2013

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. *(a)* Two interfering waves each of amplitude 2 units superpose at a certain position on a screen. The path difference between the waves is $\frac{\lambda}{4}$. Find the resultant intensity at the experimental point. 1

(b) What is optic axis of a uniaxial crystal? 1

(c) Find the focal length of a zone plate for $m = 1$ and $\lambda = 5000$ Å if the diameter of the first ring of the zone plate is 1 mm. 1

(d) In an air-glass interface, an unpolarised light is incident which is partially reflected and partially transmitted. If the reflected light is 100% polarised, find the polarising angle $[a\mu_g = \frac{3}{2}]$. 1

2. (a) From Stokes' law, establish the relation $r = -r'$ and interpret the result. 1+1=2

(b) Calculate the fringe width of interference pattern produced in Young's double-slit experiment with the slits 10^{-3} m apart on a screen 1 m away. [Wavelength of light is $\lambda = 5893$ Å] 2

(c) What is optical activity? Define specific rotation for an optically active solution. 1+1=2

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

(a) Draw a neat ray diagram for the experimental arrangement of Newton's rings experiment.

Why is central point dark when Newton's rings are observed in reflected light?

Deduce the relation

$$\lambda = \frac{D_{m+p}^2 - D_m^2}{4PR}$$

for Newton's rings. 1+1+3=5

(b) What is a zone plate? Deduce the relation

$$\frac{1}{u}+\frac{1}{v}=\frac{m\lambda}{r_m^2}$$

for a zone plate. Give one dissimilarity of a zone plate and a convex lens. 1+3+1=5

(c) How is circularly polarised light produced and analysed? 5

4. Answer any *two* questions of the following : 10×2=20

(a) (i) Find an expression for $\cos^2$ intensity distribution pattern in Young's double-slit interference experiment. 5

(ii) Narrate the construction and working of Laurent half-shade plate. 5

(b) (i) Find an expression for intensity distribution pattern in single-slit Fraunhofer diffraction pattern. 5

(ii) What is the condition for missing order in double-slit diffraction pattern?

Show that when $a = b$, 2nd, 4th, 6th order, etc., of interference maximum will be missing. (a is slit width and b is opaque space.)

What is grating constant of a plane transmission grating? 1+3+1=5

(c) (i) Find an expression for resolving power of a plane transmission grating in terms of grating constant and wavelength of light. 5

(ii) A parallel beam of monochromatic light is allowed to be incident normally on a plane transmission grating having 4250 lines/cm and a second-order spectral line is observed to be deviated through 30°. Find the wavelength of the spectral line.

Give the concept of Rowland circle in concave grating. 3+2=5

GROUP—B

(Special Theory of Relativity)

5. Answer the following questions : 1×3=3

(a) What are inertial frames of reference?

(b) Define proper time interval.

(c) Find the moving mass of an electron in terms of rest mass m_0 if $u = 0 \cdot 8c$.

6. Using Galilean transformations, show that acceleration of a body is invariant under Galilean transformations. 2

7. Answer any *one* question of the following : 5

(a) Show by using Lorentz transformation equations that the expression $x^2 + y^2 + z^2 - c^2t^2$ is invariant.

(b) Derive the relativistic formula for composition of velocities.

8. Answer any *one* question of the following : 10

(a) (i) Derive the equation $E = mc^2$. 5

(ii) Light of frequency ν is emitted by a source. The frequency as measured by an observer moving with a speed u is ν'. Prove that

$$\nu' = \nu \sqrt{\frac{1 - \frac{u}{c}}{1 + \frac{u}{c}}}$$

5

(b) (i) Write brief notes on space-like and time-like intervals. 5

(ii) Explain the concept of twin paradox with the help of space-time diagram. 5

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