4. (c) $\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{P_1}{100}+\frac{P_2}{100}=\frac{1}{100}\Rightarrow f=100\,cm$

$\therefore$ A convergent lens of focal length 100 *cm*.

5. (a) Focal length of the combination can be calculated as

$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}\Rightarrow\frac{1}{F}=\frac{1}{(+40)}+\frac{1}{(-25)}\Rightarrow F=-\frac{200}{3}\,cm$

$\therefore P=\frac{100}{F}=\frac{100}{-200/3}=-1.5\,D$

6. (d) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}\Rightarrow\frac{1}{80}=\frac{1}{20}+\frac{1}{f_2}\Rightarrow f_2=-\frac{80}{3}\,cm$

$\therefore$Power of second lens

$P_2=\frac{100}{f_2}=\frac{100}{-80/3}=-3.75\,D$

7. (b) In each case two plane-convex lens are placed close to each other, and $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$.

8. (a) Power of the combination $P=P_1+P_2$ $=12-2=10\,D$

$\therefore$ Focal length of the combination

$F=\frac{100}{P}=\frac{100}{10}=10\,cm$

9. (c) Resultant focal length $=\infty$

$\therefore$ It behaves as a plane slab of glass.

10. (c) $f=\frac{R}{(\mu-1)}\Rightarrow 30=\frac{10}{(\mu-1)}\Rightarrow\mu=1.33$.

11. (c) In case of convex lens if rays are coming from the focus, then the emergent rays after refraction are parallel to principal axis.

12. (d) Because to form the complete image only two rays are to be passed through the lens and moreover, since the total amount of light released by the object is not passing through the lens, therefore image is faint (intensity is decreased).

13. (b) $f=\frac{f_1 f_2}{f_1+f_2}=\frac{10(-10)}{10+(-10)}=\frac{-100}{10-10}=\infty$

14. (c) Focal length of the combination

$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{(+84)}+\frac{1}{(-12)}\Rightarrow F=-14\,cm$

$\therefore P=\frac{100}{F}=\frac{100}{-14}=-\frac{50}{7}\,D$

15. (b) $O=\sqrt{I_1 I_2}=\sqrt{4\times 16}=8\,cm$

16. (d) $\frac{f_l}{f_a}=\frac{({}_a\mu_g-1)}{({}_l\mu_g-1)}\Rightarrow\frac{f_w}{f_a}=\frac{(1.5-1)}{\left(\frac{1.5}{1.33}-1\right)}\Rightarrow f_w=32\,cm$

17. (c) If $n_l>n_g$ then the lens will be in more denser medium. Hence its nature will change and the convex lens will behave like a concave lens.

18. (d) $\frac{f_l}{f_a}=\frac{({}_a\mu_g-1)}{({}_l\mu_g-1)}\Rightarrow\frac{f_l}{15}=\frac{(1.5-1)}{\left(\frac{1.5}{4/3}-1\right)}\Rightarrow f_l=60\,cm$

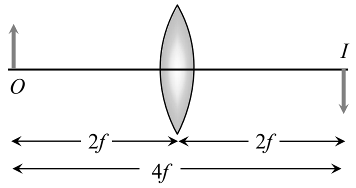
19. (c) $\frac{f_l}{f_a}=\frac{({}_a\mu_g-1)}{({}_l\mu_g-1)}\Rightarrow f_l=\infty$ if ${}_l\mu_g=1\Rightarrow {}_a\mu_l={}_a\mu_g$.

20. (c) $\frac{I_1}{O}=\frac{v}{u}$ and $\frac{I_2}{O}=\frac{u}{v}\Rightarrow O^2=I_1 I_2$

21. (c) A lens shows opposite behaviour if $\mu_{\text{medium}}>\mu_{\text{lens}}$

22. (a) A concave lens always forms virtual image for real objects.

23. (d)



24. (a) $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ (Given $u=-20\,cm$, $f=10\,cm$, $v=?$)

$\therefore\ \frac{1}{10}=\frac{1}{v}-\frac{1}{(-20)}\Rightarrow v=20\,cm$

25. (d) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{60}+\frac{1}{(-20)}\Rightarrow F=-30$

26. (a) $f_{\text{water}}=4\times f_{\text{air}}$, air lens is made up of glass.

27. (b) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{20}+\frac{1}{25}\Rightarrow F=\frac{100}{9}\,cm=\frac{1}{9}\,metre$

$\therefore\ P=\frac{1}{1/9}D=9D$

28. (a) $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ (Given $u=\frac{-f}{2}$)

$\Rightarrow\ \frac{1}{f}=\frac{1}{v}+\left(\frac{1}{f/2}\right)\Rightarrow\frac{1}{v}=\frac{1}{f}-\frac{2}{f}$

$\Rightarrow\ \frac{1}{v}=\frac{-1}{f}$ and $m=\frac{v}{u}=\frac{f}{f/2}=2$

So virtual at the focus and of double size.

29. (a) $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

Given $R_1=+20\,cm, R_2=-20\,cm$, $\mu=1.5$

$\Rightarrow f=20\,cm$. Parallel rays converge at focus. So $L=f$.

30. (c) $\mu_{air}<\mu_{lens}<\mu_{water}$ *i.e.*, $1<\mu_{lens}<1.33$

31. (c) $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

For biconvex lens $R_2=-R_1$ $\therefore$ $\frac{1}{f}=(\mu-1)\left(\frac{2}{R}\right)$

Given $R=\infty$ $\therefore$ $f=\infty$, so no focus at real distance.

32. (d) $f=\frac{R}{(\mu-1)}=\frac{15}{(1.6-1)}=25\,cm$

$\therefore P=\frac{100}{f}=\frac{100}{25}=+4\,D$

33. (d) $f\propto\frac{1}{(\mu-1)}$ and $\mu\propto\frac{1}{\lambda}$. Hence $f\propto\lambda$ and $\lambda_r>\lambda_v$

34. (c) $m_1=\frac{A_1}{O}$ and $m_2=\frac{A_2}{O}$ $\Rightarrow m_1m_2=\frac{A_1A_2}{O_2}$

Also it can be proved that $m_1m_2=1$

So $O=\sqrt{A_1A_2}$

35. (b) Combined power $P=P_1+P_2=6-2=4D$. So focal length of combination $F=\frac{1}{P}=\frac{1}{4}m$

36. (b) $\frac{1}{60}=\frac{1}{f_1}+\frac{1}{f_2}$ ...(i)

and $\frac{1}{30}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{10}{f_1f_2}$ ...(ii)

On solving (i) and (ii) $f_1f_2=-600$ and $f_1+f_2=-10$

Hence $f_1=20\ cm$ and $f_2=-30\ cm$

37. (c) For an achromatic combination $\frac{\omega_1}{f_1}+\frac{\omega_2}{f_2}=0$

i.e. 1 convex lens and 1 concave lens.

38. (d) $\frac{1}{F}=\frac{2}{f_l}+\frac{1}{f_m}$ $\Rightarrow$ $\frac{1}{F}=\frac{2}{20}+\frac{1}{\infty}\Rightarrow F=10\ cm$

39. (b) Since aperture of lens reduces so brightness will reduce but their will be no effect on size of image.

40. (d) Convex mirror and concave lens do not form real image. For concave mirror $v>u$, so image will be enlarged, hence only convex lens can be used for the purpose.

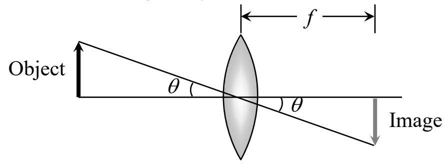
41. (a) $m=\frac{f}{f+u}\Rightarrow-\frac{1}{4}=\frac{30}{30+u}\Rightarrow u=-150\,cm$

42. (c) Covering a portion of lens does not effect position and size of image.

43. (a) $\frac{1}{f}=\left({}_g\mu_a-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)=\left(\frac{2}{3}-1\right)\left(\frac{2}{10}\right)$

$\Rightarrow f=-15\,cm$, so behaves as concave lens.

44. (c) Size of image $=f\theta=0.5\times(1\times10^{-3})=0.5\ mm$



45. (d) $\frac{f_l}{f_a}=\frac{({}_a\mu_g-1)}{({}_l\mu_g-1)}=\frac{\left(\frac{3}{2}-1\right)}{\left(\frac{3/2}{5/4}-1\right)}=\frac{5}{2}$

$\therefore$ $f_l=f_a\left(\frac{5}{2}\right)=\frac{12\times5}{2}=30\ cm$

46. (d) $P=\frac{1}{F}=\frac{f_1+f_2}{f_1f_2}$

47. (c) $f=\frac{R}{(\mu-1)}=\frac{R}{(1.5-1)}=2R$

48. (b) For achromatic combination, $\frac{w_1}{f_1}+\frac{w_2}{f_2}=0$

$\Rightarrow w_1f_2+w_2f_1=0$

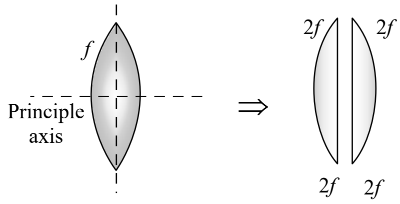
49. (a) $\frac{\omega_1}{\omega_2}=-\frac{f_1}{f_2}\Rightarrow\frac{5}{3}=\frac{-(-15)}{f_2}\Rightarrow f_2=9\ cm$

50. (b) $f=\frac{R}{2(\mu-1)}\Rightarrow f=\frac{40}{2(1.65-1)}\approx31\,cm$

51. (c) Focal length of effective lens

$\frac{1}{F}=\frac{2}{f_l}+\frac{1}{f_m}=\frac{2}{f_l}+\frac{1}{\infty}\Rightarrow F=\frac{f_l}{2}$

52. (a)



Ratio of focal length of new plano convex lenses is 1 : 1

53. (a) $\frac{1}{f}=\left(\frac{n-1}{1}\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ and

$\frac{1}{f'}=\left(\frac{n-n'}{n'}\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

$\therefore$ $\frac{f'}{f}=\frac{n-1}{1}\times\frac{n'}{n-n'}$ $\Rightarrow$ $f'=-\frac{fn'(n-1)}{n'-n}$

54. (b) $\frac{I}{O}=\frac{f-v}{f}\Rightarrow\frac{I}{+1.5}=\frac{(25-75)}{25}=-2\Rightarrow I=-3\,cm$

55. (a) $P=P_1+P_2$, if $P_1=P_2=P'$ $\Rightarrow$ $P'=P/2=2D$.

56. (b) $f=\frac{R}{(\mu-1)}=\frac{60}{(1.6-1)}=100\ cm$

57. (a) $\frac{f_l}{f_a}=\frac{_a\mu_g-1}{_l\mu_g-1}=\frac{1.5-1}{\frac{1.5}{1.75}-1}=-\frac{1.75\times0.50}{0.25}=-3.5$

$\therefore f_l=-3.5\ f_a \Rightarrow f_l=+3.5\,R \quad (\because f_a=R)$

Hence on immersing the lens in the liquid, it behaves as a converging lens of focal length 3.5 R.

