

# IIT JAM 2024 MSQ Model Questions

## Subject - Physics (PH)

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Q.1 The spectral energy density  $u_T(\lambda)$  vs wavelength ( $\lambda$ ) curve of a black body shows a peak at  $\lambda = \lambda_{\max}$ . If the temperature of the black body is doubled, then

- (A) the maximum of  $u_T(\lambda)$  shifts to  $\lambda_{\max}/2$
- (B) the maximum of  $u_T(\lambda)$  shifts to  $2\lambda_{\max}$
- (C) the area under the curve becomes 16 times the original area
- (D) the area under the curve becomes 8 times the original area

Q.2 A periodic function  $f(x) = x^2$  for  $-\pi < x < \pi$  is expanded in a Fourier series. Which of the following statement(s) is/are correct?

- (A) Coefficients of all the sine terms are zero
- (B) The first term in the series is  $\pi^2/3$
- (C) The second term in the series is  $-4\cos x$
- (D) Coefficients of all the cosine terms are zero

Q.3 A particle ( $p_1$ ) of mass  $m$  moving with speed  $v$  collides with a stationary identical particle ( $p_2$ ). The particles bounce off each other elastically with  $p_1$  getting deflected by an angle  $\theta = 30^\circ$  from its original direction. Then, which of the following statement(s) is/are true after the collision?

- (A) Speed of  $p_1$  is  $\sqrt{3}/2 v$
- (B) Kinetic energy of  $p_2$  is 25% of the total energy
- (C) Angle between the directions of motion of the two particles is  $90^\circ$
- (D) The kinetic energy of the centre of mass of  $p_1$  and  $p_2$  decreases

Q.4 Which of the following statement(s) is/are true for a LC circuit with  $L = 25$  mH and  $C = 4$   $\mu$ F?

- (A) Resonance frequency is close to 503 Hz
- (B) The impedance at 1 kHz is 15  $\Omega$
- (C) At a frequency of 200 Hz, the voltage lags the current in the circuit
- (D) At a frequency of 700 Hz, the voltage lags the current in the circuit

Q.5 For a particle moving in a general central force field, which of the following statement(s) is/are true?

- (A) The angular momentum is a constant of motion
- (B) Kepler's second law is valid
- (C) The motion is confined to a plane
- (D) Kepler's third law is valid

Q.6 A gaseous system, enclosed in an adiabatic container, is in equilibrium at pressure  $P_1$  and volume  $V_1$ . Work is done on the system in a quasi-static manner due to which the pressure and volume change to  $P_2$  and  $V_2$ , respectively, in the final equilibrium state. At every instant, the

pressure and volume obey the condition  $PV^\gamma = C$ , where  $\gamma = C_p / C_v$  and  $C$  is a constant. If the work done is zero, then identify the correct statement(s).

- (A)  $P_2V_2 = P_1V_1$
- (B)  $P_2V_2 = \gamma P_1V_1$
- (C)  $P_2V_2 = (\gamma + 1)P_1V_1$
- (D)  $P_2V_2 = (\gamma - 1)P_1V_1$

Q.7 An isolated ideal gas is kept at a pressure  $P_1$  and volume  $V_1$ . The gas undergoes free expansion and attains a pressure  $P_2$  and volume  $V_2$ . Identify the correct statement(s).

( $\gamma = C_p / C_v$ )

- (A) This is an adiabatic process
- (B)  $P_1V_1 = P_2V_2$
- (C)  $P_1V_1^\gamma = P_2V_2^\gamma$
- (D) This is an isobaric process

Q.8 Consider the following differential equation that describes the oscillations of a physical system:  $\alpha (d^2y / dt^2) + \beta (dy / dt) + \gamma y = 0$  If  $\alpha$  and  $\beta$  are held fixed, and  $\gamma$  is increased, then, (A) the frequency of oscillations increases

- (B) the oscillations decay faster
- (C) the frequency of oscillations decreases
- (D) the oscillations decay slower

Q.9 A time independent conservative force  $F$  has the form,  $F = 3y\hat{i} + f(x, y)\hat{j}$ . Its magnitude at  $x = y = 0$  is 8. The allowed form(s) of  $f(x, y)$  is(are)

- (A)  $3x + 8$
- (B)  $2x + 8(y - 1)^2$
- (C)  $3x + 8e^{-y^2}$
- (D)  $2x + 8 \cos y$

Q.10 Identify the correct statement(s) regarding nuclei

- (A) The uncertainty in the momentum of a proton in a nucleus is roughly  $10^5$  times the uncertainty in the momentum of the electron in the ground state of Hydrogen atom
- (B) The volume of a nucleus grows linearly with the number of nucleons in it
- (C) The energy of  $\gamma$  rays due to de-excitation of a nucleus can be of the order of MeV
- (D)  $^{56}\text{Fe}$  is the most stable nucleus

Q.11 The relation between the nuclear radius (R) and the mass number (A), given by  $R = 1.2 A^{1/3}$  fm, implies that

- (A) The central density of nuclei is independent of A
- (B) The volume energy per nucleon is a constant
- (C) The attractive part of the nuclear force has a long range
- (D) The nuclear force is charge dependent

Q.12 Consider an object moving with a velocity  $\vec{v}$  in a frame which rotates with a constant angular velocity  $\vec{\omega}$ . The Coriolis force experienced by the object is

- (A) along  $\vec{v}$
- (B) along  $\vec{\omega}$
- (C) perpendicular to both  $\vec{v}$  and  $\vec{\omega}$
- (D) always directed towards the axis of rotation

Q.13 The gradient of a scalar field  $S(x,y,z)$  has the following characteristic(s).

- (A) Line integral of a gradient is path-independent
- (B) Closed line integral of a gradient is zero
- (C) Gradient of  $S$  is a measure of the maximum rate of change in the field  $S$
- (D) Gradient of  $S$  is a scalar quantity

Q.14 Which of the following statement(s) is/are true?

- (A) Newton's laws of motion and Maxwell's equations are both invariant under Lorentz transformations.
- (B) Newton's laws of motion and Maxwell's equations are both invariant under Galilean transformations.
- (C) Newton's laws of motion are invariant under Galilean transformations and Maxwell's equations are invariant under Lorentz transformations.
- (D) Newton's laws of motion are invariant under Lorentz transformations and Maxwell's equations are invariant under Galilean transformations.

Q.15 For an underdamped harmonic oscillator with velocity  $v(t)$ ,

- (A) Rate of energy dissipation varies linearly with  $v(t)$
- (B) Rate of energy dissipation varies as square of  $v(t)$
- (C) The reduction in the oscillator frequency, compared to the undamped case, is independent of  $v(t)$
- (D) For weak damping, the amplitude decays exponentially to zero

## ANSWER KEY

Question No.	Question Type (QT)	Subject Name (SN)	Key/Range (KY)	Mark (MK)
1	MSQ	PH	A, C	2
2	MSQ	PH	A, B, C	2

<b>3</b>	MSQ	PH	A, B, C	2
<b>4</b>	MSQ	PH	A,C OR A,D	2
<b>5</b>	MSQ	PH	A, B, C	2
<b>6</b>	MSQ	PH	A	2
<b>7</b>	MSQ	PH	A, B	2
<b>8</b>	MSQ	PH	A	2
<b>9</b>	MSQ	PH	A, C	2
<b>10</b>	MSQ	PH	A,B,C,D	2
<b>11</b>	MSQ	PH	A, B	2
<b>12</b>	MSQ	PH	C	2
<b>13</b>	MSQ	PH	A, B, C	2
<b>14</b>	MSQ	PH	C	2
<b>15</b>	MSQ	PH	B, C, D	2