PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

CSIR NET Physics - Dec 2018 - Full Paper

Complete question paper with answer key

75 questions . Answer key included

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Q1. [Dec 2018] . 2.0 marks

General Aptitude > Geometry

CSIR NET	2018 Dec	2M

A rectangular photo frame of size $30cm \times 40cm$ has a photograph mounted at the center leaving a $5cm$ border all around. The area of the border is

1. $600\ \text{cm}^2$
2. $350\ \text{cm}^2$
3. $400\ \text{cm}^2$
4. $700\ \text{cm}^2$

Q2. [Dec 2018] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2018 Dec	2M

At a birthday party, every child gets 2 chocolates, every mother gets 1 chocolate, while no father gets a chocolate. In total 69 persons get 70 chocolates. If the number of children is half of the number of mothers and fathers put together, then how many fathers are there?

1. 22
2. 23
3. 24
4. 69

Q3. [Dec 2018] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2018 Dec	2M

What is the value of

$1^2 - 2^2 + 3^2 - 4^2 + 5^2 - \cdots . + 17^2 - 18^2 + 19^2$?

1. -5
2. 12
3. 95
4. 190

Q4. [Dec 2018] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2018 Dec	2M

The curves of $y = 2x^2$ and $y = 4x$ intersect each other at

1. only one point
2. exactly two points
3. more than two points
4. no point at all

Q5. [Dec 2018] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2018 Dec	2M

The diameters of the pinholes of two otherwise identical cameras A and B are $500\mu m$ and $200\mu m$, respectively. Then the image in camera A will be

1. sharper than in B
2. darker than in B
3. less sharp and brighter than in B
4. sharper and brighter than in B

Q6. [Dec 2018] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2018 Dec	2M

If $D = ABC + BCA + CAB$, where A, B and C are decimal digits, then D is divisible by

1. 37 and 29
2. 37 but not 29
3. 29 but not 37
4. neither 29 nor 37

Q7. [Dec 2018] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2018 Dec	2M

For the following set of observed values

$\{60,65,65,70,70,70,70,82,85,90,95,95,100,160,160\}$

which of the statements is true?

1. mode < median < mean
2. mode < mean < median
3. mean < median < mode
4. median < mode < mean

Q8. [Dec 2018] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2018 Dec	2M

A circular running track has six lanes, each $1m$ wide. How far ahead (in meters) should the runner in the outermost lane start from, so as to cover the same distance in one lap as the runner in the innermost lane?

1. 6π
2. 10π
3. 12π
4. 36π

Q9. [Dec 2018] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2018 Dec	2M

In an examination 100 questions of 1 mark each are given. After the examination, 20 questions are deleted from evaluation, leaving 80 questions with a total of 100 marks. Student A had answered 4 of the deleted questions correctly and got 40 marks, whereas student B had answered 10 of the deleted questions correctly and got 35 marks. In this situation

1. A and B were equally benefited
2. A and B lost equally
3. B lost more than A
4. A lost more than B

Q10. [Dec 2018] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2018 Dec	2M

A tourist drives 20 km towards east, turns right and drives 6 km , then drives 6 km towards west. He then turns to his left and drives $4km$ and finally turns right and drives $14km$. Where is he from his starting point?

1. 6 km towards east
2. 20 km towards west
3. 14 km towards north
4. 10 km towards south

Q11. [Dec 2018] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2018 Dec	2M

If 'SELDOON' means 'NOODLES' then what does 'SPUOS' mean?

1. SALAD
2. SOUPS
3. RASAM
4. ONION

Q12. [Dec 2018] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2018 Dec	2M

An ideal pendulum oscillates with angular amplitude of 30^0 from the vertical. If it is observed at a random instant of time, its angular deviation from the vertical is most likely to be

1. 0^0
2. $\pm 10^0$
3. $\pm 20^0$
4. $\pm 30^0$

Q13. [Dec 2018] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2018 Dec	2M

In the context of tiling a plane surface, which of the following polygons is the odd one out?

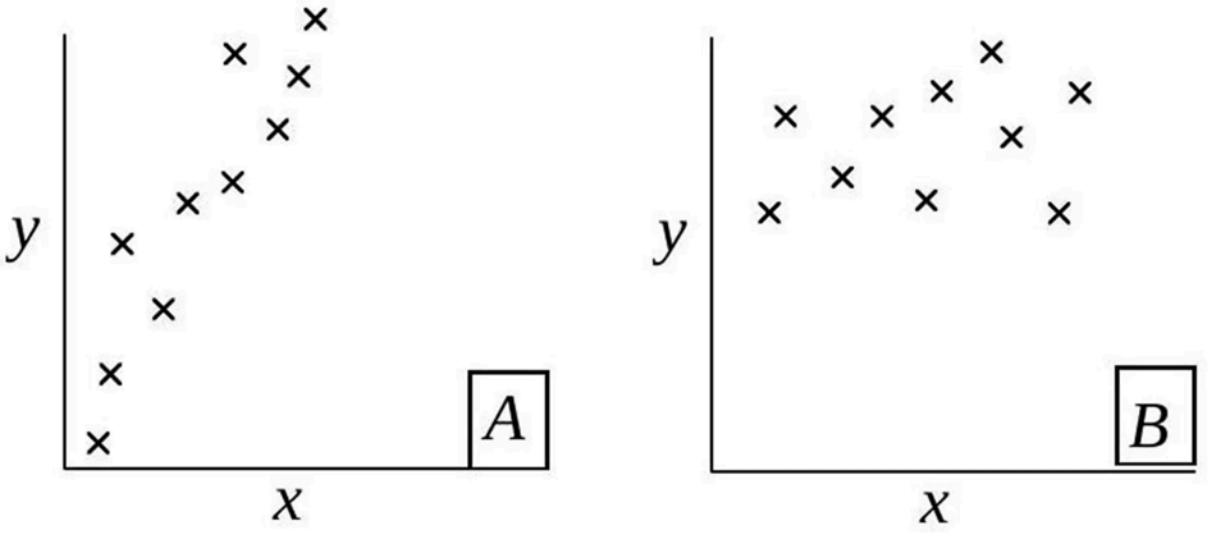
1. Equilateral triangle
2. Square
3. Regular pentagon
4. Regular hexagon

Q14. [Dec 2018] . 2.0 marks

General Aptitude > Data Analysis

CSIR NET	2018 Dec	2M

Scatter plots for pairs of observations on the variables x and y in samples A and B are shown in the figure.



Which of the following is suggested by the plots?

1. Correlation between x and y is stronger in A than in B
2. Correlation between x and y is absent in B
3. Correlation between x and y is weaker in A than in B
4. y and x have a cause - effect relationship in A but not in B

Q15. [Dec 2018] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2018 Dec	2M

Two solutions X and Y containing ingredients A, B and C in proportions $a: b: c$ and $c: b: a$, respectively, are mixed. For the resultant mixture to have A, B and C in equal proportion, it is necessary that

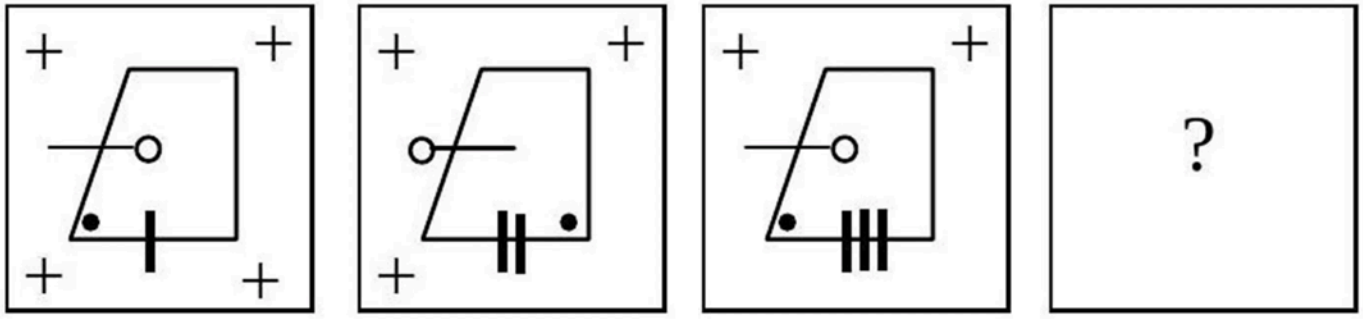
1. $b = \frac{c-a}{2}$
2. $c = \frac{a+b}{2}$
3. $c = \frac{a-b}{2}$
4. $b = \frac{c+a}{2}$

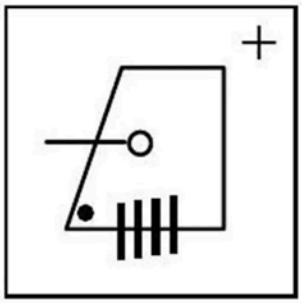
Q16. [Dec 2018] . 2.0 marks

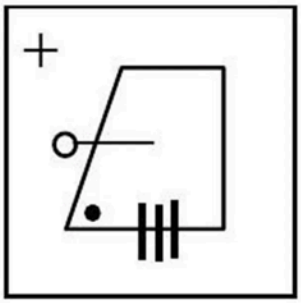
General Aptitude > Reasoning

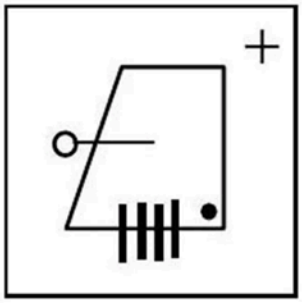
CSIR NET	2018 Dec	2M

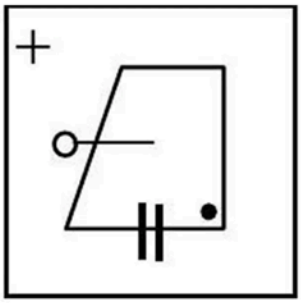
Find the missing figure in the following sequence.