58. (a) $P=P_1+P_2=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{(0.5)}+\frac{1}{(-1)}=1\,D$

59. (d) $f=\frac{R}{2(\mu-1)}\Rightarrow 30=\frac{R}{2(1.5-1)}\Rightarrow R=30\ cm$

60. (c) Total power $P=P_1+P_2=11-6=5D$

Also $\frac{f_l}{f_a}=\frac{(_a\mu_g-1)}{(_l\mu_g-1)}\Rightarrow\frac{P_a}{P_l}=\frac{(_a\mu_g-1)}{(_l\mu_g-1)}$

$\Rightarrow\frac{5}{P_l}=\frac{(1.5-1)}{(1.5/1.6-1)}\Rightarrow P_l=-0.625\,D$

61. (b) For first case : $\frac{1}{f}=\frac{1}{v}-\frac{1}{\infty}\Rightarrow f=v$

For second case $\frac{1}{f}=\frac{1}{(f+5)}-\frac{1}{-(f+20)}\Rightarrow f=10\ cm$

Alternative sol. – $f^2=x_1x_2 \Rightarrow f=10cm$

62. (b) $f=\frac{D^2-x^2}{4D}$ (Focal length by displacement method)

$\Rightarrow f=\frac{(100)^2-(40)^2}{4\times40}=21\ cm$

$\therefore P=\frac{100}{f}=\frac{100}{21}\approx5\,D$

63. (d) $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}\Rightarrow\frac{1}{+5}=\frac{1}{v}-\frac{1}{(-10)}\Rightarrow v=10\ cm$

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

65. (d) $f=\frac{R}{2(\mu-1)}\Rightarrow10=\frac{R}{2(1.6-1)}\Rightarrow R=12\ cm$

66. (a)

67. (d) $P=P_1+P_2=2.50-3.75=-1.25D$

So $f=\frac{100}{1.25}=-80\ cm$

68. (c) $\frac{f_l}{f_a}=\frac{_a\mu_g-1}{_l\mu_g-1}\Rightarrow f_l=4R$

69. (c) $\frac{f_l}{f_a}=\frac{_a\mu_g-1}{_l\mu_g-1}=\frac{_a\mu_g-1}{\frac{_a\mu_g}{_a\mu_l}-1}\Rightarrow\frac{f_l}{2}=\frac{1.5-1}{\frac{1.5}{1.25}-1}\Rightarrow f_l=5\,cm$

70. (b) $f\propto\frac{1}{\mu-1}$ and $\mu\propto\frac{1}{\lambda}$

71. (d) $P=\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{(+0.8)}+\frac{1}{(-0.5)}=-0.75\,D$

72. (b) According to lens makers formula

$\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)\Rightarrow\frac{1}{f}\propto(\mu-1)$

Since $\mu_{Red}<\mu_{violet}\Rightarrow f_v<f_r$ and $F_v<F_r$

Always keep in mind that whenever you are asked to compare (greater than or less than) u, v or f you must not apply sign conventions for comparison.

73. (a) Since light transmitting area is same, there is no effect on intensity.

74. (c) $m=\frac{f}{(f+u)}\Rightarrow-\frac{1}{n}=\frac{f}{(f+u)}\Rightarrow u=-(n+1)f$

75. (a) $P=P_1+P_2=2D-4D=-2D.$

76. (c)

77. (a) $\frac{1}{F}=\frac{2}{f}+\frac{1}{f_m}$. Here $f_m=\infty$, hence $F=\frac{f}{2}=10\,cm$

78. (b) $O=\sqrt{I_1I_2}\Rightarrow O=\sqrt{4\times9}=6\ cm$

79. (b) $P=P_1+P_2\Rightarrow P=+6-4=+2\,D.$ So focal length $f=\frac{100}{2}=+50\ cm$; convex lens

80. (d) $f=\frac{R}{2(\mu-1)}\Rightarrow P=\frac{2(\mu-1)}{R}=\frac{2(1.5-1)}{0.2}=+5\,D$

81. (c) $P=\frac{1}{f}\Rightarrow f=\frac{1}{0.5}=2m$

82. (a) $\frac{f_l}{f_a}=\left(\frac{_a\mu_g-1}{_l\mu_g-1}\right)\Rightarrow\frac{f_l}{4}=\frac{(1.4-1)}{\frac{1.4}{1.6}-1}\Rightarrow f_l=-12.8\,cm$

83. (d) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}\Rightarrow\frac{1}{F}=\frac{1}{(+18)}\Rightarrow F=18\,cm$

84. (a) $\frac{f_l}{f_a}=\frac{(_a\mu_g-1)}{(_l\mu_g-1)}$; $f_a=\frac{R}{2(\mu_g-1)}=\frac{15}{2(1.6-1)}=12.5$

$\Rightarrow\frac{f_l}{12.5}=\frac{(1.6-1)}{\left(\frac{1.6}{1.63}-1\right)}\Rightarrow f_l=-407.5\ cm$

85. (c) $P=P_1+P_2\Rightarrow P=+2+(-1)=+1D,$

$f=\frac{+100}{P}=\frac{+100}{1}=100\,cm$

86. (c)

87. (b) Nature of lens changes, if $\mu_{mediume}>\mu_{lens}$

88. (a) $u=-25\ cm, v=+75\,cm$

$\Rightarrow\frac{1}{f}=\frac{1}{+75}-\frac{1}{-25}\Rightarrow f=+18.75\,cm$; convex lens.

89. (a) $F=\frac{f_1 f_2}{f_2-f_1}$, F will be negative if $f_1>f_2$

90. (b) $f=\frac{R}{2(\mu-1)}=\frac{10}{2(1.5-1)}=10\,cm$

91. (b) $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

$\Rightarrow \frac{1}{+10}=(1.5-1)\left(\frac{1}{+7.5}-\frac{1}{R_2}\right)\Rightarrow R_2=-15\,cm$

92. (d) $f=\frac{R}{2(\mu-1)}$, $f'=\frac{R}{(\mu-1)}\Rightarrow f'=2f$

93. (c) $m=\pm 3$, using $m=\frac{f}{f+u}$

For virtual image $3=\frac{f}{f-8}$ .....(i)

For real image $-3=\frac{f}{f-16}$ .....(ii)

Solving (i) and (ii) we get $f=12\,cm$

94. (a) $\frac{1}{F}=\frac{1}{+18}+\frac{1}{(-9)}\Rightarrow F=-18\,cm$ (*i.e.* concave lens)

95. (c) $O=\sqrt{I_1 I_2}=\sqrt{8\times 2}=4\,cm$

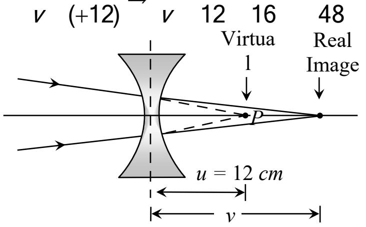
96. (c) $P=\frac{100}{f_1}+\frac{100}{f_2}=\frac{100}{(+25)}+\frac{100}{(-10)}=-6D$

97. (c)

98. (a) $f_w=4\times f_a=4\times 12=48\,cm$

99. (d) By using lens formula

$\frac{1}{-16}=\frac{1}{v}-\frac{1}{(+12)}\Rightarrow\frac{1}{v}=\frac{1}{12}-\frac{1}{16}=\frac{4-3}{48}\Rightarrow v=48\,cm$



100. (a) $P=P_1+P_2-dP_1P_2\Rightarrow P=10-25d$

$\Rightarrow$ For P to be negative $25d>10$

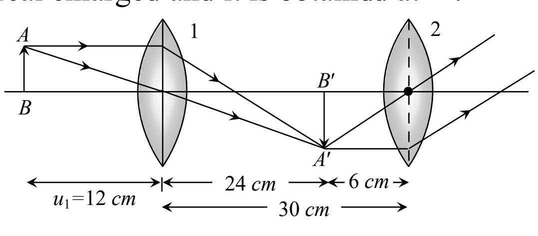
$\Rightarrow d>0.4\,m$ or $d>40\,cm$

101. (a) $m=\frac{f}{f+u}\Rightarrow -m=\frac{f}{f+u}\Rightarrow u=-\left(\frac{m+1}{m}\right)f$

102. (d) Number of images = (Number of materials)

103. (c) For lens (1) $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}\Rightarrow\frac{1}{(+8)}=\frac{1}{v}-\frac{1}{(-12)}$

$\Rightarrow v=24\,cm$ *i.e.* Image $A'B$ is obtained 6 *cm* before the lens 2 or at the focus of lens 2. Hence final image formed by lens 2 will be real enlarged and it is obtained at ∞.



104. (d) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}\Rightarrow\frac{1}{F}=\frac{1}{+80}+\frac{1}{-50}$

$\Rightarrow F=-\frac{400}{3}\Rightarrow P=\frac{-3}{4}D$

105. (a) By using formula $\frac{\mu_2}{v}-\frac{\mu_1}{u}=\frac{\mu_2-\mu_1}{R}$

$\Rightarrow\frac{1.5}{v}-\frac{1}{(-15)}=\frac{(1.5-1)}{+30}\Rightarrow v=-30\,cm.$

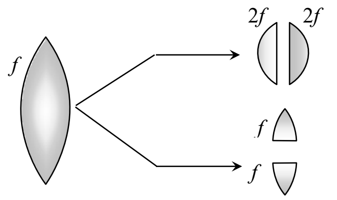
Negative sign shows that, image is obtained on the same side of object *i.e.* towards left.

106. (c) By using $\frac{f_l}{f_a}=\frac{({}_a\mu_g-1)}{({}_l\mu_g-1)}\Rightarrow f_w=4f_a=4\times 30=120$ *cm*.

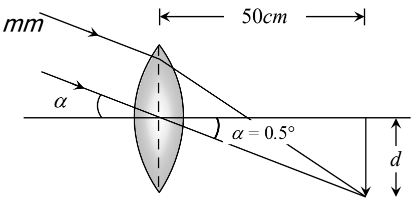
107. (b)

108. (a)

109. (d)



110. (b) Diameter of image $d=\left(0.5\times\frac{\pi}{180}\right)\times 500=4.36$ mm



111. (c) $f\propto\frac{1}{\mu-1}$ and $\mu\propto\frac{1}{\lambda}$.

112. (c) Since intensity $\propto$ (Aperature)^2, so intensity of image will decrease but no change in the size occurs.

113. (c) In liquids converging ability (power) of convex lens decreases.

114. (d) Since $f\propto\frac{1}{\mu}\propto\lambda$, so voilet colour is focused nearer to the lens.

115. (a) Focal length for voilet is minimum.

116. (c) $m=\frac{v}{u}=5\Rightarrow v=5$ *inch* (Given $u=1$ *inch*)

Using sign convention $u=-1$ *inch*, $v=-5$ *inch*

$\therefore \frac{1}{f}=\frac{1}{v}-\frac{1}{u}=\frac{1}{-5}-\frac{1}{-1}\Rightarrow f=1.25$ *inch*

117. (a) $m_L=4$

$m_A=(m_1)^2$ so that $A'=A_0\times 16=1600\ cm^2$

118. (d) $u=-10\ cm,\ v=20\ cm$

$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}=\frac{1}{20}-\left(-\frac{1}{10}\right)=\frac{3}{20}\Rightarrow f=\frac{20}{3}\ cm$

Now $P=\frac{100}{f}=\frac{100}{20/3}=+15\ D$

119. (c) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$

120. (b)

$f=\frac{R}{2(\mu-1)}\Rightarrow R=2f(\mu-1)$

$=2\times 0.2(1.5-1)=0.2m.$

121. (c) Using refraction formula $\frac{{}_1\mu_2-1}{R}=\frac{{}_1\mu_2}{v}-\frac{1}{u}$

in given case, medium (1) is glass and (2) is air

So $\frac{{}_g\mu_a-1}{R}=\frac{{}_g\mu_a}{v}-\frac{1}{u}\Rightarrow\frac{\frac{1}{1.5}-1}{-6}=\frac{1}{1.5v}-\frac{1}{-6}$

$\Rightarrow\frac{1-1.5}{-6}=\frac{1}{v}+\frac{1.5}{6}\Rightarrow\frac{0.5}{6}=\frac{1}{v}+\frac{1}{4}$

$\Rightarrow\frac{1}{v}=\frac{1}{12}-\frac{1}{4}=-\frac{2}{12}=-\frac{1}{6}\Rightarrow v=6\ cm.$

122. (d) For real image $m=-2$

$\therefore m=\frac{f}{u+f}\Rightarrow -2=\frac{f}{u+f}=\frac{20}{u+20}\Rightarrow u=-30\ cm.$

123. (a) Focal length of the system (concave mirror)

$F=\frac{R}{2\mu}=\frac{30}{2\times 1.5}=10\ cm$

In order to have a real image of the same size of the object, object must be placed at centre of curvature $u=(2f)$.

