2024

(NEP—2020)

(3rd Semester)

PHYSICS (MAJOR)

(Ray Optics and Optical Instruments)

Full Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

(SECTION : A—OBJECTIVE)

(*Marks* : 10)

Tick (✓) the correct answer in the brackets provided : 1×10=10

1. When a lens is placed in air, lensmaker's formula takes which form?

(a) $\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$ ( )

(b) $f = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$ ( )

(c) $\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} + \frac{1}{R_2}\right]$ ( )

(d) $\frac{1}{f} = (\mu + 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$ ( )

2. If an object is taken at a very large distance from a concave mirror, then the image distance v in terms of radius of curvature R is given by

(a) $v = 2R$ ( )

(b) $v = \frac{R}{2}$ ( )

(c) $v = R$ ( )

(d) $v = 3R$ ( )

3. A ray of light passes through a parallel-sided slab. If θ_i and θ_e are the angles of incidence and emergence respectively, then

(a) $\theta_i < \theta_e$ ( )

(b) $\theta_i > \theta_e$ ( )

(c) $\theta_i = \theta_e$ ( )

(d) $\theta_i - \theta_e = 30°$ ( )

4. If two lenses of power P_1 and P_2 are in contact, the effective power is given by

(a) $P = 0$ ( )

(b) $P = P_1 + P_2$ ( )

(c) $P = P_1 - P_2$ ( )

(d) $P = P_1 / P_2$ ( )

5. If R is the radius of curvature of a spherical refracting surface forming interface between two media with refractive indexes μ_1 and μ_2, then the law of refraction at the spherical surface is given by

(a) $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$ ( )

(b) $\frac{\mu_2}{v} + \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$ ( )

(c) $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 + \mu_1}{R}$ ( )

(d) $\frac{\mu_1}{v} - \frac{\mu_2}{u} = \frac{\mu_2 - \mu_1}{R}$ ( )

6. For crossed lens, the ratio between the radii R_1 and R_2 is

(a) 1:6 ( )

(b) 1:8 ( )

(c) −1:6 ( )

(d) −1:8 ( )

7. The basic reason for chromatic aberration of a lens is

(a) different wavelengths of light have different refractive indices ( )

(b) different wavelengths of light have the same refractive index ( )

(c) different wavelengths of light have different colours ( )

(d) different wavelengths of light have same colour ( )

8. The condition for achromatism of two lenses in contact is

(a) $\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0$ ( )

(b) $\frac{\omega_1}{f_1} - \frac{\omega_2}{f_2} = 0$ ( )

(c) $\frac{\omega_1}{f_1}\frac{\omega_2}{f_2} = 0$ ( )

(d) $\omega_1 f_1 = \omega_2 f_2$ ( )

9. The resolving power of microscope can be increased by (if ν and μ are wavelengths of light in vacuum and refractive index of the object space respectively)

(a) increasing both ν and μ ( )

(b) decreasing ν and increasing μ ( )

(c) increasing ν and decreasing μ ( )

(d) decreasing both ν and μ ( )

10. If β is the angle subtended by the image at the eye through the telescope and α is the angle at the unaided eye by a distant object, angular magnification M is

(a) α / β ( )

(b) β / α ( )

(c) $\alpha\beta$ ( )

(d) $\alpha^2 \beta^2$ ( )

(SECTION : B—SHORT ANSWERS)

(*Marks* : 25)

Answer *five* questions, taking at least *one* from each Unit : 5×5=25

UNIT—I

1. Explain Fermat's principle of extreme path.

2. Write the uses of concave and convex mirrors.

UNIT—II

3. Derive Abbe's sine condition.

4. What are cardinal points in a thick lens?

UNIT—III

5. Explain the defects astigmatism and distortion. Explain how they may be minimized.

6. Write short notes on *(a)* scattering of light and *(b)* rainbow.

UNIT—IV

7. Mention five distinctions between Ramsden's eyepiece and Huygens' eyepiece.

8. The objective of a telescope has a diameter 125 cm. If the main wavelength of incident light be 6000 Å, calculate the least angular separation of two stars which can be resolved by it.

(SECTION : C—DESCRIPTIVE)

(*Marks* : 40)

Answer *four* questions, taking at least *one* from each Unit : 10×4=40

UNIT—I

1. *(a)* Derive the law of refraction at a spherical refracting surface. 5

(b) Explain the refraction of light through a compound slab. 5

2. *(a)* Derive the spherical mirror equation. 5

(b) State Fermat's principle and establish the law of refraction from this principle. 5

UNIT—II

3. Explain nodal points. Show that the principal point coincides with the nodal points when the optical system is situated in the same medium. 2+8=10

4. *(a)* What is the magnification in a thick lens? 2

(b) Find the focal length of two lenses separated by a distance d. 8

UNIT—III

5. *(a)* What do you mean by spherical aberration? 3

(b) Discuss its minimization method by using crossed lens and two plano-convex lenses. 7

6. *(a)* What is chromatic aberration of a lens? 2

(b) Derive an expression for the condition of achromatic of two lenses *(i)* when they are in contact and *(ii)* when separated by a distance *d*. 8

UNIT—IV

7. *(a)* Explain the function of an eyepiece in an optical instrument. 3

(b) Explain the construction and theory of Ramsden's and Huygens' eyepieces. 7

8. *(a)* What do you understand by visual angle and angular magnification? 3

(b) Give the construction and working of a simple microscope. Calculate its magnifying power. 5+2=7

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