Please note that the Physics question pattern has changed for JEST 2026.
Part A: 10 multiple choice questions each carrying 1 mark
Part B: 20 multiple choice questions each carrying +3 marks
Part C: 10 numericals: 3 marks
For details, please visit the FAQ page at https://www.jest.org.in.

JEST-2026 Sample Question Paper

Part A: 1-Mark MCQ

1. A particle is moving under the force field given by $\vec{F} = k\vec{r}$, where k is a positive constant. The difference in work done (in arbitrary units) if the particle moves from point A $(-1, 0, 0)$ to point B $(1, 0, 0)$ following semi-circular paths in the clockwise and anti-clockwise directions on the X-Y plane will be

   A. 0

   B. $2\pi k$

   C. $\frac{1}{2}\pi k$

   D. πk

2. The Fraunhofer diffraction pattern formed by an elliptical aperture will be

   A. elliptical with the semi-major axis perpendicular to that of the aperture.

   B. circular.

   C. elliptical with the semi-major axis parallel to that of the aperture.

   D. hyperbolic.

3. For a relativistic point particle the momentum is $\vec{p} = \frac{m_0\vec{v}}{\sqrt{1-v^2/c^2}}$, where $\vec{v}$ is its velocity as measured by an inertial observer. Then the acceleration is in the same direction as the applied force

   A. only when force is parallel or perpendicular to the velocity.

   B. always.

   C. never.

   D. only when force is neither parallel nor perpendicular to the velocity.

4. For a plane electromagnetic wave propagating with wave vector $\vec{k}$ in a homogeneous and isotropic medium, which of the following holds?

   A. $\vec{E} \cdot \vec{B} = 0$

   B. $\vec{E} \times \vec{B} = \vec{0}$

   C. $\vec{k} \cdot (\vec{E} \times \vec{B}) = 0$

   D. None of the others.

5. Given the differential operator: $D \equiv \frac{d^2}{dx^2} + P\frac{d}{dx} + Q$, where P and Q are constants, what is the eigenvalue corresponding to the eigenfunction $y = e^x$?

   A. $(1 + P + Q)$

   B. $(P + Q)$

   C. $(1 + Q)$

   D. $(P + Q - 1)$

6. Suppose the mass of the Sun is reduced to half of its original value very slowly, e.g., over a billion years, what will be the effect of this on the Earth's orbit?

   A. Remains elliptical, but the mean radius changes.

   B. Remains elliptical with the same mean radius.

   C. Orbit remains closed but not elliptical.

   D. The Earth flies away.

7. Consider the time-independent Schrödinger equation with a real potential and suppose $\psi(x)$ is a solution of this equation. Which of the following is true?

   A. ψ^* is a solution of the same equation.

   B. ψ^* is never a solution of the same equation.

   C. ψ^* is a solution of the same equation only if the potential is symmetric about $x = 0$.

   D. ψ^* is a solution of the same equation only if the potential vanishes at infinity.

8. Consider a quantum system that is evolved sequentially with a finite sequence of Hermitian Hamiltonians $\{H_0, H_1, \dots H_n\}$. The full evolution operator is written as:

   $$\mathcal{U} = U_n U_{n-1} \dots U_1 U_0 = e^{-i\mathcal{H}}, \text{ with } \quad U_j = e^{-iH_j} \text{ and, } \quad j = 0, 1, \dots n$$

   Then $\mathcal{H}$ is

   A. a Hermitian operator.

   B. a unitary operator.

   C. undefined.

   D. None of the others.

9. Consider two identical charged balls, each of mass m and charge q. One of them is initially held fixed on a frictionless insulating horizontal surface and the other is carefully placed above the first one at a height h from the surface, such that the gravitational force on it is balanced by the Coulomb repulsion. The upper ball is now shifted horizontally by a distance d ($d \ll h$) to the right and then both the balls are released. Which way will the balls move immediately after this?