1. 

2. 

3. 

4. 

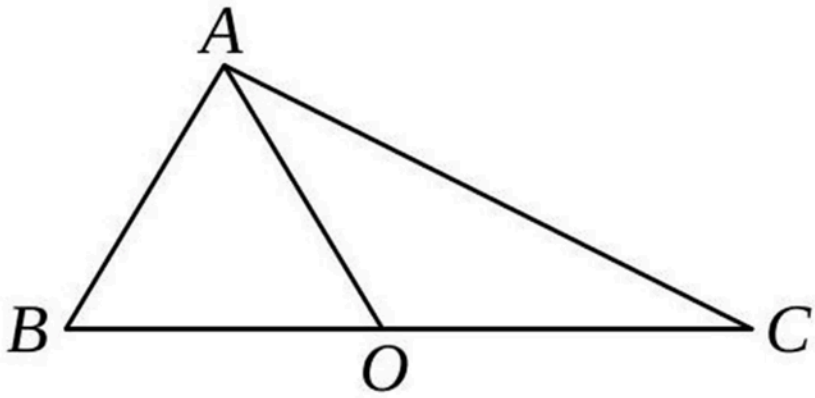
Q17. [Dec 2018] . 2.0 marks

General Aptitude > Geometry

CSIR NET	2018 Dec	2M

In triangle ABC, $AB=11$, $BC=61$, $AC=60$, and O is the mid-point of BC. Then AO is

1. 18.5
2. 24.0
3. 30.5
4. 36.0



(Not to scale)

Q18. [Dec 2018] . 2.0 marks

General Aptitude > Geometry

CSIR NET	2018 Dec	2M

Areas of three parts of a rectangle are given in unit of cm^2. What is the total area of the rectangle?

1. 18
2. 24
3. 36
4. 108

3	9
6	

Q19. [Dec 2018] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2018 Dec	2M

A student is free to choose only Chemistry, only Biology or both. If out of 32 students, Chemistry has been chosen by 16 and Biology by 25, then how many students have chosen Biology but not Chemistry?

1. 9
2. 16
3. 25
4. 7

Q20. [Dec 2018] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2018 Dec	2M

The lift (upward force due to air) generated by the wings and engines of an aircraft is

1. positive (upwards) while landing and negative (downwards) while taking off.
2. negative (downwards) while landing and positive (upwards) while taking off.
3. negative (downwards) while landing as well as while taking off.
4. positive (upwards) while landing as well as while taking off.

Q21. [Dec 2018] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2018 Dec	3.5M

One of the eigenvalues of the matrix e^A is e^a, where $A = \begin{pmatrix} a & 0 & 0 \\ 0 & 0 & a \\ 0 & a & 0 \end{pmatrix}$. The product of the other two eigenvalues of e^A is

1. e^{2a}
2. e^{-a}
3. e^{-2a}
4. 1

Q22. [Dec 2018] . 3.5 marks

Mathematical Physics > Special Functions

CSIR NET	2018 Dec	3.5M

The polynomial $f(x) = 1 + 5x + 3x^2$ is written as linear combination of the Legendre polynomials $\left(P_0(x) = 1, P_1(x), P_2(x) = \frac{1}{2}\left(3x^2 - 1\right)\right)$ as $f(x) = \sum_n c_n P_n(x)$. The value of c_0 is

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

Q23. [Dec 2018] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2018 Dec	3.5M

The value of the integral $\oint_C \frac{dz}{z}\frac{\tanh 2z}{\sin \pi z}$, where C is a circle of radius $\frac{\pi}{2}$, traversed counterclockwise, with center at $z = 0$, is

1. 4
2. $4i$
3. $2i$
4. 0

Q24. [Dec 2018] . 3.5 marks

Classical Mechanics > Basic Mechanics

CSIR NET	2018 Dec	3.5M

A particle of mass m, moving along the x - direction, experiences a damping force $-\gamma v^2$, where γ is a constant and v is its instantaneous speed. If the speed at $t = 0$ is v_0, the speed at time t is

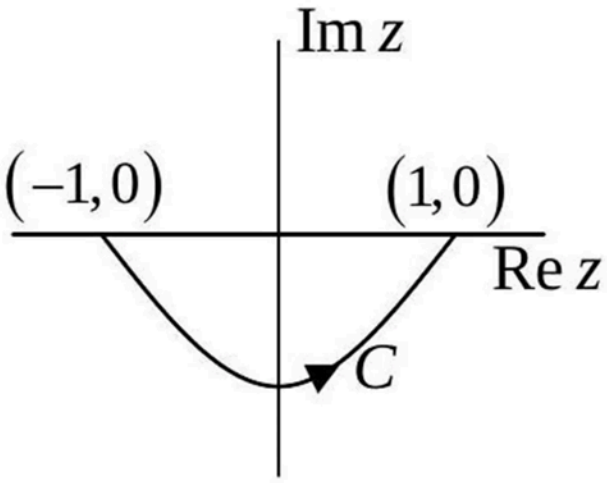
1. $v_0 e^{-\frac{\gamma v_0 t}{m}}$
2. $\frac{v_0}{1+\ln\left(1+\frac{\gamma v_0 t}{m}\right)}$
3. $\frac{m v_0}{m+\gamma v_0 t}$
4. $\frac{2v_0}{1+e^{\frac{\gamma v_0 t}{m}}}$

Q25. [Dec 2018] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2018 Dec	3.5M

The integral $I = \int_C e^z dz$ is evaluated from the point $(-1,0)$ to $(1,0)$ along the contour C, which is an arc of the parabola $y = x^2 - 1$, as shown in the figure. The value of I is



1. 0
2. $2 sin\, h\, 1$
3. $e^{2i} sin\, h\, 1$
4. $e + e^{-1}$

Q26. [Dec 2018] . 3.5 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2018 Dec	3.5M

In terms of arbitrary constants A and B, the general solution to the differential equation

$$x^2\frac{d^2y}{dx^2}+5x\frac{dy}{dx}+3y=0 \text{ is}$$

1. $y=\frac{A}{x}+Bx^3$
2. $y=Ax+\frac{B}{x^3}$
3. $y=Ax+Bx^3$
4. $y=\frac{A}{x}+\frac{B}{x^3}$

Q27. [Dec 2018] . 3.5 marks

Classical Mechanics > Central forces

CSIR NET	2018 Dec	3.5M

In the attractive Kepler problem described by the central potential $V(r) = \frac{-k}{r}$ (where k is a positive constant), a particle of mass m with a non-zero angular momentum can never reach the center due to the centrifugal barrier. If we modify the potential to

$$V(r) = -\frac{k}{r} - \frac{\beta}{r^3}$$

one finds that there is a critical value of the angular momentum ℓ_c below which there is no centrifugal barrier. This value of ℓ_c is

1. $[12km^2\beta]^{1/2}$
2. $[12\ \mathrm{km}^2\beta]^{-1/2}$
3. $[12\ \mathrm{km}^2\beta]^{1/4}$
4. $[12km^2\beta]^{-1/4}$

Q28. [Dec 2018] . 3.5 marks

Classical Mechanics > Oscillations

CSIR NET	2018 Dec	3.5M

The time period of a particle of mass m, undergoing small oscillations around $x = 0$, in the potential $V = V_0 \cosh\left(\frac{x}{L}\right)$, is

1. $\pi\sqrt{\frac{mL^2}{V_0}}$
2. $2\pi\sqrt{\frac{mL^2}{2V_0}}$
3. $2\pi\sqrt{\frac{mL^2}{V_0}}$
4. $2\pi\sqrt{\frac{2mL^2}{V_0}}$

Q29. [Dec 2018] . 3.5 marks

Classical Mechanics > Special theory of relativity

CSIR NET	2018 Dec	3.5M

Consider the decay $A \rightarrow B + C$ of a relativistic spin-$\frac{1}{2}$ particle A. Which of the following statements is true in the rest frame of the particle A ?

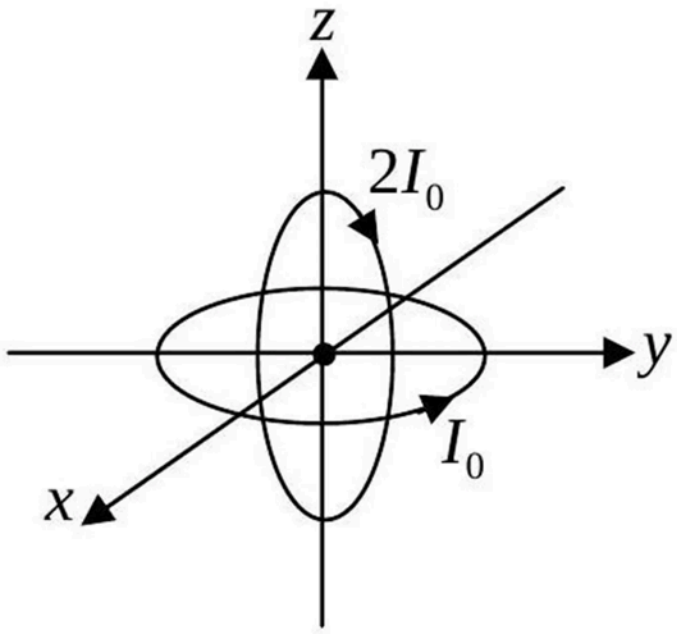
1. The spin of both B and C may be $\frac{1}{2}$
2. The sum of the masses of B and C is greater than the mass of A
3. The energy of B is uniquely determined by the masses of the particles
4. The spin of both B and C may be integral