124. (b) $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

$=(1.5-1)\left(\frac{1}{10}+\frac{1}{10}\right)=\frac{1}{10}\Rightarrow f=10\ cm$

$\therefore$ Radius of curvature of concave mirror $=2f=20\ cm$.

125. (d) $m=-\frac{1}{2}$

$\therefore m=\frac{f}{u+f}\Rightarrow -\frac{1}{2}=\frac{30}{u+30}\Rightarrow u=-90\ cm$

126. (c) $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

$\frac{1}{f}=(1.6-1)\left(\frac{1}{60}-\frac{1}{\infty}\right)=\frac{1}{100}\Rightarrow f=100\ cm$

127. (d) $\frac{1}{F}=(1.5-1)\left(\frac{1}{20}-\frac{1}{\infty}\right)\Rightarrow F=40\ cm.$

128. (b) For minimum spherical and chromatic aberration distance between lenses.

$d=f_1-f_2=0.3-0.1=0.2\ m.$

129. (b) $\frac{f_l}{f_a}=\frac{{}_a\mu_g-1}{{}_l\mu_g-1}=\frac{(1.5-1)\times 1.7}{(1.5-1.7)}$

$\Rightarrow f_l=\frac{0.85}{-0.2}f_a=-4.25\ f_a.$

130. (c)

131. (b) $\omega=\frac{f_R-f_V}{f_y}=\frac{f_R-f_V}{\sqrt{f_Vf_R}}$

Putting value of f_V and f_R we get $\omega=0.0325$.

132. (b) $P_1+P_2=2D$ and $P_1=5D$, so $P_2=-3D$

For achromatic combination

$\frac{\omega_1}{\omega_2}=\left(-\frac{p_2}{p_1}\right)=-\left(\frac{-3}{5}\right)=\frac{3}{5}$

133. (b) $f\propto\frac{1}{\mu-1}$ and $\mu\propto\frac{1}{\lambda}$

134. (d) $P=P_1+P_2=+12-2=10D$

Now $F=\frac{1}{P}=\frac{1}{10}m=10\ cm.$

135. (b) Focal length for voilet colour is minimum

136. (d) $\frac{f_1}{f_2}=\frac{2}{3}$ .....(i)

$\frac{1}{f_1}-\frac{1}{f_2}=\frac{1}{30}$ .....(ii)

Solving equation (i) and (ii)

$f_2=-15\ cm$ (Concave)

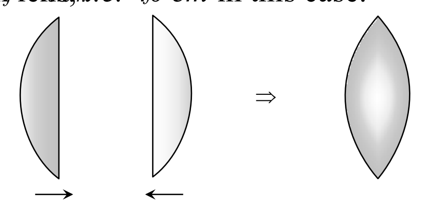
$f_1=10\ cm$ (Convex)

137. (d) $\frac{f_l}{f_a}=\frac{({}_a\mu_g-1)}{({}_l\mu_g-1)}$

$\Rightarrow \frac{f_l}{f_a} = \frac{{}_a\mu_g - 1}{{}_l\mu_g - 1} = \frac{1.5-1}{\frac{1.5}{1.6}-1} = \frac{0.5\times 1.6}{-0.1} = -8$

$\Rightarrow P_l = \frac{P_a}{8} = \frac{5}{8}$

138. (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.



139. (a) Using $P = P_1 + P_2 - d\times P_1P_2$

for equivalent power to be negative

$d\times P_1P_2 > P_1 + P_2 \Rightarrow d\times 25 > 10$

$\Rightarrow d > \frac{10}{25}m \Rightarrow d > \frac{10\times 100}{25} \Rightarrow d > 40cm$

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

141. (b) For achromatic combination $\frac{f_1}{f_2} = -\frac{\omega_2}{\omega_1} = -\frac{0.036}{0.024} = -\frac{3}{2}$

and $\frac{1}{f_1} - \frac{1}{f_2} = \frac{1}{90}$

solving above equations be get $f_1 = 30cm, f_2 = -45cm$

142. (b)

143. (c) $f \propto \frac{1}{\mu - 1}$ and $\mu \propto \frac{1}{\lambda}$.

144. (b) $\frac{f_l}{f_a} = \frac{{}_a\mu_g - 1}{{}_l\mu_g - 1} \Rightarrow \frac{-0.5}{0.2} = \frac{1.5-1}{{}_l\mu_g - 1} \Rightarrow {}_l\mu_g - 1 = -0.2$

$\Rightarrow {}_l\mu_g = 0.8 = \frac{4}{5} \Rightarrow \frac{{}_a\mu_g}{{}_a\mu_l} = \frac{4}{5} \Rightarrow \frac{1.5}{{}_a\mu_l} = \frac{4}{5}$

$\Rightarrow {}_a\mu_l = \frac{15}{8}$.

145. (c) Longitudinal chromatic aberration

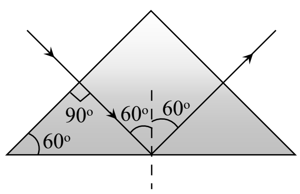
$= \omega f = 0.08\times 20 = 1.6cm$.

Prism Theory & Dispersion of Light

1. (b) Neon street sign emits light of specific wavelengths.

2. (b)

3. (b)



4. (c) $\delta \propto (\mu - 1) \Rightarrow \mu_R$ is least so δ_R is least.

5. (c)

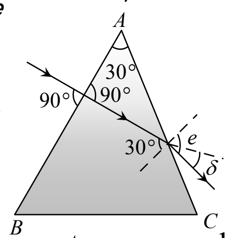
6. (a) For surface $AC \frac{1}{\mu} = \frac{\sin 30°}{\sin e} \Rightarrow \sin e = \mu \sin 30°$

$\Rightarrow \sin e = 1.5\times\frac{1}{2} = 0.75$

$\Rightarrow e = \sin^{-1}(0.75) = 48°36'$

From figure $\delta = e - 30°$

$= 48°\,36' - 30° = 18°36'$



7. (a) The black lines in solar spectrum are called Fraunhoffer lines.

8. (d) $\frac{\sin\frac{A+\delta m}{2}}{\sin\frac{A}{2}} = \mu$, But $\frac{A+\delta_m}{2} = i = 45°$

So $\frac{\sin 45°}{\sin(A/2)} = \sqrt{2} \Rightarrow \frac{1}{2} = \sin\frac{A}{2} \Rightarrow A = 60°$

9. (d) We know that $\frac{\delta_v - \delta_r}{\delta_{mean}} = \omega$

$\Rightarrow$ Angular dispersion $= \delta_v - \delta_r = \theta = \omega\delta_{mean}$

10. (d) According to Kirchhoff's law, a substance in unexcited state will absorb these wavelength which it emits in de-excitation.

11. (c) By prism formula $n = \frac{\sin\frac{A+A}{2}}{\sin\frac{A}{2}} = \frac{2\sin\frac{A}{2}\cos\frac{A}{2}}{\sin\frac{A}{2}}$

$\therefore \cos\frac{A}{2} = \frac{n}{2} = \frac{1.5}{2} = 0.75 = \cos 41° \Rightarrow A = 82°$

12. (b)

13. (b) ω depend only on nature of material.

14. (a) Because achromatic combination has same μ for all wavelengths.

15. (a) $\because \mu = a + \frac{b}{\lambda^2}$ (Cauchy's equation)

and dispersion $D = -\frac{d\mu}{d\lambda} \Rightarrow D = -(-2\lambda^{-3})b = \frac{2b}{\lambda^3}$

$\Rightarrow D \propto \frac{1}{\lambda^3} \Rightarrow \frac{D}{D} = \left(\frac{\lambda}{\lambda'}\right)^3 = \left(\frac{\lambda}{2\lambda}\right) = \frac{1}{8} \Rightarrow D = \frac{D}{8}$

16. (b) $\mu = \frac{\sin i}{\sin A/2} \Rightarrow \sqrt{2} = \frac{\sin i}{\sin\left(\frac{60}{2}\right)}$

$\Rightarrow \sqrt{2} \times \sin 30 = \sin i \Rightarrow i = 45^o$

17. (d) $\frac{\delta_w}{\delta_a} = \frac{({}_w\mu_g - 1)}{({}_a\mu_g - 1)} = \frac{\left(\frac{9}{8} - 1\right)}{\left(\frac{3}{2} - 1\right)} = \frac{1}{4}$

18. (a) Since $A(\mu_y - 1) + A'(\mu_y - 1) = 0 \Rightarrow \frac{A'}{A} = -\left(\frac{\mu_y - 1}{\mu_y - 1}\right)$

19. (d)

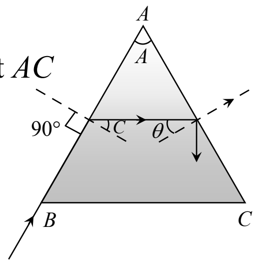
20. (b)

21. (a)

22. (c) From ray diagram

$A = C + \theta$ for TIR at AC

$\theta > C$ so $A > 2C$



23. (a) By the hypothesis, we know that

$i_1 + i_2 = A + \delta \Rightarrow 55^o + 46^o = 60^o + \delta \Rightarrow \delta = 41^o$

But $\delta_m < \delta$, so $\delta_m < 41^o$

24. (a)

25. (b) $\delta_m = (\mu - 1)A$. $A =$ angle of prism.

26. (c)

27. (c)

28. (b)

29. (a) Total deviation = 0

$\delta_1 + \delta_2 + \delta_3 + \delta_4 + \delta_5 = (\mu_1 - 1)A_1 - (\mu_2 - 1)A_2$

$+(\mu_3 - 1)A_3 - (\mu_4 - 1)A_4 + (\mu_5 - 1)A_5 = 0$

$\Rightarrow 2 \times A_2(1.6 - 1) = 3(1.53 - 1)9$

$\Rightarrow A_2 = 3\left(\frac{0.53 \times 9}{1.2}\right) = 11.9^o$

30. (a) The dispersive power for crown glass $\omega = \frac{n_v - n_r}{n_y - 1}$

$= \frac{1.5318 - 1.5140}{(1.5170 - 1)} = \frac{0.0178}{0.5170} = 0.034$

and for flint glass $\omega' = \frac{1.6852 - 1.6434}{(1.6499 - 1)} = 0.064$

31. (c)

32. (b)

33. (a) For dispersion without deviation $\frac{A}{A'} = \left(\frac{\mu'_y - 1}{\mu_y - 1}\right)$

$\therefore \frac{A}{10} = \frac{(1.602 - 1)}{(1.500 - 1)} = \frac{0.602}{0.500} \Rightarrow A = 12°2.4'$

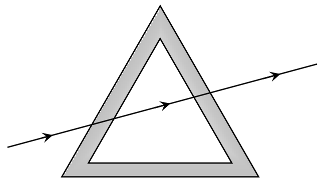
34. (c) $i = \frac{A + \delta_m}{2} = 50°$

35. (d) In minimum deviation position $\angle i = \angle e$

36. (a) $\underset{\text{(Primary)}}{\text{Yellow}} + \underset{\text{(Primary)}}{\text{Blue}} = \underset{\text{(Secondary)}}{\text{Green}}$

37. (b) All colours are reflected.

