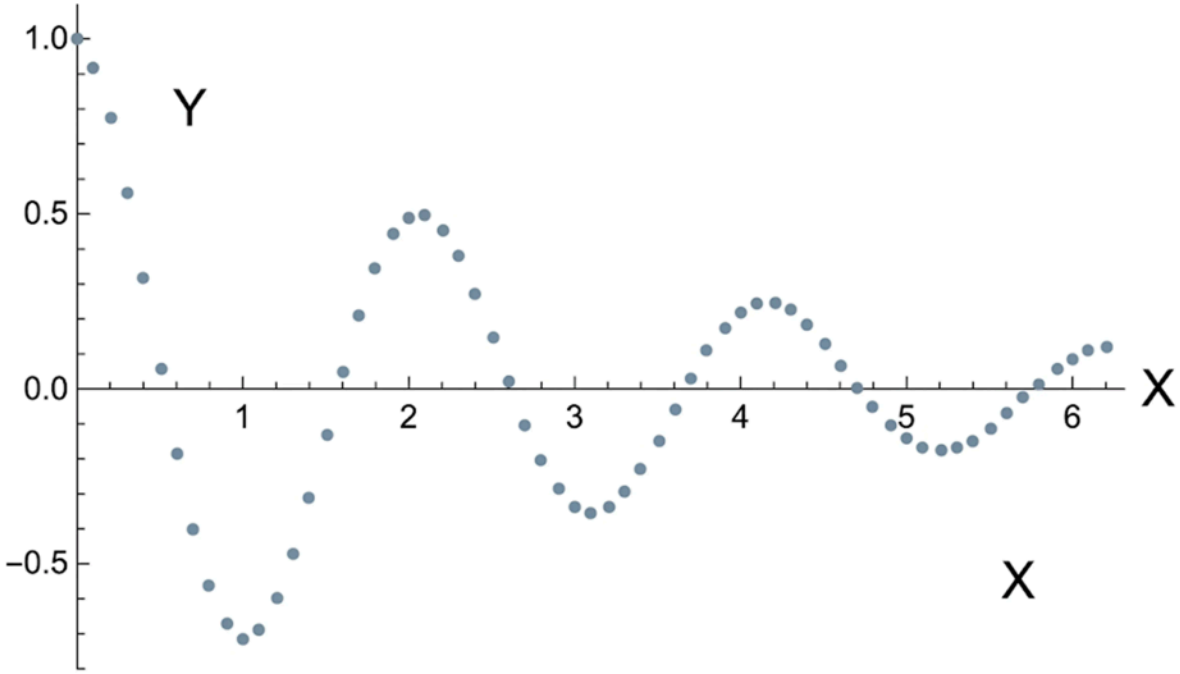
Q8. [Dec 2024] . 2.0 marks

General Aptitude > Data Analysis

CSIR NET	2024 Dec	2M

An experiment has collected data in some units which is presented in the below X-Y graph.

What would be the best function to fit the data? (for some positive constant k)



1. $Y = \cos[kX]$
2. $Y = \sin[kX^2]$
3. $\mathrm{Y} = \tan[\mathrm{kX}^3]$
4. $Y = e^{-\frac{x}{k}}\cos[kX]$

Q9. [Dec 2024] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2024 Dec	2M

The value of $\left(1-\frac{1}{2025}\right)\left(1-\frac{1}{2024}\right)\left(1-\frac{1}{2023}\right)\ldots\left(1-\frac{1}{2001}\right)$ is

1. $\left(1-\frac{1}{79}\right)$
2. $\left(1-\frac{1}{80}\right)$
3. $\left(1-\frac{1}{81}\right)$
4. $\left(1-\frac{1}{82}\right)$

Q10. [Dec 2024] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2024 Dec	2M

If Asha's mother is Tanisha's daughter's aunt and Tanisha has no nephew, then Asha is Tanisha's

1. mother
2. niece
3. grand mother
4. sister

Q11. [Dec 2024] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2024 Dec	2M

An OTP is made of six digits using 0 to 9 . If three digits and their positions are known, what is the probability (in percentage) of discovering the full pin within 100 trials?

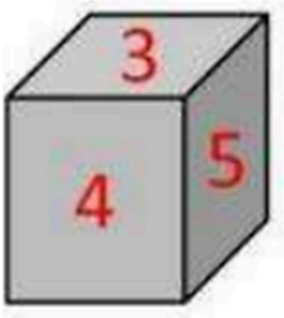
1. 10%
2. 20%
3. 30%
4. 40%

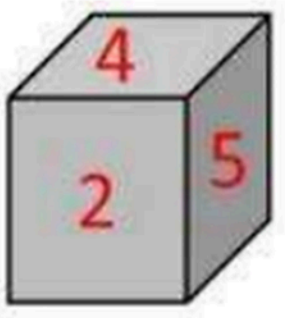
Q12. [Dec 2024] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2024 Dec	2M

The diagrams show two orientations of a die having numbers 1 to 6 written on different faces. The number on the face opposite the face showing 3





1. is 2
2. is 1
3. is 6
4. cannot be determined from the given data

Q13. [Dec 2024] . 2.0 marks

General Aptitude > Geometry

CSIR NET	2024 Dec	2M

There are four containers of equal height, whose bases are a circle, a square, a rectangle and an equilateral triangle having the same area. Which one of the following statements about these containers is true?

1. Their volumes are equal.
2. Volume of the rectangular container is larger than that of the square container.
3. Volume of the triangular container is smaller than that of the square container.
4. Volume of the square container is larger than that of the circular container.

Q14. [Dec 2024] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2024 Dec	2M

If A is B's daughter, B is C's brother and D is C's father, then what is A to D?

1. Grandfather
2. Grandmother
3. Grandson
4. Granddaughter

Q15. [Dec 2024] . 2.0 marks

General Aptitude > Geometry

CSIR NET	2024 Dec	2M

A block of marble $4\ \mathrm{m} \times 3\ \mathrm{m} \times 2\ \mathrm{m}$ in size is cut into square tiles of 1 m side having thickness of 10 cm . Assuming there is no wastage in cutting, how many tiles will be made?

1. 120
2. 240
3. 360
4. 480

Q16. [Dec 2024] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2024 Dec	2M

How many 5 -digit numbers, using 0 to 9 , can be generated such that ' 123 ' appears as a string and no digit appears more than once?

1. 228
2. 108
3. 156
4. 114

Q17. [Dec 2024] . 2.0 marks

General Aptitude > Geometry

CSIR NET	2024 Dec	2M

One side and one diagonal of a rhombus are 13 cm and 24 cm , respectively. Then the area of the rhombus is

1. $90\ \text{cm}^2$
2. $100\ \text{cm}^2$
3. $110\ \text{cm}^2$
4. $120\ \text{cm}^2$

Q18. [Dec 2024] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2024 Dec	2M

A lady walks one-tenth of the total distance at 3 km/h, one-sixth she runs at 5 km/h, one-fifth at 6 km/h, and covers the remaining 16 km at 16 km/h by cycle. What is the total distance?

1. 14 km
2. 16 km
3. 24 km
4. 30 km

Q19. [Dec 2024] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2024 Dec	2M

An electric heater uses approximately 1 KWH for increasing temperature of 1 L water by 1°C. If the heating element has a rating of 10 KW , what is the time taken to raise the temperature of 1 L water by 1°C ?

1. 1 hour
2. 15 mins
3. 10 mins
4. 6 mins

Q20. [Dec 2024] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2024 Dec	2M

A monkey covers exactly 10 m on ground in each jump. What is the least number of jumps required to reach a distance 1 m away from where the monkey jumps first?

1. 1

2. 2

3. 3

4. 9

Q21. [Dec 2024] . 3.5 marks

Classical Mechanics > Special theory of relativity

CSIR NET	2024 Dec	3.5M

A certain elementary particle is created in the upper atmosphere. It then moves downward with speed $v = 0.9999c$ with respect to an observer on earth. Its lifetime in its rest frame is 2×10^{-6}sec. The distance (in the earth's frame) travelled by the elementary particle before it decays is closest to

1. 0.6 km
2. 42 km
3. 12 km
4. 72 km

Q22. [Dec 2024] . 3.5 marks

Classical Mechanics > Special theory of relativity

CSIR NET	2024 Dec	3.5M

A particle of rest mass m_0 and energy E collides with another particle at rest, with the same rest mass. What is the minimum value of E so that after the collision, there may be four particles of rest mass m_0 ?

