# PHYSICS

# BOOKS - HC VERMA

# DISPERSION AND SPECTRA

## Example

**1.** 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.

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**2.** The focal lengths of a thin lens for red and violet light are 90.0 cm and 86.4cm respectively. Find the dispersive power of the material of the lens. Make appropriate assumptions.

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## Worked Out Examples

**1.** The refractive inidices of filnt glass for red and violet light are 1.613 and 1.632 respectively. Find the angular dispersion prouduced by a thin prism of flint glass having refracting angle $5^\circ$

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**2.** A crown glass prism of angle $5^\circ$ is to be combined with a flint glass prism in such a way

that the mean ray passes undeviated. Find (a) the angle of the flint glass prism needed and (b) the angular dispersion produced by the combination when white light goes through it. Refractive indices for red, yellow and viloet light are 1.514, 1.517 and 1.523 respectively for crown glass and 1.613 1.620 and 1.632 for flint glass.

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**3.** The dispersive powers of crown and flint glasses are 0.03 and 0.05 respectively, The refractive indices for yellow light for these glasses are 1.517 and 1.621 respectively. It is desired to from an achromatice combination of prisms of crown and flint glasses which can produce a deviation of $1^\circ$ in the yellow ray. Find the refracting angles of the two prisms needed.

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## Question For Short Answer

**1.** The equation $\omega = \dfrac{\mu_v - \mu_r}{\mu - 1}$ was derived for a prism having small refracting ange. Is it also valid for a prism of large refracting angle? Is it also valid for a glass slab or a glass sphere?

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**2.** Can the dispersive power $\omega = \dfrac{\mu_v - \mu_r}{\mu - 1}$ be negative? What is the sign of $\omega$ if a holow prism is immersed into water?

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**3.** If three identical prisms are combined is it possible to pass a beam that emerges undeviated? Undispersed?

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**4.** Monochromatic light shold be used to produce pure specturm. Comment on this statement.

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**5.** Does focal length of lens depend on the colour of light used? Does focal length of a mirror depend on the colour?

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## Short Answer

**1.** Suggest a method to produce a rainbow in your house.

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## Objective 1

**1.** The angular dispersion produced by a prism

A. increases if the average refractive index increases

B. increases if the averge refractive index decrease

C. remains constant whether the average refractive index increases or decreases

D. has no relation with average refractive index.

**Answer: A**

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Objective 1

**1.** If a glass prism in dipped in water its dispersive power

A. increases

B. decreases

C. does not change

D. may increase or decrease depedig on whether the angle of the prism is less than or greater than $60^\circ$

**Answer: B**

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**2.** A prism can produce a minmum deviation $\delta$ in a the beam. If three such prisms are combined, the minimum deviation that can be produced in this beam is

A. 0

B. $2\delta$

C. $2\delta$

D. `3 delta

**Answer: B**

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**3.** Consider the following two statemets

Line spectra contain information about atoms.

Band spectra contain information about molecules

A. Both A and B are wrong

B. A is correct but B is wrong

C. B is correct but A wrong

D. Both A and B are correct

**Answer: D**

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**4.** The focal length ofa converging lens are $f_v$ and $f_r$ for violet and red light respectively.

A. $f_v > f_r$

B. $f_v = f_r$

C. $f_v < f_r$

D. Any of the three is possible depending on the value of the average refractive index $\mu$.

**Answer: C**

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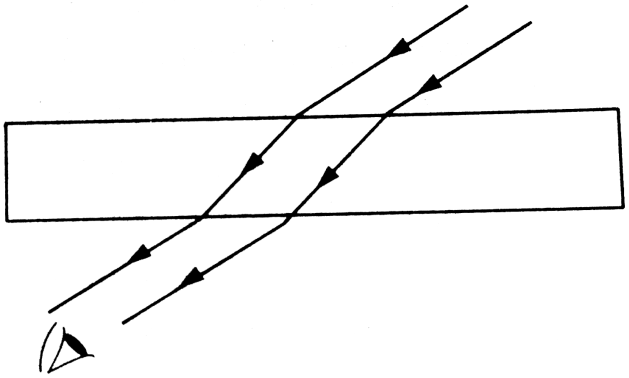
## Objective 2

**1.** A narrow beam of light passes through a slab obliquely and is then received by an eye.

The index of refraction of the material in the slab fluctuates slowly with time. How will it appear to the eye? The twinkling of stars has a similar explanation.



