Assignment 3

ANSWERS OF 1 MARK QUESTIONS

1. M depends on the focal length of objective and eyepiece.
2. Real, inverted and magnified with respect to object.
3. Adjustment in which final image is formed at infinity.
4. Magnifying power M= $-\frac{f_o}{f_e}$
5. Newtonian type and Cassegrain type
6. High magnifying power, large light gathering power and high resolving power.
7. Magnifying power M=$\frac{angle\ subtended\ by\ the\ image\ at\ the\ eye}{ngle\ subtended\ by\ the\ object\ at\ the\ eye}$ when both are at the least distance of distinct vision.
8. Magnifying power M= $-\frac{f_o}{f_e}(1+\frac{f_e}{D})$
9. For larger angular magnification
10. Deviation produced by a prism is $d = (n-1)A$ and refractive index n$\propto \frac{1}{\lambda^2}$.

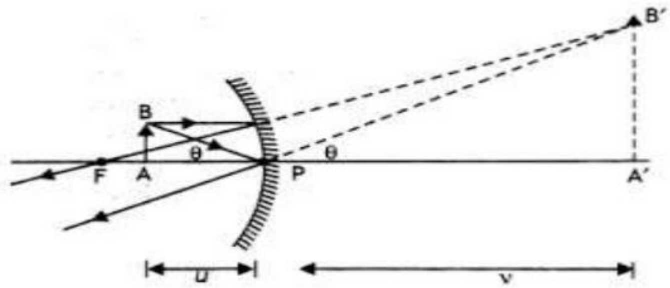
    Since violet has lesser wavelength its refractive index is more, hence deviation is more for violet.

ANSWERS TO MCQ

11. a) Focal length of the objective
12. a) 50
13. a) $f_o + f_e$
14. b) 1m
15. a) 96cm, 4cm

ANSWERS TO QUESTIONS OF 2 MARKS

16.



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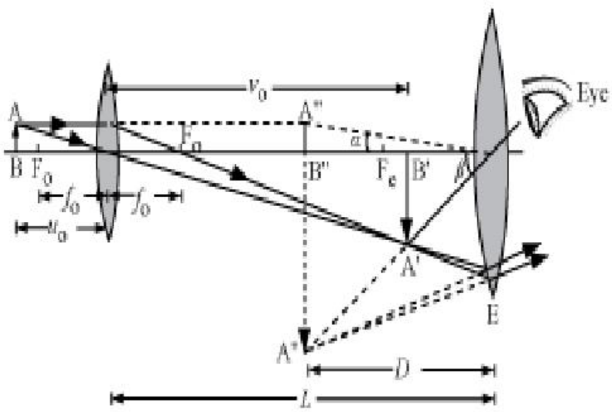

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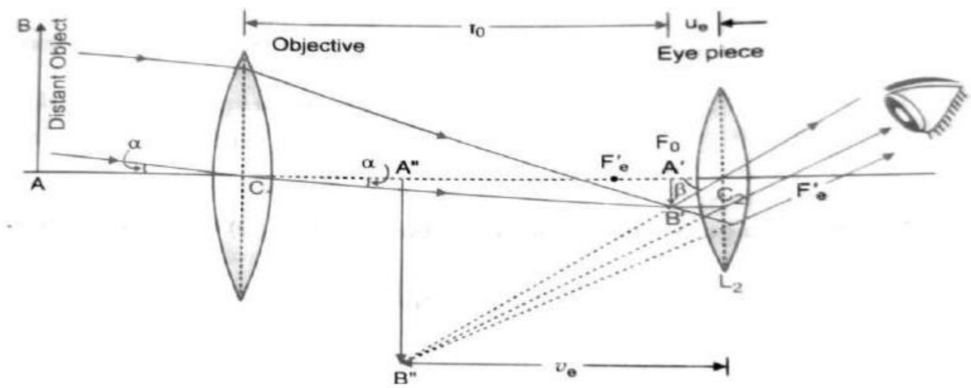

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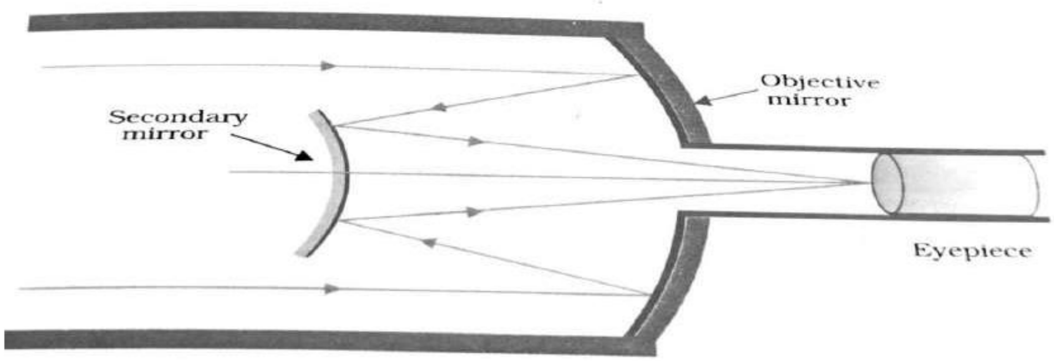