38. (a) Effectively there is no deviation or dispersion.

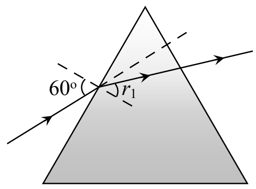


39. (d) From figure it is clear that $\angle e = \angle r_2 = 0$

From $A = r_1 + r_2$

$\Rightarrow r_1 = A = 45^o$

$\therefore \mu = \frac{\sin i}{\sin r_1} = \frac{\sin 60}{\sin 45} = \sqrt{\frac{3}{2}}$



Also from $i + e = A + \delta \Rightarrow 60 + 0 = 45 + \delta$

$\Rightarrow \delta = 15^o$

40. (b) Deviation is zero only for a particular colour, it is generally taken to be yellow.

41. (b) $5 = (\mu - 1)A = (1.5 - 1)A \Rightarrow A = 10^o$

42. (b) $\delta = (\mu_v - \mu_r)A = 0.02 \times 10 = 0.2$

43. (a) $\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin(A/2)} = \frac{\sin 45^o}{\sin 30^o} = \sqrt{2}$

44. (c) $\omega = \frac{\mu_V - \mu_R}{\mu_Y - 1} = \frac{1.65 - 1.61}{1.63 - 1}$

45. (a) For minimum angle of deviation for a prism

$A = 2r$, $\therefore A = 60^o$

Now $\mu = \frac{\sin\frac{60 + 30}{2}}{\sin\frac{60}{2}} = \frac{\sin 45^o}{\sin 30^o} = \frac{1}{\sqrt{2}} \times \frac{2}{1} = \sqrt{2}$

46. (c) In minimum deviation condition $\angle i = \angle e$, $\angle r_1 = \angle r_2$

47. (b) For dispersion without deviation $\frac{A}{A'} = \frac{(\mu' - 1)}{(\mu - 1)}$

$\frac{4}{A_F} = \frac{(1.72-1)}{(1.54-1)} = \frac{0.72}{0.54}$ or $A_F = \frac{4\times 0.54}{0.72} = 3^o$

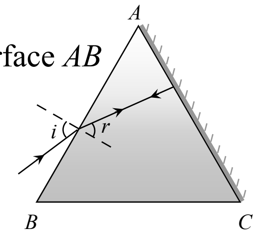
48. (a) $A(\mu_v - \mu_r) + A'(\mu'_v - \mu'_r) = 0^o \Rightarrow A' = 5^o$

49. (c) $A = r + 0 \Rightarrow r = 30^o$

From Snell's law at surface *AB*

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

$\Rightarrow \sqrt{2} = \frac{\sin i}{\sin 30^o} \Rightarrow i = 45^o$



50. (c) $\omega = \frac{1.64-1.52}{1.6-1} = \frac{0.12}{0.6} = 0.2$

51. (c) Because band spectrum can be found in case of molecules (generally gas).

52. (a) Solids and liquids give continuous and line spectra. Only gases are known to give band spectra.

53. (d)

54. (d)

55. (a) Hydrogen is molecular, therefore it gives band spectrum but not continuous spectrum.

56. (c)

57. (a) Dispersion take place because the refractive index of medium for different colour is different, for example, red light bends less than violet, refractive index of the material of the prism for red light is less than that for violet light. Equivalently, we can say that red light travels faster than violet light in a glass prism.

58. (a) We know that $\delta = i + e - A \Rightarrow e = \delta + A - i$

$= 30^o + 30^o - 60^o = 0^o$

$\therefore$ Emergent ray will be perpendicular to the face.

Therefore it will make an angle of 90° with the face through which it emerges.

59. (a) $\delta_m = (\mu - 1)(2r) = (1.5-1)2r = 0.5 \times 2r = r$

60. (c)

61. (c)

62. (b)

63. (d) Given $i = e = \frac{3}{4}A = \frac{3}{4}\times 60 = 45^o$

In the position of minimum deviation

$2i = A + \delta_m$ or $\delta_m = 2i - A = 90 - 60 = 30^o$

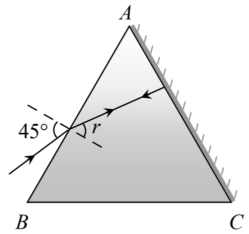
64. (d)

65. (a) Sky appears white due to scattering. In absence of atmosphere no scattering will occur.

66. (b)

67. (c) $A = r + 0 \Rightarrow r = 30°$

$\therefore \mu = \frac{\sin i}{\sin r} = \frac{\sin 45°}{\sin 30°} = \sqrt{2}$



68. (c) By formula $\delta = (n-1)A \Rightarrow 34 = (n-1)A$ and in the second position $\delta' = (n-1)\frac{A}{2}$

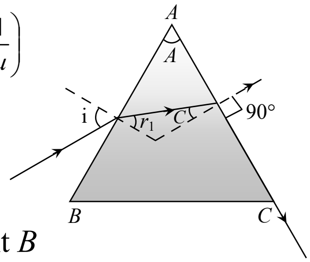
$\therefore \frac{34}{\delta'} = \frac{(n-1)A}{(n-1)\frac{A}{2}}$ or $\delta' = \frac{34}{2} = 17^o$

69. (b) From figure

$A = r_1 + c = r_1 + \sin^{-1}\left(\frac{1}{\mu}\right)$

$\Rightarrow r_1 = 75 - \sin^{-1}\left(\frac{1}{\mu}\right)$

$\Rightarrow 75 - 45 = 30^o$



From Snell's law At *B*

$\mu = \frac{\sin i}{\sin r_1} \Rightarrow \sqrt{2} = \frac{\sin i}{\sin 30^o} \Rightarrow i = 45^o$

70. (c) In both *A* and *B*, the refracted ray is parallel to the base of prism.

71. (a) According to given conditions TIR must take place at both the surfaces *AB* and *AC*. Hence only option (*a*) is correct.

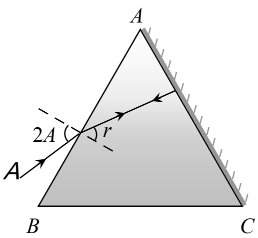
72. (d)

73. (a)

74. (b) $A = r + 0$ and $\mu = \frac{\sin i}{\sin r}$

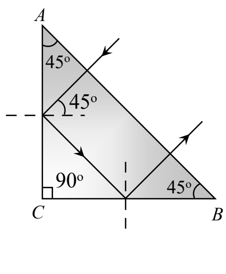
$\Rightarrow \mu = \frac{\sin 2A}{\sin A}$

$= \frac{2\sin A\cos A}{\sin A} = 2\cos A$



75. (a) From figure it is clear that TIR takes place at surface *AC* and *BC*

i.e. $45^o > C$



$\Rightarrow \sin 45^o > \sin C$

$\Rightarrow \frac{1}{\sqrt{2}} > \frac{1}{\mu} \Rightarrow \mu > \sqrt{2}$

Hence $\mu_{\text{least}} = \sqrt{2}$

76. (b)

77. (b) According to Rayleigh's law of scattering, intensity scattered is inversely proportional to the forth power of wavelength. So red is least scattered and sun appears Red.

78. (b)

79. (d)

80. (a) Only red colour will be seen in spectrum.

81. (b) $i = \frac{A+\delta_m}{2} = \frac{60^\circ + 30^\circ}{2} = 45^\circ$

82. (a) $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}} = \frac{\sin\left(\frac{60^\circ+60^\circ}{2}\right)}{\sin\left(\frac{60^\circ}{2}\right)} = \sqrt{3}$

83. (b) Because in dispersion of white light, the rays of different colours are not parallel to each other. Also deviation takes place in same direction.

84. (c)

85. (a) $\omega = \frac{\mu_F - \mu_C}{(\mu_D - 1)} = \frac{(1.6333 - 1.6161)}{(1.622 - 1)} = 0.0276$

86. (c) For total internal reflection $\theta > C$

$\Rightarrow \sin\theta > \sin C \Rightarrow \sin\theta > \frac{1}{\mu}$

or $\mu > \frac{1}{\sin\theta} \Rightarrow \mu > \frac{1}{\sin 45^o} \Rightarrow \mu > \sqrt{2} \Rightarrow \mu > 1.41$

87. (c)

88. (a) $\theta = (\mu_v - \mu_r)A = 0.02 \times 5^o = 0.1^o$

89. (b)

90. (b) $\frac{A'}{A} = \frac{(\mu_y - 1)}{(\mu_y - 1)} \Rightarrow \frac{A'}{6} = -\frac{(1.54-1)}{(1.72-1)}$

$\Rightarrow A' = -4.5^o = 4^o 30'$

91. (c) $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}} \Rightarrow \sqrt{3} = \frac{\sin\left(\frac{60^\circ+\delta_m}{2}\right)}{\sin\frac{60^\circ}{2}}$

$\Rightarrow \frac{\sqrt{3}}{2} = \sin\left(30^\circ + \frac{\delta_m}{2}\right) \Rightarrow \delta_m = 60^o$

92. (a) Dispersion is caused due to refraction as μ depends on λ.

93. (c) From colour triangle

94. (c) Due to the absorption of certain wavelengths by the elements in outer layers of sun.

95. (b)

96. (c)

97. (c) $\omega = \frac{\mu_v - \mu_R}{\mu_y - 1} = \frac{1.62 - 1.52}{1.55 - 1} = 0.18$

98. (a) $\frac{\omega_1}{\omega_2} = -\frac{f_1}{f_2} = -\frac{2}{3}$.

99. (a) $\omega = \frac{\mu_V - \mu_R}{\mu_Y - 1} = \frac{1.62 - 1.42}{1.5 - 1} = 0.4$

100. (c) Since the ray emerges normally, therefore $e = 0$.

According to relation $A + \delta = i + e$, we get $i = A + \delta$.

Hence by $\delta = (\mu - 1)A$, we get $i = \mu A$.

101. (a) The atoms in the chromosphere absorb certain wavelengths of light coming from the photosphere. This gives rise to absorption lines.

102. (b) $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)} \Rightarrow \sqrt{2}\mu = \frac{\sin\left(\frac{60+\delta_m}{2}\right)}{\sin\left(\frac{60}{2}\right)}$

$\Rightarrow \sqrt{2} \times \sin 30 = \sin\left(\frac{60+\delta_m}{2}\right) \Rightarrow \sin 45^o$

$= \sin\left(\frac{60+\delta_m}{2}\right) \Rightarrow \delta_m = 30^o$

103. (a) Intensity of scattered light $I \propto \frac{1}{\lambda^4}$, since λ_{blue} is least that's why sky looks blue.

