Assignment 2 -ANSWER KEY

1. $\frac{1}{f} = (n-1)(\frac{1}{R_1} - \frac{1}{R_2})$ when the lens is immersed in water, $\frac{1}{f_w} = (\frac{n_g}{n_w} - 1)(\frac{1}{R_1} - \frac{1}{R_2})$.

   The focal length increases.

2. Power of the lens immersed in water decreases as the focal length increases.

3. Convex lens behaves like a diverging lens when it is placed in a medium of refractive index greater than the refractive index of the lens material.

4. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ for a concave lens $u = -f$, $v = \infty$ the image is formed at infinity.

5. $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ where, f is the focal length of the combination.

6. $\frac{1}{f} = \frac{1}{f_1} - \frac{1}{f_1} = 0$, $f = \frac{1}{0} = \infty$ power $P = \frac{1}{f} = 0$

7. $\frac{1}{f} = (n-1)(\frac{1}{R_1} - \frac{1}{R_2}) = \left(\frac{n_2}{n1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

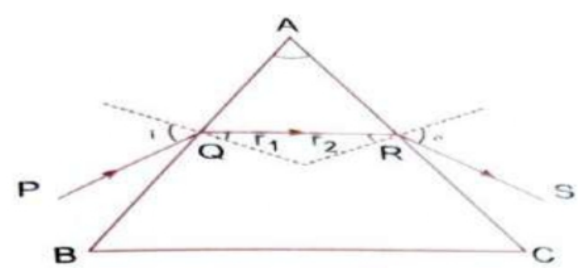
   Since, $n_2 > n1$, f is positive nature of lens is the same.

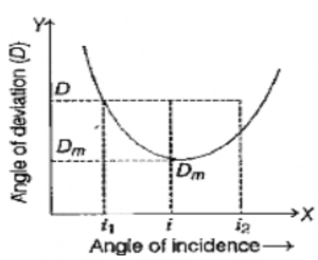
8. Refractive index of liquid should be same as that of glass.

9. $n = \frac{\sin i}{\sin r}$ when r increases, μ decreases

   $v = \frac{c}{n}$ when n decreases, v increases. Velocity is minimum in medium A

10. $\frac{1}{f} = (\frac{n_g}{n_w} - 1)(\frac{1}{R_1} - \frac{1}{R_2})$ since $n_g > n_w$ focal length is positive and will behave as a converging lens.

11. 

12. 

13. Refractive index $n = \frac{\sin\frac{A+d_m}{2}}{\sin\frac{A}{2}}$ where A= angle of prism and d_m is the minimum deviation.

14. The exterior angle formed between the directions of the incident ray produced forwards and the emergent ray drawn backwards is called angle of deviation.

15. Refractive index $n = A + \frac{B}{\lambda^2}$ where A, B are constants

16. $M = -\frac{L}{f_0}(1 + \frac{D}{f_e})$

MCQ

17. d) Convex, 20cm

18. a) 8cm

19. a) 0 °

20. d) 30°

21. d) Diverging lens of focal length different than 15 cm

A and R

22. (b) Both A and R are true but R is not the correct explanation of A.

23. (d) A is false and R is also false.

24. (a) Both A and R are true and R is the correct explanation of A.

25. (c) A is true but R is false.

26. (a) Both A and R are true and R is the correct explanation of A.

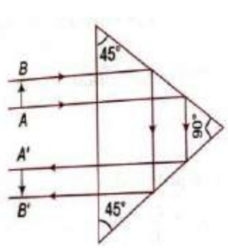
2 MARKS

27.i) No chromatic aberration because mirrors are used.

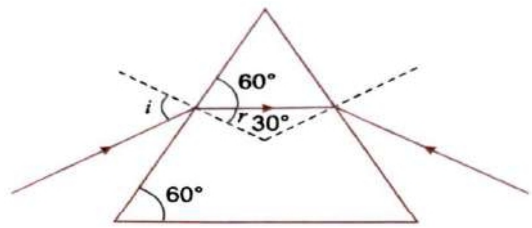
i) Spherical aberration can be minimised using parabolic mirrors.

ii) Image formed is bright.

28.



29.



From figure r=30°, $n = \sqrt{3}n = \frac{\sin i}{\sin r}$

$$\sin i = \sqrt{3}\sin 30$$

$$i = 60$$

30. The phenomenon by which rays of light proceeding from an object in the denser medium returns back to the same medium when incident an angle greater than the critical angle for the pair of media is called total internal reflection.

Conditions for TIR

1. Object should be placed in the denser medium.
2. Angle of incidence in the denser medium should be greater than the critical angle for the pair of media.

31. Telescopes should have large light gathering power and a large magnifying power.

3-MARKS

32.