Q30. [Dec 2018] . 3.5 marks

Electromagnetism > Magetostatics

CSIR NET	2018 Dec	3.5M

Two current-carrying circular loops, each of radius R, are placed perpendicular to each other, as shown in the figure. The loop in the xy-plane carries a current I_0 while that in the xz-plane carries a current $2I_0$. The resulting magnetic field $\vec{B}$ at the origin is



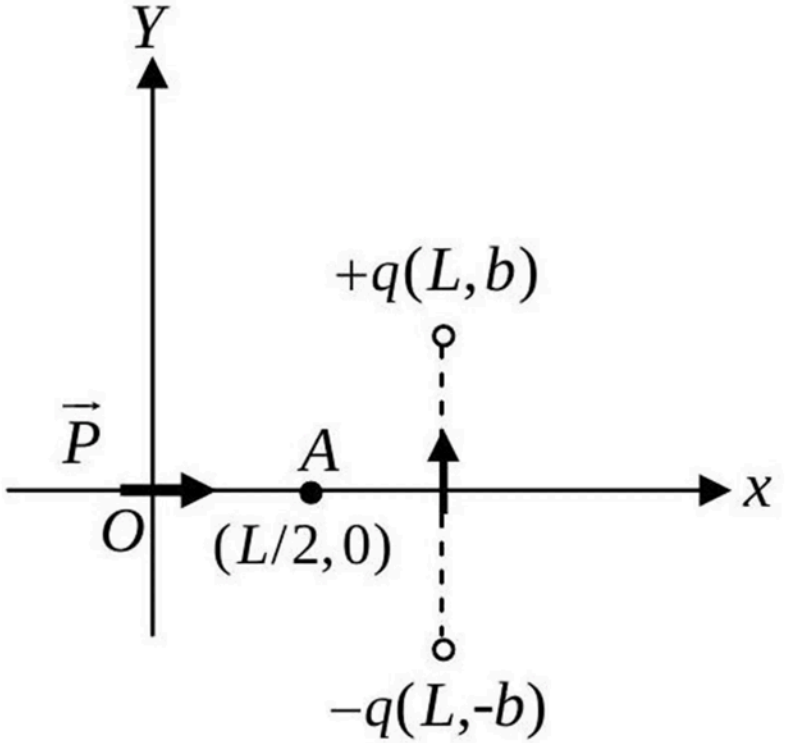
1. $\frac{\mu_0 I_0}{2R}\left[2\hat{j}+\hat{k}\right]$
2. $\frac{\mu_0 I_0}{2R}\left[2\hat{j}-\hat{k}\right]$
3. $\frac{\mu_0 I_0}{2R}\left[-2\hat{j}+\hat{k}\right]$
4. $\frac{\mu_0 I_0}{2R}\left[-2\hat{j}-\hat{k}\right]$

Q31. [Dec 2018] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2018 Dec	3.5M

An electric dipole of dipole moment $\vec{P} = qb\hat{i}$ is placed at origin in the vicinity of two charges $+q$ and $-q$ at (L, b) and $(L, -b)$, respectively, as shown in the figure. The electrostatic potential at the point $\left(\frac{L}{2}, 0\right)$ is



1. $\frac{qb}{\pi\varepsilon_0}\left(\frac{1}{L^2} + \frac{2}{L^2+4b^2}\right)$
2. $\frac{4qbL}{\pi\varepsilon_0[L^2+4b^2]^{3/2}}$
3. $\frac{qb}{\pi\varepsilon_0 L^2}$
4. $\frac{3qb}{\pi\varepsilon_0 L^2}$

Q32. [Dec 2018] . 3.5 marks

Optics > Interference and diffraction

CSIR NET	2018 Dec	3.5M

A monochromatic and linearly polarized light is used in a Young's double slit experiment. A linear polarizer, whose pass axis is at an angle 45^0 to the polarization of the incident wave, is placed in front of one of the slits. If $I_{\max}$ and $I_{\min}$, respectively, denote the maximum and minimum intensities of the interference pattern on the screen, the visibility, defined as the ratio $\frac{I_{max}-Imin}{I_{max}+Imi_n}$, is

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

Q33. [Dec 2018] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2018 Dec	3.5M

An electromagnetic wave propagates in a nonmagnetic medium with relative permittivity $\varepsilon = 4$. The magnetic field for this wave is

$$\vec{H}(x,y) = \hat{k}H_0\cos(\omega t - \alpha x - \alpha\sqrt{3}y)$$

where H_0 is a constant. The corresponding electric field $\vec{E}(x,y)$ is

1. $\frac{1}{4}\mu_0 H_0 c\left(-\sqrt{3}\hat{i} + \hat{j}\right)co\,s\left(\omega t - \alpha x - \alpha\sqrt{3}y\right)$
2. $\frac{1}{4}\mu_0 H_0 c\left(\sqrt{3}\hat{i} + \hat{j}\right)co\,s\left(\omega t - \alpha x - \alpha\sqrt{3}y\right)$
3. $\frac{1}{4}\mu_0 H_0 c\left(\sqrt{3}\hat{i} - \hat{j}\right)co\,s\left(\omega t - \alpha x - \alpha\sqrt{3}y\right)$
4. $\frac{1}{4}\mu_0 H_0 c(-\sqrt{3}\hat{i} - \hat{j})\cos(\omega t - \alpha x - \alpha\sqrt{3}y)$

Q34. [Dec 2018] . 3.5 marks

Quantum Mechanics > Quantum Harmonic Oscillator

CSIR NET	2018 Dec	3.5M

The ground state energy of an anisotropic harmonic oscillator described by the potential

$$V(x,y,z) = \frac{1}{2}m\omega^2x^2 + 2m\omega^2y^2 + 8m\omega^2z^2$$

(in units of $\hbar\omega$) is

1. $\frac{5}{2}$
2. $\frac{7}{2}$
3. $\frac{3}{2}$
4. $\frac{1}{2}$

Q35. [Dec 2018] . 3.5 marks

Quantum Mechanics > Quantum Harmonic Oscillator

CSIR NET	2018 Dec	3.5M

The product $\Delta x \Delta p$ of uncertainties in the position and momentum of a simple harmonic oscillator of mass m and angular frequency ω in the ground state $|0\rangle$, is $\frac{\hbar}{2}$. The value of the product $\Delta x \Delta p$ in the state, $e^{-i\hat{p}\ell/\hbar}|0\rangle$ (where ℓ is a constant and $\hat{p}$ is the momentum operator) is

1. $\frac{\hbar}{2}\sqrt{\frac{m\omega\ell^2}{\hbar}}$
2. $\hbar$
3. $\frac{\hbar}{2}$
4. $\frac{\hbar^2}{m\omega\ell^2}$

Q36. [Dec 2018] . 3.5 marks

Quantum Mechanics > Orbital angular Momentum and Hydrogen atom

CSIR NET	2018 Dec	3.5M

Let the wavefunction of the electron in a hydrogen atom be

$$\psi(\vec{r}) = \frac{1}{\sqrt{6}}\phi_{200}(\vec{r}) + \sqrt{\frac{2}{3}}\phi_{21-1}(\vec{r}) - \frac{1}{\sqrt{6}}\phi_{100}(\vec{r})$$

where $\phi_{nlm}(\vec{r})$ are the eigenstates of the Hamiltonian in the standard notation. The expectation value of the energy in this state is

1. -10.8 eV
2. -6.2 eV
3. -9.5 eV
4. -5.1 eV

Q37. [Dec 2018] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2018 Dec	3.5M

Three identical spin $\frac{1}{2}$ particles of mass m are confined to a one-dimensional box of length L, but are otherwise free. Assuming that they are non-interacting, the energies of the lowest two energy eigen states, in units of $\frac{\pi^2\hbar^2}{2mL^2}$, are

1. 3 and 6
2. 6 and 9
3. 6 and 11
4. 3 and 9

Q38. [Dec 2018] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2018 Dec	3.5M

The heat capacity C_V at constant volume of a metal, as a function of temperature, is $\alpha T + \beta T^3$, where α and β are constants. The temperature dependence of the entropy at constant volume is

1. $\alpha T + \frac{1}{3}\beta T^3$
2. $\alpha T + \beta T^3$
3. $\frac{1}{2}\alpha T + \frac{1}{3}\beta T^3$
4. $\frac{1}{2}\alpha T + \frac{1}{4}\beta T^3$

Q39. [Dec 2018] . 3.5 marks

Statistical Mechanics > Canonical Ensemble

CSIR NET	2018 Dec	3.5M

The rotational energy levels of a molecule are $E_\ell = \frac{\hbar^2}{2I_0}\ell(\ell+1)$, where $\ell = 0,1,2,\ldots$ and I_0 is its moment of inertia. The contribution of the rotational motion to the Helmholtz free energy per molecule, at low temperatures in a dilute gas of these molecules, is approximately

1. $-k_BT\left(1+\frac{\hbar^2}{I_0k_BT}\right)$
2. $-k_BTe^{-\frac{\hbar^2}{I_0k_BT}}$
3. $-k_BT$
4. $-3k_BTe^{-\frac{\hbar^2}{I_0k_BT}}$

Q40. [Dec 2018] . 3.5 marks

Statistical Mechanics > Canonical Ensemble

CSIR NET	2018 Dec	3.5M

The vibrational motion of a diatomic molecule may be considered to be that of a simple harmonic oscillator with angular frequency ω. If a gas of these molecules is at temperature T, what is the probability that a randomly picked molecule will be found in its lowest vibrational state?