104. (b) In continuos spectrum all wavelength are present.

105. (d)

106. (b) Deviation is greater for lower wavelengths.

107. (b) $\frac{\delta_a}{\delta_w} = \frac{({}_a\mu_g - 1)}{({}_w\mu_g - 1)} = \frac{\left(\frac{3}{2} - 1\right)}{\left(\frac{3/2}{4/3} - 1\right)} = 4 \Rightarrow \delta_w = \frac{\delta_a}{4}$

108. (a) $\theta = (\mu_v - \mu_r)A = (1.66 - 1.64) \times 10^o = 0.2^o$

109. (b) $\omega = \frac{(\mu_v - \mu_R)}{(\mu_y - 1)} \Rightarrow \frac{(1.69 - 1.65)}{(1.66 - 1)} = 0.06$

110. (a) $\omega = \frac{\delta_V - \delta_R}{\delta_Y} = \frac{3.72 - 2.84}{3.28} = 0.268$

111. (a)

112. (d)

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

$$= \frac{\sin\left(\frac{60^\circ + 30^\circ}{2}\right)}{\sin\frac{60^\circ}{2}} = \frac{\sin 45^o}{\sin 30^o} = 1.414$$

113. (a) Rock salt prism is used to see infrared radiations.

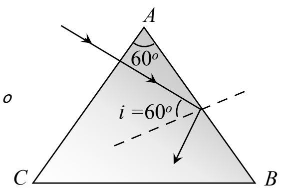
114. (b) For different colours μ changes so deviation of different colour is also different.

115. (a) By using $\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0 \Rightarrow \frac{0.02}{f_1} + \frac{0.04}{40} = 0$

$f_1 = -20\ cm$

116. (d) Critical angle for the material of prism

$C = \sin^{-1}\left(\frac{1}{\mu}\right) = \sin^{-1} = 42^o$



since angle of incidence at surface $AB(60^o)$ is greater then the critical angle (42^o) so total internal reflection takes place.

117. (d) Line and band spectrum are also known as atomic and molecular spectra respectively.

118. (d) In minimum deviation $i = e = 30^o$, so angle between emergent ray and second refracting surface is $90^o - 30^o = 60^o$

119. (c) $\theta = (\mu_v - \mu_R)A = (1.6 - 1.5) \times 5 = 0.5^o$

120. (d) $\frac{\delta_1}{\delta_2} = \frac{A_1}{A_2}$

121. (a) Sunlight consists of all the wavelength with some black lines.

122. (d) $A = 30^o, \mu = \sqrt{2}$. As we know

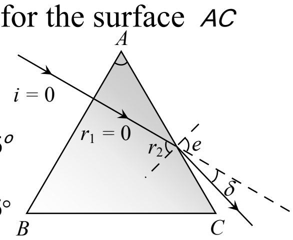
$A = r_1 + r_2 = 0 + r_2 \Rightarrow A = r_2$.

Applying Snell's law for the surface AC

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

$\Rightarrow \frac{1}{\sqrt{2}} = \frac{\sin 30^o}{\sin e} \Rightarrow e = 45^o$

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



123. (c) $\mu = \frac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}} = \frac{\sin\frac{A+A}{2}}{\sin\frac{A}{2}} = \frac{\sin A}{\sin\frac{A}{2}}$

$$= \frac{2\sin\frac{A}{2}\cos\frac{A}{2}}{\sin\frac{A}{2}} = 2\cos\frac{A}{2}$$

So, $\sqrt{3} = 2\cos\frac{A}{2} \Rightarrow \frac{\sqrt{3}}{2} = \cos\frac{A}{2} \Rightarrow A = 60^\circ$

124. (d) Light from lamp or electric heater gives continuos spectrum.

125. (b) $A = 60^o, \delta_m = 30^o$ so $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$$\mu = \frac{\sin\left(\frac{60^\circ + 30^\circ}{2}\right)}{\sin\left(\frac{60^\circ}{2}\right)} = \frac{\sin 45^\circ}{\sin 30^\circ} = \sqrt{2}$$

Also $\mu = \frac{1}{\sin C} \Rightarrow C = \sin^{-1}\left(\frac{1}{\mu}\right) \Rightarrow C = 45^o$

126. (a) $\delta \propto (\mu - 1)$

127. (c) In minimum deviation position $\angle i_1 = \angle i_2$ and $\angle r_1 = \angle r_2$.

128. (c) $\theta_{net} = \theta + \theta' = 0 \Rightarrow \omega d + \omega' d' = 0$

(θ = Angular dispersion = $\omega. \delta_y$)

129. (d) $A = 60^o, i = e = 45^o$ By $i + e = A + \delta$

$\Rightarrow 45 + 45 = 60 + \delta \Rightarrow \delta = 30^o$

130. (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.

131. (a) In the morning or evening, the sun is at the horizon and refractive index in the atmosphere of the earth decreases with height. Due to this, the light reaching the earth's atmosphere, bends unequally, and the image of the sun get's distorted and it appears elliptical and larger.

132. (c) In Rainbow formation dispersion and TIR both takes place.

133. (a)

134. (c) Given $\delta_m = A$, as $\mu = \dfrac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$$\Rightarrow \mu = \frac{\sin\left(\frac{A+A}{2}\right)}{\sin\left(\frac{A}{2}\right)} = 2\cos\frac{A}{2} \Rightarrow A = 2\cos^{-1}\left(\frac{\mu}{2}\right)$$

135. (b) As the prisms Q and R are of the same material and have identical shape they combine to form a slab with parallel faces. Such a slab does not cause any deviation.

136. (c) Angle of prism is the angle between incident and emergent surfaces.

137. (a) $\mu = \dfrac{\sin i}{\sin\frac{A}{2}} \Rightarrow \sqrt{2} = \dfrac{\sin i}{\sin\left(\frac{60}{2}\right)} \Rightarrow i = 45^o$

138. (d) Convex lens, glass slab, prism and glass sphere they all disperse the light.

139. (c) For a lens $f_r - f_v = \omega\, f_y$

$$\Rightarrow \omega = \frac{f_r - f_v}{f_y} = \frac{0.214 - 0.200}{0.205} = \frac{14}{205}.$$

140. (b) $\omega = \dfrac{(\mu_V - \mu_R)}{(\mu_y - 1)} \Rightarrow \dfrac{(1.69 - 1.65)}{(1.66 - 1)} = 0.06$

141. (a) In minimum deviation condition $r = \dfrac{A}{2} = \dfrac{60}{2} = 30^o$

142. (a) $\omega = \dfrac{\mu_v - \mu_r}{\mu_y - 1} = \dfrac{1.67 - 1.63}{1.65 - 1} = 0.615.$

143. (b) In minimum deviation position refracted ray inside the prism is parallel to the base of the prism.

144. (b) Angle of refraction will be different, due to which red and green emerge from different points and will be parallel.

145. (a) Deviation $\delta \propto \mu \propto \dfrac{1}{\lambda}$

146. (a) $\mu = \dfrac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}} = \dfrac{\sin\frac{60+38}{2}}{\sin\frac{60}{2}}$

$$= \frac{\sin 49^o}{\sin 30^o} = \frac{0.7547}{0.5} = 1.5.$$

147. (d) Using $\delta = i_1 + i_2 - A \Rightarrow 55 = 15 + i_2 - 60$

$\Rightarrow i_2 = 100^o$

148. (b) Sodium light gives emission spectrum having two yellow lines.

149. (c) Colour of the sky is highly scattered light (colour).

150. (a)

151. (c)

Human Eye and Lens Camera

1. (c) Man is suffering from hypermetropia. The hole works like a convex lens.

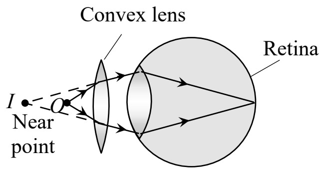
2. (a)

3. (b) In myopia, $u = \infty$, $v = d =$ distance of far point

By $\dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u}$, we get $f = -d$

Since f is negative, hence the lens used is concave.

4. (d) Hypermetropia is removed by convex lens.



5. (b)

6. (c) Cylindrical lens are used for removing astigmatism.

7. (b)

8. (a) Image formed at retina is real and inverted.

9. (d) Visible region decreases, so the depth of image will not be seen.

10. (a) $P = \dfrac{1}{f} = -\dfrac{1}{v} + \dfrac{1}{u} = -\dfrac{1}{100} + \dfrac{1}{25} = \dfrac{3}{100} = +3\ D$

11. (c) If eye is kept at a distance d, then $MP = \dfrac{L(D-d)}{f_0 f_e}$, MP decreases.

12. (c) For lens u = want's to see $= \infty$

v = can see $= -5\ m$

$\therefore$ From $\dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u} \Rightarrow \dfrac{1}{f} = \dfrac{1}{-5} - \dfrac{1}{\infty} \Rightarrow f = -5\,m.$

13. (a) For improving near point, convex lens is required and for this convex lens

$u = -25\ cm$, $v = -75\ cm$

$\therefore \dfrac{1}{f} = \dfrac{1}{-75} - \dfrac{1}{-25} \Rightarrow f = \dfrac{75}{2}\ cm$

So power $P=\frac{100}{f}=\frac{100}{75/2}=+\frac{8}{3}D$

14. (b) In short sightedness, the focal length of eye lens decreases, so image is formed before retina.

15. (d) The image of object at infinity should be formed at 100 *cm* from the eye

$\frac{1}{f}=\frac{1}{\infty}-\frac{1}{100}=-\frac{1}{100}$

So the power $=\frac{-100}{100}=-1D$

(Distance is given in *cm* but $P=\frac{1}{f}$ in *metres*)

16. (b) For improving far point, concave lens is required and for this concave lens $u=\infty,\ v=-30\ cm$

So $\frac{1}{f}=\frac{1}{-30}-\frac{1}{\infty}\Rightarrow f=-30\ cm$

for near point $\frac{1}{-30}=\frac{1}{-15}-\frac{1}{u}\Rightarrow u=-30\ cm$

17. (c) For myopic eye *f* = – (defected far point)

$\Rightarrow f=-40\,cm\ \Rightarrow\ P=\frac{100}{-40}=-2.5\ D$

18. (c) For lens *u* = want's to see $=-60\,cm$

v = can see $=-10\,cm$

$\therefore \frac{1}{f}=\frac{1}{v}-\frac{1}{u}\Rightarrow\frac{1}{f}=\frac{1}{-10}-\frac{1}{(-60)}\Rightarrow f=-12\,cm$

19. (b) Focal length = – (Detected far point)

20. (c) In this case, for seeing distant objects the far point is 40 *cm*. Hence the required focal length is

$f=-d$(distance of far point) = – 40 *cm*

Power $P=\frac{100}{f}cm=\frac{100}{-40}=-2.5\ D$

21. (b)

22. (a)

23. (a)

24. (a) For viewing far objects, concave lenses are used and for concave lens

u = wants to see $=-60\,cm$; *v* = can see $=-15\,cm$

so from $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}\Rightarrow f=-20\,cm$.

25. (d)

26. (a) In short sightedness, the focal length of eye lens decreases and so the power of eye lens increases.

27. (d) Colour blindness is a genetic disease and still cannot be cured.

28. (c) Convexity to lens changes by the pressure applied by ciliary muscles.

