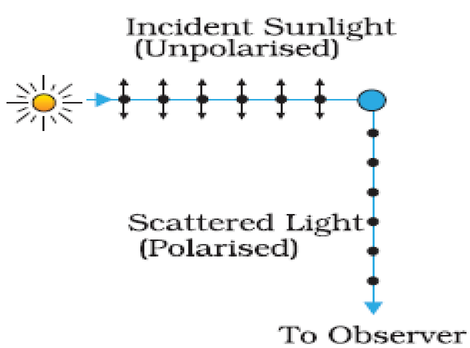
INDIAN SCHOOL MUSCAT

SENIOR SECTION

RAPID REVISION IN OPTICS

1.Explain the polarization of sun light in the atmosphere by scattering .

Under the influence of the electric field of the incident wave the electrons in the molecules acquire components of motion in both these directions.



An observer looking at 90° to the direction of the sun. Clearly, charges accelerating parallel to the double arrows do not radiate energy towards this observer since their acceleration has no transverse component. The radiation scattered by the molecule is therefore represented by dots. It is polarized perpendicular to the plane of the figure.

2. In interference or diffraction some points on the screen appear bright and other points appear dark . Is this a violation of law of conservation of energy.

In interference and diffraction, light energy is redistributed. If it reduces in one region, producing a dark fringe, it increases in another region, producing a bright fringe. There is no gain or loss of energy, which is consistent with the principle of conservation of energy.

3. A diverging lens of focal length F is divided into two identical parts , each forming a Plano concave lens . What is the focal length of each part ?

$\frac{1}{F} = (ng - 1)\,(-\frac{1}{R} - \frac{1}{R})$

$F = -\frac{R}{2(ng-1)}$ for each Plano concave lens $1/f = (n_g - 1)\,(-1/R - 1/\infty)$ $f = -\frac{R}{(ng-1)} = 2F$

Each half will have twice the focal lengthfocal lengthofdiverging lens.

4. You are given three lenses ,whose parameters are given below. Which two of the two lenses you will select as objective and eye piece of a compound microscope? Justify .

Lens	Power P (D)	Aperture A (cm)
L1	3	8
L2	6	1
L3	10	1

Objective is L3 , its focal length f ,and aperture A, must be less . L3 has less f because of its high Power. Eye piece is L2 , its focal length f ,and aperture A, must be less. but greater than that of objective lens L3 .

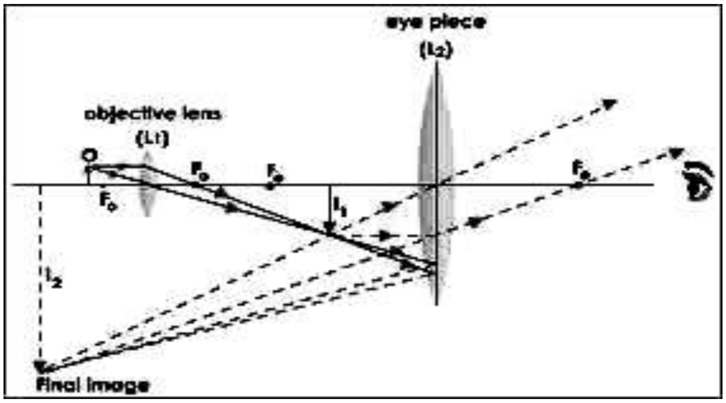
5. How does the following Parameters about a lens change with wavelength of light ?

i) focal length of light ii) Power iii) aperture?

When λ increases i) f increases ii) power P decreases iii) no change in aperture

6. Draw a neat ray diagram of COMPOUND MICROSCOPE forming image at near point . Mention one disadvantage of this position. Write the expression for magnification produced by it.

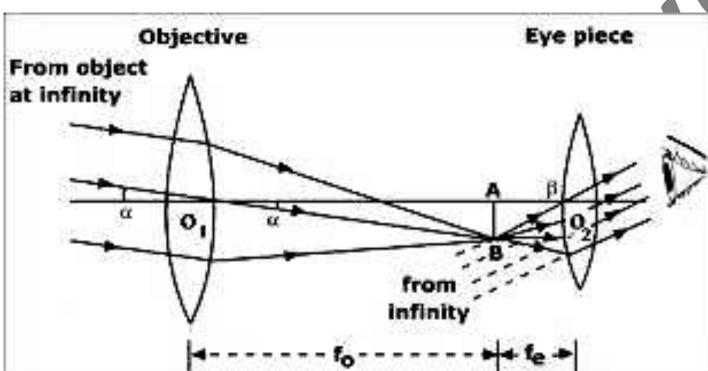
Disadvantage : even though magnification is more there is a strain to the eye. m = fo/fe (1+ fe/D)



Disadvantage : even though magnification is more there is a strain to the eye.

m = fo/fe (1+ fe/D)

7. Draw a neat ray diagram of an astronomical telescope in normal adjustment position. Mention one advantage of this position. Write the expression for magnification produced by it and the length of the telescope.



Advantage : Strain to the eye is minimized.

$$m \approx \frac{\beta}{\alpha} = \frac{f_o}{f_e}$$

the length of the telescope tube is fo + fe .

