<u>Sample Questions - Physics</u>

The syllabus for JEST M.Sc. level Physics paper is the standard M.Sc. Physics syllabus. In particular, it presumes that the candidates have taken basic courses in Mathematical Physics, Classical Mechanics, Electromagnetic Theory, Quantum Mechanics, Statistical Mechanics and some special subjects such as Condensed Matter Physics, Electronics, Nuclear Physics etc.

The B.Sc. level Physics paper will have the standard B.Sc. syllabus followed in most universities.

B.Sc. / B.E. / B.Tech. candidates have to answer the B.Sc. level paper while M.Sc. / M.E. / M.Tech. candidates will answer the M.Sc. level paper.

Both the question papers will be fully of objective type. It will contain 50 multiple-choice questions and the answers are to be given in an OMR sheet. Sample questions for the M.Sc. level paper follow (B.Sc. level paper will have similar pattern).

1. Black-body radiation, at temperature T_i, fills a volume V. The system expands adiabatically and reversibly to a volume $8V$. The final temperature $T_f = xT_i$, where the factor x is equal to

   (a) 0.5 (b) 2.8 (c) 0.25 (d) 1

2. A particle of mass m, constrained to move along the x-axis. The potential energy is given by, $V(x) = a + bx + cx^2$, where a, b, c are positive constants. If the particle is disturbed slightly from its equilibrium position, then it follows that

   (a) it performs simple harmonic motion with period $2\pi\sqrt{m/2c}$

   (b) it performs simple harmonic motion with period $2\pi\sqrt{ma/2b^2}$

   (c) it moves with constant velocity

   (d) it moves with constant acceleration

3. Consider a square $ABCD$, of a side a, with charges $+q, -q, +q, -q$ placed at the vertices, A, B, C, D respectively in a clockwise manner. The electrostatic potential at some point located at distances r (where $r >> a$) is proportional to

   (a) a constant (b) $1/r$ (c) $1/r^2$ (d) $1/r^3$

4. The general solution of $dy/dx - y = 2e^x$ is (C is an arbitrary constant)

   (a) $e^{2x} + Ce^x$ (b) $2xe^x + Ce^x$
   (c) $2xe^x + C$ (d) $ex^2 + C$

5. As $\theta \to 0$, $\lim \left(\frac{\ln(1+\sin q)}{\sin q} \right)$ is

(a) ∞ (b) $-\infty$ (c) 1 (d) 0

6. If $\mathbf{P}^{\wedge}$ is the momentum operator, and $s^{\wedge}$ are the three Pauli spin matrices, the eigenvalues of $(s^{\wedge}.\mathbf{P}^{\wedge})$ are

(a) p_x and p_z (b) $p_x \pm ip_y$ (c) $\pm |\boldsymbol{p}|$ (d) $\pm (p_x + p_y + p_z)$

7. Two parallel infinitely long wires separated by a distance D carry steady currents I_1 and I_2 $(I_1 > I_2)$ flowing in the same direction. A positive point charge moves between the wires parallel to the currents with a speed v at a distance $D/2$ from either wire. The magnitude of an electric field that must be turned on to maintain the trajectory of the particle is proportional to

(a) $(I_1 - I_2)v/D$ (b) $(I_1 + I_2)v/D$
(c) $(I_1 - I_2)v^2/D^2$ (d) $(I_1 + I_2)v^2/D^2$

8. An ideal gas of non-relativistic fermions in three dimensions is at a temperature of 0 K. When both the mass of the particles and the number density are doubled, the energy per particle is multiplied by a factor,

(a) $\sqrt{2}$ (b) 1 (c) $2^{1/3}$ (d) $1/2^{1/3}$

9. The rotational part of the Hamiltonian of a diatomic molecule is $(1/2\ \mu_1)(L_x^2 + L_y^2) + (1/2\ \mu_2)\ L_z^2$ where μ_1 and μ_2 are moments of inertia. If $\mu_1 = 2\mu_2$, the three lowest energy levels (in units of $h^2/4\ \mu_2$) are given by

(a) 0, 2, 3 (b) 0, 1, 2 (c) 1, 2, 3 (d) 0, 2, 4

10. A particle of mass 1 gm starts from rest and moves under the action of a force of 30 Newtons defined in the rest frame. It will reach 99% the velocity of light in time

(a) 9.9×10^3 sec (b) 7×10^4 sec
(c) 0.999 sec (d) 0.7 sec