29. (b) $f=-d=-100\ cm=-1\ m$

$\therefore P=\frac{1}{f}=\frac{1}{-1}=-1\ D$

30. (c) For correcting myopia, concave lens is used and for lens.

u = wants to see $=-50\,cm$

v = can see $=-25\,cm$

From $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}\Rightarrow\frac{1}{f}=\frac{1}{-25}-\frac{1}{(-50)}\Rightarrow f=-50\,cm$

So power $P=\frac{100}{f}=\frac{100}{-50}=-2\,D$

31. (c)

32. (c) $f=-d=-60\ cm$

$\therefore P=\frac{100}{f}=-\frac{100}{60}=-\frac{10}{6}=-1.66\ D$

33. (b) For correcting the near point, required focal length

$f=\frac{50\times 25}{(50-25)}=50\,cm$

So power $P=\frac{100}{50}=+2\,D$

For correcting the far point, required focal length

$f=-(\text{defected far point})=-3\,m$

$\therefore P=-\frac{1}{3}D=-0.33\,D$

34. (b) Negative power is given, so defect of eye is nearsigntedness

Also defected far point $=-f=-\frac{1}{p}=-\frac{100}{(-2.5)}=40\,cm$

35. (a) In myopia, eye ball may be elongated so, light rays focussed before the retina.

36. (c)

37. (d) $P=\frac{1}{f}=\frac{1}{-(\text{defected far point})}=-\frac{1}{2}=-0.5\,D$

38. (a) Resolving limit of eye is one minute (1').

39. (d) Because for healthy eye image is always formed at retina.

40. (a) The defect is myopia (nearsightness)

As we know for myopic person f = – (defected far point)

$\Rightarrow$ Defected far point = – f = – $\frac{1}{P} = -\frac{1}{(-2)} = 0.5\,m$

= 50 *cm*

41. (b) Power of convex lens $P_1 = \frac{100}{40} = 2.5\ D$

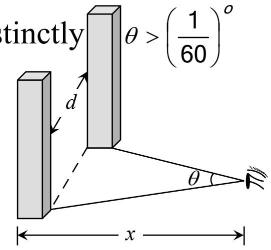
Power of concave lens $P_2 = -\frac{100}{25} = -4\ D$

Now $P = P_1 + P_2 = 2.5\ D - 4\ D = -1.5\ D$

42. (c)

43. (d)

44. (a) As limit of resolution of eye is $\left(\frac{1}{60}\right)^o$, the pillars will be seen distinctly $\theta > \left(\frac{1}{60}\right)^o$



i.e., $\frac{d}{x} > \left(\frac{1}{60}\right) \times \frac{\pi}{180}$

$\Rightarrow d > \frac{\pi \times x}{60 \times 180}$

$\Rightarrow d > \frac{3.14 \times 11 \times 10^3}{60 \times 180} \Rightarrow d > 3.2\ m$

45. (b)

46. (b)

47. (d)

48. (d) f = – (defected far point) = – 20 *cm*

49. (b) Power of the lens given positive so defect is hypermetropia.

50. (b) Far point of the eye = focal length of the lens

$= \frac{100}{P} = \frac{100}{0.66} = 151\ cm$

51. (c) A bifocal lens consist of both convex or concave lenses with lower part is convex.

52. (a) For lens u = wants to see = – 30 *cm*

and v = can see = – 10 *cm*

$\therefore \frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{-10} - \frac{1}{(-30)} \Rightarrow f = -15\ cm$

53. (a) Focal length = – (far point)

54. (c) For lens u = wants to see = – 12 *cm*

v = can see = – 3 *m*

$\therefore P = \frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow P = \frac{1}{-3} - \frac{1}{(-12)} = -\frac{1}{4}\ D$

55. (d) $I_1 D_1^2 t_1 = I_2 D_2^2 t_2$

Here D is constant and $I = \frac{L}{r^2}$

So $\frac{L_1}{r_1^2} \times t_1 = \frac{L_2}{r_2^2} \times t_2 \Rightarrow \frac{60}{(2)^2} \times 10 = \frac{120}{(4)^2} \times t \Rightarrow 20\ sec$

56. (a) $f = -40\ cm$ and $P = \frac{100}{-40} = -2.5\ D$

57. (a) Focal length of the lens $f = \frac{100}{3}\ cm$

By lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\Rightarrow \frac{1}{+100/3} = \frac{1}{v} - \frac{1}{-25} \Rightarrow v = -100\ cm = -1\ m$

58. (d) This is the defect of hypermetropia.

59. (a) For large objects, large image is formed on retina.

60. (d) $v = -15 cm,\ u = -300 cm,$

From lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\Rightarrow \frac{1}{f} = \frac{1}{-15} - \frac{1}{-300} = \frac{-19}{300} \Rightarrow f = \frac{-300}{19} = -15.8\ cm$

and power $P = \frac{100}{f}\ cm = \frac{-100 \times 19}{300} = -6.33\ D.$

61. (d) Time of exposure $\propto \frac{1}{(\text{Aperture})^2}$

62. (a) Light gathering power $\propto$ Area of lens aperture or d^2

63. (b) Time of exposure $\propto (f.\text{number})^2$

$\Rightarrow \frac{t_2}{t_1} = \left(\frac{5.6}{2.8}\right)^2 = 4$

$t_2 = 4\,t_1 = 4 \times \frac{1}{200} = \frac{1}{50}\,sec = 0.02\ sec.$

64. (d)

65. (a)

Microscope and Telescope

1. (c) By using $m_\infty = \frac{(L_\infty - f_o - f_e).D}{f_o f_e}$

$\Rightarrow 45 = \frac{(L_\infty - 1 - 5) \times 25}{1 \times 5} \Rightarrow L_\infty = 15\,cm.$

2. (b) For a compound microscope $m \propto \frac{1}{f_o f_e}$

3. (b) For a compound microscope $f_{objective} < f_{eyepiece}$

4. (b) In microscope final image formed is enlarged which in turn increases the visual angle.

5. (b)

6. (d) Magnification of a compound microscope is given by $m = -\frac{v_o}{u_o} \times \frac{D}{u_e} \Rightarrow |m| = m_o \times m_e$.

7. (c) Magnifying power of a microscope $m \propto \frac{1}{f}$

Since $f_{\text{violet}} < f_{\text{red}}$; $\therefore m_{\text{violet}} > m_{\text{red}}$

8. (a) $L_\infty = v_o + f_e \Rightarrow 14 = v_o + 5 \Rightarrow v_o = 9\ cm$

Magnifying power of microscope for relaxed eye

$$m = \frac{v_o}{u_o} \cdot \frac{D}{f_e} \text{ or } 25 = \frac{9}{u_o} \cdot \frac{25}{5} \text{ or } u_o = \frac{9}{5} = 1.8\ cm$$

9. (b) $m_\infty = -\frac{v_o}{u_o} \times \frac{D}{f_e}$

From $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$$\Rightarrow \frac{1}{(+1.2)} = \frac{1}{v_o} - \frac{1}{(-1.25)} \Rightarrow v_o = 30\ cm$$

$$\therefore |m_\infty| = \frac{30}{1.25} \times \frac{25}{3} = 200$$

10. (b) For objective lens $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$$\Rightarrow \frac{1}{(+4)} = \frac{1}{v_o} - \frac{1}{(-4.5)} \Rightarrow v_o = 36\ cm$$

$$\therefore |m_D| = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right) = \frac{36}{4.5}\left(1 + \frac{24}{8}\right) = 32$$

11. (a) For a microscope $|m| = \frac{v_o}{u_o} \times \frac{D}{u_e}$ and $L = v_o + u_e$

For a given microscope, with increase in L, u_e will increase and hence magnifying power (m) will decrease.

12. (b) In compound microscope objective forms real image while eye piece forms virtual image.

13. (b) $m = 1 + \frac{D}{f}$

Smaller the focal length, higher the magnifying power.

14. (a) In electron microscope, electron beam $(\lambda \approx 1Å)$ is used so it's *R.P.* is approx. 5000 times more than that of ordinary microscope $(\lambda \approx 5000Å)$.

15. (c) If nothing is said then it is considered that final image is formed at infinite and $m_\infty = \frac{(L_\infty - f_o - f_e).D}{f_o f_e} \sim \frac{LD}{f_0 f_e}$

$$\Rightarrow 400 = \frac{20 \times 25}{0.5 \times f_e} \Rightarrow f_e = 2.5\ cm$$

16. (d) $m_{\max} = 1 + \frac{D}{f} = 1 + \frac{25}{2.5} = 11$.

17. (a)

18. (b) $m = 1 + \frac{D}{f} = 1 + DP$ (m increases with P)

19. (b)

20. (b) Like Gallilean telescope.

21. (a) $|m| \propto \frac{1}{f_o f_e}$

22. (d) A microscope consists of lens of small focal lengths. A telescope consists of objective lens of large focal length.

23. (c) $m = m_o \times m_e = 25 \times 6 = 150$

24. (a) When final image is formed at infinity, length of the tube $= v_o + f_e$

$$\Rightarrow 15 = v_o + 3 \Rightarrow v_o = 12\ cm$$

For objective lens $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$$\Rightarrow \frac{1}{(+2)} = \frac{1}{(+12)} - \frac{1}{u_o} \Rightarrow u_o = -2.4\ cm$$

25. (d) R.P. of microscope $= \frac{2\mu \sin\theta}{\lambda}$

26. (c) $m = m_o \times m_e \Rightarrow m = m_o \times \left(1 + \frac{D}{f_e}\right)$

$$\Rightarrow 100 = 10 \times \left(1 + \frac{25}{f_e}\right) \Rightarrow f_e = \frac{25}{9}\ cm$$

27. (c) A simple microscope is just a convex lens with object lying between optical centre and focus of the lens.

28. (d) In general, the simple microscope is used with image at D, hence

$$m = 1 + \frac{D}{f} = 1 + \frac{25}{5} = 6$$

29. (d)

30. (b) Resolving power of microscope $\propto \frac{1}{\lambda}$

31. (a) Cross wire arrangement is used to make measurements.

32. (d) $L = v_o + u_e = \frac{u_o f_o}{(u_o - f_o)} + \frac{f_e D}{f_e + D}$

$\Rightarrow L = \frac{2 \times 1.5}{(2-1.5)} + \frac{6.25 \times 25}{(6.25+25)} = 11\ cm$

33. (d) $m \simeq \frac{LD}{f_o f_e} \Rightarrow m = \frac{10 \times 25}{0.5 \times 1} = 500$.

34. (c) Intermediate image means the image formed by objective, which is real, inverted and enlarged.

35. (d) $m \propto \frac{1}{f_o f_e}$

36. (b) R.P. $\propto \frac{1}{\lambda}$; $\lambda_{Blue} < \lambda_{Red}$ so $(R.P.)_{Blue} > (R.P.)_{Red}$

37. (a) $m = 1 + \frac{D}{f} \Rightarrow 6 = 1 + \frac{25}{f} \Rightarrow f = 5\ cm = 0.05\ m$

38. (a) Resolving limit

$x \propto \lambda \Rightarrow \frac{x_1}{x_2} = \frac{\lambda_1}{\lambda_2} \Rightarrow \frac{0.1}{x_2} = \frac{6000}{4800} \Rightarrow x_2 = 0.08\ mm$

39. (b) $m = m_o \times m_e \Rightarrow 100 = 5 \times m_e \Rightarrow m_e = 20$

40. (d) $m \propto \frac{1}{f} \propto P$

41. (d) R.P. $\propto \frac{1}{\lambda} \Rightarrow \frac{(R.P.)_1}{(R.P.)_2} = \frac{\lambda_2}{\lambda_1} = \frac{5}{4}$

42. (b) Resolving limit (minimum separation) $\propto \lambda$

$\Rightarrow \frac{P_A}{P_B} = \frac{2000}{3000} \Rightarrow P_A < P_B$

43. (d) Similar to Q.No. 34

44. (a) For achromatic telescope objective lens, convergent of crown and divergent of flint is the best combination because $\mu_{crown} < \mu_{flint}$

45. (c)

46. (b) Magnifying power of telescope is $\frac{f_o}{f_e}$, so as $\frac{1}{f_e}$ increases, magnifying power increases.