A. The light neve splits in different colours.

B. The emergent beam is white

C. the light inside the slab is split into different colours

D. The light inside the slab is white

**Answer: B::C**

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**2.** By properly combining two prisms made of different materials, it is possible to

A. have disersion whitout average deviation

B. have deviation without dispersion

C. have both dispersion and average deviation

D. have neither dispersion nor average deviation.

**Answer: A::B::C**

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**3.** In producing a pure specturm, the incident light is passed through a narrow slit placed i

the focal plane of an chromatic lens because a narrow slit

A. a produces less diffraction

B. increases intensity

C. allows onlyone colour at a time

D. allows miore paralle beam whenit pases thorugh the lens

**Answer: D**

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**4.** Which of the following quantities increae when wavelength in increased? Consider only the magnitudes

A. the power of a converging lens

B. the focasl length of a converging lens

C. the power of a diverging lens

D. the focal length of a diverging lens.

**Answer: B::D**

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## Objective 2

**1.** Which of the following quantities related to a lens depend on the wavelength or wavelengths of the incident light?

(Choose the incorrect option)

A. power

B. focal length

C. chromatic aberration

D. radii of curvature

**Answer: A::B::C**

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## Exercises

**1.** A flint glass prism and a crown glass prism are to be combined in such a way that the deviation of the mean ray is zero. The refractive index of flint and crown glasses for the mean ray are 1.620 and 1.518 respectively. If the refracting angle of the flint prism is $6.0^\circ$,

what would be the refracting angle of the crown prism ?

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**2.** A certain material has refractive indices 1.56, 1.60 and 1.68 for red, yellow and violet light respectively. (a) Calculate the dispersive power. (b) Find the angular dispersion produced by a thin prism of angle $6^{\circ}$ made of this material.

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**3.** 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.

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**4.** The refractive index of a material changes by 0.014 as the colour of the light changes from red to violet. A rectangular slab of height 2.00 cm made of this material is placed on a newspaper. When viewed normally in yellow

light, the letters appear 1.32 cm below the top surface of the slab. Calculate the dispersive power of the material.

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**5.** A thin prism is made of a material having refractive indices 1.61 and 1.65 for red and violet light. The dispersive power of the material is 0.07. It is found that a beam of yellow light passing through the prism suffers

a minimum deviation of $4.0^\circ$ in favourable conditions. Calculate the angle of the prism.

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**6.** The minimum deviations suffered by red, yellow and violet beam passing through an equilateral transparent prism are $38.4^\circ$, $38.7^\circ$ and $39.2^\circ$ respectively. Calculate the dispersive power of the medium.

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**7.** Two prisms of identical geometrical shape are combined with their refracting angles oppositely directed. The materials of the prisms have refractive indices 1.52 and 1.62 for violet light. A violet ray is deviated by $1.0^{\circ}$ when passes symmetrically through this combination. What is the angle of the prisms ?

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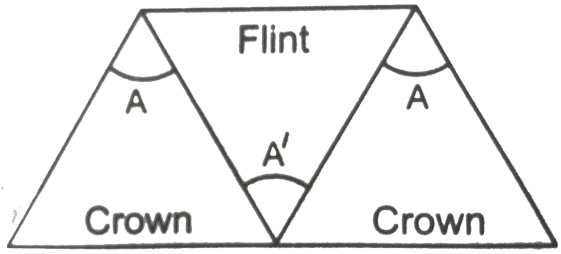
**8.** Three thin prisms are combined as shown in figure. The refractive indices of the crown

glass for red, yellow and violet rays are $\mu_r, \mu_y$ and $\mu_v$ respectively and those for the flint glass are $\mu_r', \mu_y^r$ and $\mu_v'$ respectively. Find the ratio A'/A for which (a) there is no net angular dispersion, and (b) there is no net deviation in the yellow ray.

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**9.** A thin prism of crown glass $(\mu_r = 1.515, \mu_v = 1.525)$ and a thin prism of flint glass $(\mu_r = 1.612, \mu_v = 1.632)$ are placed in contact with each other. Their refracting angles are $5.0^\circ$ each and are similarly directed. Calculate the angular dispersion produced by the combination.

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**10.** A thin prism of angle $6.0^\circ, \omega = 0.07$ and $\mu_y = 1.50$ is combined with another thin prism having $\omega = 0.08$ and $\mu_y = 1.60$. The combination produces no deviation in the mean ray. (a) Find the angle of the second prism. (b) Find the net angular dispersion produced by the combination when a beam of white light passes through it. (c) If the prisms are similarly directed, what will be the deviation in the mean ray ? (d) Find the angular dispersion in the situation described in (c).

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**11.** The refractive index of a material $M_1$ changes by $0.014$ and that of another material $M_2$ changes by $0.024$ as the colour of the light is changed from red to violet. Two thin prisms one made of $M_1(A = 5.3^\circ)$ and other made of $M_2(A = 3.7^\circ)$ are combined with their refracting angles oppositely directed.

(a) Find the angular dispesion produced by the combination.

(b) the prisms are now combined with their

refracting angles similarly directed. Find the angular dispersion produced by the combination.

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