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3 (Sem-2/CBCS) PHY HC 2

2023

PHYSICS

(Honours Core)

(Waves and Optics)

Paper : PHY-HC-2026

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions: $1 \times 7 = 7$

(a) What is the relation between group velocity v_g and wave velocity v in a dispersive medium?

(b) What is the nature of wavefront emitted by a point source?

Contd.

- (c) Which method is used for producing two coherent sources from one single source in Newton's rings experiment?
- (d) What is the grating element for a plane diffraction grating having 5,00,000 *lines/cm*?
- (e) What do you mean by a positive zone plate?
- (f) What is the velocity of a particle at the nodes of a standing wave?
- (g) Which assumption was considered by Newton while formulating the velocity of sound as incorrect?

2. Answer the following questions : $2 \times 4 = 8$

- (a) Fundamental frequency of a stretched string of length 50 *cm* and mass 10 *gm* is 300 *Hz*. What is the tension applied?

(b) What are the conditions essential to obtain sustained interference of light ?

(c) In Fraunhofer diffraction pattern formed by a single slit, suppose that the slit width is 0.03 cm and the wavelength of light used is $6 \times 10^{-5} \text{ cm}$. Find the diffraction angle for the first dark band.

(d) Show that two perpendicular SHMs of equal frequency and equal amplitude but having a phase difference of $\pi/2$ can produce a circular motion.

3. Answer **any three** of the following questions : 5×3=15

(a) Deduce an expression for the velocity of transverse vibrations in a stretched string.

- (b) Explain the phenomenon of refraction of a plane wave at a plane surface using Huygens' principle.
- (c) Illustrate Stokes treatment for explanation of the change of phase when reflection takes place at the denser medium.
- (d) Mention three differences between Fresnel and Fraunhofer diffraction. A zone plate behaves like a convex lens of focal length 50 cm. If the wavelength of light is 5000 Å, calculate the radius of first half period zone. $3+2=5$
- (e) What do you mean by standing (stationary) waves? Deduce an equation illustrating the relationship between phase and group velocities. $1+4=5$

4. Answer **any three** of the following questions : 10×3=30

(a) Determine the resultant of two perpendicular SHMs having frequency ratio 2:1 and a phase difference zero. Obtain a representation of the resultant path graphically. 6+4=10

(b) Discuss the phenomenon of Fraunhofer diffraction at a single slit. Find an expression for the width of the central maximum. Fraunhofer diffraction pattern due to a narrow slit of width 0.2 mm is observed in a screen placed on the focal plane of a lens having focal length 2 m . If the first minima is at 5 mm on either side of central maximum, calculate the wavelength of the incident light. 7+3=10

- (c) Describe Fresnel's biprism experiment for interference. How can you determine the wavelength of light by this method? Light of wavelength 5896 \AA falls normally on a thin wedge-shaped air film forming fringes that are 3 mm apart. Find the angle of the wedge.

$$2+5+3=10$$

- (d) Find the expression for intensity due to a plane diffraction grating. Why cannot the secondary maxima be observed? What is its resolving power?

$$5+2+3=10$$

- (e) Elucidate the construction and working principle of a Michelson's interferometer. Under what conditions are circular fringes formed in Michelson's interferometer? How are localized fringes formed in Michelson's interferometer?

$$6+2+2=10$$

(f) Write short notes on **any two** of the following: 5×2=10

(i) Ripple and gravity waves

(ii) Vibrations in a plucked string

(iii) Haidinger fringes

(iv) Holography