47. (b) Since $m = \frac{f_o}{f_e}$

Also $m = \frac{\text{Angle subtended by the image}}{\text{Angle subtended by the object}}$

$\therefore \frac{f_o}{f_e} = \frac{\alpha}{\beta} \Rightarrow \alpha = \frac{f_o \times \beta}{f_e} = \frac{60 \times 2}{5} = 24^o$

48. (d) Resolving power $= \frac{d}{1.22\lambda} = \frac{0.1}{1.22 \times 6000 \times 10^{-10}}$

$\cong 1.36 \times 10^5\ radian$

49. (b) Because size of the aperture decreases.

50. (d) Resolving power $\propto$ aperture.

51. (c) Telescope is used to see the distant objects. More magnifying power means more nearer image.

52. (a) When the final image is at the least distance of distinct vision, then

$m = -\frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) = \frac{200}{5}\left(1 + \frac{5}{25}\right) = \frac{200 \times 6}{5 \times 5} = -48$

When the final image is at infinity, then

$m = \frac{-f_o}{f_e} = \frac{200}{5} = -40$

53. (a) In terrestrial telescope erecting lens absorbs a part of light, so less constant image. But binocular lens gives the proper three dimensional image.

54. (a) By formula $m = \frac{f_o}{f_e}$

55. (b) In telescope $f_o >> f_e$ as compared to microscope.

56. (a) Because magnification in this case becomes reciprocal of initial magnification.

57. (d) $m = \frac{f_o}{f_e} \Rightarrow \frac{80}{f_e} = 20 \Rightarrow f_e = 4\ cm$

Hence length of terrestrial telescope $= f_o + f_e + 4f = 80 + 4 + 4 \times 20 = 164\ cm$

58. (d) In this case $|m| = \frac{f_o}{f_e} = 5$ .... (i)

and length of telescope $= f_o + f_e = 36$ .... (ii)

Solving (i) and (ii), we get $f_e = 6\ cm$, $f_o = 30\ cm$

59. (c) $|m| = \frac{f_o}{f_e} = \frac{180}{6} = 30$

60. (c) Same as Q. No. 58.

61. (c) $f_o = \frac{1}{1.25} = 0.8\ m$ and $f_e = \frac{1}{-20} = -0.05\ m$

$\therefore |L_\infty| = |f_o| - |f_e| = 0.8 - 0.05 = 0.75\ m = 75\ cm$

and $|m_\infty| = \frac{f_o}{f_e} = \frac{0.8}{0.05} = 16$

62. (a) For greater aperture of lens, light passing through lens is more and so intensity of image increases.

63. (b)

64. (a) Same as Q. No. 58.

65. (b) $m = \frac{f_o}{f_e} = \frac{60}{10} = 6$.

66. (a) $f_o + f_e = 54$ and $\frac{f_o}{f_e} = m = 8 \Rightarrow f_o = 8f_e$

$\Rightarrow 8f_e + f_e = 54 \Rightarrow f_e = \frac{54}{9} = 6$

$\Rightarrow f_o = 8f_e = 8 \times 6 = 48$

67. (a) $f_o - f_e = 9\, cm$ and $f_e = f_o - 9 = 15 - 9 = 6\, cm$

$\Rightarrow m = \frac{f_o}{f_e} = \frac{15}{6} = 2.5$

68. (c) $f_o + f_e = 80$ and $\frac{f_o}{f_e} = 19 \Rightarrow f_o = 76$ and $f_e = 4$ *cm*.

69. (a)

70. (b) $R.P. \propto \frac{D}{\lambda}$

71. (c) $m = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$

72. (b) Resolving power $\propto$ Aperture

73. (a) If final image is formed at infinity, then the distance between the two lenses of telescope is equal to length of tube $= f_o + f_e = 0.3 + 0.05 = 0.35\, m$

74. (a) Limit of resolution $= \frac{1.22\,\lambda}{a} \times \frac{180}{\pi}$ (in degree)

$= \left(\frac{1.22 \times (6000 \times 10^{-10})}{5} \times \frac{180}{\pi}\right)^o = 0.03\, sec$

75. (b) Final image formed by astronomical telescope is inverted not erect.

76. (d)

77. (c)

78. (b) For normal vision (relaxed eye), the image is formed at infinity. Hence the magnifying power of Gallilean telescope $= \frac{f_o}{f_e} = \frac{200}{2} = 100$.

79. (a) $m = -\frac{f_o}{f_e} = -\frac{100}{2} = -50.$

80. (c)

81. (b) Magnifying power of astronomical telescope

$m = -\frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) = -\frac{200}{5}\left(1 + \frac{5}{25}\right) = -48$.

82. (b) $m \propto \frac{1}{f_e}$

83. (b) $f_0 > f_e$ for telescope.

84. (a) $m = -\frac{f_0}{f_e}$.

85. (b) $|m| = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) = \frac{100}{5}\left(1 + \frac{5}{25}\right) = 24$

86. (a, b, c, d)

87. (a) $|m| = \frac{f_o}{f_e} = 20$ and $L = f_o + f_e = 105 \Rightarrow f_o = 100\, cm$

88. (a) Total length $L = f_o + f_e$ and both lenses are convex.

89. (b) $L = f_o + f_e = 44$ and $|m| = \frac{f_o}{f_e} = 10$

This gives $f_o = 40\, cm$

90. (c) In case of a telescope if object and final image are at infinity then $m = \frac{f_o}{f_e}$

91. (b) Three lenses are $\rightarrow$ objective, eye piece and erecting lens.

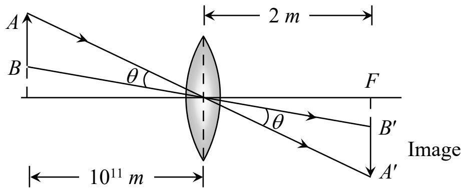
92. (d) Length of the telescope when final image is formed at least distance of distinct vision is

$L = f_o + u_e = f_o + \frac{f_e D}{f_e + D} = 50 + \frac{5 \times 25}{5 + 25} = \frac{325}{6}\, cm$

93. (c) $\frac{\beta}{\alpha} = \frac{f_o}{f_e} \Rightarrow \frac{\beta}{0.5^o} = \frac{100}{2} \Rightarrow \beta = 25^o$

94. (d)

95. (c) $\theta = \frac{AB}{10^{11}} = \frac{A'B'}{2} \Rightarrow A'B' = \frac{2 \times 1.4 \times 10^9}{10^{11}} = 2.8\, cm$



96. (c) $m = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) \Rightarrow m = \frac{90}{6}\left(1 + \frac{6}{30}\right) \Rightarrow m = 18$

97. (d) Resolving power of telescope $= \frac{d}{1.22\,\lambda}$

98. (a) For largest magnification focal length of eye lens should be least.

99. (b) $m = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) = \frac{150}{6}\left(1 + \frac{6}{25}\right) = 30$.

100. (d) To make telescope of higher magnifying power, f_o should be large and f_e should be least.

101. (c) $f_o = 50\,cm$, $f_e = 5\,cm$, $D = 25\,cm$ and $u_o = 200\,cm$

Separation between the objective and the eye lens is

$$L = \frac{u_o f_o}{(u_o - f_o)} + \frac{f_e D}{(f_e + D)} = \frac{200 \times 50}{(200 - 50)} + \frac{5 \times 25}{(5 + 25)} = 71\,cm$$

102. (b) Resolving power $= \frac{d}{1.22\,\lambda} = \frac{1.22}{1.22 \times 5000 \times 10^{-10}} = 2 \times 10^6$

103. (a)

104. (b) By using $m = \frac{f_o}{f_e} \Rightarrow f_e = \frac{100}{50} = 2\,cm$

Also $L = f_o - f_e = 100 - 2 = 98\,cm$

105. (b) $m = \frac{f_o}{f_e} \Rightarrow 10 = \frac{f_o}{20} \Rightarrow f_o = 200\,cm$

106. (c) Minimum angular separation $\Delta\theta = \frac{1}{R.P.} = \frac{1.22\,\lambda}{d}$

$$= \frac{1.22 \times 5000 \times 10^{-10}}{2} = 0.3 \times 10^{-6}\,rad$$

107. (c) $m = 1 + \frac{D}{f_e} \Rightarrow 10 = 1 + \frac{25}{f_e} \Rightarrow f_e = \frac{25}{9} \simeq 25\,mm$

108. (a) $\frac{D}{F}$ or $\frac{25}{F}$

109. (c) $L = v_0 + u_e$ and $v_0 >> f_0$, $u_e \simeq f_e$

110. (c) Magnification will be done by compound microscope only when $f_o < f_e$

111. (d) Angular resolution $d\theta = \frac{1.22\,\lambda}{a}$

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

112. (a) Resolving power $= \frac{a}{1.22\,\lambda}$

113. (d) $M = \frac{f_o}{f_e} = \frac{P_e}{P_o} = \frac{20}{0.5} = 40$.

114. (a) Radio, waves can pass through dust, clouds, fog, etc, in a radio, telescope. It can detect very faint radio signal due to enormous size of its reflector. So it can be used at night and even in cloudy weather.

115. (a) Resolving limit

$$d\theta = \frac{1.22\,\lambda}{a} = \frac{1.22 \times 4538 \times 10^{-10}}{1} = 5.54 \times 10^{-7}\,rad.$$

116. (a) Magnification of objective lens

$$m = \frac{I}{O} = \frac{v_0}{u_0} = \frac{f_0}{u_0}$$

$$\Rightarrow \frac{I}{50} = \frac{200 \times 10^{-2}}{2 \times 10^3} \Rightarrow I = 5 \times 10^{-2}\,m = 5\,cm.$$

117. (b) $m = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right) = m_o\left(1 + \frac{D}{f_e}\right)$

$$\Rightarrow 30 = m_o\left(1 + \frac{25}{5}\right) = m_0 \times 6 \qquad \Rightarrow m_o = 5.$$

118. (a)

119. (a) $m = \frac{f_o}{f_e} \Rightarrow \frac{100}{f_e} = 50 \Rightarrow f_e = 2\,cm$

Normal distance $f_o - f_e = 100 - 2 = 98\,cm$

120. (a) For objective lens $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$$\Rightarrow \frac{1}{v_o} = \frac{1}{f_o} + \frac{1}{u_o} = \frac{1}{4} + \frac{1}{-5} = \frac{1}{20} \Rightarrow v_o = 20\,cm$$

Now $M = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right) = \frac{20}{5}\left(1 + \frac{20}{10}\right) = 12.$