1. $1 - e^{-\frac{\hbar\omega}{k_B T}}$
2. $e^{-\frac{\hbar\omega}{2k_B T}}$
3. $tan\, h\left(\frac{\hbar\omega}{k_B T}\right)$
4. $\frac{1}{2}\,\text{cosech}\left(\frac{\hbar\omega}{2k_B T}\right)$

Q41. [Dec 2018] . 3.5 marks

Statistical Mechanics > Grand Canonical ensemble

CSIR NET	2018 Dec	3.5M

Consider an ideal Fermi gas in a grand canonical ensemble at a constant chemical potential. The variance of the occupation number of the single particle energy level with mean occupation number $\bar{n}$ is

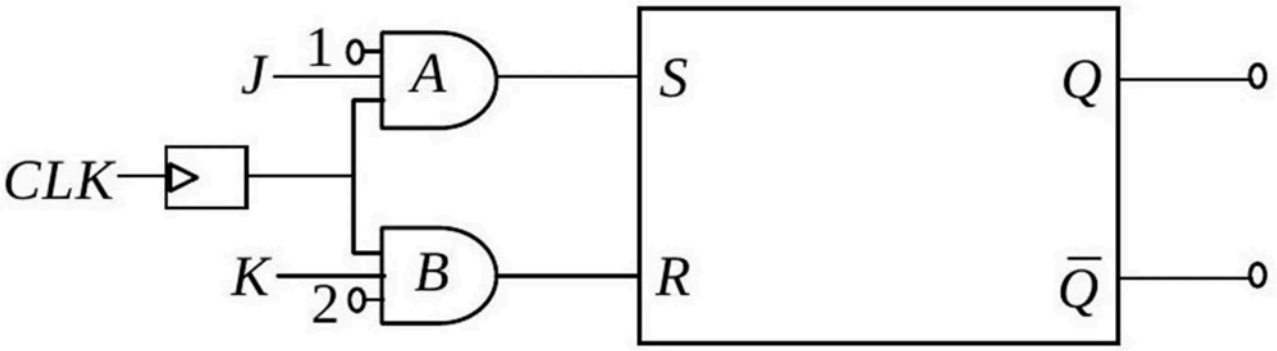
1. $\bar{n}(1-\bar{n})$
2. $\sqrt{\bar{n}}$
3. $\bar{n}$
4. $\frac{1}{\sqrt{\bar{n}}}$

Q42. [Dec 2018] . 3.5 marks

Electronics > Flip flops/Counters/Registers/microcontroller etc.

CSIR NET	2018 Dec	3.5M

Consider the following circuit, consisting of an RS flip-flop and two AND gates.



Which of the following connections will allow the entire circuit to act as a JK flip-flop?

1. connect Q to pin 1 and $\bar{Q}$ to pin 2
2. connect Q to pin 2 and $\bar{Q}$ to pin 1
3. connect Q to K input and $\bar{Q}$ to J input
4. connect Q to J input and $\bar{Q}$ to K input

Q43. [Dec 2018] . 3.5 marks

Electronics > Digital Electronics

CSIR NET	2018 Dec	3.5M

The truth table below gives the value $Y(A, B, C)$ where A, B and C are binary variables. The output Y can be represented by

1. $Y = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}C + AB\bar{C}$
2. $Y = \bar{A}\bar{B}\bar{C} + \bar{A}BC + A\bar{B}\bar{C} + ABC$
3. $Y = \bar{A}\bar{B}C + \bar{A}BC + A\bar{B}C + ABC$
4. $Y = \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}\bar{C} + AB\bar{C}$

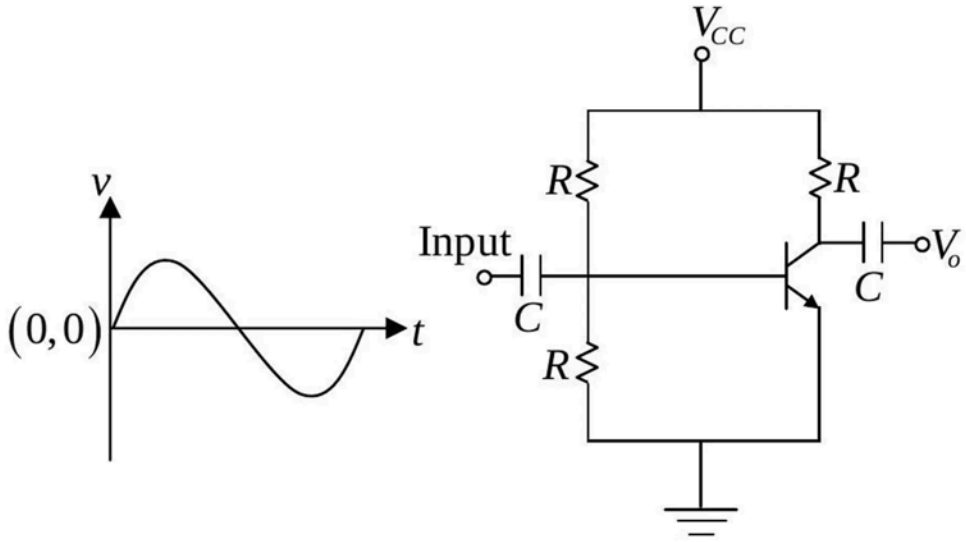
A	B	C	Y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	1	0	0
1	1	1	1

Q44. [Dec 2018] . 3.5 marks

Electronics > Transistors

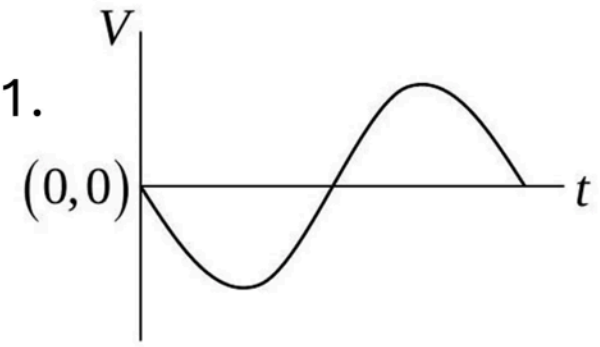
CSIR NET	2018 Dec	3.5M

A sinusoidal signal is an input to the following circui

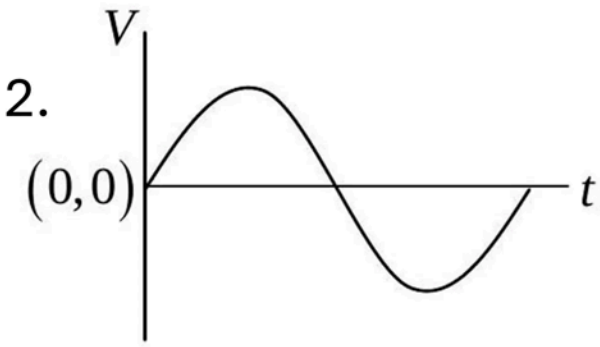


Which of the following graphs best describes the output wave function?

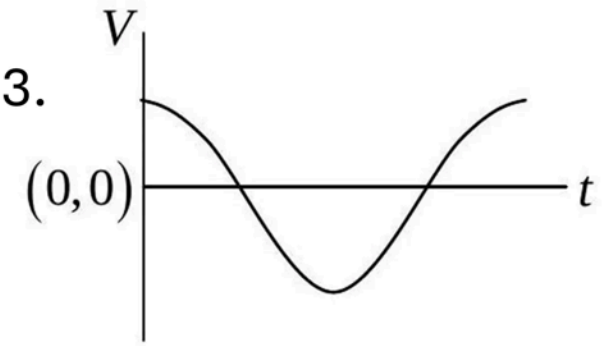
1.



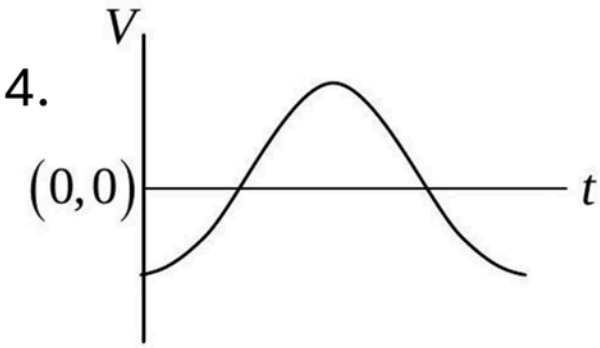
2.



3.



4.

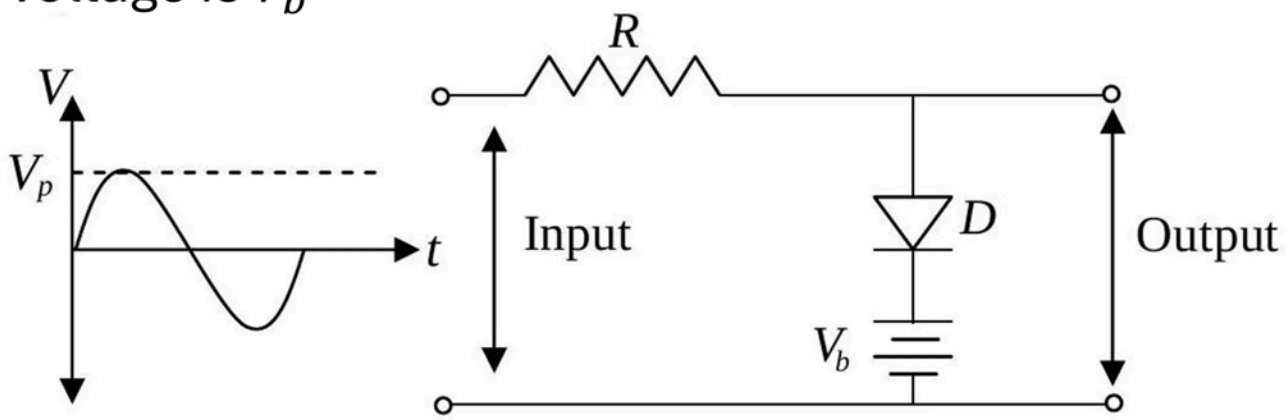


Q45. [Dec 2018] . 3.5 marks

Electronics > Diodes

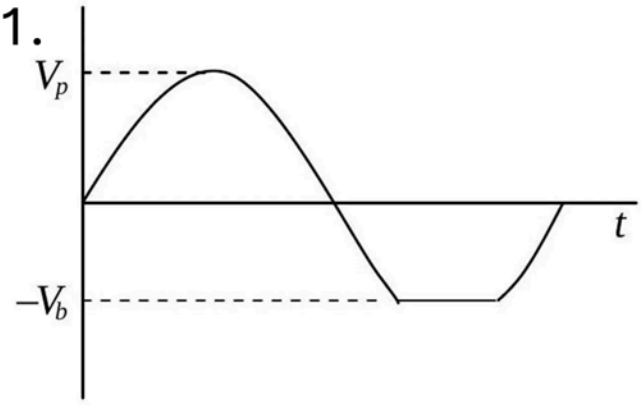
CSIR NET	2018 Dec	3.5M

A sinusoidal voltage having a peak value of V_p is an input to the following circuit, in which the DC voltage is V_b

