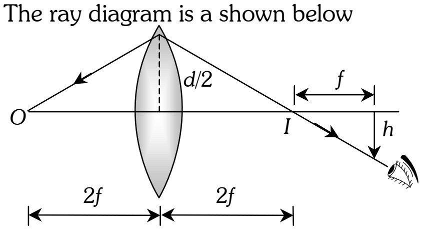
SOLUTION : CPT RAY OPTICS

PHYSICS : RAY OPTICS

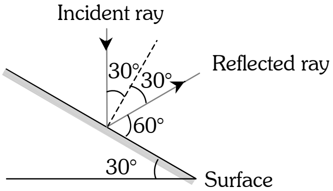
1. **(b)** Using lens makers formula $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

2. **(d)** The ray diagram is a shown below



from two similar triangles , $\frac{h}{d/2}=\frac{f}{2f}\Rightarrow h=\frac{d}{4}$

3. **(c)**



4. **(a)** Focal length of the mirror remains unchanged.

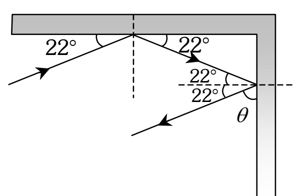
5. **(d)** $\frac{I}{O}=\frac{f}{f-u}\Rightarrow\frac{I}{2}=\frac{20}{20+20}=\frac{1}{2}\Rightarrow I=1\,mm$

6. **(a)** For total internal reflection ray must travel from denser to rarer medium. So, $\mu_A>\mu_B>\mu_C$

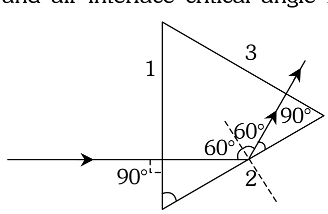
7. **(b)** $t=\frac{\mu x}{c}=\frac{1.5\times4\times10^{-3}}{3\times10^{8}}=2\times10^{-11}\,sec=20\ pico\ sec.$

8. **(c)**

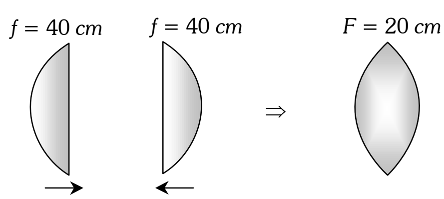
9. **(b)** From figure it is clear
$\theta=90^\circ-22^\circ$
$=68^\circ$



10. **(c)** For glass $(\mu=1.5)$ and air interface critical angle is 41.8°. So at surface 2 ray will be reflected $(\because\theta_i>c)$ and further it will incident perpendicularly on surface 3 and will emerge out through surface 3 without any refraction.



11. **(b)** To obtain, an inverted and equal size image, object must be paced at a distance of $2f$ from lens, *i.e.* 40 *cm* in this case.



12. **(b)** $f=R/2(\mu-1)\Rightarrow R=2f(\mu-1)=2\times0.2(1.5-1)=0.2m.$

13. **(c)** By using $\frac{f_l}{f_a}=\frac{({}_a\mu_g-1)}{({}_l\mu_g-1)}\Rightarrow f_w=4f_a=4\times30=120\ cm.$

14. **(a)** $P=P_1+P_2-dP_1P_2\Rightarrow P=10-25d$
$\Rightarrow$ For P to be negative $25d>10\Rightarrow\ d>40\ cm$

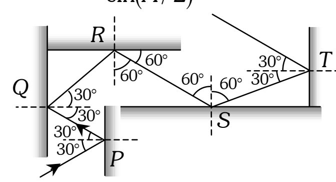
15. **(d)** $\omega/f=-2\omega/f'\Rightarrow f'=-2f$

16. **(b)** Diminished, erect image is formed by convex mirror.

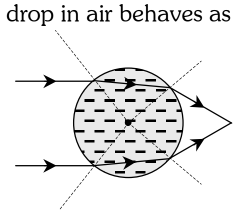
17. **(a)** $\omega=\mu_v-\mu_r/\mu_y-1=1.67-1.63/1.65-1=0.0615.$

18. **(c)** Given $\delta_m=A$, as $\mu=\sin(A+\delta_m/2)/\sin(A/2)$
$\Rightarrow\ \mu=\frac{\sin(A+A/2)}{\sin(A/2)}=2\cos(A/2)\Rightarrow A=2\cos^{-1}(\mu/2)$

19. **(c)**



20. **(b)** A water drop in air behaves as converging lens.



