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DPP – 11(Geometrical Optics & Dispersion)

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Q 1. The respective angles of the flint and crown glass prisms are A and A' and their refractive indices for the mean ray are n and n′ respectively. They are to be used for dispersion without deviation, then the ratio of their angles A/A' will be

(a) $\frac{n-1}{n'-1}$ (b) $-\frac{n'-1}{n-1}$

(c) $\frac{n+1}{n'+1}$ (d) $\frac{n'+1}{n+1}$

Q 2. A ray of light passes through a prism whose refracting angle is 5° and dispersive power is 0.03. The refractive index for the mean ray in a spectrum is 1.62. The mean deviation and angle of dispersion respectively are

(a) 3.1°, 0.077° (b) 3.1°, 0.093°

(c) 6.2°, 0.093° (d) 6.2°, 0.077°

Q 3. A crown glass prism and a flint glass prism are combined to produce dispersion without deviation. Mean refractive indices of crown and flint glass are respectively 1.5 and 1.6. Ratio of angle of crown glass prism to that of flint prism is

(a) 1.06 (b) 0.9375

(c) 1.2 (d) 1.5

Q 4. A crown glass prism of refracting angle 6° is to be used for deviation without dispersion with a flint glass of angle of prism a. Given: for crown glass μ_r =1.513 and μ_V =1.523, for flint glass μ_r =1.645 and μ_V =1.665. Find a.

(a) 3° (b) 4°

(c) 4.5° (d) 5°

Q 5. For a material, the refractive indices for red, violet and yellow color light are respectively 1.52, 1.64 and 1.60. The dispersive power of the material is

(a) 2 (b) 0.45

(c) 0.2 (d) 0.045

Q 6. The refractive indices of flint glass for red and violet light are 1.613 and 1.632 respectively. Find the angular dispersion produced by a thin prism of flint glass having refracting angle 5°

(a) 0.095° (b) 0.195°

(c) 0.125° (d) 0.035°

Q 7. Find the dispersive power of flint glass. The refractive indices of flint glass for red, yellow and violet light are 1.613, 1.620 and 1.632 respectively

(a) 0.01 (b) 0.12
(c) 0.33 (d) 0.03

Q 8. Two lenses having f_1: f_2 =2 : 3 has combination to make no dispersion. Find the ratio of dispersive power of glasses used
(a) 2 : 3 (b) 3 : 2
(c) 4 : 9 (d) 9 : 4

Q 9. Two lenses have focal lengths f_1 and f_2 and their dispersive powers are ω_1 and ω_2 respectively. They will together form an achromatic combination if
(a) $\omega_1 f_1 = \omega_2 f_2$ (b) $\omega_1 f_2 + \omega_2 f_1 = 0$
(c) $\omega_1 + f_1 = \omega_2 + f_2$ (d) $\omega_1 - f_1 = \omega_2 - f_2$

Q 10. For an achromatic combination, three different lenses are combined. Dispersive power of their material are 0.066, 0.055 and 0.040 and their main focal length are -22 cm, -11 cm, and 'f' respectively then find the value of 'f' (in cm.)
(a) 17 cm (b) -17 cm
(c) 5 cm (d) -5 cm

Q 11. The focal lengths of a convex lens for red, yellow and violet rays are 100 cm, 98 cm and 96 cm respectively. Find the dispersive power of the material of the lens.
(a) 0.048 (b) 0.0804
(c) 0.084 (d) 0.0408

Q 12. The deviations produced for violet, yellow and red lights in case of flint glass prism are 3.32°, 3.27° and 3.22° respectively. Calculate dispersive power of flint glass
(a) 0.0306 (b) 0.306
(c) 0.0136 (d) 0.136

Q 13. Dispersion of white light is due to
(a) density of medium (b) intensity of light
(c) wavelength (d) none of these

Q 14. In the visible region the dispersive powers and the mean angular deviations for crown glass and flint glass prism are ω, ω' and d, d' respectively. The condition for getting deviation with zero dispersion when the two prisms are combined is
(a) $\sqrt{\omega d} + \sqrt{\omega' d'} = 0$ (b) $\omega' d + \omega d' = 0$
(c) $\omega d + \omega' d' = 0$ (d) $\omega d^2 + (\omega' d')^2 = 0$

Q 15. The Cauchy's dispersion formula is
(a) $n = A + B\lambda^{-2} + C\lambda^{-4}$ (b) $n = A + B\lambda^2 + C\lambda^{-4}$
(c) $n = A + B\lambda^{-2} + C\lambda^4$ (d) $n = A + B\lambda^2 + C\lambda^4$

Q 16. The chromatic aberration in lenses is due to
(a) Dissimilarity of main axis of rays
(b) Dissimilarity of radii of curvature
(c) Variation of focal length of lenses with wavelength
(d) None of these