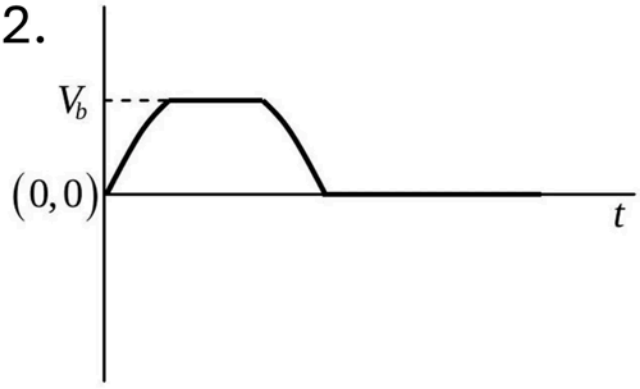


Assuming an ideal diode which of the following best describes the output waveform?

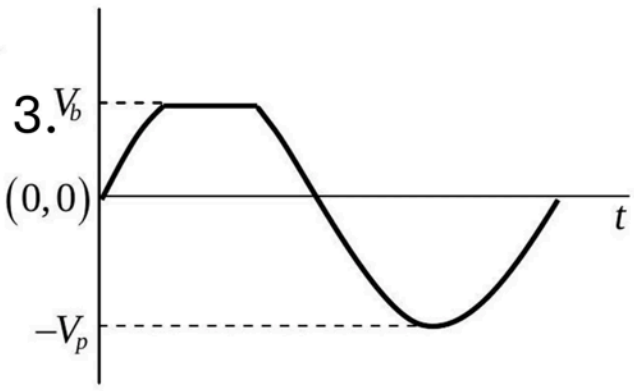
1.



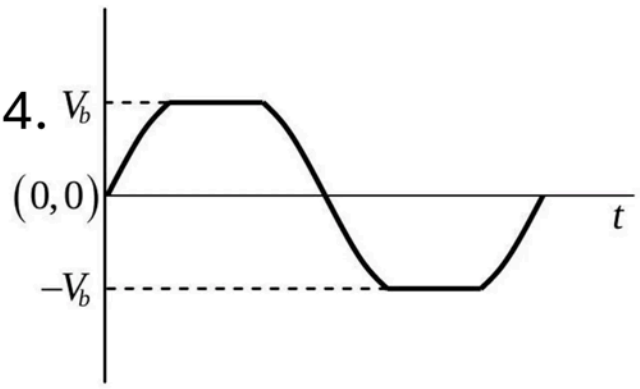
2.



3.



4.



Q46. [Dec 2018] . 5.0 marks

Mathematical Physics > Green Function

CSIR NET	2018 Dec	5M

The Green's function $G(x,x')$ for the equation $\frac{d^2y(x)}{dx^2} = f(x)$, with the boundary values $y(0) = 0$ and $y(1) = 0$, is

1. $G(x,x') = \begin{cases} \frac{1}{2}x(1-x'), & 0 < x < x' < 1 \\ \frac{1}{2}x'(1-x) & 0 < x' < x < 1 \end{cases}$

2. $G(x,x') = \begin{cases} x(x'-1), & 0 < x < x' < 1 \\ x'(1-x) & 0 < x' < x < 1 \end{cases}$

3. $G(x,x') = \begin{cases} -\frac{1}{2}x(1-x'), & 0 < x < x' < 1 \\ \frac{1}{2}x'(1-x) & 0 < x' < x < 1 \end{cases}$

4. $G(x,x') = \begin{cases} x(x'-1), & 0 < x < x' < 1 \\ x'(x-1) & 0 < x' < x < 1 \end{cases}$

Q47. [Dec 2018] . 5.0 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2018 Dec	5M

A 4×4 complex matrix A satisfies the relation $A^{\dagger}A = 4I$, where I is the 4×4 identity matrix. The number of independent real parameters of A is

1. 32
2. 10
3. 12
4. 16

Q48. [Dec 2018] . 5.0 marks

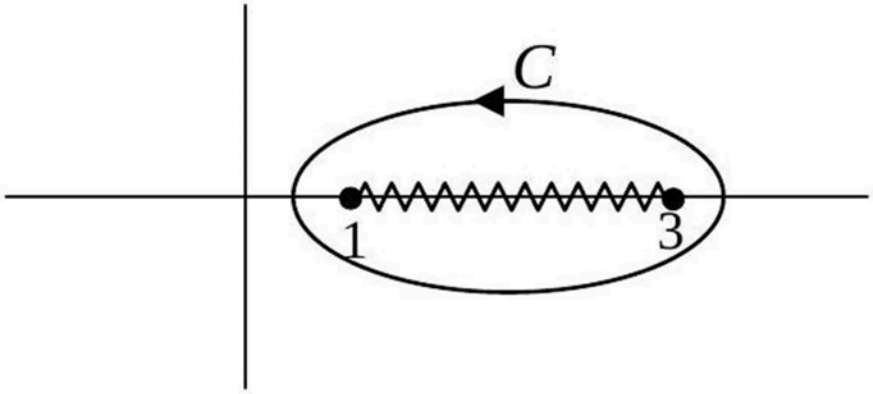
Mathematical Physics > Complex analysis

CSIR NET	2018 Dec	5M

The contour C of the following integral

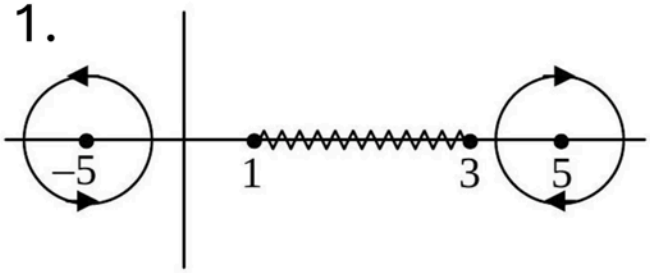
$$\oint_C dz \frac{\sqrt{(z-1)(z-3)}}{(z^2-25)^3}$$

in the complex z plane is shown in the figure below.

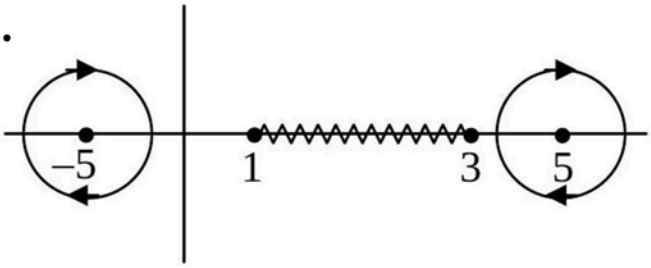


This integral is equivalent to an integral along the contours

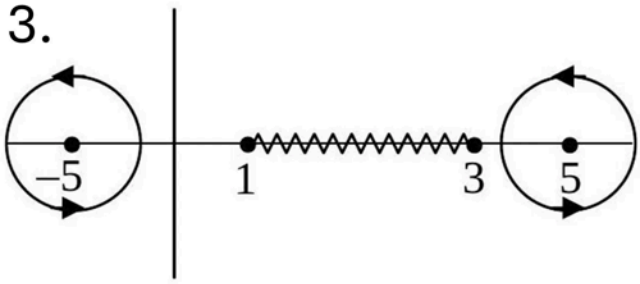
1.



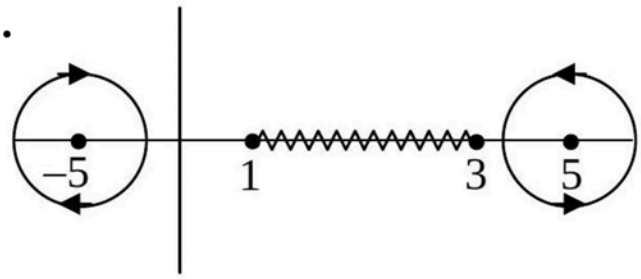
2.



3.



4.