1. $4m_0c^2$
2. $3m_0c^2$
3. $7m_0c^2$
4. $16m_0c^2$

Q23. [Dec 2024] . 3.5 marks

Mathematical Physics > Basic Mathematics

CSIR NET	2024 Dec	3.5M

Given the sum of the infinite series

$$\frac{1}{1^4}+\frac{1}{2^4}+\frac{1}{3^4}+\frac{1}{4^4}\cdots=\frac{\pi^4}{90}$$

the sum of the infinite series

$$\frac{1}{1^4}+\frac{1}{3^4}+\frac{1}{5^4}+\cdots$$

would be

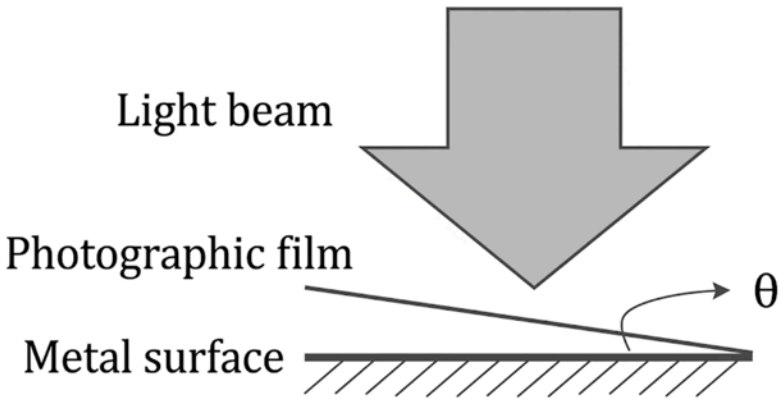
1. $\frac{\pi^4}{128}$
2. $\frac{\pi^4}{144}$
3. $\frac{\pi^4}{120}$
4. $\frac{\pi^4}{96}$

Q24. [Dec 2024] . 3.5 marks

Optics > Interference and diffraction

CSIR NET	2024 Dec	3.5M

When a photographic film is exposed to light, the electric field of light causes the film to turn dark after chemical processing. A photographic film of thickness 50 *nm* is kept inclined to a shiny metal surface at an angle of $\theta = 0.01$ radian, as shown in the figure. After exposing this film to a linearly polarized beam of light of wavelength 500 *nm* incident normally to the metal surface, it developed periodic bright bands. We can explain this observation as the proof of



1. Interference between the incident wave and the wave reflected from the surface of the metal.
2. Diffraction pattern produced by the photographic film.
3. Interference of light due to the presence of photographic film.
4. Polarization of light due to photographic film.

Q25. [Dec 2024] . 3.5 marks

Quantum Mechanics > Pertubation theory

CSIR NET	2024 Dec	3.5M

Consider a particle in a one-dimensional infinite potential well between $0 \leq x \leq L$. If a small perturbation, $V(x) = \lambda \cos\left(\frac{\pi x}{L}\right)$, (where $\lambda \ll 1$) is applied, the firstorder energy correction to the ground state is

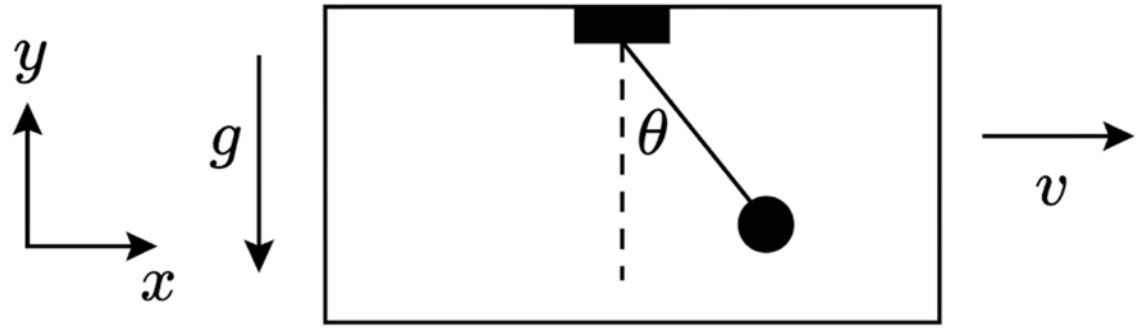
1. λ
2. 0
3. $-\lambda$
4. 2λ

Q26. [Dec 2024] . 3.5 marks

Classical Mechanics > Lagrangian and Hamiltonian

CSIR NET	2024 Dec	3.5M

The point of support of a simple pendulum, of mass m and length l, is attached to the roof of a taxi as shown in the figure. The taxi is moving with uniform velocity v. The Lagrangian for the pendulum is



1. $L = \frac{1}{2}ml^2\dot{\theta}^2 + \frac{1}{2}mv^2 + mlv\cos\theta\dot{\theta} - mgl\cos\theta$
2. $L = \frac{1}{2}ml^2\dot{\theta}^2 + \frac{1}{2}mv^2 + mlv\cos\theta\dot{\theta} + mgl\cos\theta$
3. $L = \frac{1}{2}ml^2\dot{\theta}^2 + \frac{1}{2}mv^2 + mlv\sin\theta\dot{\theta} + mgl\cos\theta$
4. $L = \frac{1}{2}ml^2\dot{\theta}^2 + \frac{1}{2}mv^2 + mlv\sin\theta\dot{\theta} - mgl\cos\theta$

Q27. [Dec 2024] . 3.5 marks

Optics > Interference and diffraction

CSIR NET	2024 Dec	3.5M

A grating spectrometer in vacuum, illuminated by 500 nm light, gives first-order spectrum at an angle of 20°. When the vacuum chamber is filled with Argon gas at pressure P, this angle

1. increases, due to increase in the refractive index of the medium
2. decreases, due to increase in the refractive index of the medium
3. decreases, due to decrease in the frequency of light in argon gas
4. increases, due to decrease in the frequency of light in argon gas

Q28. [Dec 2024] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2024 Dec	3.5M

Two non-interacting identical spin $-\frac{1}{2}$ particles, each of mass m, are placed in a two-dimensional infinite square well of side L. The single-particle spatial wavefunction is given by

$$\varphi_{n_x,n_y}(x,y) = \frac{2}{L}\sin\left(\frac{n_x\pi x}{L}\right)\sin\left(\frac{n_y\pi y}{L}\right)$$

where n_x and n_y are positive integers. If the particles are in a total spin state $|j=1, m=0\rangle$, the lowest possible energy eigenvalue is

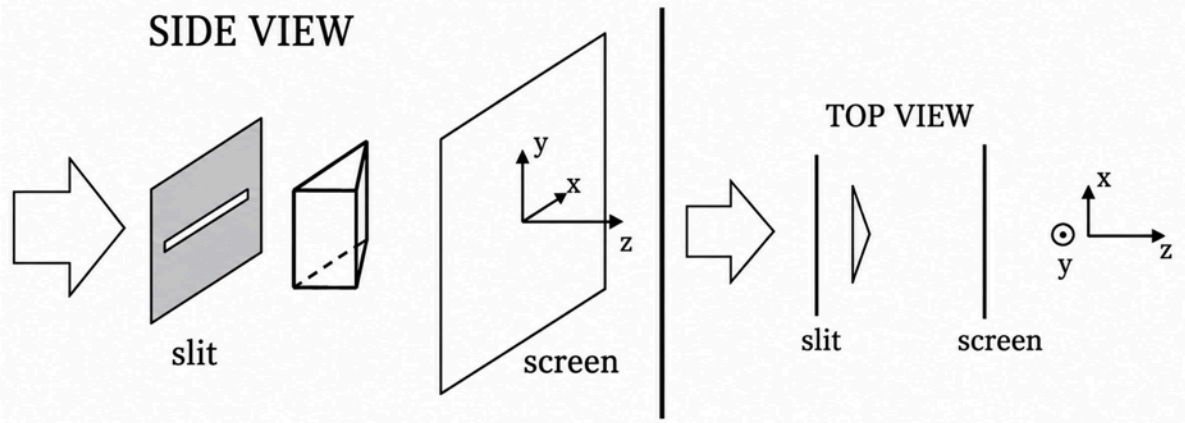
1. $\frac{5\hbar^2\pi^2}{2mL^2}$
2. $\frac{\hbar^2\pi^2}{mL^2}$
3. $\frac{2\hbar^2\pi^2}{mL^2}$
4. $\frac{7\hbar^2\pi^2}{2mL^2}$

Q29. [Dec 2024] . 3.5 marks

Optics > Interference and diffraction

CSIR NET	2024 Dec	3.5M

A narrow horizontal slit is illuminated by an extended sodium lamp. A thin Fresnel biprism with its edge aligned perpendicular to the slit is positioned, as shown in the figure. Given that the length of the slit is larger than the base of the biprism, the pattern of illumination on the screen is best described by



1. Fringes in both x and y direction.
2. Almost uniform illumination.
3. Horizontal fringes periodic only along the x-axis.
4. Horizontal fringes periodic only along the y-axis

Q30. [Dec 2024] . 3.5 marks

Statistical Mechanics > Black Body Radiations

CSIR NET	2024 Dec	3.5M

A spherical cavity of volume V is filled with thermal radiation at temperature T. The cavity expands adiabatically to 8 times its initial volume. If σ is Stefan's constant and c is the speed of light in vacuum, what is the closest value of the work done in the process?