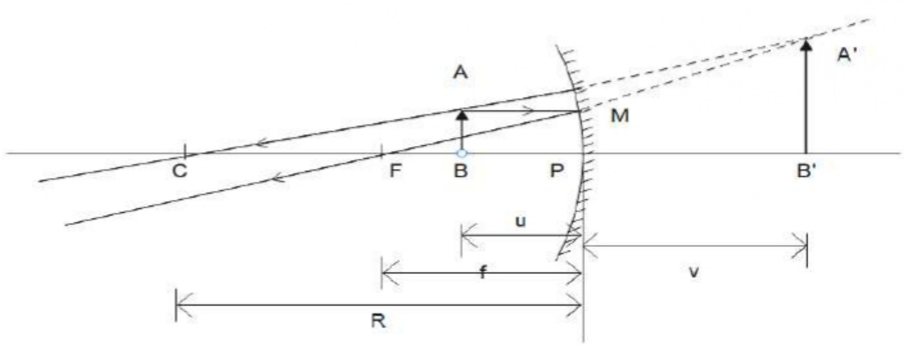


Fig : Image formed by a concave mirror when the object lies between F and P
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1.

$\Delta MPF \sim \Delta A'B'F'$

$$\frac{A'B'}{MP} = \frac{FB'}{FP}$$

$$\frac{A'B'}{AP} = \frac{FP + PB'}{FP}$$

Applying the new Cartesian sign convention,

$A'B' = +h_2, \quad AB = +h_1, \quad FP = -f, \quad PB' = v$

$$\frac{h_2}{h_1} = \frac{-f+v}{-f} = -\frac{v}{u} \dots\dots\dots (using\ mirror\ formula)$$

$$m = \frac{h_2}{h_1} = -\frac{v}{u}$$

2. Refer question 4 of section A 5 marks questions & Refer question 2 of section B 5 marks questions.

(ii) $\delta = \delta_{min}$ $\quad i = e$ $\quad r_1 = r_2$

$$i + e = A + \delta$$

$$i + i = A + \delta_{min}$$

$$\delta_{min} = 2i - A$$

34. (a)

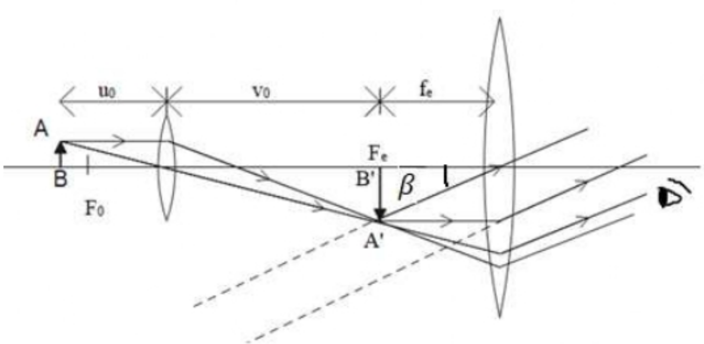
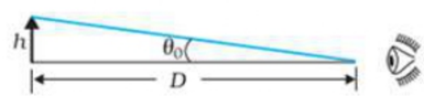


IMAGE FORMATION BY COMPOUND MICROSCOPE
(FINAL IMAGE AT INFINITY)
(CREDIT: IMAGE CREATED USING EDRAW)



(b)

FIG: Angle subtended by the object at LDDV on eye.
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$$m = \frac{\beta}{\theta_0} = \frac{\tan\beta}{\tan\theta_0} = \frac{AB'/B'E}{h/D} = \frac{h'/u_e}{h/D} = \frac{h'}{h}.\frac{D}{u_e} = m_o m_e \dots\dots (1)$$

$$m_o = \frac{h'}{h} = \frac{L}{-f_0}$$

$$m_e = \frac{D}{f_e}$$

$$m = m_o m_e = \frac{L}{-f_0}\frac{D}{f_e}$$

<u>Consideration while choosing objective and eyepiece:</u>

(i) Both the lenses should have short focal lengths.

(ii) The focal length of the objective should be smaller than the eyepiece.