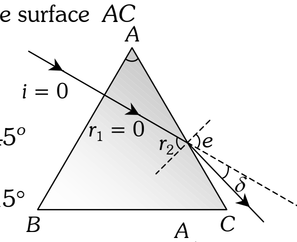
21. **(a)** At the time of solar eclipse light received from chromosphere. The bright lines appear exactly at the places where dark lines were there. Hence at the time of solar eclipse continuos spectrum is obtained.

22. **(d)** As we know $A=r_1+r_2=0+r_2\Rightarrow A=r_2$.
Applying Snell's law for the surface AC

$\frac{1}{\mu}=\frac{\sin r_2}{\sin e}=\frac{\sin A}{\sin e}$

$\Rightarrow\ \frac{1}{\sqrt2}=\frac{\sin 30^o}{\sin e}\Rightarrow e=45^o$

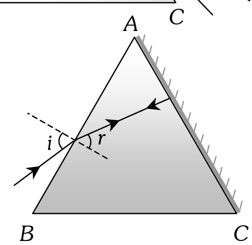
$\delta=e-r_2=45^o-30^o=15^o$



23. **(c)** $A=r+0\Rightarrow r=30^o$
From Snell's law at surface AB

$\mu=\frac{\sin i}{\sin r}$

$\Rightarrow\sqrt2=\frac{\sin i}{\sin 30^o}\Rightarrow i=45^o$



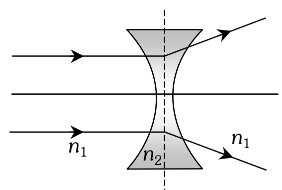
24. **(a)** Focal length of the lens $f=100/3cm$
By lens formula $1/f=1/v-1/u$
$\Rightarrow\frac{1}{+100/3}=\frac{1}{v}-\frac{1}{-25}\Rightarrow v=-100\ cm=-1\ m$

25. **(b)** Resolving limit (minimum separation) $\propto\lambda$
$\Rightarrow P_A/P_B=2000/3000\Rightarrow P_A<P_B$

26. **(d)** $L = v_o + u_e = u_o f_o /(u_o - f_o) + f_e D / f_e + D$

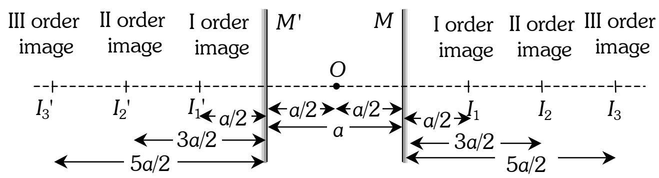
$\Rightarrow L = 2 \times 1.5/(2-1.5) + 6.25 \times 25/(6.25+25) = 11\,cm$

27. **(d)** $1/f = (n_2/n_1 - 1)(1/R_1 - 1/R_2)$ where n_2 and n_1 are the refractive indices of the material of the lens and of the surroundings respectively. For a double concave lens, $(1/R_1 - 1/R_2)$ is always negative.



Hence f is negative only when $n_2 > n_1$

28. **(b)**



From above figure it can be proved that separation between nth order image formed in the two mirrors = $2na$

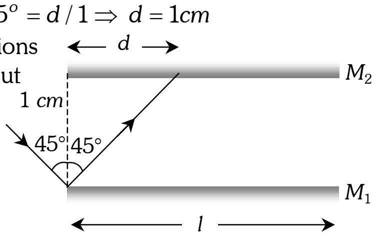
29. **(b)** n concave mirror, if virtual images are formed, u can have values zero and f

At $u = 0$, $m = f/f - u = f/f = 1$

At $u = f$, $m = f/f - u = -f/-f-(-f) = \infty$.

30. **(c)** From figure $\tan 45^\circ = d/1 \Rightarrow d = 1cm$

Now no. of reflections before ray going out $n = l/d = 100/1$



31. **(c)** Combination of lenses will act as a simple glass plate.

