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Paper Code : BSPH101 Physics-I

UPID : 001003

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) Calculate the wavelength of an electron of energy 10 eV.

(II) Why do not we observe the de Broglie wavelength with a fast moving cricket ball?

(III) What is the phase difference between displacement and velocity of a particle executing SHM?

(IV) Fill in the blank: Planck's formula for black body radiation can be derived from _____ statistics.

(V) Why the Sound wave doesn't show the phenomenon of polarization?

(VI) What is the expression of separation between interference fringes in double slit diffraction?

(VII) A conductor of length L is placed in a magnetic field of magnetic flux density $\vec{B}$. If current I is flowing through the conductor then how much force will be experienced by it?

(VIII) What would be the amount of change in wavelength of a monochromatic X-ray photon, when it is scattered by carbon atoms at an angle 180° ?

(IX) In which statistics, Pauli's exclusion principle is valid?

(X) Find $\vec{\nabla}.\vec{r}$.

(XI) The differential equation of motion of a freely oscillating body is given by $\frac{d^2x}{dt^2} + 36\pi^2 x = 0$. Find the natural frequency of the body.

(XII) At absolute zero temperature, what is the Fermi distribution of electrons when the energy of the system is greater than Fermi energy?

Group-B (Short Answer Type Question)

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

2. What do you mean by harmonic motion? [5]
Give a graphical comparison among the following four types of harmonic motion:
i) simple harmonic motion,
ii) underdamped harmonic motion,
iii) overdamped harmonic motion and
iv) critically damped harmonic motion.

3. a) Deduce Brewster's law. [5]
b) Find the Brewster's angle of a glass slab of refractive angle 1.5. If the slab is immersed in water of refractive index 4/3, find the angle of polarization.

4. What do you mean by irrotational vector? [5]
Show that $\vec{A} = (6xy + z^3)\hat{i} + (3x^2 - z)\hat{j} + (3xz^2 - y)\hat{k}$ is irrotational.

5. Write down the expression for the intensity of light due to Fraunhofer diffraction in a single slit and hence find the conditions for maxima and minima in the diffraction pattern. [5]

6. Evaluate $\vec{\nabla}.\left(\frac{\vec{r}}{r^3}\right)$. [5]

Group-C (Long Answer Type Question)

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

7. (a) What are positive and negative crystals? Give examples. What is optic axis of a crystal? [1+1+1+1]
(b) How can you distinguish between circularly polarized light and unpolarized light with help of quarter wave plate and Nicol prism. [4]

(c) Explain why light wave can be polarized but sound wave cannot be polarized. [2]

(d) Find the state of the polarization when x and y components of the electric fields are given by $E_x=E_0 \sin(wt+kz)$ and $E_y=E_0 \cos(wt+kz)$. [2]

(e) A plane polarized light of wavelength 600 nm changes to circularly polarized light on passing through a quartz crystal cut parallel to optic axis. Calculate the minimum thickness to produce such effect. Given $(\mu_e-\mu_o)=0.005$. [3]

8. (a) Define Magnetic susceptibility and permeability. Obtain the relation between them. [2+3]

(b) Write the differences between diamagnetic, paramagnetic and ferromagnetic substances. [4]

(c) What is hysteresis? Draw a hysteresis curve for a sample of iron. Explain the curve step by step. [1+2+3]

9. (a) What are dielectrics? Differentiate between polar and non-polar dielectrics with examples. [4]

(b) Find the relation between electronic polarizability and atomic radius. [4]

(c) Establish the relation $\vec{D} = \varepsilon_0 \vec{E} + \vec{P}$, where the parameters have their usual meaning. [3]

(d) A potential of 10V is applied across a parallel plate capacitor having area of $6.45 \times 10^{-4} m^2$ and plate separation is 0.002m. If a material having dielectric constant of 6.0 is placed within the region between the plates calculate the amount of charge stored in the plate and the net amount of polarization. [4]

10. (a) Write down the expression for intensity distribution of single slit diffraction and explain the symbol used. [2]

(b) Sketch how the intensity varies with angle of diffraction. [2]

(c) Find the values of the angle at which minima are located. [2]

(d) Find the condition that the angle satisfies in order to be the position of a secondary maximum. [2]

(e) Describe the fringe pattern when white light is incident on a plane transmission grating. [3]

(f) A light of wavelength 6×10^{-5} cm falls normally on a slit of width 0.2 mm. Calculate i) the total angular width of the central maximum ii) the linear width of central maximum on a screen placed 2 m away. [4]

11. (a) Write down Maxwell's wave equations for free space with their physical significance. Hence prove that velocity of EM wave is equal to the velocity of light. [5]

(b) Write down the Maxwell's modification of Ampere's law. [2]

(c) An electric wave is represented by $E = E_0 \cos(1000x - 5000t)$. Calculate the wavelength and speed of propagation of the wave. Show that the displacement current is negligible compared to the conduction current at any frequency when the conductor is subjected to an alternating field. [2+2]

(d) A circular conducting disc of 5 cm radius maintains an angular motion of 1000 rpm with its plane perpendicular to the magnetic field. If due to this motion, the induced e. m. f. between the center and the edge of the disc is 3.22 mV, calculate the magnetic flux density. [4]