Q49. [Dec 2018] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2018 Dec	5M

The value of the integral $\int_0^1 x^2 dx$, evaluated using the trapezoidal rule with a step size of 0.2 , is

1. 0.30
2. 0.39
3. 0.34
4. 0.27

Q50. [Dec 2018] . 5.0 marks

Classical Mechanics > Lagrangian and Hamiltonian

CSIR NET	2018 Dec	5M

The motion of a particle in one dimension is described by the Langrangian $L = \frac{1}{2}\left(\left(\frac{dx}{dt}\right)^2 - x^2\right)$ in suitable units. The value of the action along the classical path from $x = 0$ at $t = 0$ to $x = x_0$ at $t = t_0$, is

1. $\frac{x_0^2}{2\sin^2 t_0}$
2. $\frac{1}{2}x_0^2 tan\, t_0$
3. $\frac{1}{2}x_0^2 cot\, t_0$
4. $\frac{x_0^2}{2\cos^2 t_0}$

Q51. [Dec 2018] . 5.0 marks

Classical Mechanics > Lagrangian and Hamiltonian

CSIR NET	2018 Dec	5M

The Hamiltonian of a classical one-dimensional harmonic oscillator is $H = \frac{1}{2}\left(p^2 + x^2\right)$, in suitable units. The total time derivative of the dynamical variable $(p + \sqrt{2}x)$ is

1. $\sqrt{2}p - x$
2. $p - \sqrt{2}x$
3. $p + \sqrt{2}x$
4. $x + \sqrt{2}p$

Q52. [Dec 2018] . 5.0 marks

Classical Mechanics > Special theory of relativity

CSIR NET	2018 Dec	5M

A relativistic particle of mass m and charge e is moving in a uniform electric field of strength ε. Starting from rest at $t = 0$, how much time will it take to reach the speed $\frac{c}{2}$?

1. $\frac{1}{\sqrt{3}}\frac{mc}{e\varepsilon}$
2. $\frac{mc}{e\varepsilon}$
3. $\sqrt{2}\frac{mc}{e\varepsilon}$
4. $\sqrt{\frac{3}{2}}\frac{mc}{e\varepsilon}$

Q53. [Dec 2018] . 5.0 marks

Electromagnetism > Relativistic electromagnetism

CSIR NET	2018 Dec	5M

In an inertial frame uniform electric and magnetic field $\vec{E}$ and $\vec{B}$ are perpendicular to each other and satisfy $|\vec{E}|^2 - |\vec{B}|^2 = 29$ (in suitable units). In another inertial frame, which moves at a constant velocity with respect to the first frame, the magnetic field is $2\sqrt{5}\hat{k}$. In the second frame, an electric field consistent with the previous observations is

1. $\frac{7}{\sqrt{2}}(\hat{i} + \hat{j})$
2. $7(\hat{i} + \hat{k})$
3. $\frac{7}{\sqrt{2}}(\hat{i} + \hat{k})$
4. $7(\hat{i} + \hat{j})$

Q54. [Dec 2018] . 5.0 marks

Electromagnetism > Plasma

CSIR NET	2018 Dec	5M

Electromagnetic wave of angular frequency ω is propagating in a medium in which, over a band of frequencies the refractive index is $n(\omega) \approx 1 - \left(\frac{\omega}{\omega_0}\right)^2$, where ω_0 is a constant. The ratio $\frac{v_g}{v_p}$ of the group velocity to the phase velocity at $\omega = \frac{\omega_0}{2}$ is

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

Q55. [Dec 2018] . 5.0 marks

Electromagnetism > Magetostatics

CSIR NET	2018 Dec	5M

A rotating spherical shell of uniform surface charge and mass density has total mass M and charge Q. If its angular momentum is L and magnetic moment is μ, then the ratio $\frac{\mu}{L}$ is

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

Q56. [Dec 2018] . 5.0 marks

Quantum Mechanics > Orbital angular Momentum and Hydrogen atom

CSIR NET	2018 Dec	5M

Consider the operator $A_x = L_y p_z - L_z p_y$, where L_i and p_i denote, respectively, the components of the angular momentum and momentum operators. The commutator $[A_x, x]$, where x is the x - component of the position operator, is

1. $-i\hbar(zp_z + yp_y)$
2. $-i\hbar(zp_z - yp_y)$
3. $i\hbar(zp_z + yp_y)$
4. $i\hbar(zp_z - yp_y)$

Q57. [Dec 2018] . 5.0 marks

Quantum Mechanics > WKB Approximation

CSIR NET	2018 Dec	5M

A one-dimensional system is described by the Hamiltonian $H = \frac{p^2}{zm} + \lambda|x|$ (where $\lambda > 0$). The ground state energy varies as a function of λ as

1. $\lambda^{5/3}$
2. $\lambda^{2/3}$
3. $\lambda^{4/3}$
4. $\lambda^{1/3}$

Q58. [Dec 2018] . 5.0 marks

Quantum Mechanics > Orbital angular Momentum and Hydrogen atom

CSIR NET	2018 Dec	5M

If the position of the electron in the ground state of a Hydrogen atom is measured, the probability that it will be found at a distance $r \geq a_0$ (a_0 being Bohr radius) is nearest to

1. 0.91
2. 0.66
3. 0.32
4. 0.13

Q59. [Dec 2018] . 5.0 marks

Quantum Mechanics > Spin Angular momentum

CSIR NET	2018 Dec	5M

A system of spin $\frac{1}{2}$ particles is prepared to be in the eigenstate of σ_z with eigenvalue +1 . The system is rotated by at angle of 60^0 about the x-axis. After the rotation, the fraction of the particles that will be measured to be in the eigenstate of σ_z with eigenvalue +1 is

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

Q60. [Dec 2018] . 5.0 marks

Statistical Mechanics > Ising model

CSIR NET	2018 Dec	5M

The Hamiltonian of a one-dimensional Ising model of N spins (N large) is

$$H = -J \sum_{i=1}^{N} \sigma_i \sigma_{i+1}$$

where the spin $\sigma_i = \pm 1$ and J is a positive constant. At inverse temperature $\beta = \frac{1}{k_B T}$, the correlation function between the nearest neighbor spins ($\sigma_i \sigma_{i+1}$) is

1. $\frac{e^{-\beta J}}{(e^{\beta J} + e^{-\beta J})}$
2. $e^{-2\beta J}$
3. $tanh(\beta J)$
4. $\coth(\beta J)$

Q61. [Dec 2018] . 5.0 marks

Solid State Physics > Lattice vibrations

CSIR NET	2018 Dec	5M

At low temperatures, in the Debye approximation, the contribution of the phonons to the heat capacity of a two dimensional solid is proportional to

1. T^2
2. T^3
3. $T^{1/2}$
4. $T^{3/2}$

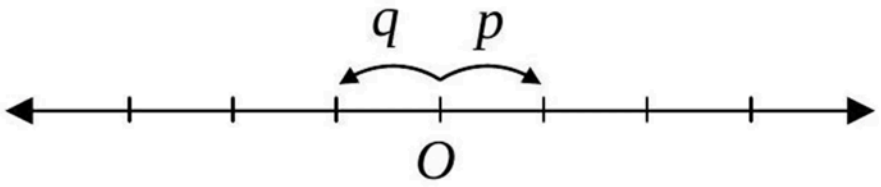
Q62. [Dec 2018] . 5.0 marks

Statistical Mechanics > Random Walk/Brownian motion/Diffusion

CSIR NET	2018 Dec	5M

A particle hops on a one-dimensional lattice with lattice spacing a. The probability of the particle to hop to the neighboring site to its right is p, while the corresponding probability to hop to the left is $q = 1 - p$. The root-mean squared deviation $\Delta x = \sqrt{\langle x^2 \rangle - \langle x \rangle^2}$ in displacement after N steps, is

1. $a\sqrt{Npq}$
2. $aN\sqrt{pq}$
3. $2a\sqrt{Npq}$
4. $a\sqrt{N}$



Q63. [Dec 2018] . 5.0 marks

Statistical Mechanics > Canonical Ensemble

CSIR NET	2018 Dec	5M

The energy levels accessible to a molecule have energies $E_1 = 0, E_2 = \Delta$ and $E_3 = 2\Delta$ (where Δ is a constant). A gas of these molecules is in thermal equilibrium at temperature T. The specific heat at constant volume in the high temperature limit ($k_B T \gg \Delta$) varies with temperature as

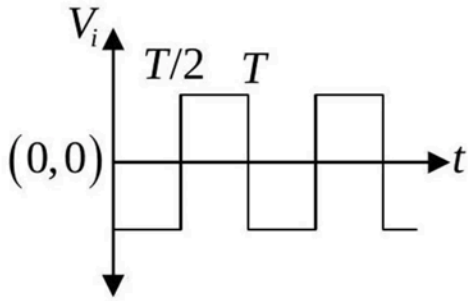
1. $\frac{1}{T^{3/2}}$
2. $\frac{1}{T^3}$
3. $\frac{1}{T}$
4. $\frac{1}{T^2}$

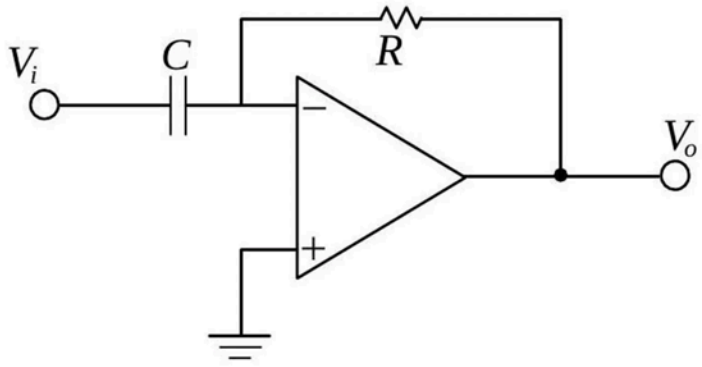
Q64. [Dec 2018] . 5.0 marks

Electronics > OPAMP

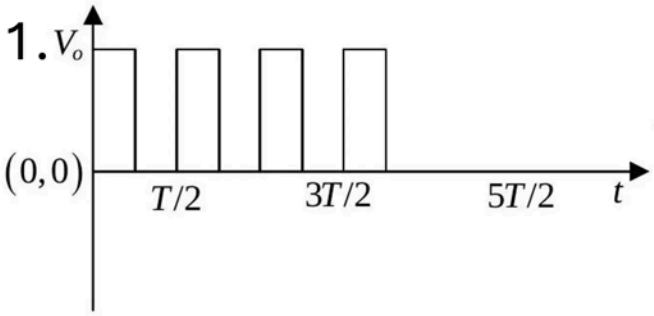
CSIR NET	2018 Dec	5M

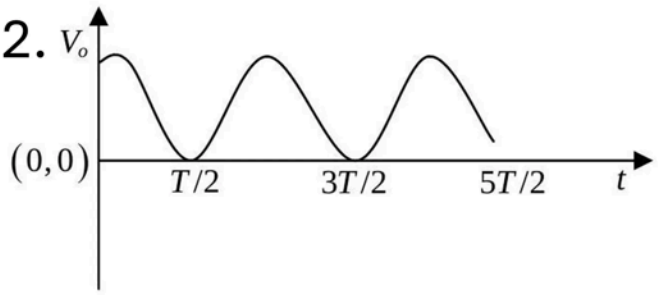
The input V_i to the following circuit is a square wave as shown in the following figure.

