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 : 1×7=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 ?

(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: 2×4=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 6×10^{-5} *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 Å 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 Micheleson'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