32. **(c)**

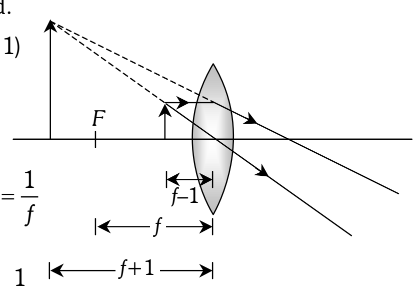
33. **(b)** $\dfrac{f_l}{f_a} = \left(\dfrac{{}_a\mu_g - 1}{{}_l\mu_g - 1}\right) = \dfrac{\mu_l(\mu_g - 1)}{(\mu_g - \mu_l)} = \dfrac{1.25(1.5-1)}{(1.5-1.25)}$ =2.5

34. **(c)** Apparent shift in mark = $t(1-1/\mu) = 3(1-1/1.5)$ = $1\,cm$. upward.

35. **(b)** Here, $u = -(f-1)$

$v = -(f+1)$

$\Rightarrow f = +f$



Applying $\dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}$

we have

$\dfrac{1}{-(f+1)} + \dfrac{1}{(f-1)} = \dfrac{1}{f}$

or $f^2 - 2f - 1 = 0$. This gives $f = (\sqrt{2}+1)\,cm$.

36. **(b)** Power of concave lens should be less than that of the convex lens to form, a real image. So, net power will decrease or focal length will increase. For real image v is positive, u is negative and f is positive.

From lens formula (substituting all values with sign), $1/v + 1/u = 1/f$; u is constant, f is increasing. So v will also increase.

37. **(a)** The given lens is a convex lens. Let the magnification be m, then for real image

$1/mx + 1/x = 1/f$ …(i)

and for virtual image $1/-my + 1/y = 1/f$ …(ii)

From eq. (i) and eq. (ii), we get

$f = x + y/2$

38. **(d)** Image will be formed at infinity if object is placed at focus of the lens i.e. at 20 cm from the lens. Hence, Shift = $25 - 20 = (1 - 1/\mu)t$

or $5 = (1 - 1/1.5)t \Rightarrow t = 5 \times 1.5/0.5 = 15cm$

39. **(a)**

40. **(d)** Angular resolution $d\theta = 1.22\lambda/a$

$= \dfrac{1.22 \times 5000 \times 10 \times 10^{-10}}{10 \times 10^{-2}} = 6.1 \times 10^{-6}\,rad$.

41. **(a)** Apparent shift = $t(1-1/\mu)$, μ for red is minimum so apparent shift for it will be minimum.

42. **(d)** $\mu_1 = \dfrac{c}{v_1}$ and $\mu_2 = \dfrac{c}{v_2} \Rightarrow \dfrac{\mu_1}{\mu_2} = \dfrac{v_2}{v_1} \Rightarrow \mu_1 v_1 = \mu_2 v_2$

43. **(a)**

44. **(a)** In air $\delta_{air} = (\mu - 1)A = (1.5-1)A = A/2$

In water, $\delta_{water} = ({}_w\mu_g - 1)A = (\mu_g/\mu_w - 1)A$

$= \left(\dfrac{3/2}{3/4} - 1\right)A = A/8$

$\therefore\ \delta_{air}/\delta_{water} = 1/4$

45. **(c)** $m = \dfrac{f}{\mu - f} = \dfrac{f}{a}$ (here $a = \mu - f =$ distance of object from focus).

46. **(b)** The stars twinkle while the planets do not. It is due to variation in density of atmospheric layer. As the stars are very far and giving light continuously to us. So, the light coming from stars is found to change their intensity continuously. Hence they are seen twinkling. Also stars are much bigger in size than planets but it has nothing to deal with twinkling phenomenon.

47. **(a)** Because of smallest wavelength of blue colour it is scattered to large extent than other colours, so the sky appears blue.

48. **(a)** For total internal reflection the angle of incidence should be greater than the critical angle. As critical angle is approximately 35°. Therefore, total internal reflection is possible.

49. **(b)** The velocity of light of different colours (all wavelengths) is same in vacuum and $\mu \propto 1/\lambda$.

50. **(a)** Resolving power $= a/1.22\lambda$.