Q 17. The dispersive power of the material of lens of focal length 20cm is 0.08. The longitudinal chromatic aberration of the lens is

(a) 0.08 cm (b) $\frac{0.08}{20}$ cm

(c) 1.6 cm (d) 0.16 cm

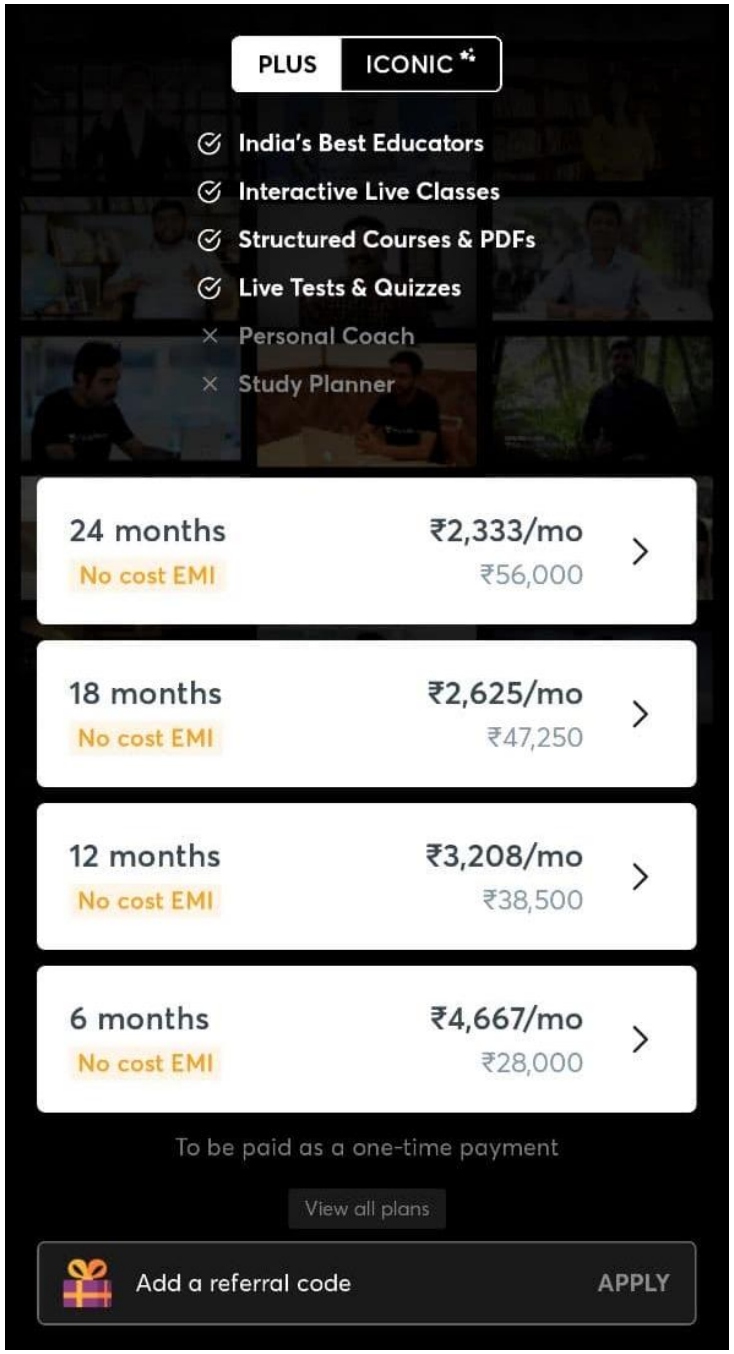
Q 18. The magnitude of longitudinal chromatic aberration produced by a convex lens for the pair of violet and red colors is 0.353 cm. If the focal length of the lens with respect to violet color is 15.295 cm, the focal length of lens for red colored rays is :

(a) 14.942 cm (b) 15.648 cm

(c) 15.295 cm (d) 15.118 cm

Answer Key

Q.1 b	**Q.2 b**	**Q.3 c**	**Q.4 a**	**Q.5 c**
Q.6 a	**Q.7 d**	**Q.8 a**	**Q.9 b**	**Q.10 c**
Q.11 d	**Q.12 a**	**Q.13 c**	**Q.14 c**	**Q.15 a**
Q.16 c	**Q.17 c**	**Q.18 b**		