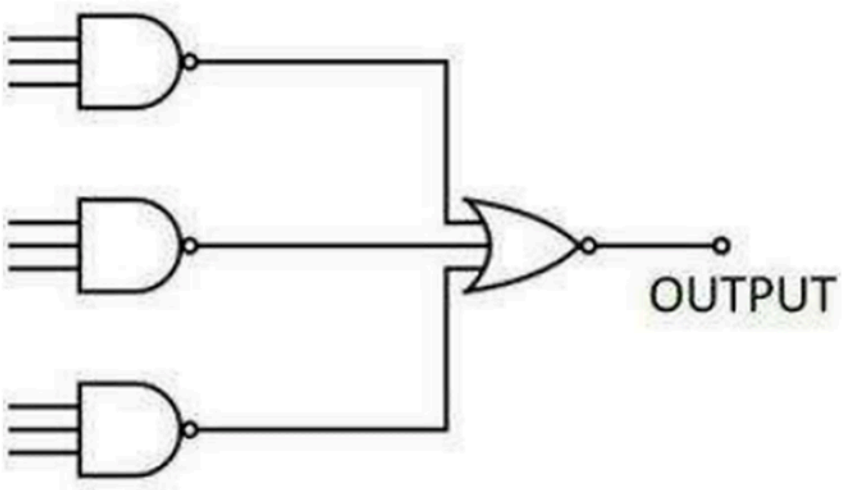
1. $8\left(\frac{\sigma T^4 V}{c}\right)$
2. $4\left(\frac{\sigma T^4 V}{c}\right)$
3. $\frac{1}{2}\left(\frac{\sigma T^4 V}{c}\right)$
4. $2\left(\frac{\sigma T^4 V}{c}\right)$

Q31. [Dec 2024] . 3.5 marks

Electronics > Digital Electronics

CSIR NET	2024 Dec	3.5M

The output of the following circuit is always found to be zero.



Such an observation can be due to

1. Two of the inputs of any one of the NAND gates being accidentally shorted to each other
2. One of the inputs to the NOR gate being accidentally grounded
3. One of the inputs to one of the NAND gates being accidentally grounded
4. Two of the inputs of the NOR gate being accidentally shorted to each other

Q32. [Dec 2024] . 3.5 marks

Electromagnetism > Magetostatics

CSIR NET	2024 Dec	3.5M

A sphere with uniform charge and mass density, having total charge Q and mass M, rotates about an axis through its center with angular velocity ω. The ratio of its magnetic dipole moment to its angular momentum is

1. $\frac{2Q}{M}$
2. $\frac{Q}{M}$
3. $\frac{Q}{2M}$
4. $\frac{Q}{4M}$

Q33. [Dec 2024] . 3.5 marks

Electronics > "Errors , curve fitting and data analysis"

CSIR NET	2024 Dec	3.5M

A DC motor operating at a voltage V and a current I is used to lift a mass m to a height h. The percentage uncertainty in the measurement of time t is 5% and that for the other parameters (V, I, m and h) are 1% each. If the measurements are independent and the errors are random, the uncertainty in the estimation of the efficiency $\left(\frac{\text{output power}}{\text{input power}}\right)$ of the motor is closest to

1. 3.1%
2. 5.4%
3. 4.8%
4. 6.3%

Q34. [Dec 2024] . 3.5 marks

Electronics > "Errors , curve fitting and data analysis"

CSIR NET	2024 Dec	3.5M

The following table shows the relationship between an independent quantity x and an experimentally measured quantity y.

x	0	1	2	3	4	5
y	0.1	2.1	8.1	17.9	32.2	49.7

The relationship between x and y is best represented by

1. $y \propto x^3$
2. $y \propto e^x$
3. $y \propto x^2$
4. $y \propto \sqrt{x}$

Q35. [Dec 2024] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2024 Dec	3.5M

An isolated box of volume V contains 5 identical, but distinguishable and noninteracting particles. The particles can either be in the ground state of zero energy or in an excited state of energy ε. The ground state is non-degenerate while the excited state is doubly degenerate. There is no restriction on the number of particles that can be put in a given state. The number of accessible microstates corresponding to the macrostate of the system with energy $E = 2\varepsilon$ are

1. 10
2. 20
3. 40
4. 30

Q36. [Dec 2024] . 3.5 marks

Quantum Mechanics > Spin Angular momentum

CSIR NET	2024 Dec	3.5M

An electron is in the spin state $|\psi\rangle = \frac{1}{5}\begin{pmatrix}3i\\4\end{pmatrix}$ in the $\hat{S}_z$ basis. A measurement of $\hat{S}_x$ is made on this state. The probabilities of getting $\hbar/2$ and $-\hbar/2$ are

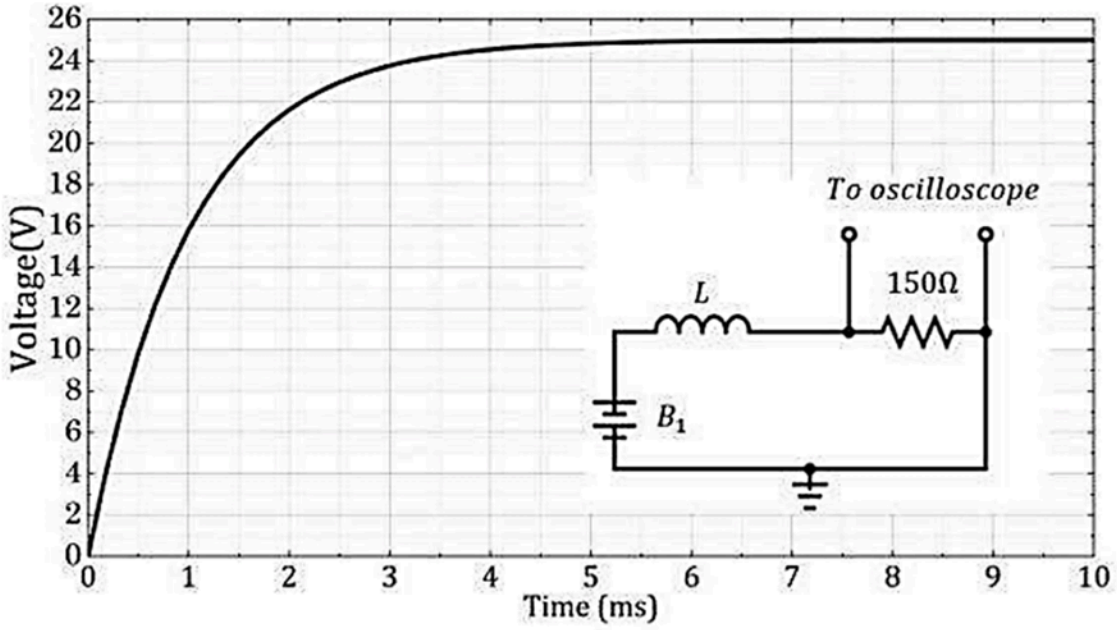
1. $\frac{1}{3}, \frac{2}{3}$
2. $\frac{1}{4}, \frac{3}{4}$
3. $\frac{1}{2}, \frac{1}{2}$
4. $\frac{3}{7}, \frac{4}{7}$

Q37. [Dec 2024] . 3.5 marks

Electronics > RLC Circuits

CSIR NET	2024 Dec	3.5M

An ideal inductor L is connected in series to a 150Ω resistor as shown in the circuit (inset). When the circuit is driven by a battery B_1, the voltage across the resistor as a function of time, as measured by an oscilloscope, is shown in the plot.



