PHY200 (MAJOR)

Student's Copy

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 (\checkmark) the correct answer in the brackets provided :

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

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

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

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

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

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 $1 \times 10 = 10$

- 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) $\theta_i \theta_e = 30^\circ$ ()
- 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) $P = P_1 / P_2$ ()

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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) $\frac{\omega_1}{f_1} \frac{\omega_2}{f_2} = 0$ ()
 - $(d) \quad \omega_1 f_1 = \omega_2 f_2 \qquad (\qquad)$
- 9. The resolving power of microscope can be increased by (if v and μ are wavelengths of light in vacuum and refractive index of the object space respectively)
 - (a) increasing both v and μ ()
 (b) decreasing v and increasing μ ()
 (c) increasing v and decreasing μ ()
 (d) decreasing both v 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
 - $(\alpha) \alpha / \beta$ ()
 - (b) β/α ()
 - (c) αβ ()
 - $(d) \alpha^2 \beta^2 \qquad ()$

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(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)

| Ans | wer. | 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 | | | | |
| | (Ь) | Explain the refraction of light through a compound slab. | 5 | | | | |
| 2. | (a) | Derive the spherical mirror equation. | 5 | | | | |
| | (Ъ) | State Fermat's principle and establish the law of refraction from principle. | this 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=1 | | | | | | | |
| 4. | (a) | What is the magnification in a thick lens? | 2 | | | | |
| | (Ъ) | 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 plano-convex lenses. | two 7 | | | | |
| /259 | | 6 | [Contd. | | | | |

- 6. (a) What is chromatic aberration of a lens?
 (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.
- 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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(SECTION : A-OBJECTIVE)

(Marks : 10)

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(a)
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(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)
$$\frac{1}{f} = (\mu + 1) \left[\frac{1}{R_1} - \frac{1}{R_2} \right]$$
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- 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
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If two lenses of power P_1 and P_2 are in contact, the effective power is given ď, 4.

 $\theta_i - \theta_e = 30^\circ$

(q)

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- (b) $P = P_1 + P_2$ ((c) $P = P_1 - P_2$ (
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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 ю.

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$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$
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SI 6. For crossed lens, the ratio between the radii R_1 and R_2

μ<u>2</u> - μ₁ R

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- (a) 1:6 (
- (b) 1:8 (
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- 7. The basic reason for chromatic aberration of a lens is
- different wavelengths of light have different refractive indices (a)
- different wavelengths of light have the same refractive index (q)
- different wavelengths of light have different colours 3
- different wavelengths of light have same colour (q)

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

- (a) $\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0$ ()
- (b) $\frac{\omega_1}{f_1} \frac{\omega_2}{f_2} = 0$ (
- $(c) \quad \frac{\omega_1}{f_1} \frac{\omega_2}{f_2} = 0 \qquad ($
- (d) $\omega_1 f_1 = \omega_2 f_2$ (
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- (a) α/β () (b) β/α ()
- (c) αβ ()

 $\alpha^2 \beta^2$

(q)

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(SECTION : B-SHORT ANSWERS)

(Marks : 25)

Answer five questions, taking at least one from each Unit :

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

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

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

UNIT-IV

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|---|---|-------|--|--|---|--|--------|---|--------|---|---|---------|--|--|----------|
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| 0 | 80 | | б | 7 |
|---|---|--------|---|--|
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| (a) | 6) | | (a) | (2) |
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What do you understand by visual angle and angular magnification? 8. (a)

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5+2=7 Give the construction and working of a simple microscope. Calculate its magnifying power. **(**9

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