    A. ball on the surface moves towards left, ball above moves downwards.

    B. both balls remain static at their new positions.

    C. ball on the surface moves towards right and ball above moves upwards.

    D. both balls oscillate around their original positions.

10. Consider the standard notation of discrete finite groups with $\mathbb{Z}_n$ corresponding to the rotation by $2\pi/n$ about a given axis, S_n corresponding to the permutation group of the set S having n elements, i.e. $S = \{1, 2, 3, .., n\}$, and the Dihedral group D_n corresponding to the reflection and rotation symmetries of a regular polygon with n number of sides. Which of the following is the smallest non-abelian group ?

    A. S_3

    B. $\mathbb{Z}_3$

    C. D_4

    D. S_4

Part B: 3-mark MCQ

1. Consider a 2×2 matrix $A = \begin{bmatrix} 0 & 1 \\ 1 & 1 \end{bmatrix}$ which has eigenvalues $\lambda_1 = \frac{1+\sqrt{5}}{2}$ and $\lambda_2 = \frac{1-\sqrt{5}}{2}$. For any natural number n which of the following is correct ?

   A. $A^n = \frac{1}{\sqrt{5}} \begin{bmatrix} \lambda_1^{n-1} - \lambda_2^{n-1} & \lambda_1^n - \lambda_2^n \\ \lambda_1^n - \lambda_2^n & \lambda_1^{n+1} - \lambda_2^{n+1} \end{bmatrix}$

   B. $A^n = \frac{1}{\sqrt{5}} \begin{bmatrix} \lambda_1^{n-1} - \lambda_2^{n-1} & \lambda_1^n + \lambda_2^n \\ \lambda_1^n + \lambda_2^n & \lambda_1^{n+1} - \lambda_2^{n+1} \end{bmatrix}$

   C. $A^n = \frac{1}{\sqrt{5}} \begin{bmatrix} \lambda_1^{n-1} + \lambda_2^{n-1} & \lambda_1^n - \lambda_2^n \\ \lambda_1^n - \lambda_2^n & \lambda_1^{n+1} + \lambda_2^{n+1} \end{bmatrix}$

   D. $A^n = \frac{1}{\sqrt{5}} \begin{bmatrix} \lambda_1^{n-1} + \lambda_2^{n-1} & \lambda_1^n + \lambda_2^n \\ \lambda_1^n + \lambda_2^n & \lambda_1^{n+1} + \lambda_2^{n+1} \end{bmatrix}$

2. A quantum mechanical system is spanned by the eigenstates $|a_1\rangle$ and $|a_2\rangle$ of a Hermitian operator A with eigenvalues a_1 and a_2 respectively. If there is no degeneracy, what is the expectation value of the operator $(A - a_1)(A - a_2)$ in the state $\dfrac{|a_1\rangle + |a_2\rangle}{\sqrt{2}}$?

   A. 0

   B. 1

   C. $(a_2 - a_1)(a_1 - a_2)$

   D. $\dfrac{(a_2 - a_1)(a_1 - a_2)}{2}$

3. Three observers successively measure the spin of a given proton along z-axis, x-axis and again z-axis, respectively. The first observer finds the spin projection to be $+\dfrac{1}{2}$. Assuming no other factors, what is the probability that the third observer finds the spin projection to be $-\dfrac{1}{2}$?

   A. 0.5

   B. 1

   C. 0

   D. None of the others

4. A capacitor with capacitance C is connected in series with a resistor of resistance R and an ideal DC source with voltage V_S. At one instant during the charging of the capacitor if the resistor is replaced by a wire of zero resistance, which of the following statements is true?

   A. The capacitor immediately attains the source voltage V_S.

   B. The voltage across the capacitor will drop immediately to zero.

   C. The voltage across the capacitor will increase slowly.

   D. None of the others is true.

5. Calculate the partition function for two indistinguishable bosonic particles at a temperature T, which can be distributed in two single-particle energy levels ϵ_1 and ϵ_2. Consider $\beta = \frac{1}{k_B T}$.