Based on this observation, the estimated value of L is closest to

1. $50mH$
2. 300 mH
3. 450 mH
4. 150 mH

Q38. [Dec 2024] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2024 Dec	3.5M

A particle of mass m is in a cubic box of side a. The potential inside the box ($0 \leq x \leq a, 0 \leq y \leq a, 0, \leq z \leq a$) is zero and infinite outside. If the particle is in an energy eigenstate with $E = \frac{7\pi^2 h^2}{ma^2}$, a possible wavefunction is

1. $\psi = \left(\frac{2}{a}\right)^{3/2} \sin\left(\frac{\pi x}{a}\right) \sin\left(\frac{\pi y}{a}\right) \sin\left(\frac{2\pi z}{a}\right)$
2. $\psi = \left(\frac{2}{a}\right)^{3/2} \sin\left(\frac{\pi x}{a}\right) \sin\left(\frac{3\pi y}{a}\right) \sin\left(\frac{\pi z}{a}\right)$
3. $\psi = \left(\frac{2}{a}\right)^{3/2} \sin\left(\frac{\pi x}{a}\right) \sin\left(\frac{2\pi y}{a}\right) \sin\left(\frac{3\pi z}{a}\right)$
4. $\psi = \left(\frac{2}{a}\right)^{3/2} \sin\left(\frac{\pi x}{a}\right) \sin\left(\frac{2\pi y}{a}\right) \sin\left(\frac{2\pi z}{a}\right)$

Q39. [Dec 2024] . 3.5 marks

Mathematical Physics > Complex analysis

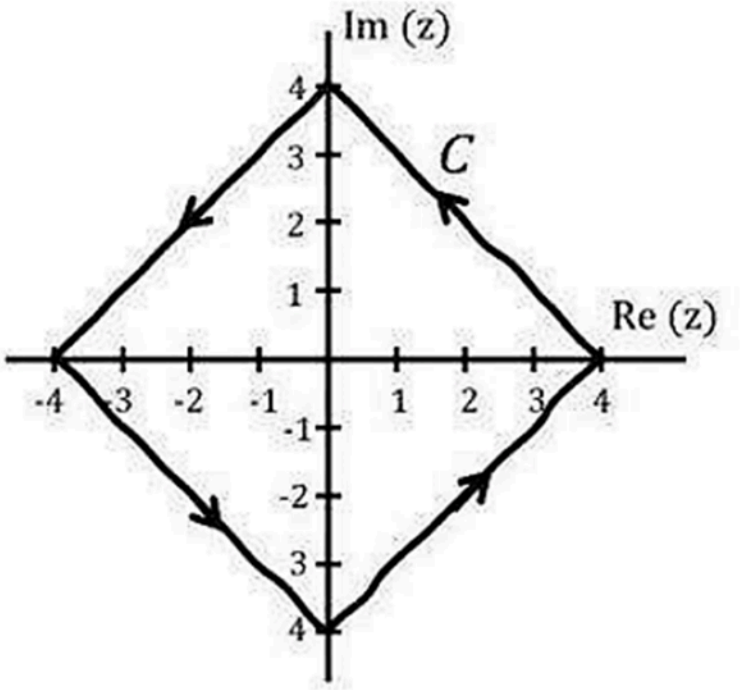
CSIR NET	2024 Dec	3.5M

The value of the integral (where k is a constant),

$$\frac{1}{2\pi i}\oint_C \frac{5}{(z-2)^2}\sin(kz)dz$$

over the closed contour C as shown below, is

1. $5k\cos(2k)$
2. $5k\sin(2k)$
3. $5\cos(2k)$
4. $-5k^2\sin(2k)$



Q40. [Dec 2024] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2024 Dec	3.5M

If I is an $n \times n$ identity matrix and $\text{adj}(2I) = 2^k I$, then k is equal to

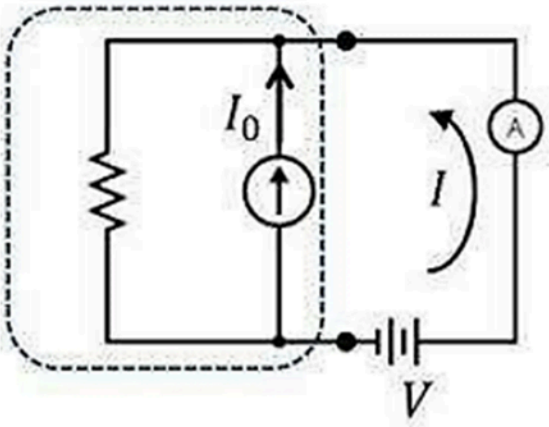
1. 1
2. n
3. $n-1$
4. 2

Q41. [Dec 2024] . 3.5 marks

Electronics > Basic Electronics

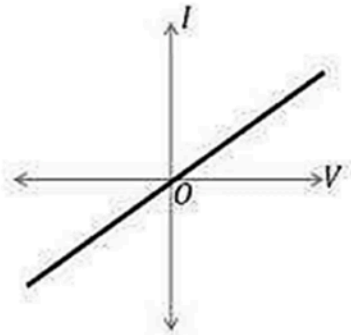
CSIR NET	2024 Dec	3.5M

A circuit component consists of a resistor in parallel with an ideal current source. The I-V characteristics of the component was measured using a variable voltage source and an ammeter ' A '.

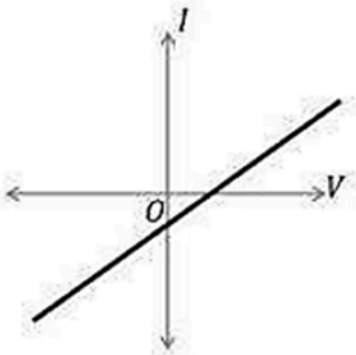


The arrow in the figure indicates the positive direction of current. The I-V characteristics of the component is best represented by

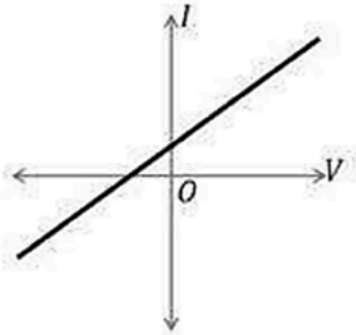
1.



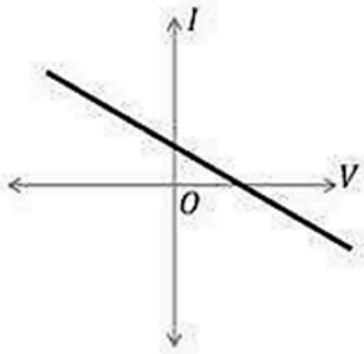
2.



3.



4.



Q42. [Dec 2024] . 3.5 marks

Statistical Mechanics > Canonical Ensemble

CSIR NET	2024 Dec	3.5M

A system comprises of N distinguishable atoms $(N \gg 1)$. Each atom has two energy levels ω and $3\omega(\omega > 0)$. Let ε_{eq} denote the average energy per particle when the system is in thermal equilibrium, the upper limit of ε_{eq} is

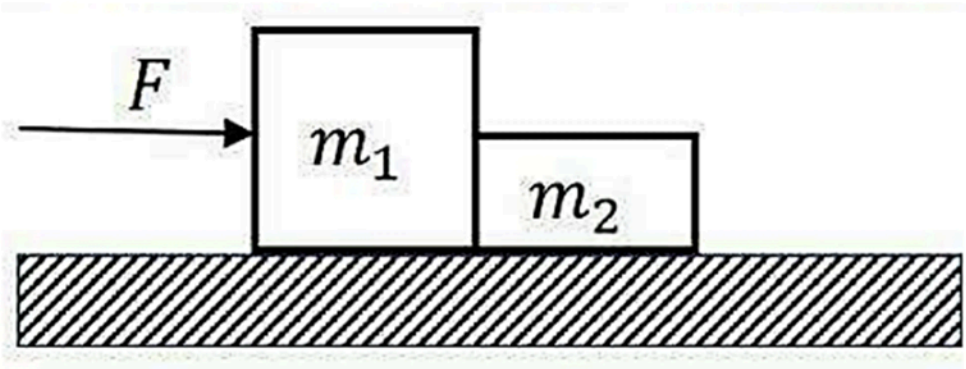
1. $\frac{3\omega}{2}$
2. 3ω
3. $\frac{5\omega}{2}$
4. 2ω

Q43. [Dec 2024] . 3.5 marks

Classical Mechanics > Basic Mechanics

CSIR NET	2024 Dec	3.5M

Two blocks m_1 and m_2 are in contact on a frictionless horizontal table. A horizontal force is applied to one of the blocks, as shown in the figure.