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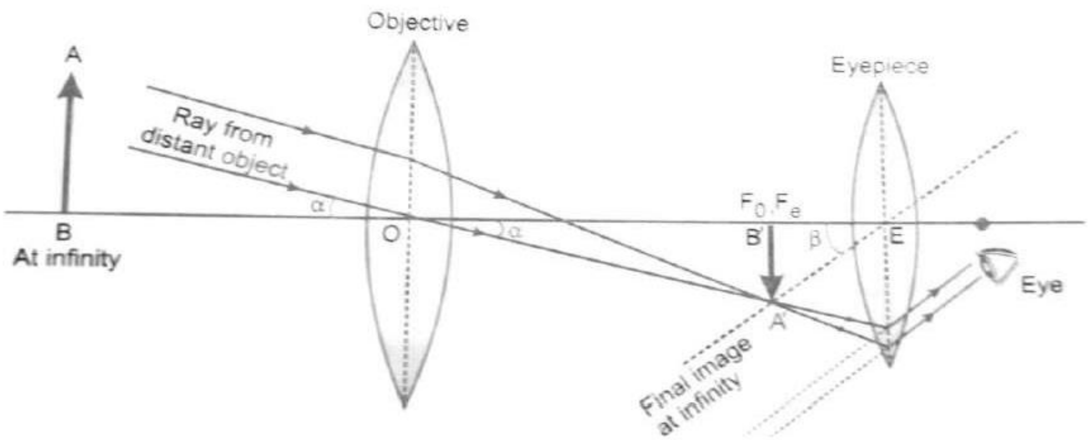

3 MARKS QUESTION

21. (i) The lens B should be used as objective because it has larger focal length and larger radius.

(ii) In normal adjustment, the distance between objective and eyepiece

= fo + fe = 20+5=25cm

Distance required to be increased between the two lenses = 25-15 = 10 cm

(iii) Magnifying power of the telescope in normal adjustment,

$$m = \frac{f_0}{f_e} = \frac{20}{5} = 4$$

22.(i) **Telescope:** L_1 as objective and L_2 as eyepiece

Reason: The objective should have large aperture and large focal length while the eyepiece should have small aperture and small focal length. Then the light gathering power and magnifying power will be larger.

(ii) **Microscope:** L_3 as objective and L_2 as eyepiece

Reason: Both the lenses of the microscope should have short focal lengths and the focal length of the objective should be smaller than that of the eyepiece. Magnifying power will be larger for short focal lengths of objective and eyepiece.

23. For constructing astronomical telescope, lens A should be used as objective because of its large focal length and large aperture. Lens D should be used as its eyepiece because of its small focal length and small aperture.

$$m = \frac{f_0}{f_e} = \frac{100}{5} = 20$$

Normal length = 100+5 =105 cm

(b)Advantages of a reflecting telescope:

(a) No chromatic aberration, because mirror objective is used.
(b) Spherical aberration can be removed by paraboloidal mirror.

OR

For constructing compound microscope, the lens D should be used as objective and C as the eyepiece because the lenses should have small focal length and the focal length of the objective should be smaller than that of the eyepiece.

$$m = -\frac{v_0}{f_0}\left(1 + \frac{D}{f_e}\right)$$

The magnifying power of a compound microscope can be increased by taking both f_0 and f_e small.

For ray diagram refer question 3 of 5marks questions, Section B

24. The optical instrument is compound microscope.

$$f_e = \frac{1}{P_e} = \frac{100}{12.5} = 8$$

$$f_0 = \frac{1}{P_0} = \frac{100}{50} = 2$$

$$m = \frac{L}{f_0} \times \frac{D}{f_e} = \frac{20}{2} \times \frac{25}{8} = 31.25$$

25. In general, any given value of deviation δ, (except for i = e) corresponds to two values i and e. This is expected from the symmetry of i and e as

δ= i + e – A, i.e., δ remains the same if i and e are interchanged.

Point P is the point of minimum deviation. This is related to the fact that the path of the ray as shown in Figure can be traced back resulting in the same angle of deviation. At the minimum deviation δ_m, the refracted ray inside the prism becomes parallel to the base.

