MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Paper Code : BSPH201 Physics-I (Gr-B)

UPID : 002001

Time Allotted : 3 Hours *Full Marks :70*

The Figures in the margin indicate full marks.

Candidate are required to give their answers in their own words as far as practicable

Group-A (Very Short Answer Type Question)

1. Answer any ten of the following : [1 x 10 = 10]

(I) What is the zero point energy of a harmonic oscillator?

(II) What do you mean by the probability of an event?

(III) What are the types of motion related to a rigid body?

(IV) What do you mean by polarized light?

(V) Which magnetic materials have negative susceptibility?

(VI) At which angle of scattering will the Compton shift be maximum?

(VII) What is a conservative force?

(VIII) What are the necessary conditions for a sustainable interference pattern?

(IX) What do you mean by the 'dielectric constant of glass is 7.0'?

(X) Does a blackbody always appear as black?

(XI) What is the effect of damping on the natural frequency of an oscillator?

(XII) What will be the change in width of the principal maxima, If the wavelength of the light used is increased in Fraunhofer diffraction?

Group-B (Short Answer Type Question)

Answer any three of the following : [5 x 3 = 15]

2. What is the physical significance of the moment of inertia? How is it related to applied torque ? [5]
3. What is diffraction of light, and how does it occur? What is the difference between Fraunhofer diffraction and Fresnel diffraction? [5]
4. Write the differential equation of motion for a damped oscillation. Solve the differential equation for underdamped motion. [5]
5. What is the difference between interference of light and diffraction of light? What do you mean by missing order in the diffraction pattern? [5]
6. Derive the expression of the momentum operator. Check the compatibility between the momentum operator and position operator. [5]

Group-C (Long Answer Type Question)

Answer any three of the following : [15 x 3 = 45]

7. (a) Establish the differential equation of simple harmonic motion and solve it. [4]

(b) A resistance R= 100 ohms, an inductance L= 10 mH, and a capacitor C= 100 micro-Farad are connected in series. Calculate the natural frequency of the circuit. Also, check whether the circuit is oscillatory or not. [3]

(c) If $\phi(x,y,z) = (xyz + 4x^2yz + xyz^2)$, find $\vec{\nabla}\phi$ at the point (1,-2,1). [3]

(d) Distinguish between amplitude resonance and velocity resonance of a forced oscillator. [3]

(e) Prove that $\vec{\nabla} \times \vec{r} = 0.$ [2]

8. (a) Write down the expression of resultant intensity due to single-slit Fraunhofer diffraction. Derive the conditions for maxima and minima. Show that the intensity of the first secondary maxima is around 4.5% of the Principal Maxima. [6]

(b) What is double refraction? Distinguish between ordinary ray and extraordinary ray. [3]

(c) Can D1 (589.0 nm) and D2 (589.6 nm) lines of sodium light be resolved in first order? Given number of lines in the grating of 2 cm wide are 1500. [3]

(d) In Ruby laser, the total number of Cr^{3+} ions in the excited state are 3×10^{20}. If the laser emits radiation of wavelength 650 nm, calculate the energy of the laser pulse. [3]

9. (a) Write down the differential equation of a series LCR circuit driven by an AC voltage. Discuss a comparison between mechanical parameters and electrical parameters in relation to oscillation. [5]

(b) Give the physical significance of the curl of a vector. Show that $\vec{F} = (2xy + z^3)\hat{i} + x^2\hat{j} + 3xz^2\hat{k}$ is a conservative force field. [4]

(c) Write down the expression of the amplitude of a particle in underdamped motion. Hence, prove that the ratio of successive amplitudes is constant. [3]

(d) A pendulum has a period of 1 second and an amplitude of 10 mm. After 10 complete oscillations, its amplitude is reduced to half of its initial amplitude. Calculate the relaxation time of the pendulum. [3]

10. (a) What is population inversion? Why is it essential for sustainable laser action? Describe the different techniques to create population inversion. [6]

(b) Write a short note on the Optical resonator. [3]

(c) Two Nicol prism are oriented with their principal planes making an angle of60^0. What percentage of light will pass through the system? [3]

(d) How many orders will be visible if the wavelength of incident radiation is 500 nm and the lines on the grating are 2540 to an inch? [3]

11. (a) Prove that, the rate of loss of energy of a damped vibrator is equal to the rate of work done by the vibrator against the resistive force. [4]

(b) Draw the graph of displacement amplitude and velocity amplitude against the frequency of the driven force for different values of the damping coefficient. Also, explain the effect of the damping coefficient on the sharpness of the resonance. [5]

(c) An obstacle of height 14.7 m is located at a horizontal distance of 19.6m from a man. At what angle will a man project a particle with an initial velocity of 19.6 m/s so that it can just pass over the obstacle? [3]

(d) Show that the vector field $\vec{A} = (2x + 3y^2)\hat{i} + (y - 3z^2)\hat{j} + (x^2 + y^2 - 3z)\hat{k}$ has neither source nor sink. [3]

*** END OF PAPER ***