If $m_1 = 2\ \text{kg}, m_2 = 1\ \text{kg}$, and $F = 3\ \text{N}$, the force of contact between the blocks is

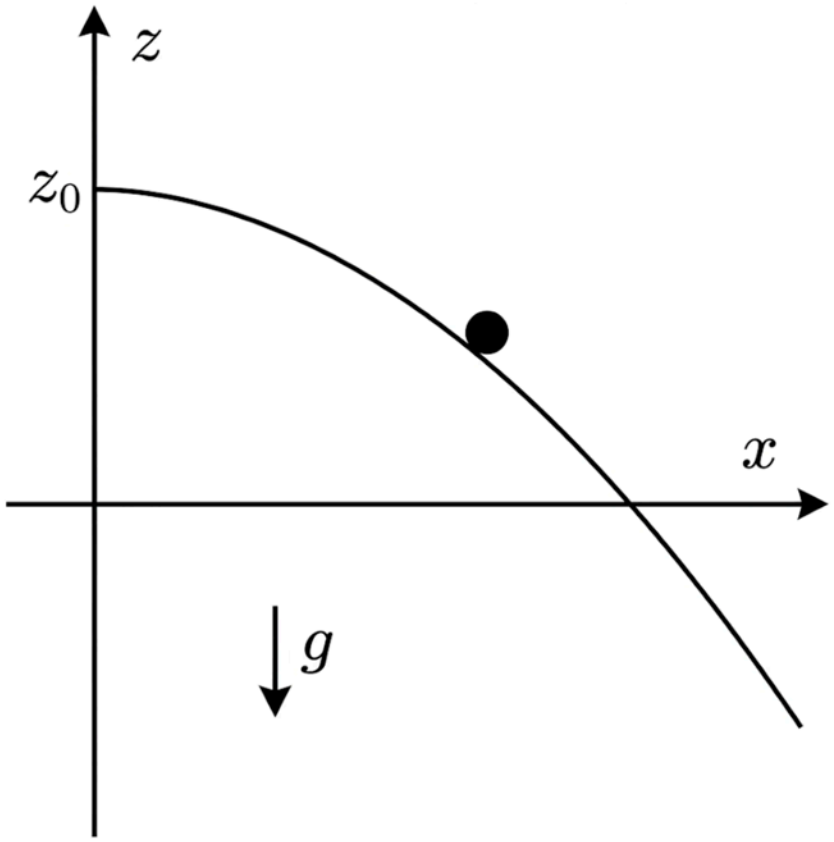
1. $1N$
2. $2N$
3. 1.5 N
4. $3N$

Q44. [Dec 2024] . 3.5 marks

Classical Mechanics > Basic Mechanics

CSIR NET	2024 Dec	3.5M

A frictionless track is defined by $z = z_0 - \frac{x^2}{4z_0}$, as shown in the figure. A particle is constrained to slide down the track under the action of gravity. The tangential acceleration at position (x, z) would be



1. $\frac{2gx}{\sqrt{x^2 + 4z_0^2}}$
2. $\frac{gx}{\sqrt{x^2 + 4z_0^2}}$
3. $\frac{gx}{2z_0}$
4. $g\sqrt{\frac{x(x + z_0)}{x^2 + 4z_0^2}}$

Q45. [Dec 2024] . 3.5 marks

Statistical Mechanics > Quantum Statistical Mechanics

CSIR NET	2024 Dec	3.5M

For an ideal Bose gas, the density of states is given by $\rho(E) = CE^2$, where C is a positive constant. Assume that the number of bosons is not conserved. The variation of the specific heat of the gas with temperature T is closest to

1. T^2
2. T^3
3. T
4. T^4

Q46. [Dec 2024] . 5.0 marks

Electronics > Digital Electronics

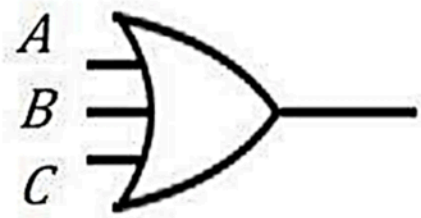
CSIR NET	2024 Dec	5M

The logic circuit that will have the output

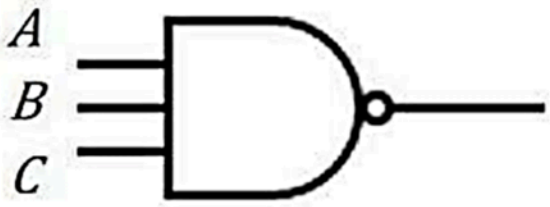
$$Y = (A + B)\overline{(\overline{A}(\overline{B} + \overline{C}))} + \overline{A}(B + C)$$

is

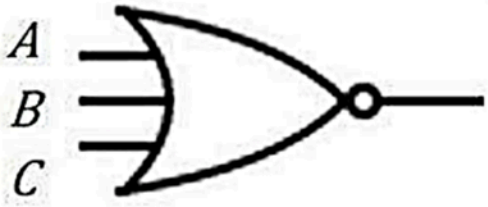
1.



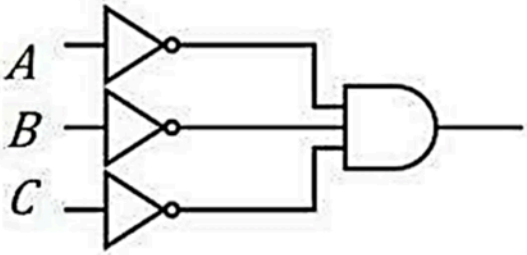
2.



3.



4.



Q47. [Dec 2024] . 5.0 marks

Classical Mechanics > Lagrangian and Hamiltonian

CSIR NET	2024 Dec	5M

The Lagrangian of a system is

$$L = \frac{15}{2}m\dot{x}^2 + 6m\dot{x}\dot{y} + 3m\dot{y}^2 - mg(x + 2y)$$

Which one of the following is conserved?

1. $12\dot{x} + 3\dot{y}$
2. $12\dot{x} - 3\dot{y}$
3. $3\dot{x} - 12\dot{y}$
4. $3\dot{x} + 3\dot{y}$

Q48. [Dec 2024] . 5.0 marks

Mathematical Physics > Complex analysis

CSIR NET	2024 Dec	5M

The complex integral $\int_c z^4 \exp\left(\frac{1}{2z}\right) dz$, where C is the unit circle centered around the origin traversed counter-clock-wise, equals

1. $\frac{\pi i}{120}$
2. $\frac{\pi i}{960}$
3. 0
4. $\frac{\pi i}{1920}$

Q49. [Dec 2024] . 5.0 marks

Atomic and Molecular Physics > "LS, JJ and other interactions"

CSIR NET	2024 Dec	5M

The hyperfine splitting of the ground state of the hydrogen atom is given as

$$\Delta E \propto \frac{g_p g_e}{m_p m_e a^3}$$

where g_p and g_e are the nuclear and electron Landê g factors respectively, and a is the orbital radius of the ground state. It is given that g (proton) $= 5.59$. In Hydrogen, transition between these split levels corresponds to radiation of wavelength 21 cm .

If the proton is replaced by a positron, the corresponding wavelength would be

1. 2.6 mm
2. 3.2 mm
3. 3.2 cm
4. 2.6 cm

Q50. [Dec 2024] . 5.0 marks

Classical Mechanics > Canonical transformations

CSIR NET	2024 Dec	5M

For the transformation

$$Q = \ln\left(1 + q^{1/2}\cos p\right), P = 2q^{1/2}\left(1 + q^{1/2}\cos p\right)\sin p$$

the generating function is

1. $-\left(e^{Q} - 1\right)^{2}\cot p$
2. $\left(e^{Q} - 1\right)^{2}\cot p$
3. $\left(e^{Q} - 1\right)^{2}\tan p$
4. $-\left(e^{Q} - 1\right)^{2}\tan p$

Q51. [Dec 2024] . 5.0 marks

Electromagnetism > Electrostatics

CSIR NET	2024 Dec	5M

A static charge distribution produces an electric field

$$\vec{E} = \frac{Q}{4\pi\epsilon_0}\frac{e^{-br}}{r^3}\vec{r},$$

where $Q, b > 0$ are constants. The charge density of the distribution is given by

1. $\frac{Q}{4\pi}\left[-\frac{b}{2r^2}\right]$
2. $\frac{Q}{4\pi}e^{-b}\left[-\frac{b}{r^2} - 4\pi\delta(\vec{r})\right]$
3. $\frac{Q}{4\pi}e^{-br}\left[-\frac{2b}{r^2}\right]$
4. $\frac{Q}{4\pi}e^{-br}\left[-\frac{b}{r^2} + 4\pi\delta(\vec{r})\right]$

Q52. [Dec 2024] . 5.0 marks

Solid State Physics > Superconductivity

CSIR NET	2024 Dec	5M

Magnetization M as a function of applied magnetic field H for two different solid samples at temperature T are shown below. These samples are known to be superconducting below their respective critical temperatures (T_C).