8.Derive expression for refractive index of material of a prism . ii) A ray of light ,incident on an equilateral prism of n=√3 moves parallel to the base inside the prism. Find the angle of incidence of

the ray.

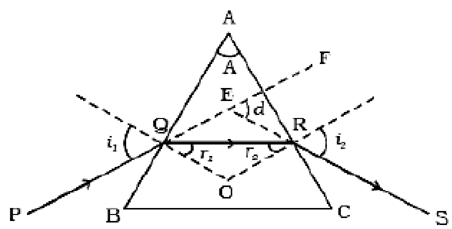
ii) Refracted ray is parallel to the base of the prism, so the prism is in minimum deviation position.

$r1 = r2 = r = A/2 = 30^\circ$

$n = \sin i / \sin r$

$\sqrt{3} = \sin i / \sin 30^\circ$

$\sin i = \sqrt{3}/2$, $i = 60^\circ$



i)

Figure shows the cross section of a triangular prism *ABC*, placed in air. Let *'A'* be the refracting angle of the
the
prism. *A* ray of light *PQ* incident on the refracting
face*AB*, gets refracted along *QR* and emerges
along*RS*. The angle of incidence and refraction at
the two faces are i_1, r_1, i_2, r_2 respectively. The angle between the incident ray *PQ* and the emergent ray *RS* is called angle of deviation, *d*.

In the ΔQER, the exterior angle $\angle FER = \angle EQR + \angle ERQ$

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$\angle Q + \angle R = 180^\circ$

$A + \angle QOR = 180^\circ$

Also, from the ΔQOR

$r_1 + r_2 + \angle QOR = 180^\circ \qquad r_1 + r_2 = A$

Substituting in (1),

$d = i_1 + i_2 - A$

or $\quad A + d = i_1 + i_2$

At minimum deviation position the incident ray and emergent ray are symmetric with respect to the base of the prism. (i.e) the refracted ray QR is parallel to the base of the prism.

$$i_1 = i_2 = i$$

$$r_1 = r_2 = r$$

$$2r = A \text{ or } r = \frac{A}{2}$$

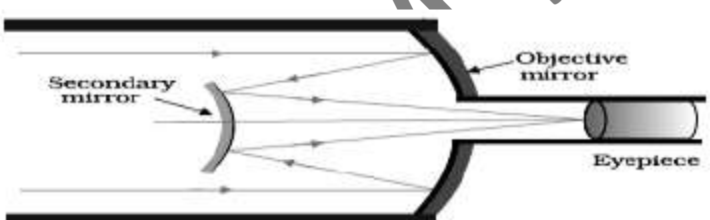
$$2i = A + D \text{ or } i = \frac{A+D}{2}$$

The refractive index is $\mu = \dfrac{\sin i}{\sin r}$

$$\mu = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

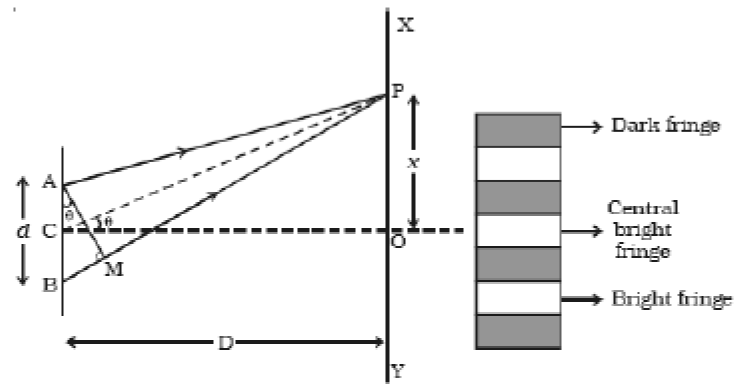
9. i)Mention two advantages of reflecting telescopes. ii) Draw a neat labeled ray diagram of Cassegrain type reflecting telescope.

i) Advantages of reflecting telescopes 1) There is no spherical aberration . 2) Chromatic aberration is absent. 3) Mechanical stability exists even for a very large aperture parabolic mirror as the objective.



9.Define band width or fringe width . Derive expression for fringe width in Young's double slit experiment.

Let d be the distance between two coherent sources A and B of wavelength λ. A screen XY is placed parallel to AB at a distance D from the coherent sources. C is the mid point of AB. O is a point on the screen equidistant from A and B. P is a point at a distance x from O. Waves from A and B meet at P in phase or out of phase depending upon the path difference between two waves.



Draw AM perpendicular to BP. The path difference δ = BP – AP AP = MP

∴ δ = BP – AP = BP – MP = BM

In right angled Δ ABM, BM = d sin θ If θ is small, sin θ = θ ∴The path difference δ = θ.d

Θ= δ/d   (1)

In In right angled triangle COP

$$\tan\theta = \frac{OP}{CO} = \frac{x}{D}$$

For small angles

$$\tan\theta = \theta$$

θ = x/D   (2)

Equating (1) and (2)

the path difference,

$$\delta = \frac{xd}{D}$$

Condition for bright fringe path difference is

$$\frac{xd}{D} = n\lambda$$

x =(D/d) nλ

Condition for dark bands

$$\text{path difference} = (2n-1)\frac{\lambda}{2}$$

where n = 0,1,2 … indicate the order of bright fringes. And n= 1,2,3… indicate the order of dark fringes.