35. (a)

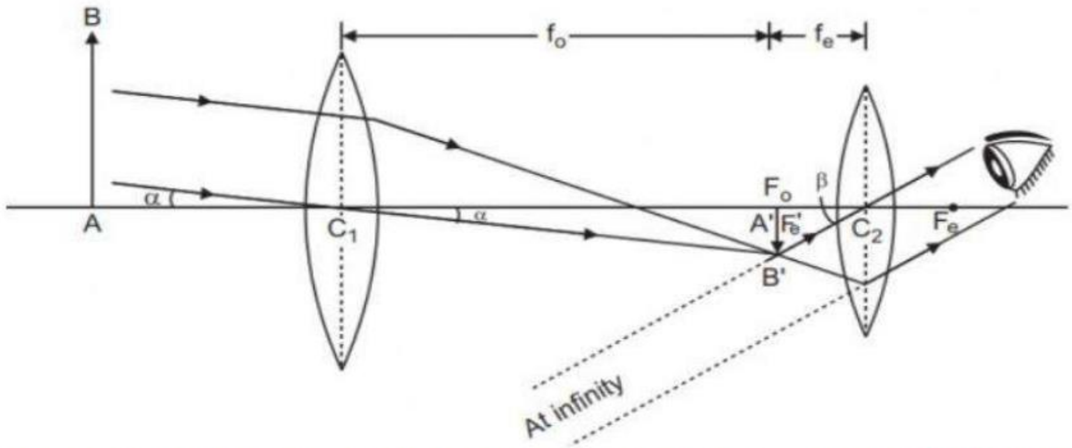

FIG: RAY DIAGRAM FOR ASTRONOMICAL TELESCOPE (FINAL IMAGE AT INFINITY/ NORMAL ADJUSTMENT)
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(b)Limitations of a refracting telescope:

(i) Suffers from chromatic aberration
(ii) Suffers from spherical aberration
(iii) Small magnifying power
(iv) Small resolving power

$(c)\ m = -\frac{f_0}{f_e}$

When $f_o >> f_e$, the telescope will have large magnifying power.

36. (a)

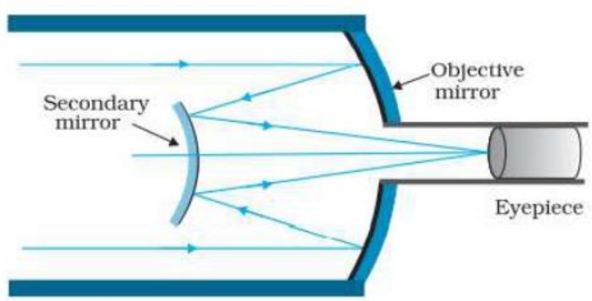

FIGURE Schematic diagram of a reflecting telescope (Cassegrain).

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(b)Advantages of a reflecting telescope:

(i) No chromatic aberration, because mirror objective is used.
(ii) Spherical aberration can be removed by paraboloidal mirror.
(iii) Image is bright because there is no loss of energy due to refraction.

(iv) Large mirror provides an easier mechanical support over its entire back surface.

(c) The objective of larger focal length produces high angular magnification while that of larger aperture has a high resolving power.

37. Refer question (3) of Section B 5 marks questions.

38. Refer question (3) of Section B 3 marks questions for diagram.

Working:

(a) <u>When the final image is formed at the least distance of distinct vision:</u>
The object AB to be viewed is placed at distance slightly larger than the focal length of the objective O. The objective forms a real, inverted and magnified image on the other side of the lens. The separation between the objective and eyepiece is so adjusted that the image lies within the focal length of the eyepiece. The image formed by the objective acts as an object for the eyepiece. The eyepiece forms a virtual and magnified final image which is inverted with respect to the object.

(b) <u>When the final image is formed at infinity:</u>
When the image formed by the objective lies at the focus of the eyepiece, the final image is formed at infinity.

39. Refer question (4a) of Section B, 3 marks questions for diagram.

Working:

(a) <u>When the final image is formed at the least distance of distinct vision:</u>

The parallel beam of light coming from the distant object falls on the objective at some angle α. The objective focusses the beam in its focal plane and forms a real, inverted and diminished image on the other side of the lens. This image acts as an object for the eyepiece. The separation between the objective and eyepiece is so adjusted that the image lies within the focal length of the eyepiece. The eyepiece magnifies this image so that final image is magnified and inverted with respect to the object.

(b) <u>When the final image is formed at infinity:</u>

When the image formed by the objective lies at the focus of the eyepiece, the final image is formed at infinity.

5 MARKS QUESTIONS:

40. (a)Refer Section A Question (2a)

(b) Refer Section A Question (3)

41.(a)Refer Section A Question (4). Derive up to equation (4)

For graph Section A Question (4).