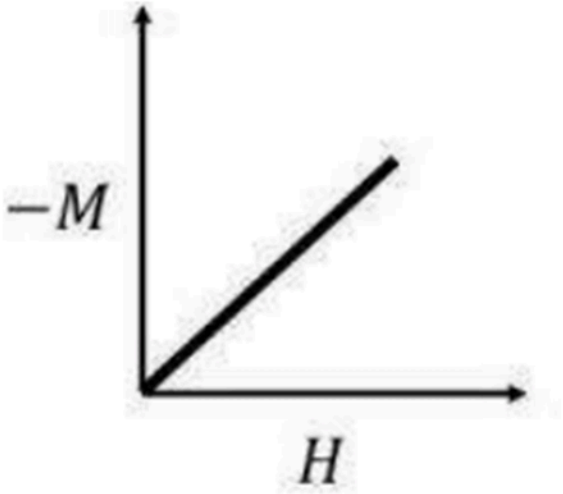


Fig. 1

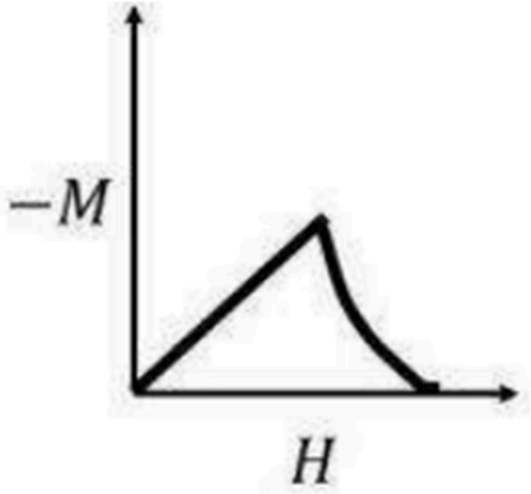


Fig. 2

The correct set of statements is

1. Fig. 1: Type I superconductor above T_C;

   Fig. 2: Type II superconductor below T_C and upto upper critical field;
2. Fig. 1: Type II superconductor below T_C and upto upper critical field;

   Fig. 2: Type II superconductor below T_C and upto lower critical field.
3. Fig. 1: Type I superconductor below T_C and below critical field;

   Fig. 2: Type II superconductor below T_C upto upper critical field;
4. Fig. 1: Type I superconductor below T_C and below critical

Q53. [Dec 2024] . 5.0 marks

Quantum Mechanics > Basic Quantum Mechanics

CSIR NET	2024 Dec	5M

The constant B which makes e^{-ax^2} an eigenfunction of the operator $\left(\frac{d^2}{dx^2} - Bx^2\right)$ is

1. $4a^2$
2. 0
3. $2a$
4. 1

Q54. [Dec 2024] . 5.0 marks

Quantum Mechanics > Spin Angular momentum

CSIR NET	2024 Dec	5M

For a system of two electrons, define an operator

$$\hat{A} = \frac{3}{a^2}\left(\hat{\vec{S}}_1 \cdot \vec{a}\right)\left(\hat{\vec{S}}_2 \cdot \vec{a}\right) - \hat{\vec{S}}_1 \cdot \hat{\vec{S}}_2$$

where $\vec{a}$ is an arbitrary vector, and $\hat{\vec{S}}_1$ and $\hat{\vec{S}}_2$ are spin operators. The eigenvalues of $\hat{A}$ (in units of $\hbar^2$) are

1. $-1, 1, \frac{3}{2}, \frac{3}{2}$
2. $-1, -\frac{1}{2}, -\frac{1}{2}, 0$
3. $\frac{1}{2}, 1, \frac{3}{2}, \frac{3}{2}$
4. $0, \frac{1}{2}, \frac{1}{2}, -1$

Q55. [Dec 2024] . 5.0 marks

Classical Mechanics > Poisson brackets

CSIR NET	2024 Dec	5M

A non-relativistic particle of mass m and charge q is moving in a magnetic field $\vec{B}(x, y, z)$. If $\vec{v}$ denotes its velocity and $\{\ldots\}_{P.B.}$ denotes the Poisson Bracket, then $\epsilon_{ijk}\{v_i, v_j\}_{P.B.}$ is equal to

1. $-\frac{q}{m^2}B_k$
2. 0
3. $\frac{2q}{m^2}B_k$
4. $\frac{q}{m^2}B_k$

Q56. [Dec 2024] . 5.0 marks

Electronics > Diodes

CSIR NET	2024 Dec	5M

An LED is required to glow brightly when the temperature sensed by a Platinum resistance thermometer exceeds a certain value. In the circuit shown below, the resistance of the Pt thermometer (in ohms) varies as

$$R_{Pt}(T) = 100 + 0.4\,T$$

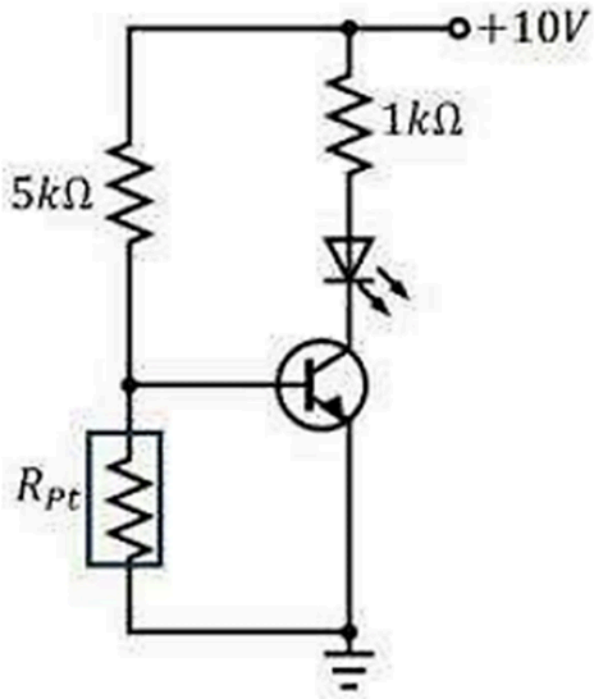
where T is temperature in degree Celsius. The transistor turns on when $V_{BE} > 0.7$ V and it has a very high current gain. The temperature at which the LED would start glowing is closest to

1. 850°C

2. 400°C

3. 500°C

4. 700°C



Q57. [Dec 2024] . 5.0 marks

Quantum Mechanics > Dirac delta potential

CSIR NET	2024 Dec	5M

A particle of mass m, moving in one-dimension is subjected to the potential

$$V(x) = \begin{cases} V_0\delta(x-a) & 0 < x < 2a \\ \infty & \text{otherwise} \end{cases}$$

The energy eigenvalues E satisfy

1. $\tan\frac{a\sqrt{2mE}}{\hbar} = \frac{\hbar}{V_0}\sqrt{\frac{2E}{m}}$
2. $\tanh\frac{a\sqrt{2mE}}{\hbar} = \frac{\hbar}{V_0}\sqrt{\frac{2E}{m}}$
3. $\tan\frac{a\sqrt{2mE}}{\hbar} = -\frac{\hbar}{V_0}\sqrt{\frac{2E}{m}}$
4. $\tanh\frac{a\sqrt{2mE}}{\hbar} = -\frac{\hbar}{V_0}\sqrt{\frac{2E}{m}}$

Q58. [Dec 2024] . 5.0 marks

Nuclear and Particle Physics > Radioactivity

CSIR NET	2024 Dec	5M

The masses of proton, neutron, Polonium and Lead nuclei are as follows:

$$m_p = 1.007825 \text{ a.u}, m_n = 1.008665 \text{ a.u}$$
$$m\left(^{210}_{84}\text{Po}\right) = 209.982876 \text{ a.u},$$
$$m\left(^{206}_{82}\text{Pb}\right) = 205.974455 \text{ a.u.}$$

Binding energy of $^{4}_{2}\text{He}$ is 28.80 MeV and

$$1\text{a.u} = 931.99 \frac{\text{MeV}}{\text{c}^2}$$

The binding energies of $^{210}_{84}\text{Po}$, $^{206}_{82}\text{Pb}$ and the Q value of the α-decay of $^{210}_{84}\text{Po}$ are closest to

1. $1645.21\text{MeV}, 1622.33\text{MeV}, 5.92\text{MeV}$
2. $1645.21\text{MeV}, 1622.33\text{MeV}, -5.92\text{MeV}$
3. $1545.21\text{MeV}, 1522.33\text{MeV}, -5.92\text{MeV}$
4. $1645.21\text{MeV}, 1522.33\text{MeV}, 5.92\text{MeV}$

Q59. [Dec 2024] . 5.0 marks

Atomic and Molecular Physics > Bohar Model and h-atom model

CSIR NET	2024 Dec	5M

A hydrogen atom, excited to electronic configuration $3S_{1/2}$ (nL_j notation), relaxes to the ground state via electric dipole transitions. Considering only fine structure and ignoring hyperfine structure, the maximum number of emitted spectral lines is

1. 3
2. 6
3. 1
4. 4

Q60. [Dec 2024] . 5.0 marks

Nuclear and Particle Physics > Radioactivity

CSIR NET	2024 Dec	5M

Naturally occurring uranium is a mixture of the $^{238}U(99.28\%)$ and $^{235}U(0.72\%)$ isotopes. The life times are $\tau(^{235}U) = 1 \times 10^9$ years and $\tau(^{238}U) = 6.6 \times 10^9$ years. What is the closest value of the age of the solar system if one assumes that at its creation both isotopes were present in equal quantities?