The distance between any two consecutive bright or dark bands is called bandwidth . The distance between (n+1) th and nth order consecutive bright fringes from O is given by

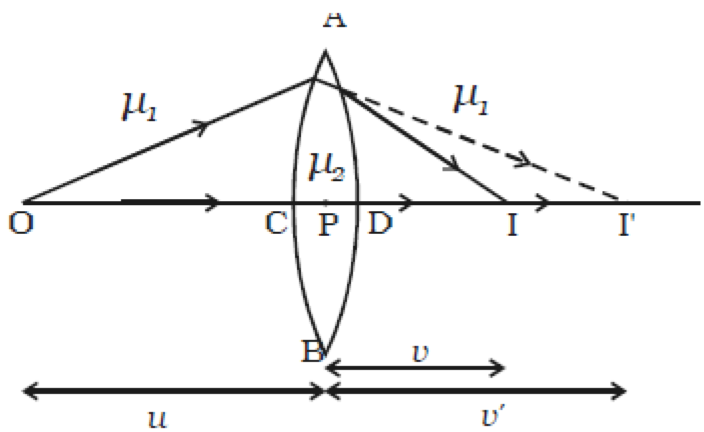
$$\beta = \frac{D}{d}\lambda$$

Similarly, it can be proved that the distance between two consecutive dark bands is also equal to

$$\beta = \frac{D}{d}\lambda$$

Since bright and dark fringes are of same width, they are equi–spaced on either side of central maximum.

10. Derive lense maker's formula



Let us consider a thin lens made up of a medium of refractive index μ_2 placed in a medium of refractive index μ_1. Let R_1 and R_2 be the radii of curvature of two spherical surfaces ACB and ADB respectively and P be the optic centre.

Let O be a point object and I be the image of O formed by ACB . For ADC I is the object and I' is the image.

The general equation for the refraction at a spherical surface is given by

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R} \quad \ldots (1)$$

For the refracting surface ACB, from equation (1) we write

$$\frac{\mu_2}{v'} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R_1} \quad \ldots (2)$$

For the refracting surface ADB, from equation (1) and applying sign conventions, we have

$$\frac{\mu_1}{v} - \frac{\mu_2}{v'} = \left(\frac{\mu_2 - \mu_1}{-R_2}\right) \quad \ldots (3)$$

Adding equations (2) and (3) $\frac{\mu_1}{v} - \frac{\mu_1}{u} = (\mu_2 - \mu_1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

Dividing the above equation by μ_1

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \quad \ldots (4)$$

Thus, for $u = \infty$, $v = f$. Then the equation (4) becomes.

$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \quad \ldots (5)$$

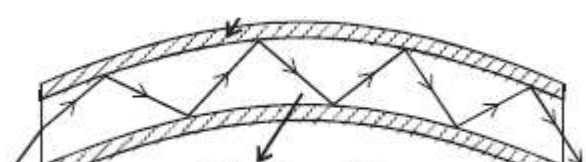
(5) is lens formula in terms of radius of curvature .

If the refractive index of the lens is μ and it is placed in air, $\mu_2 = \mu$ and $\mu_1 = 1$. So the equation (5) becomes

$$\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \quad \ldots (6)$$

This is called the *lens maker's formula*, because it tells what curvature will be needed to make a lens of desired focal length. This formula is true for concave lens also.

11 .With a neat diagram explain the working of optical fibres. Mention the uses of optic fibres.



Fibre ($\mu = 1.7$)

The refractive index of the material of the core is higher than that of the cladding. When the light is incident at one end of the fibre at a small angle, the light passes inside, undergoes repeated total internal reflections along the fibre and finally comes out. The angle of incidence is always larger than the critical angle of the core material with respect to its cladding. Even if the fibre is bent or twisted, the light can easily travel through the fibre.

Light pipes are used in medical and optical examination(endoscopy) . They are also used to transmit communication signals.

12. Define critical angle and derive the relation between critical angle and refractive index of the denser medium.

If μ_d is the refractive index of the denser medium then, from Snell's Law, the refractive index of air with respect to the denser medium is given by,

$$ {}_d\mu_a = \frac{\sin i}{\sin r} $$

$$ \frac{\mu_a}{\mu_d} = \frac{\sin i}{\sin r} $$

$$ \frac{1}{\mu_d} = \frac{\sin i}{\sin r} \quad (\because \mu_a = 1 \text{ for air}) $$

If $r = 90°$, $i = c$

$$ \frac{\sin c}{\sin 90°} = \frac{1}{\mu_d} \quad \text{(or)} \quad \sin c = \frac{1}{\mu_d} \text{ or } c = \sin^{-1}\left(\frac{1}{\mu_d}\right) $$

If the denser medium is glass, $c = \sin^{-1}\left(\frac{1}{\mu_g}\right)$