26.The power P of a lens is defined as the tangent of the angle by which it converges or diverges a beam of light falling at unit distant from the optical centre

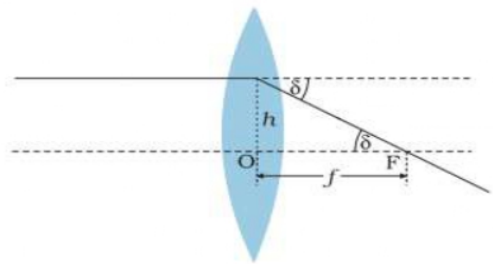

FIGURE Power of a lens.

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$$\tan\delta = \frac{h}{f}$$

$$If\ h = 1, \tan\delta = \frac{1}{f}$$

$$P = \frac{1}{f}$$

Power of a lens is a measure of the convergence or divergence, which a lens introduces in the light falling on it. Clearly, a lens of shorter focal length bends the incident light more. So, the power of a lens is measured as the reciprocal of its focal length.

SI unit of power is dioptre .One dioptre is the power of the lens whose focal length is 1m.

Both the surfaces of sun glasses are equally curved i.e., $R_1 = R_2$

$$P = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = 0$$

5 MARKS QUESTIONS:

<u>SECTION-C</u>

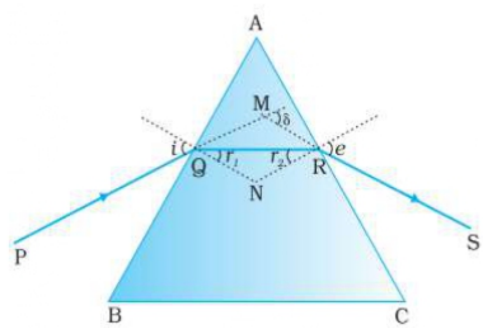

FIG: Light passing through the triangular prism
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27. (a) Refer 5 marks questions section A question (1)

(b) For a convex mirror, $f > 0$ and for an object on left, $u < 0$

From mirror formula,

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

As $f\ is + ve\ and \quad u\ is - ve, \quad so\ \frac{1}{v} > 0 \qquad \therefore v > 0$

Thus, a convex mirror always produces a virtual image, independent of the location of the object.

28. Refer Section A of 5 marks questions, Qn(2) and Qn(3)

29. Refer qn 3 of Section B of 5 marks questions

$f_0 = 1 \cdot 25cm$

$f_e = 5\ cm$

$u_0 = -1.5\ cm$

$v_0 = -D = -25\ cm$

$$\frac{1}{f_0} = \frac{1}{v_0} - \frac{1}{u_0}$$

$$\frac{1}{v_0} = \frac{1}{f_0} + \frac{1}{u_0} = \frac{1}{1.25} - \frac{1}{1.5} = \frac{100}{125} - \frac{10}{15} = \frac{50}{375}$$

$$v_0 = \frac{375}{50} = 7.5\ cm$$

Magnifying power,

$$m = \frac{v_0}{u_0}\left(1 + \frac{D}{f_e}\right) = \frac{7.5}{-1.5}\left(1 + \frac{25}{5}\right) = -30$$

30. (a) Refer qn 3 of Section B of 5 marks questions

(b) $f_0 = 1.25\ cm$ $f_e = 5cm$ $D = 25\ cm$

Angular magnification of the compound microscope = 30X

Total magnifying power of the compound microscope, m = 30

The angular magnification of the eyepiece is given by the relation

$$m_e = \left(1 + \frac{D}{f_e}\right)$$

$$m_e = \left(1 + \frac{25}{5}\right) = 6$$

The angular magnification of the objective lens (m_0)

$$m = m_o m_e$$

$$m_0 = \frac{m}{m_e} = \frac{30}{6} = 5$$

$$m_0 = \frac{image\ distance\ for\ the\ objective\ lens}{object\ distance\ for\ the\ objective\ lens}$$

$$5 = \frac{v_0}{-u_0}$$

$$v_0 = -5u_0 \dots\dots (1)$$

Applying the lens formula for the objective lens:

$$\frac{1}{f_0} = \frac{1}{v_0} - \frac{1}{u_0}$$

$$\frac{1}{1.25} = \frac{1}{-5u_0} - \frac{1}{u_0} = \frac{-6}{5u_0}$$

$$u_0 = \frac{-6}{5} \times 1.25 = -1.5\ cm$$

$$v_0 = -5u_0 = -5\ \times (-1.5) = 7.5\ cm$$

The object should be placed 1.5 cm away from the objective lens to obtain the desired magnification.