Condition under which δ is minimum: At $\delta = \delta_m i = e \therefore r_1 = r_2$

(b) $A = \delta_m$

$$n_{21} = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

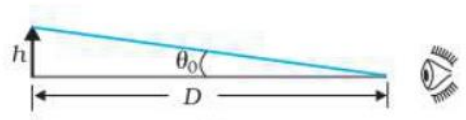
$$n_{21} = \frac{\sin\left(\frac{A+A}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin A}{\sin\left(\frac{A}{2}\right)} = \frac{2\sin\left(\frac{A}{2}\right)\cos\left(\frac{A}{2}\right)}{\sin\left(\frac{A}{2}\right)} = 2\cos\left(\frac{A}{2}\right)$$

$$n_{21} = \frac{\sin\left(\frac{120}{2}\right)}{\sin\left(\frac{60}{2}\right)} \dots\dots(A = 60^0)$$

$$n_{21} = \frac{\sin 60}{\sin 30}$$

$$n_{21} = \frac{\sqrt{3}/_2}{1/_2} = \sqrt{3}$$

42..



(b)

FIG: Angle subtended by the object at LDDV on eye.
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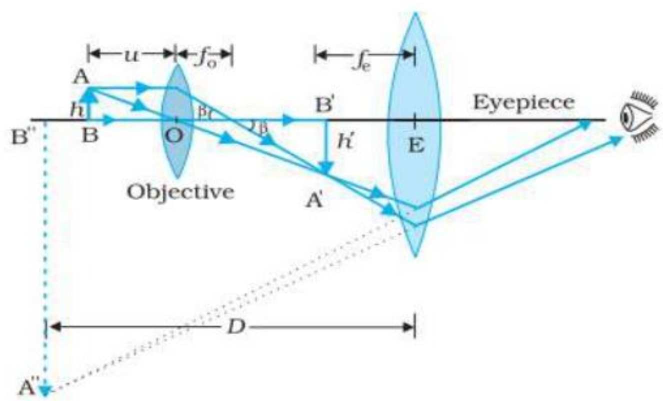

Fig: Formation of image by a compound microscope (Final image at LDDV)
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Magnifying power: The magnifying power of a compound microscope is defined as the ratio of the angle subtended at the eye by the final virtual image to the angle subtended at the eye by the object, when both are at the least distance of distinct vision from the eye.

Advantages of a reflecting telescope:

(v) No chromatic aberration, because mirror objective is used.
(vi) Spherical aberration can be removed by paraboloidal mirror.
(vii) Image is bright because there is no loss of energy due to refraction.
(viii) Large mirror provides an easier mechanical support over its entire back surface.

44.

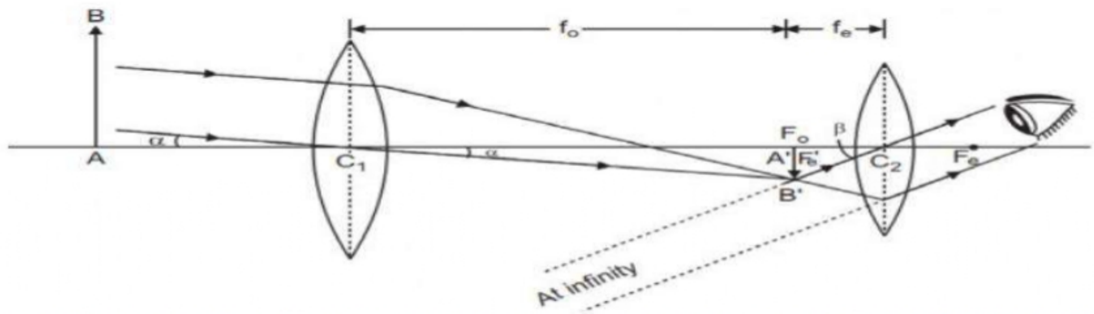

FIG: RAY DIAGRAM FOR ASTRONOMICAL TELESCOPE (FINAL IMAGE AT INFINITY/ NORMAL ADJUSTMENT)
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Magnifying power, $m = \frac{\beta}{\alpha} = \frac{\tan\beta}{\tan\alpha} = \frac{A'B'/A'C_2}{A'B'/A'C_1}$

$$m = \frac{A'C_1}{A'C_2}$$

$$m = -\frac{f_0}{f_e} where, A'C_1 = -f_0 \;, \qquad A'C_2 = f_e$$

Construction difference:

Microscope	Telescope
1. Objective is of very short focal length and of short aperture.	1. Objective is of large focal length and of large aperture.
2.Eyepiece is of short focal length (but $f_e > f_o$) and large aperture.	2. Eyepiece is of short focal length and short aperture.

Working difference:

Microscope	Telescope
1. Objective forms real and magnified image of an object kept just beyond the focus.	1. Objective forms image of the distant object at, or within, the focus of its eyepiece.
2. It produces linear magnification, i.e., size of the image is larger than that of the object.	2. It produces angular magnification i.e, the image is nearer to the eye but the size does not increase.

45. (i) Refer 5 marks question, section B, question (5)

(ii) $f_0 = 20 f_e \quad \therefore \frac{f_0}{f_e} = 20 \qquad \therefore m = 20$