   A. $e^{-2\beta\epsilon_1} + e^{-2\beta\epsilon_2} + e^{-\beta(\epsilon_1+\epsilon_2)}$

   B. $\dfrac{1}{2!}\left(e^{-\beta\epsilon_1} + e^{-\beta\epsilon_2}\right)^2$

   C. $(e^{-\beta\epsilon_1} + e^{-\beta\epsilon_2})^2$

   D. $e^{-2\beta\epsilon_1} + e^{-2\beta\epsilon_2} + e^{-2\beta(\epsilon_1+\epsilon_2)}$

6. For a particle in a one-dimensional box of width L, the uncertainty Δp in momentum in the n-th eigenstate of energy for large n is

   A. $\dfrac{n\pi\hbar}{L}$

   B. $\dfrac{2n\pi\hbar}{L}$

   C. $\dfrac{2n\hbar}{L}$

   D. $\dfrac{\hbar}{n\pi L}$

7. Consider a circular disk of radius R and mass M in the X-Y plane, with a surface mass density $\sigma(r) = \sigma_0 e^{-r^2/a}$, where r is the distance from the center of the disk. What is the moment of inertia around the Z-axis through the center of the disk? [consider $R \gg a$]

   A. Ma^2

   B. $\frac{1}{3}Ma^2$

   C. $6Ma^2$

   D. $\frac{1}{2}Ma^2$

8. For a one-dimensional simple harmonic oscillator with mass m and angular frequency ω, consider a perturbation λx^4 in the Hamiltonian ($\lambda > 0$). What is the lowest order correction to the ground state energy?

   [The position operator expressed in terms of the raising and lowering operators is $\hat{x} = \sqrt{\frac{\hbar}{2m\omega}}\,(\hat{a} + \hat{a}^\dagger)$.]

   A. $\frac{3\lambda}{4}\left(\frac{\hbar}{m\omega}\right)^2$

   B. $\frac{3\lambda}{2}\left(\frac{\hbar}{m\omega}\right)^2$

   C. $\frac{5\lambda}{2}\left(\frac{\hbar}{m\omega}\right)^2$

   D. $\frac{5\lambda}{4}\left(\frac{\hbar}{m\omega}\right)^2$

9. The time averaged electrostatic potential of a neutral H-atom is given by

$$\Phi(\vec{r}) = \frac{q}{4\pi\epsilon_0}\frac{e^{-\alpha r}}{r}\left(1 + \frac{\alpha r}{2}\right)$$

   The classical charge distribution corresponding to this is

   A. $-\frac{q}{8\pi}\alpha^3 e^{-\alpha r} + q\delta^3(\vec{r})$

   B. $qe^{-\alpha r}\left(1 + \frac{\alpha r}{2}\right)$

   C. $-\frac{q}{8\pi}\alpha^3 e^{-\alpha r}$

   D. $\frac{q}{8\pi}\alpha^3 e^{-\alpha r}\left(1 + \frac{\alpha r}{2}\right) - q\delta^3(\vec{r})$

10. Given an isolated thermodynamic system with a total energy E, total volume V and total number of particles N, the condition for stable thermal equilibrium, in terms of its entropy S under small changes ΔE and ΔV, is given by

   A. $S(E + \Delta E, V + \Delta V, N) + S(E - \Delta E, V - \Delta V, N) - 2S(E, V, N) < 0$

   B. $S(E + \Delta E, V + \Delta V, N) + S(E - \Delta E, V - \Delta V, N) + 2S(E, V, N) < 0$

   C. $-S(E + \Delta E, V + \Delta V, N) + S(E - \Delta E, V - \Delta V, N) - 2S(E, V, N) < 0$

   D. $S(E + \Delta E, V + \Delta V, N) - S(E - \Delta E, V - \Delta V, N) - 2S(E, V, N) < 0$

11. Consider the group S_4 corresponding to the permutations of the set S having four elements, say $S = \{1, 2, 3, 4\}$. How many non-identity self-inverse (i.e. order 2) elements does S_4 have?

    A. 9

    B. 6

    C. 8

    D. 12

12. The volume of a nucleus, treated as a Fermi gas in three-dimensional space, is proportional to the number of fermions present in it. If the total number of fermions is changed from N to $2N$, the total energy of the system will

    A. be doubled.

    B. remain the same.

    C. be 4 times its original value.

    D. be half of its original value.

13. Consider a two-dimensional Fermi gas at 0 K with Fermi energy ϵ_F. The average energy per particle of this gas is:

    A. $\frac{\epsilon_F}{2}$

    B. $\frac{3\epsilon_F}{5}$

    C. $\frac{\epsilon_F}{3}$

    D. $\frac{\epsilon_F}{4}$

14. A block, suspended from a massless spring, is fully immersed in a liquid contained in a reservoir. What is the time period of small oscillations of the block?