Applying the lens formula for the eyepiece:

$$\frac{1}{f_e} = \frac{1}{v_e} - \frac{1}{u_e}$$

$$\frac{1}{u_e} = \frac{1}{v_e} - \frac{1}{f_e}$$

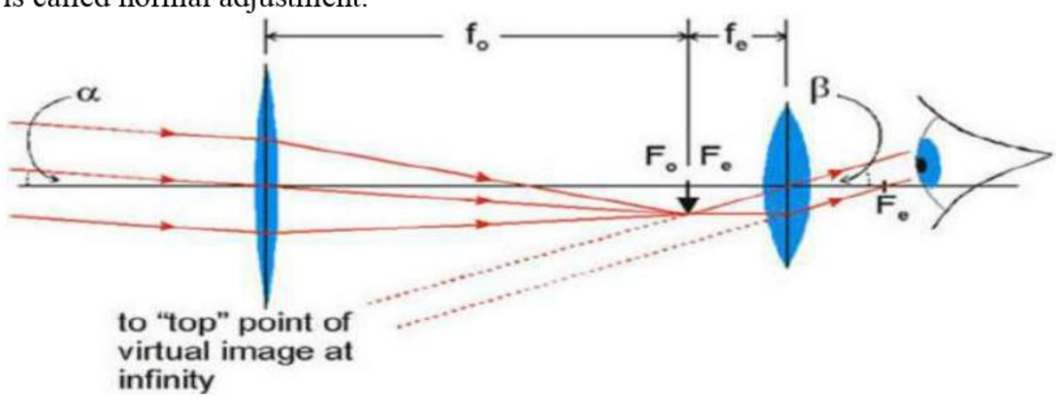
$$\frac{1}{u_e} = \frac{-1}{25} - \frac{1}{5} = -\frac{6}{25}$$

$$\therefore u_e = -4.17\ cm$$

Separation between the objective lens and the eyepiece = $|u_e| + |v_0| = 4.17 + 7.5 = 11.67cm$

Therefore, the separation between the objective lens and the eyepiece should be 11.67 for the required magnification.

31. (a) **Normal adjustment for the telescope:** When the astronomical telescope is adjusted in such a way that the final image is at infinity so that the eye is completely relaxed when viewing it. This is called normal adjustment.



(ii)

f_0 :

f_e : Fig: Image formation by an astronomical telescope (for Normal adjustment)

When the final image is at infinity, $m = -\frac{f_0}{f_e} = -\frac{140}{5} = -28$

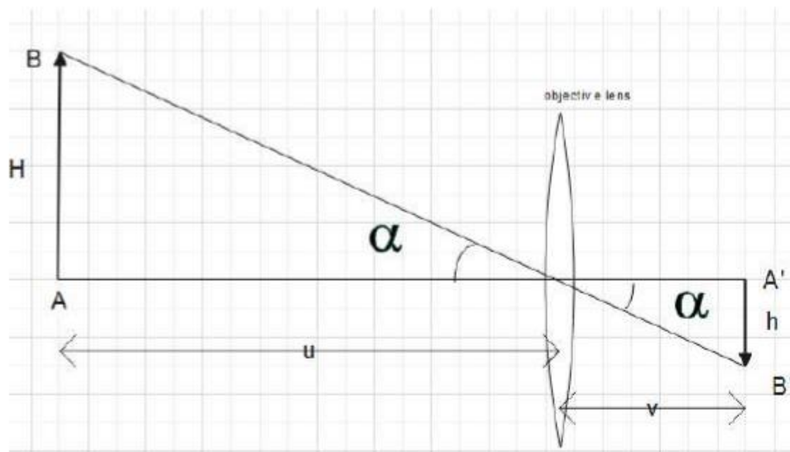
(b) When the final image is at the least distance of distinct vision,

$$m = -\frac{f_0}{f_e}\left(1+\frac{f_e}{D}\right) = -\frac{140}{5}\left(1+\frac{5}{25}\right) = -33.6$$

(c) Seperation between objective and eye lens when final image is formed at infinity

$$L = f_0 + f_e = 140 + 5 = 145cm$$

(d) Let AB be tower and $A'B'$ its image then



$$\frac{H}{u} = \frac{h}{v}$$

For distance object $v = f_0$

$$h = \frac{H}{u} f_0 = \frac{100}{3000} \times 1.4$$

$$h = 4.7 \times 10^{-2} m = 4.7\ cm$$

(e) Magnification produced by eyepiece :

$$m_e = \left(1+\frac{D}{f_e}\right) = \left(1+\frac{25}{5}\right) = 6$$

$$m_e = \frac{h_2}{h_1}$$

$$h_2 = m_e h_1 = 6 \times 4.7 = 28.2\ cm$$