2014

PHYSICS

(Major)

Paper : 4.2

Full Marks : 60

Time : 2½ hours

The figures in the margin indicate full marks for the questions

GROUP—A

(Wave Optics)

1. Answer the following questions : 1×4=4

(a) What is the type of wavefronts for parallel rays of light in a homogeneous medium?

(b) What is resolving power of an optical instrument?

(c) An infinitesimally thin transparent film is observed in reflected light. What do you observe? Explain with reason.

(d) What is circularly polarized light?

2. *(a)* From Stokes' law, establish the relation

$$tt' = 1 - r^2$$ 2

(b) What is a quarter-wave plate? Give the use of a quarter-wave plate. 1+1=2

(c) What are the fringes of equal inclination? Explain in brief. 2

3. Answer any *two* questions from the following : 5×2=10

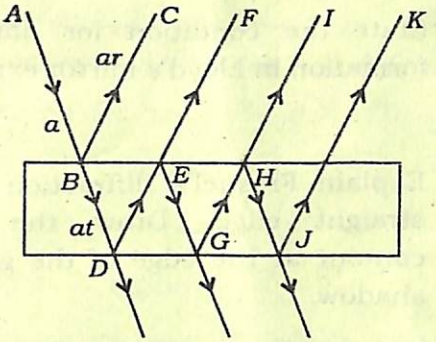
(a) Prove that in connection with biprism experiment

$$d = 2a(\mu - 1)A$$

where d is the separation between two virtual coherent sources, A is the angle of the prism, μ is the refractive index of the prism and a is the distance of the edge of the biprism from the location of the source. Find d for $A = 2°$, $\mu = 1 \cdot 5$ and $a = 10$ cm.

(b) What are Fresnel's half-period zones? How is a plane wavefront divided into half-period zones?

(c)



In the above diagram a transparent film of thickness t is illuminated by a monochromatic radiation. A series of reflected and transmitted rays are formed due to multiple reflection and transmission. Find an expression for resultant intensity when reflected rays are superposed. [Take r as reflection coefficient in first medium; r' is the reflection coefficient in film; t is the transmission coefficient in film and t' is the transmission coefficient in first medium.]

Answer any *two* questions from the following : 10×2=20

4. *(a)* Describe Lloyd's mirror experiment to determine the unknown wavelength of a monochromatic radiation. 8

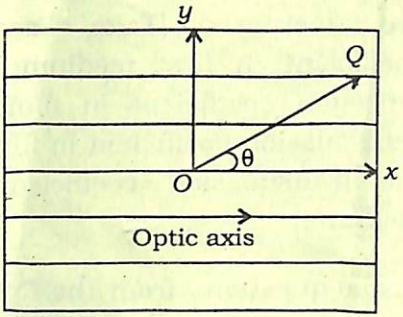
(b) Give one difference between biprism and Lloyd's mirror fringes. 1

(c) State the condition for dark fringes formation in Lloyd's mirror experiment. 1

5. (a) Explain Fresnel's diffraction due to a straight edge. Draw the intensity contour at the edge of the geometrical shadow. 5+1=6

(b) The central circle of a zone plate has a radius of 0·07 cm. Light of wavelength $\lambda = 5000$ Å is coming from a source 147 cm away from the plate falls on it. Find the position of the principal image. 4

6. (a)



A calcite plate is cut parallel to the optic axis. Plane polarized monochromatic light is incident normally on the plate. Find an expression for resultant vibration after emerging out of the plate. 6

(b) If the relative phase difference between the emergent vibrations is δ, discuss the condition for $\delta = 2n\pi$ and $\delta = (2n+1)\frac{\pi}{2}$. 2+2=4

GROUP—B

(Special Theory of Relativity)

Answer *any* **two** questions

7. (a) Why was Michelson-Morley experiment performed? What was the outcome of the experiment? 2+2=4

(b) Establish Einstein's velocity addition theorem

$$u = \frac{u' + v}{1 + \frac{u'v}{c^2}}$$

where u' is the speed in S' frame and v is the speed relative to S frame. 3

(c) Two electrons leave a radioactive sample in opposite directions each having a speed 0·67 c with respect to the sample. Find the relative speed of one electron with respect to the other from relativistic aspect. 3

8. *(a)* A rod of length L_0 is moving with a velocity v. Prove that

$$L = L_0\sqrt{1-\frac{v^2}{c^2}}$$

parallel to the relative motion in the frame. 3

(b) Establish the relation $E_k = mc^2 - m_0c^2$. 4

(c) What are the different types of relativistic optical Doppler effects? Why are they called the second-order effects? 2+1=3

9. *(a)* The average lifetime of a μ-meson at rest is $2\cdot3\times10^{-6}$ s and a laboratory measurement on μ-meson yields an average lifetime of $6\cdot9\times10^{-6}$ s. Find the speed and effective mass of the meson in the laboratory frame (rest mass of meson = $207\times m_e$). 3+2=5

(b) Find the effective mass of a photon of energy E. 1

(c) What is the world line of a particle in Minkowski space-time? Can the tangent to the world line of a massive particle at a point have an angle equal to or more than 45°? Explain. 2+2=4

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