[Given: Mass of the block m, density of the block ρ_b, natural length of the spring L, spring constant k, acceleration due to gravity g, density of the liquid ρ_l, damping coefficient of the liquid i.e., damping per unit mass per unit velocity γ.]

A. $2\pi\sqrt{\dfrac{1}{k/m - \gamma^2/4}}$

B. $2\pi\sqrt{\dfrac{1}{k/m + \gamma^2/4}}$

C. $2\pi\sqrt{\dfrac{L}{(1 - \rho_l/\rho_b)\, g}}$

D. $2\pi\sqrt{\dfrac{m}{k}}$

15. A circular loop of radius a, carrying a current I in an anticlockwise direction (when seen downwards from the positive Z axis), is placed on the X-Y plane centered at the origin. What is the magnetic field on the X-Y plane at $r \gg a$?

A. $\dfrac{\mu_0 I}{4}\dfrac{a^2}{r^3}$ in the negative Z direction

B. $\dfrac{\mu_0 I}{4\pi}\dfrac{a^2}{r^3}$ in the positive Z direction

C. 0

D. $\dfrac{\mu_0 I}{4}\dfrac{a^2}{r^3}\hat{r}$

16. Evaluate $\vec{\nabla} \cdot (r^4 \vec{r})$, where $\vec{r}$ represents a three dimensional position vector.

A. $7r^4$

B. $5r^4$

C. $3r^4$

D. 0

17. A particle is moving with velocity $v_x = v_y = v_z = c/2$ in frame S. The ratio of velocity component v_y to the velocity component $v_{y'}$ as measured in frame S' moving with velocity $c/2$ with respect to frame S along the common x direction is

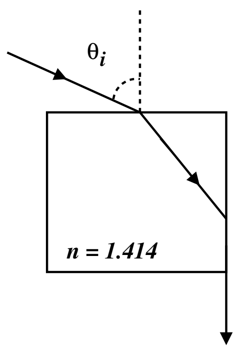
A. $\cos(\pi/6)$

B. $\cos(\pi/3)$

C. $\sin(\pi/6)$

D. $\sin(\pi/3)$

18. A ray of light is incident on a glass cube of refractive index 1.414 as shown in the figure. Find the angle of incidence θ_i, such that the ray grazes down the side of the glass cube.



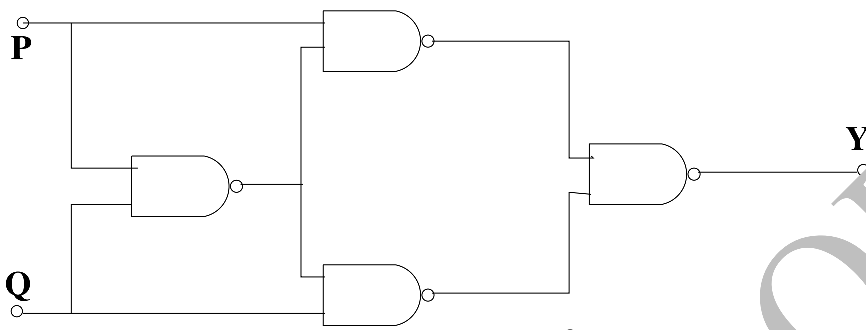
A. $\pi/2$

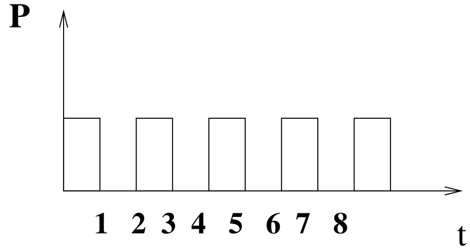
B. $\pi/3$

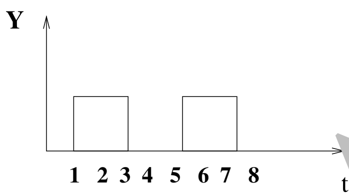
C. $\pi/4$

D. 0

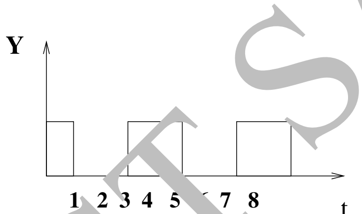
19. For the circuit and the inputs P and Q shown, which of the following is the correct output Y?