1. 6.2×10^9 years
2. 5.8×10^9 years
3. 4.7×10^9 years
4. 7.2×10^9 years

Q61. [Dec 2024] . 5.0 marks

Electromagnetism > Electrostatics

CSIR NET	2024 Dec	5M

Consider a spherical region of radius $\frac{R}{2}$ centered at the origin of the coordinate system. Three point charges each of magnitude Q are placed at $(0,0,R),(0,R,0)$ and $(\sqrt{2}R,0,0)$. What is the magnitude of the average electric field over the spherical region due to these charges in units of $\frac{Q}{4\pi\epsilon_0 R^2}$?

1. $\frac{3}{5}$
2. 0
3. $\frac{5}{2}$
4. $\frac{3}{2}$

Q62. [Dec 2024] . 5.0 marks

Solid State Physics > Tight binding model

CSIR NET	2024 Dec	5M

Consider N mutually non-interacting electrons moving in a crystal where the ionic potential seen by an electron satisfies the condition $V(\vec{r}) = V(\vec{r} + \vec{R})$, where $\vec{R}$ is one of the lattice translation vectors. The energy eigenstates of the electrons are labelled as $\psi_{\vec{k}}(\vec{r})$ where $\vec{k}$ is a vector in the first Brillouin zone. Which of the following is true?

1. $\left|\psi_{\vec{k}}(\vec{r})\right|$ is constant.
2. $\psi_{\vec{k}}(\vec{r})$ is also an eigenstate of the momentum operator.
3. $\psi_{\vec{k}}(\vec{r}) = \psi_{\vec{k}}(\vec{r} + \vec{R})$
4. $\left|\psi_{\vec{k}}(\vec{r})\right| = \left|\psi_{\vec{k}}(\vec{r} + \vec{R})\right|$

Q63. [Dec 2024] . 5.0 marks

Solid State Physics > Free electron theory

CSIR NET	2024 Dec	5M

Consider a free fermion gas in a hypercubic infinite potential well in hypothetical 4-dimensional space. What will be the expression for ground state energy per particle in term of the Fermi energy E_F ? (Ignore spin degeneracy of the fermions)

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

Q64. [Dec 2024] . 5.0 marks

Quantum Mechanics > Dirac delta potential

CSIR NET	2024 Dec	5M

A particle of mass m is bound in one dimension by the potential $V(x) = V_0\delta(x)$ with $V_0 < 0$. If the probability of finding it in the region $|x| < a$ is 0.25, then a is

1. $\frac{\hbar^2}{4mV_0}\ln\frac{3}{4}$
2. $\frac{\hbar^2}{2mV_0}\ln\frac{3}{4}$
3. $\frac{\hbar^2}{4mV_0}\ln\frac{1}{4}$
4. $\frac{\hbar^2}{2mV_0}\ln\frac{1}{4}$

Q65. [Dec 2024] . 5.0 marks

Nuclear and Particle Physics > Particle physics

CSIR NET	2024 Dec	5M

For the decay of the Δ-baryons, the ratio of the decay rates $\frac{\Gamma(\Delta^- \to n\pi^-)}{\Gamma(\Delta^0 \to p\pi^-)}$ is best approximated by

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

Q66. [Dec 2024] . 5.0 marks

Quantum Mechanics > Quantum Harmonic Oscillator

CSIR NET	2024 Dec	5M

Eigenstates of a system are specified by two non negative integers n_1 and n_2. The energy of the system is given by

$$E_n = \left(n_1 + \frac{1}{2}\right)\hbar\omega + \left(n_2 + \frac{1}{2}\right)2\hbar\omega.$$

If $\alpha \equiv \exp\left(-\frac{\hbar\omega}{k_B T}\right)$, what is the probability that at temperature T the energy of the system will be less than $4\hbar\omega$?

1. $(1-\alpha^2)(1-\alpha)(2+\alpha+2\alpha^2)$
2. $(1-\alpha)^2(1-\alpha)(2+\alpha+\alpha^2)$
3. $(1-\alpha^2)(1+\alpha)(1+\alpha+2\alpha^2)$
4. $(1-\alpha)^2(1+\alpha)(1+\alpha+2\alpha^2)$

Q67. [Dec 2024] . 5.0 marks

Statistical Mechanics > Quantum Statistical Mechanics

CSIR NET	2024 Dec	5M

Bose condensation experiments are carried out on two samples A and B of an ideal Bose gas. The same gas species is used in both. The condensate densities achieved at a given temperature below the critical temperature are $n_{\mathrm{A}} = 1.80 \times 10^{14}\ \mathrm{cm}^{-3}$ and $n_{\mathrm{B}} = 1.44 \times 10^{15}\ \mathrm{cm}^{-3}$, respectively. If P_{A} and P_{B} are the pressures of the two gas samples, the ratio $\frac{P_{\mathrm{A}}}{P_{\mathrm{B}}}$ is

1. 1
2. $\left(\frac{1}{8}\right)^{\frac{3}{2}}$
3. $\left(\frac{1}{8}\right)^{\frac{2}{3}}$
4. 8

Q68. [Dec 2024] . 5.0 marks

Electromagnetism > Magetostatics

CSIR NET	2024 Dec	5M

An electron enters a region of uniform electric and magnetic fields $\vec{E}_0$ and $\vec{B}_0$. Its velocity, $\vec{E}_0$ and $\vec{B}_0$ are mutually perpendicular to each other. Initially, E_0 is so adjusted that the electron suffers no deflection. E_0 is then switched off and the electron moves in a circular path of radius R. The speed of the electron and its charge to mass ratio would be

1. $\frac{2E_0}{B_0}, \frac{E_0}{2B_0^2R}$
2. $\frac{2E_0}{B_0}, \frac{E_0}{B_0^2R}$
3. $\frac{E_0}{B_0}, \frac{E_0}{B_0^2R}$
4. $\frac{E_0}{B_0}, \frac{2E_0}{B_0^2R}$

Q69. [Dec 2024] . 5.0 marks

Atomic and Molecular Physics > "LS, JJ and other interactions"

CSIR NET	2024 Dec	5M

Consider the Bromine ion Br^{+}in its ground state. The atomic number of Br is 35. The fine structure term symbol $\left({}^{2S+1}L_J\right)$ under the LS coupling scheme for the lowest energy state of this ion would be

1. ${}^3P_2$
2. ${}^3P_0$
3. ${}^1D_2$
4. ${}^4S_{3/2}$

Q70. [Dec 2024] . 5.0 marks

Statistical Mechanics > Ising model

CSIR NET	2024 Dec	5M

Energy of two Ising spins $\left(s = \pm\frac{1}{2}\right)$ is given by

$$E = s_1 s_2 + s_1 + s_2.$$

At temperature T, the probability that both spins take the value $-\frac{1}{2}$ is 16 times the probability that both take the value $+\frac{1}{2}$. At the same temperature, what is the probability that the spins take opposite values?