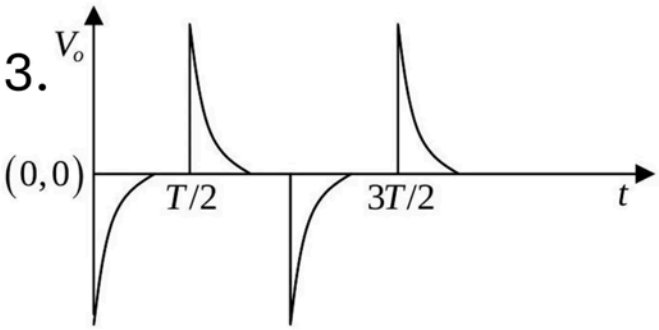


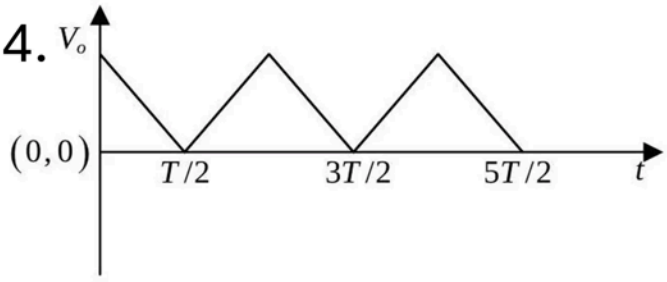


which of the waveforms best describes the output?

1. 

2. 

3. 

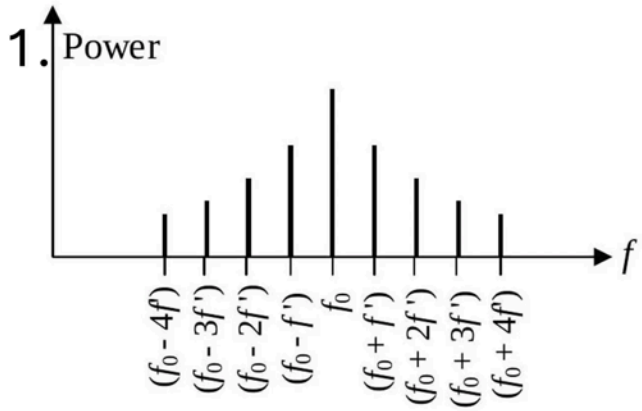
4. 

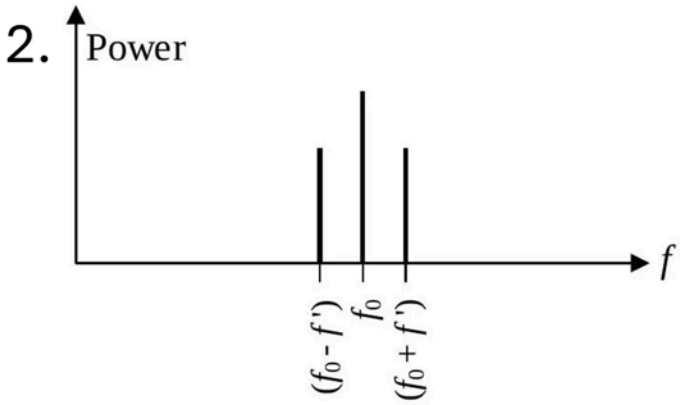
Q65. [Dec 2018] . 5.0 marks

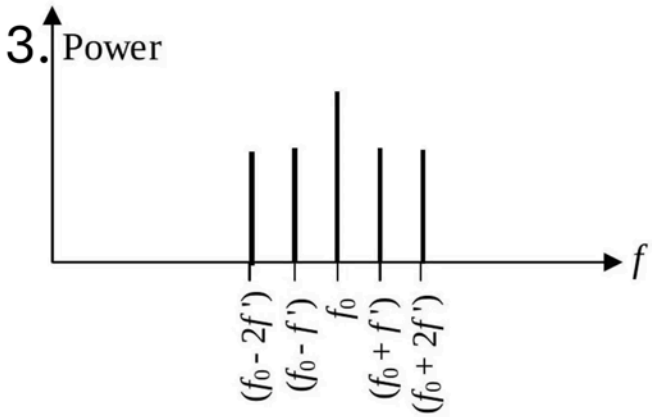
Electronics > Instruments

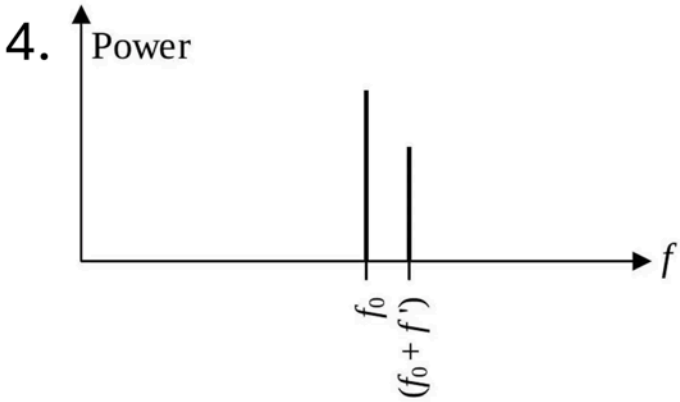
CSIR NET	2018 Dec	5M

The amplitude of a carrier signal of frequency f_0 is sinusoidally modulated at a frequency $f' \ll f_0$. Which of the following graphs best describes its power spectrum?

1.


2.


3.


4.


Q66. [Dec 2018] . 5.0 marks

Mathematical Physics > Probability

CSIR NET	2018 Dec	5M

The standard deviation of the following set of data $\{10.0,10.0,9.9,9.9,9.8,9.9,9.9,9.9,9.8,9.9\}$ is nearest to

1. 0.10
2. 0.07
3. 0.01
4. 0.04

Q67. [Dec 2018] . 5.0 marks

Atomic and Molecular Physics > Molecular physics

CSIR NET	2018 Dec	5M

The diatomic molecule HF has an absorption line in the rotational band at $40\ \mathrm{cm}^{-1}$ for the isotope ^{18}F. The corresponding line for the isotope ^{19}F will be shifted by approximately

1. $0.05\ \mathrm{cm}^{-1}$
2. $0.11\ \mathrm{cm}^{-1}$
3. $0.33\ \mathrm{cm}^{-1}$
4. $0.01\ \mathrm{cm}^{-1}$

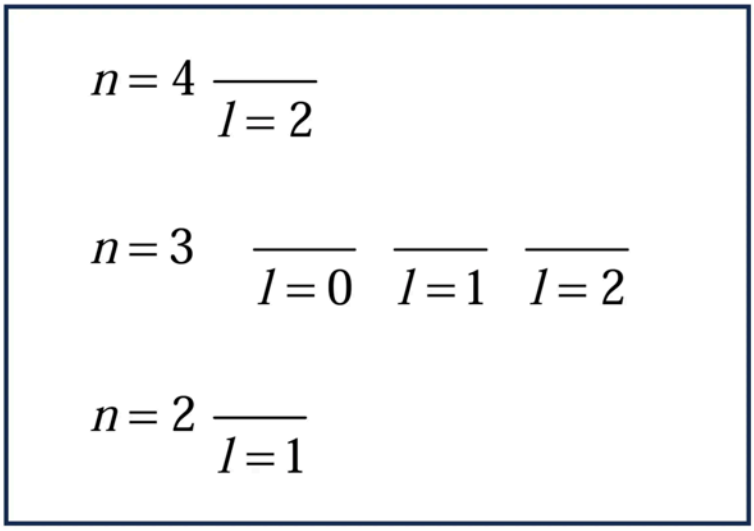
Q68. [Dec 2018] . 5.0 marks

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

CSIR NET	2018 Dec	5M

The excited state ($n = 4, l = 2$) of an election in an atom may decay to one or more of the lower energy levels shown in the diagram below. Of the total emitted light, a fraction $\frac{1}{4}$ comes from the decay to the state ($n = 2, l = 1$). Based on selection rules, the fractional intensity of the emission line due to the decay to the state ($n = 3, l = 1$)

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



Q69. [Dec 2018] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2018 Dec	5M

The volume of an optical cavity is $1\,\mathrm{cm}^3$. The number of modes it can support within a bandwidth of 0.1 nm , centered at $\lambda = 500\,\mathrm{nm}$, is of the order of