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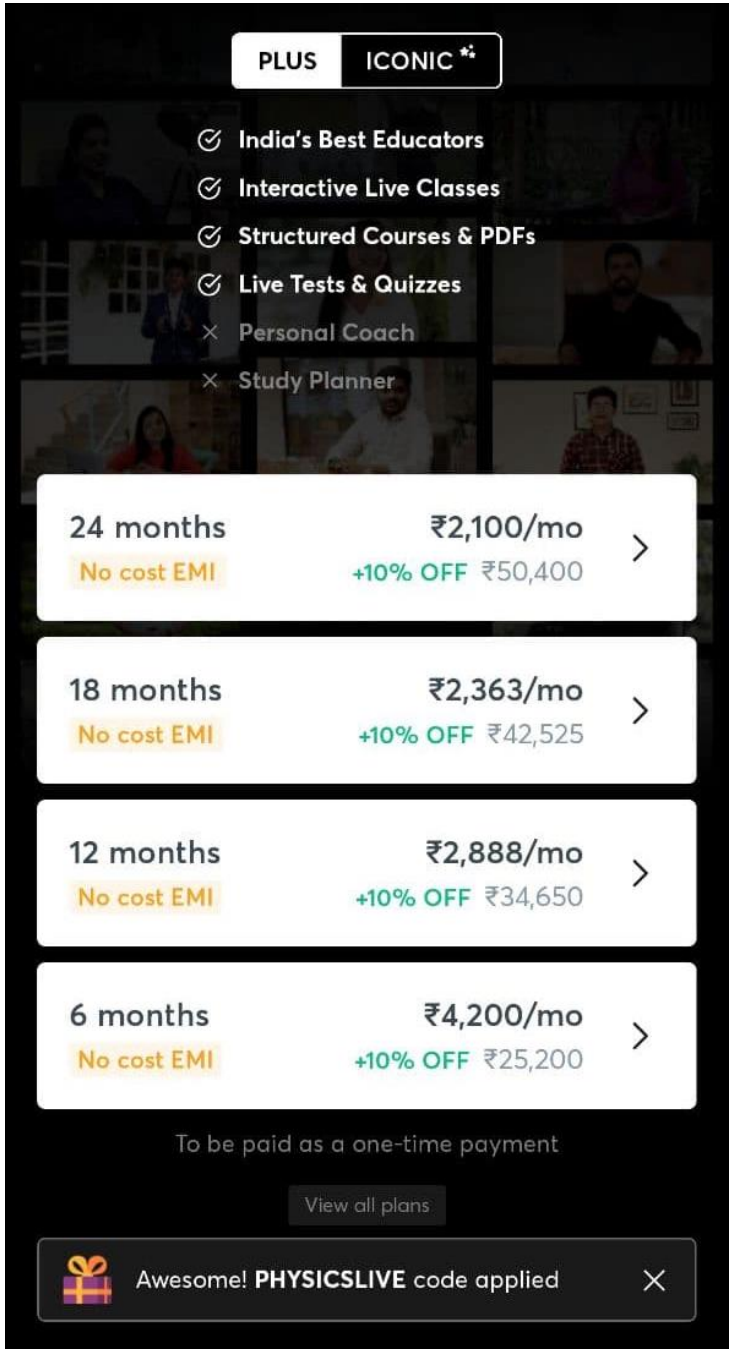

Written Solution

DPP-11 Geometrical Optics- Dispersion

By Physicsaholics Team

Solution: 1

$$(\delta_y)_{net} = 0$$

$$(\delta_y) + (\delta_{y'}) = 0$$

$$(\delta_y) = -(\delta_{y'})$$

$$(n-1)A = -(n'-1)A'$$

$$\frac{A}{A'} = -\frac{n'-1}{n-1}$$ Ans.

Ans. b

Solution: 2

$\delta = (\mu - 1)A$

$\delta = (1.62 - 1)\ 5^\circ$

$= 0.62 \times 5^\circ$

$\boxed{\delta = 3.1^\circ}$ Ans

$\omega = \frac{\phi}{\delta}$

$0.03 = \frac{\phi}{3.1^\circ}$

$\boxed{\phi = 0.093^\circ}$ Ans

Ans. b

Solution: 3

Crown glass

$\delta_1 = (\mu - 1) A_c$

$\delta_1 = (1.5 - 1) A_c$

$= 0.5 A_c$

flint glass

$\delta_2 = (\mu - 1) A_f$

$\delta_2 = (1.6 - 1) A_f$

$= 0.6 A_f$

$\therefore \delta_1 + \delta_2 = 0$

$0.5 A_c = -0.6 A_f$

$|0.5 A_c| = |-0.6 A_f|$

$\frac{A_c}{A_f} = \frac{0.6}{0.5} = \frac{6}{5} = 1.2$

$\Rightarrow \boxed{\frac{A_c}{A_f} = 1.2}$ Ans

Ans. c

Solution: 4

For crown

$\theta_1 = (\mu_v - \mu_R) A$

for flint

$\theta_2 = (\mu_v - \mu_R) A$

$|\theta_1| = |\theta_2|$ [for deviation without dispersion]