1. $\frac{16}{25}$
2. $\frac{8}{25}$
3. $\frac{8}{33}$
4. $\frac{16}{33}$

Q71. [Dec 2024] . 5.0 marks

Solid State Physics > Crystallography

CSIR NET	2024 Dec	5M

The lattice spacing in a simple cubic lattice is given to be 5Å. The number of lattice points per square nanometer in the lattice plane with Miller index (212) is closest to

1. 7.5
2. 3
3. 1.33
4. 0.66

Q72. [Dec 2024] . 5.0 marks

Mathematical Physics > Complex analysis

CSIR NET	2024 Dec	5M

Gamma function with argument z is defined as

$$\Gamma[z] = \int_0^\infty dt t^{z-1} e^{-t}$$

where z is a complex variable and $\text{Re}z \geq 0$. $\Gamma[z]$ has

1. a branch point at $z = 0$
2. a simple pole at $z = 0$
3. a removable singularity at $z = 0$
4. an essential singularity at $z = 0$

Q73. [Dec 2024] . 5.0 marks

Statistical Mechanics > Quantum Statistical Mechanics

CSIR NET	2024 Dec	5M

A spherical cavity of radius r_0 has an impenetrable wall. A quantum particle of mass m inside the cavity is in its ground state. The pressure exerted on the cavity wall is

1. $\frac{\pi\hbar^2}{4mr_0^5}$
2. $\frac{\pi\hbar^2}{mr_0^5}$
3. $\frac{\pi^2\hbar^2}{2mr_0^5}$
4. $\frac{\pi^2\hbar^2}{4mr_0^5}$

Q74. [Dec 2024] . 5.0 marks

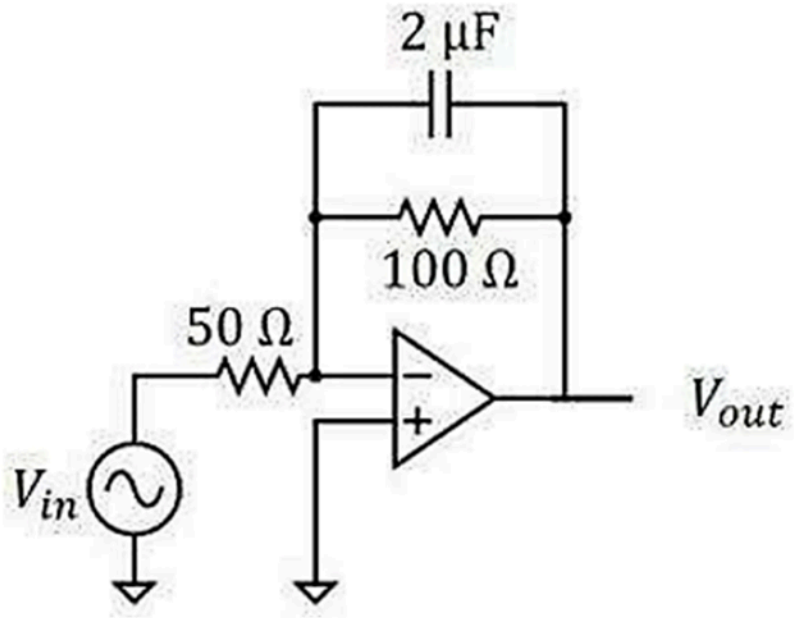
Electronics > OPAMP

CSIR NET	2024 Dec	5M

In the circuit shown below, the input voltage (in volts) is given by

$$V_{in}(t) = 0.1\sin(\omega_1 t) + \sin(\omega_2 t)$$

where $\omega_1 = 5 \times 10^2\ \mathrm{s}^{-1}$ and $\omega_2 = 5 \times 10^4\ \mathrm{s}^{-1}$.



The time varying part of the output voltage $V_{\mathrm{out}}(t)$ (in volts) is closest to

1. $-0.2\sin(\omega_1 t) - 2\sin(\omega_2 t)$
2. $-0.2\sin(\omega_1 t) + 0.2\cos(\omega_2 t)$
3. $2\cos(\omega_1 t) + 0.2\cos(\omega_2 t)$
4. $2\cos(\omega_1 t) - 2\sin(\omega_2 t)$

Q75. [Dec 2024] . 5.0 marks

Mathematical Physics > Probability

CSIR NET	2024 Dec	5M

A class has 60% boys and 40% girls. In an examination 8% of the boys and 12% of the girls got an ' A ' grade. If a randomly selected student had an ' A ' grade, what is the probability that the student is male?

1. 0.7
2. 0.6
3. 0.4
4. 0.5

Answer Key

75 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	General Aptitude	Geometry	**2**
Q2	General Aptitude	Mathematical Analysis	**2**
Q3	General Aptitude	Mathematical Analysis	**4**
Q4	General Aptitude	Reasoning	**2**
Q5	General Aptitude	Mathematical Analysis	**4**
Q6	General Aptitude	Data Analysis	**2**
Q7	General Aptitude	Basic Physics	**2**
Q8	General Aptitude	Data Analysis	**4**
Q9	General Aptitude	Mathematical Analysis	**3**
Q10	General Aptitude	Reasoning	**2**
Q11	General Aptitude	Mathematical Analysis	**1**
Q12	General Aptitude	Reasoning	**1**
Q13	General Aptitude	Geometry	**1**
Q14	General Aptitude	Reasoning	**4**
Q15	General Aptitude	Geometry	**2**
Q16	General Aptitude	Mathematical Analysis	**4**
Q17	General Aptitude	Geometry	**4**
Q18	General Aptitude	Basic Physics	**4**
Q19	General Aptitude	Basic Physics	**4**
Q20	General Aptitude	Reasoning	**2**
Q21	Classical Mechanics	Special theory of relativity	**2**
Q22	Classical Mechanics	Special theory of relativity	**3**
Q23	Mathematical Physics	Basic Mathematics	**4**
Q24	Optics	Interference and diffraction	**1**
Q25	Quantum Mechanics	Pertubation theory	**2**
Q26	Classical Mechanics	Lagrangian and Hamiltonian	**2**
Q27	Optics	Interference and diffraction	**2**
Q28	Quantum Mechanics	Potential Well	**4**
Q29	Optics	Interference and diffraction	**2**
Q30	Statistical Mechanics	Black Body Radiations	**4**
Q31	Electronics	Digital Electronics	**3**
Q32	Electromagnetism	Magetostatics	**3**
Q33	Electronics	"Errors , curve fitting and data analysis"	**2**
Q34	Electronics	"Errors , curve fitting and data analysis"	**3**
Q35	Statistical Mechanics	Microcanonical Ensemble	**3**
Q36	Quantum Mechanics	Spin Angular momentum	**3**
Q37	Electronics	RLC Circuits	**4**
Q38	Quantum Mechanics	Potential Well	**3**
Q39	Mathematical Physics	Complex analysis	**1**
Q40	Mathematical Physics	Matrices and Linear Algebra	**3**

Answer Key (cont.)

Q. No	Subject	Topic	Answer
Q41	Electronics	Basic Electronics	**2**
Q42	Statistical Mechanics	Canonical Ensemble	**4**
Q43	Classical Mechanics	Basic Mechanics	**1**
Q44	Classical Mechanics	Basic Mechanics	**2**
Q45	Statistical Mechanics	Quantum Statistical Mechanics	**2**
Q46	Electronics	Digital Electronics	**1**
Q47	Classical Mechanics	Lagrangian and Hamiltonian	**1**
Q48	Mathematical Physics	Complex analysis	**4**
Q49	Atomic and Molecular Physics	"LS, JJ and other interactions"	**1**
Q50	Classical Mechanics	Canonical transformations	**4**
Q51	Electromagnetism	Electrostatics	**4**
Q52	Solid State Physics	Superconductivity	**3**
Q53	Quantum Mechanics	Basic Quantum Mechanics	**1**
Q54	Quantum Mechanics	Spin Angular momentum	**4**
Q55	Classical Mechanics	Poisson brackets	**3**
Q56	Electronics	Diodes	**4**
Q57	Quantum Mechanics	Dirac delta potential	**3**
Q58	Nuclear and Particle Physics	Radioactivity	**1**
Q59	Atomic and Molecular Physics	Bohar Model and h-atom model	**4**
Q60	Nuclear and Particle Physics	Radioactivity	**2**
Q61	Electromagnetism	Electrostatics	**4**
Q62	Solid State Physics	Tight binding model	**4**
Q63	Solid State Physics	Free electron theory	**2**
Q64	Quantum Mechanics	Dirac delta potential	**2**
Q65	Nuclear and Particle Physics	Particle physics	**2**
Q66	Quantum Mechanics	Quantum Harmonic Oscillator	**4**
Q67	Statistical Mechanics	Quantum Statistical Mechanics	**1**
Q68	Electromagnetism	Magetostatics	**3**
Q69	Atomic and Molecular Physics	"LS, JJ and other interactions"	**1**
Q70	Statistical Mechanics	Ising model	**4**
Q71	Solid State Physics	Crystallography	**3**
Q72	Mathematical Physics	Complex analysis	**2**
Q73	Statistical Mechanics	Quantum Statistical Mechanics	**1**
Q74	Electronics	OPAMP	**2**
Q75	Mathematical Physics	Probability	**4**

Study with PhysicsByAaryan

Full CSIR NET / GATE / JEST / BARC Physics live batch by Aaryan Mehra Sir.
Concept-first teaching, complete PYQ coverage, daily doubt support.

Use coupon CONSISTENCY for Rs. 500 off

Visit
www.physicsbyaaryan.com
www.csirnetphysics.com

Contact
9501976811