1. 10^3
2. 10^5
3. 10^{10}
4. 10^7

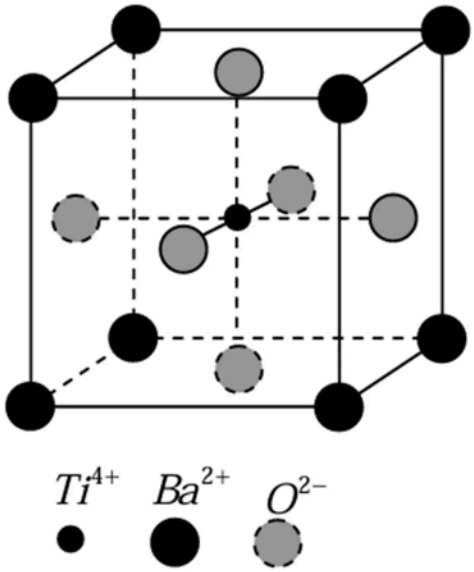
Q70. [Dec 2018] . 5.0 marks

Solid State Physics > Crystallography

CSIR NET	2018 Dec	5M

Barium Titanate ($BaTiO_3$) crystal has a cubic perovskite structure, where the Ba^{2+} ions are at the vertices of a unit cube, the O^{2-} ions are at the centers of the faces while the Ti^{2+} is at the center. The number of optical phonon modes of the crystal is

1. 12
2. 15
3. 5
4. 18



Q71. [Dec 2018] . 5.0 marks

Solid State Physics > Tight binding model

CSIR NET	2018 Dec	5M

The dispersion relation of optical phonons in a cubic crystal is given by $\omega(k) = \omega_0 - ak^2$ where ω_0 and a are positive constants. The contribution to the density of states due to these phonons with frequencies just below ω_0 is proportional to

1. $(\omega_0 - \omega)^{1/2}$
2. $(\omega_0 - \omega)^{3/2}$
3. $(\omega_0 - \omega)^2$
4. $(\omega_0 - \omega)$

Q72. [Dec 2018] . 5.0 marks

Solid State Physics > Semiconductor Physics

CSIR NET	2018 Dec	5M

A silicon crystal is doped with phosphorus atoms. (The binding energy of a H atom is $13.6eV$, the dielectric constant of silicon is 12 and the effective mass of electrons in the crystal is $0.4m_e$). The gap between the donor energy level and the bottom of the conduction band is nearest to

1. 0.01 eV
2. 0.08 eV
3. 0.02 eV
4. 0.04 eV

Q73. [Dec 2018] . 5.0 marks

Nuclear and Particle Physics > Nuclear forces and Scattering

CSIR NET	2018 Dec	5M

Assume that pion-nucleon scattering at low energies, in which isospin is conserved is described by the effective interaction potential $V_{\text{eff}} = F(r)\vec{I}_\pi.\vec{I}_N$, where $F(r)$ is a function of the radial separation r and $\vec{I}_\pi$ and $\vec{I}_N$ denote, respectively, the isospin vectors of a pion and the nucleon. The ratio $\frac{\sigma_{I=3/2}}{\sigma_{I=1/2}}$ of the scattering cross-sections corresponding to total isospins $I = \frac{3}{2}$ and $\frac{1}{2}$ is

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

Q74. [Dec 2018] . 5.0 marks

Nuclear and Particle Physics > Radioactivity

CSIR NET	2018 Dec	5M

A nucleus decays by the emission of a gamma ray from an excited state of spin parity 2^+ to the ground state with spin-parity 0^+ what is the type of the corresponding radiation?

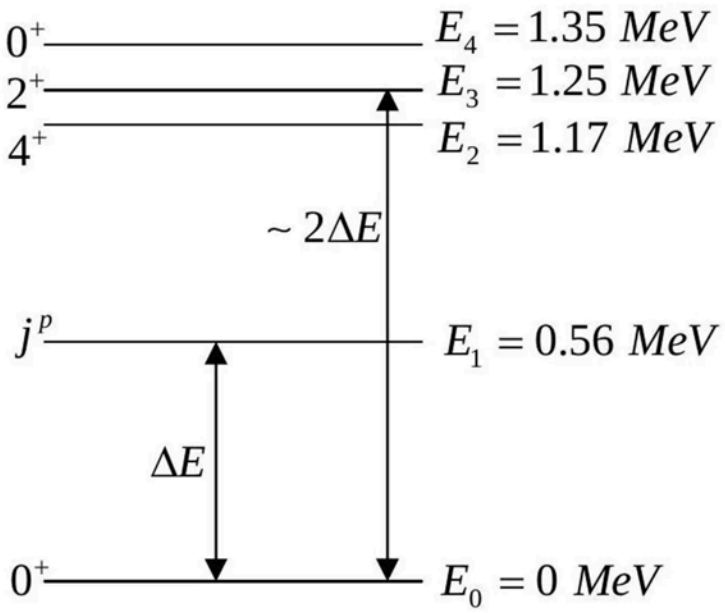
1. magnetic dipole
2. electric quadrupole
3. electric dipole
4. magnetic quadrupole

Q75. [Dec 2018] . 5.0 marks

Nuclear and Particle Physics > Collective model

CSIR NET	2018 Dec	5M

The low-lying energy levels due to the vibrational excitations of an even-even nucleus are shown in the figure below. The spin-parity j^p of the level E_1 is



1. 1^+
2. 1^-
3. 2^-
4. 2^+

Answer Key

75 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	General Aptitude	Geometry	**1**
Q2	General Aptitude	Mathematical Analysis	**1**
Q3	General Aptitude	Mathematical Analysis	**4**
Q4	General Aptitude	Mathematical Analysis	**2**
Q5	General Aptitude	Basic Physics	**3**
Q6	General Aptitude	Mathematical Analysis	**2**
Q7	General Aptitude	Mathematical Analysis	**1**
Q8	General Aptitude	Basic Physics	**2**
Q9	General Aptitude	Mathematical Analysis	**3**
Q10	General Aptitude	Basic Physics	**4**
Q11	General Aptitude	Reasoning	**2**
Q12	General Aptitude	Basic Physics	**4**
Q13	General Aptitude	Reasoning	**3**
Q14	General Aptitude	Data Analysis	**1**
Q15	General Aptitude	Basic Physics	**4**
Q16	General Aptitude	Reasoning	**3**
Q17	General Aptitude	Geometry	**3**
Q18	General Aptitude	Geometry	**3**
Q19	General Aptitude	Mathematical Analysis	**2**
Q20	General Aptitude	Basic Physics	**4**
Q21	Mathematical Physics	Matrices and Linear Algebra	**4**
Q22	Mathematical Physics	Special Functions	**3**
Q23	Mathematical Physics	Complex analysis	**None**
Q24	Classical Mechanics	Basic Mechanics	**3**
Q25	Mathematical Physics	Complex analysis	**2**
Q26	Mathematical Physics	Ordinary Differential Equations	**4**
Q27	Classical Mechanics	Central forces	**3**
Q28	Classical Mechanics	Oscillations	**3**
Q29	Classical Mechanics	Special theory of relativity	**3**
Q30	Electromagnetism	Magetostatics	**3**
Q31	Electromagnetism	Electrostatics	**3**
Q32	Optics	Interference and diffraction	**2**
Q33	Electromagnetism	EM Waves	**1**
Q34	Quantum Mechanics	Quantum Harmonic Oscillator	**2**
Q35	Quantum Mechanics	Quantum Harmonic Oscillator	**3**
Q36	Quantum Mechanics	Orbital angular Momentum and Hydrogen atom	**4**
Q37	Quantum Mechanics	Potential Well	**2**
Q38	Statistical Mechanics	Microcanonical Ensemble	**1**
Q39	Statistical Mechanics	Canonical Ensemble	**4**
Q40	Statistical Mechanics	Canonical Ensemble	**1**

Answer Key (cont.)

Q. No	Subject	Topic	Answer
Q41	Statistical Mechanics	Grand Canonical ensemble	**1**
Q42	Electronics	Flip flops/Counters/Registers/microcontroller etc.	**2**
Q43	Electronics	Digital Electronics	**2**
Q44	Electronics	Transistors	**1**
Q45	Electronics	Diodes	**3**
Q46	Mathematical Physics	Green Function	**4**
Q47	Mathematical Physics	Matrices and Linear Algebra	**4**
Q48	Mathematical Physics	Complex analysis	**2**
Q49	Mathematical Physics	Numerical Methods	**3**
Q50	Classical Mechanics	Lagrangian and Hamiltonian	**3**
Q51	Classical Mechanics	Lagrangian and Hamiltonian	**1**
Q52	Classical Mechanics	Special theory of relativity	**1**
Q53	Electromagnetism	Relativistic electromagnetism	**1**
Q54	Electromagnetism	Plasma	**1**
Q55	Electromagnetism	Magetostatics	**3**
Q56	Quantum Mechanics	Orbital angular Momentum and Hydrogen atom	**1**
Q57	Quantum Mechanics	WKB Approximation	**2**
Q58	Quantum Mechanics	Orbital angular Momentum and Hydrogen atom	**2**
Q59	Quantum Mechanics	Spin Angular momentum	**4**
Q60	Statistical Mechanics	Ising model	**3**
Q61	Solid State Physics	Lattice vibrations	**1**
Q62	Statistical Mechanics	Random Walk/Brownian motion/Diffusion	**3**
Q63	Statistical Mechanics	Canonical Ensemble	**4**
Q64	Electronics	OPAMP	**None**
Q65	Electronics	Instruments	**2**
Q66	Mathematical Physics	Probability	**2**
Q67	Atomic and Molecular Physics	Molecular physics	**2**
Q68	Atomic and Molecular Physics	Bohar Model and h-atom model	**1**
Q69	Atomic and Molecular Physics	Lasers	**3**
Q70	Solid State Physics	Crystallography	**1**
Q71	Solid State Physics	Tight binding model	**1**
Q72	Solid State Physics	Semiconductor Physics	**4**
Q73	Nuclear and Particle Physics	Nuclear forces and Scattering	**2**
Q74	Nuclear and Particle Physics	Radioactivity	**2**
Q75	Nuclear and Particle Physics	Collective model	**4**

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