$(1.523 - 1.513) 6^\circ = (1.667 - 1.647) a$

$a = \dfrac{0.010}{0.020} \times 6^\circ$

$\boxed{a = 3^\circ}$ Ans

Ans. a

Solution: 5

$$\omega = \frac{\mu_v - \mu_k}{\mu_g - 1} = \frac{1.64 - 1.52}{1.60 - 1}$$

$$\omega = \frac{0.12}{0.60} = \frac{12}{60} = \frac{1}{5}$$

$$\boxed{\omega = \frac{1}{5}} \text{ Ans.}$$

Ans. c

Solution: 6

$$\theta = (\mu_V - \mu_R) A$$

$$\theta = (1.632 - 1.613) \times 5^\circ$$

$$\theta = (0.019) \times 5^\circ$$

$$\boxed{\theta = 0.095^\circ}$$ Ans

Ans. a

Solution: 7

$$\omega = \left(\frac{\mu_V - \mu_R}{\mu_Y - 1}\right)$$

$$\omega = \frac{1.632 - 1.613}{1.620 - 1}$$

$$\omega = \frac{0.019}{0.62}$$

$$\boxed{\omega = 0.03}$$

Ans. d

Solution: 8

$$\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0 \qquad \frac{f_1}{f_2} = \frac{2}{3}$$

$$\frac{\omega_1}{f_1} = -\frac{\omega_2}{f_2} \Rightarrow \left|\frac{\omega_1}{f_1}\right| = \left|\frac{\omega_2}{f_2}\right|$$

$$\frac{\omega_1}{\omega_2} = \frac{f_1}{f_2}$$

$$\boxed{\frac{\omega_1}{\omega_2} = \frac{2}{3}} \quad \text{Ans.}$$

Ans. a

Solution: 9

for achromatic combination :

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

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

$$\boxed{\omega_1 f_2 + \omega_2 f_1 = 0} \quad \text{Ans.}$$

Ans. b

Solution: 10

$$\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} + \frac{\omega_3}{f_3} = 0$$

$$\frac{0.066}{-22} + \frac{0.055}{-11} + \frac{0.040}{f} = 0$$

$$\frac{0.04}{f} = \frac{0.066}{22} + \frac{0.055}{11} = \frac{0.033}{11} + \frac{0.055}{11}$$

$$\frac{0.04}{f} = \frac{0.088}{11} \Rightarrow \frac{40}{f} = \frac{88}{11}$$

$$f = 5\ \text{cm}$$ Ans.

Ans. c

Solution: 11

$$\omega = \frac{f_v - f_R}{f_y}$$

$$\omega = \frac{96 - 100}{98}$$

$$\omega = \frac{-4}{98}$$

$$\omega = -0.0408$$

$$\boxed{\omega = 0.0408} \text{ Ans.}$$

Ans. d

Solution: 12

$$\omega = \frac{\delta_v - \delta_R}{\delta_y}$$

$$\omega = \frac{3.32^\circ - 3.22^\circ}{3.27^\circ}$$

$$\omega = \frac{0.10}{3.27}$$

$$\boxed{\omega = 0.0306} \quad \text{Ans}$$

Ans. a

Solution: 13

The splitting of white light into its constituent color is called dispersion of light. In this phenomenon, different colors contained in white emerge from the glass prism in different directions due to their different wavelengths.

Ans. c

Solution: 14

$\omega = \frac{\phi}{\delta}$

$\phi = \omega \delta$

so, $\phi_1 = \omega d$, $\phi_2 = \omega' d'$

for deviation without dispersion

$\phi_1 + \phi_2 = 0$

$\boxed{\omega d + \omega' d' = 0}$ Ans

Ans. c

Solution: 15

Cauchy's dispersion formula:

$$n = A + B\lambda^{-2} + C\lambda^{-4}$$

Ans. a

Solution: 16

$\therefore \quad \frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$f \propto \frac{1}{\mu - 1}$

i $\quad \mu = A + \frac{B}{\lambda^2}$

So, f is dependent of λ

Ans. c

Solution: 17

$$LCA = \omega f$$

$$= 0.08 \times 20$$

$$\boxed{LCA = 1.6\,(m)}$$ Ans.

Ans. c

Solution: 18

$$LCA = f_R - f_V$$

$$LCA = 0.353\ cm$$

$$f_V = 15.295\ cm$$

$$\Rightarrow 0.353 = f_R - 15.295$$

$$f_R = 15.295 + 0.353$$

$$\boxed{f_R = 15.648 \quad cm} \quad \text{Ans.}$$

Ans. b

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