A.



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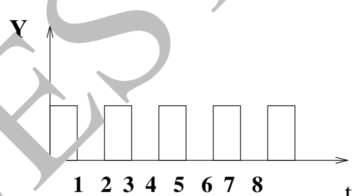

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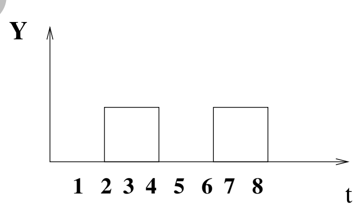

D.

20. A silicon p-n junction diode operates at 27°C. The current I is doubled when the forward bias is increased. The increase in the forward bias is closest to:

[Assume $I \gg I_s$, where I_s is the reverse saturation current and the emission coefficient $\eta_{\mathrm{Si}} = 2$.]

A. 36 mV

B. 18 mV

C. 72 mV

D. 54 mV

Part C: 3-Mark Numerical

1. Given the mass of the proton $m_p \simeq 1836\ m_e$ and mass of the deuteron $m_d \simeq 3670\ m_e$, where m_e is the electron mass, find the fractional shift (in parts per million, to the nearest integer) of the ground state energy of the deuterium atom as compared to H-atom.

2. If a resistor of 10 $k\Omega$ and a capacitor of 0.5 μF are connected in series across an AC supply of 220 V (rms) at 50 Hz, what is the average power (in mW, to the nearest integer) dissipated in the circuit?

3. The average lifetime of a muon in its rest frame is 2200 ns. What will be the average distance (in meters, to the nearest integer) travelled by it, when created with a velocity of $\frac{1}{3}c$, before it decays? Here c is the speed of light.

4. What is the value of the integral

$$I = \frac{3}{2\pi} \oint_{\mathcal{C}} \frac{dz}{1+z^2},$$

where the contour $\mathcal{C}$ is a circle of radius 2 centered at the origin?

5. A simple pendulum with effective length l and a bob of mass m has a time period T_1. Suppose now that the bob is given an electric charge $+Q$. It is made to oscillate just above a two dimensional infinite sheet with surface charge density $+\sigma$, where $\dfrac{Q\sigma}{mg\epsilon_0} = \dfrac{3}{2}$, ϵ_0 being the permittivity of free space and g being the acceleration due to gravity. If the period of oscillation in this case is T_2, determine $\dfrac{T_2}{T_1}$. [Neglect radiation from the charge.]

6. The Fraunhofer diffraction intensity pattern for light of wavelength λ by a single slit of width a is given by

$$I = A_0^2 \left(\frac{\sin\beta}{\beta}\right)^2$$

where A_0 is the intensity of the central maximum and $\beta = \frac{\pi a \sin\theta}{\lambda}$, where θ is the angle with the incident beam. What is the angular separation in milli-radians, between the two first minima on two sides of the central beam, if $a = 1$ mm and $\lambda = 5000$ Å?

7. A heat engine works between a high temperature source and a sink at 27°C. If the maximum efficiency possible for it to achieve is 50%, what is the temperature of the source in °C?

8. Suppose the wave function of a free particle in one dimension obeys $\frac{d^2\psi}{dx^2} = -4\psi$ in units where $\hbar = 1$. What is the magnitude of the momentum of the particle?

9. A current of $10A$ is maintained for $1s$ in a resistor of resistance 25 Ω, which is thermally insulated. The initial temperature of the resistor is 23^oC . The resistor has a mass of 10 gm and a specific heat of 836 $\text{Jkg}^{-1}\text{K}^{-1}$. What is the entropy change of the resistor, rounding off to the nearest whole number in units of JK^{-1} ?

10. A 3×3 matrix M satisfies $M^2 - 3M + 2I = 0$. Find the determinant of the matrix M if its trace is 6.