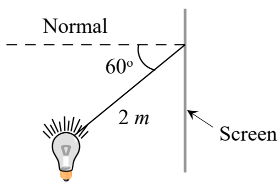
Photometry

1. (d) Luminous flux $= 4\pi\,L = 4 \times 3.14 \times 42 = 528\,Lumen$

Power of lamp $= \frac{\text{Luminous flux}}{\text{Luminous efficiency}}$

$$= \frac{528}{2} = 264\,W$$

2. (b) $I = \frac{L\cos\theta}{r^2}$



$$\Rightarrow L = \frac{I \times r^2}{\cos\theta}$$

$$= \frac{5 \times 10^{-4} \times 10^4 \times 2^2}{\cos 60°} = 40\,Candela$$

3. (d) $I = \frac{L}{r^2} \Rightarrow \frac{dI}{I} = -\frac{2dr}{r}$ ($\because L =$ constant)

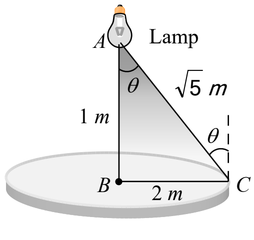
$$\Rightarrow \frac{dI}{I} \times 100 = -\frac{2 \times dr}{r} \times 100 = -2 \times 1 = -2\%$$

4. (c) For equal fogging $I_2 \times t_2 = I_1 \times t_1$

$$\Rightarrow \frac{L_2}{r_2^2} \times t_2 = \frac{L_1}{r_1^2} \times t_1 \Rightarrow \frac{16}{4} \times t_2 = \frac{20}{1} \times 10$$

$$\Rightarrow t_2 = 50\,\text{sec.}$$

5. (d) The illuminance at B



$I_B = \frac{L}{1^2}$ ....(i)

and illuminance at point C

$I_C = \frac{L\cos\theta}{(\sqrt{5})^2} = \frac{L}{(\sqrt{5})^2} \times \frac{1}{\sqrt{5}}$

$\Rightarrow I_C = \frac{L}{5\sqrt{5}}$ ...... (ii)

From equation (i) and (ii) $I_B = 5\sqrt{5}\ I_0$

6. (b) $I \propto \frac{1}{r^2}$ so,

$$\frac{\text{Illuminance on slide}}{\text{Illuminance on screen}} = \frac{(\text{Length of image on screen})^2}{(\text{Length of object on slide})^2}$$

$$= \left(\frac{3.5\ m}{35\ mm}\right)^2 = 10^4 : 1$$

7. (a) The illuminance at A is

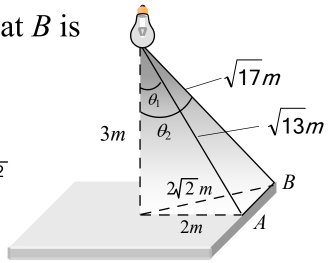
$I_A = \frac{L}{(\sqrt{13})^2} \times \cos\theta_1 = \frac{L}{13} \times \frac{3}{\sqrt{13}} = \frac{3L}{(13)^{3/2}}$

The illuminance at B is

$I_B = \frac{L}{(\sqrt{17})^2} \times \cos\theta_2$

$= \frac{L}{17} \times \frac{3}{\sqrt{17}} = \frac{3L}{(17)^{3/2}}$

$\therefore \frac{I_A}{I_B} = \left(\frac{17}{13}\right)^{3/2}$



8. (b)

9. (c) Luminous intensity

$L = \frac{\phi}{4\pi} \Rightarrow 1 = \frac{\phi}{4\pi} \Rightarrow \phi = 4\pi$.

10. (c) $\phi = 4\pi L = 4 \times 3.14 \times 100 = 1256$ *lumen*.

11. (a) $I = \frac{L}{r^2} \Rightarrow L = I.r^2 = 22 \times 2^2 = 100$

Now $\phi = 4\pi\ L = 4 \times 3.14 \times 100 = 1256$ *lumen*.

12. (c) Illuminance at A,

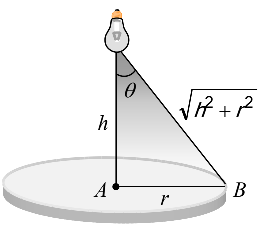
$I_A = \frac{L}{h^2}$

Illuminance at B,

$I_B = \frac{L}{\sqrt{(h^2 + r^2)^2}}\cos\theta$

$= \frac{Lh}{(r^2 + h^2)^{3/2}}$

$\therefore \frac{I_A}{I_B} = \left(1 + \frac{r^2}{h^2}\right)^{3/2} = \left(1 + \frac{8^2}{8^2}\right)^{3/2} = 2^{3/2} = 2\sqrt{2} : 1$



13. (c) $I = \frac{L}{r^2}$

14. (c) Efficiency of light source

$\eta = \frac{\phi}{p}$ ..... (i)

and $L = \frac{\phi}{4\pi}$ ..... (ii)

From equation (i) and (ii)

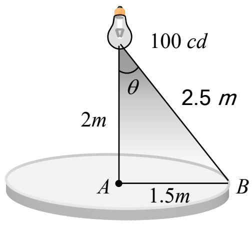
$\Rightarrow p = \frac{4\pi L}{\eta} = \frac{4\pi \times 35}{5} \approx 88\ W$.

15. (a) Case I

$I_A = \frac{100}{2^2} = 25\ cd$

and $I_B = \frac{100}{(2.5)^2}\cos\theta$

$= \frac{100}{2.5^2} \times \frac{2}{2.5} = \frac{200}{(2.5)^3}$

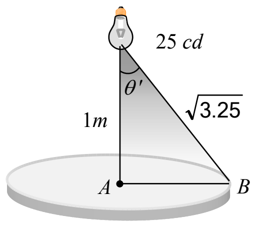


Case II,

$I'_B = X\ I_B = \frac{25}{(3.25)^{3/2}}$

so $\frac{I'_B}{I_B} = \frac{25}{200} \times \frac{(2.5)^3}{(3.25)^{3/2}}$

$\Rightarrow X = 1/3$



16. (a) $I \propto \frac{1}{r^2} \Rightarrow \frac{I_2}{I_1} = \frac{r_1^2}{r_2^2} = \frac{60^2}{180^2} = \frac{1}{9}$

17. (b)

18. (b) $I \propto \frac{1}{r^2}$

19. (c) To develop a print a fix amount of energy is required. Total light energy incident on photo print

$I \times A\,t = \frac{L}{r^2}A\,t \Rightarrow \frac{L_1}{r_1^2}A_1 t_1 = \frac{L_2}{r_2^2}A_2 t_2$

$\Rightarrow \frac{t_1}{r_1^2} = \frac{t_2}{r_2^2}$ $(\because L_1 = L_2$ and $A_1 = A_2)$

$\Rightarrow t_2 = \frac{r_2^2}{r_1^2}.t_1 = \left(\frac{0.40}{0.25}\right)2 \times 5 = 12.8$ *sec.*

20. (b) $\frac{I_{centre}}{I_{edge}} = \frac{(r^2 + h^2)^{3/2}}{h^3} = \frac{\left(1 + \frac{1}{4}\right)^{3/2}}{1^3} = \left(\frac{5}{4}\right)^{3/2}$

21. (c) $I = \frac{L}{r^2} \Rightarrow \frac{L_1}{r_1^2} = \frac{L_2}{r_2^2}$ (I is same)

$\Rightarrow \frac{L_1}{L_2} = \frac{r_1^2}{r_2^2} = \left(\frac{1}{10}\right)^2 = 1 : 100$.

22. (c) $I_\theta = I_o\cos\theta = I_o\cos 60^o = \frac{I_o}{2}$

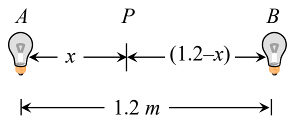
23. (a)

24. (b) $\phi = 4\pi L = 200\,\pi$ *lumen.*

so $I = \frac{\phi}{100\,A} = \frac{200\pi}{100\times\pi r^2} = \frac{2}{(0.1)^2} = 200$ *lux*.

25. (b,c) According to the problem

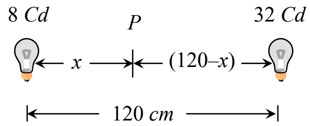
$\frac{I_A}{x^2} = 4\frac{I_B}{(1.2-x)^2}$



$\Rightarrow \frac{1}{x^2} = \frac{4}{(1.2-x)^2}$

$\Rightarrow \frac{1}{x} = \frac{2}{1.2-x} \Rightarrow x = 0.4\,m$ and $1.2 - x = 0.8\,m$.

26. (c) $I = \frac{L}{r^2} \Rightarrow \frac{L_1}{L_2} = \frac{r_1^2}{r_2^2}$



or $\frac{8}{x^2} = \frac{32}{(120-x)^2}$

Solving it we get $x = 40\,cm$.

27. (d) $\frac{I_{center}}{I_{edge}} = \frac{(r^2+h^2)^{3/2}}{h^3}$

$\Rightarrow 8 = \frac{(r^2+h^2)^{3/2}}{h^3} \Rightarrow 2h = (r^2+h^2)^{1/2}$

$\Rightarrow 4h^2 = r^2 + h^2 \Rightarrow 3h^2 = r^2 \Rightarrow h = \frac{r}{\sqrt{3}}$

28. (b) $I = \frac{L}{r^2} = \frac{100}{5^2} = 4$ *Lux.*

29. (d) $I_1 = \frac{L}{r_1^2} = \frac{L}{1600}$ and $I_2 = \frac{L}{2500}$

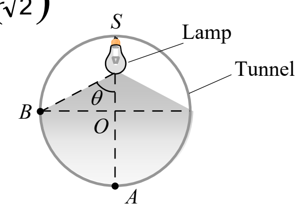
$\therefore$ % decease in illuminance

$= \frac{I_1 - I_2}{I_1}\times 100 = \left(1 - \frac{1600}{2500}\right)\times 100 = \frac{900}{2500}\times 100 = 36$

30. (b)

31. (d) $I_A = \frac{L}{(2r)^2}$ and $I_B = \frac{L}{(r\sqrt{2})^2}\cos\theta$

$= \frac{L}{2r^2}\cdot\frac{r}{r\sqrt{2}} = \frac{L}{2\sqrt{2}\,r^2}$



$\therefore \frac{I_A}{I_B} = \frac{2\sqrt{2}}{4} = \frac{1}{\sqrt{2}}$

32. (a) $I = \frac{L}{r^2} \Rightarrow L = 1.57\times10^5\times(1.5\times10^{11})^2$

$= 3.53\times10^{27}$ *Cd*

33. (d) $\phi = 4\pi L = 4\times3.14\times3.53\times10^{27} = 4.43\times10^{28}$ *lumen*

34. (d) $\phi = \frac{3}{1.5\times10^{-3}}\times 0.685 = 1.37\times10^3$ *lumen*

35. (a) $\phi_{surface} = \frac{3000}{6} = 500$ *lumen*

36. (c) Rotation of area about incident light doesn't change the inclination of the light ray on the area.

37. (c) $I = \frac{Lh}{r^3}$

38. (d) By the symmetry of the rays and location of the points.

39. (d) If η is the luminous efficiency of the bulb then.

luminous flux by 120 *watt* at 555 *nm* $= \eta\times120$

Let bulb of *P* watt at 600 *nm* produces the same luminous flux as by 120 *watt* at 555 *nm* then

$\eta\times120 = \eta P\times0.6 \;\Rightarrow P = \frac{120}{0.6} = 200$ *watt*

40. (c) Illuminance produce by the sun $= \frac{L}{(1.5\times10^{11})^2}$

Illuminance produce by the bulb $= \frac{10000}{(0.3)^2}$

According to problem $\frac{L}{(1.5\times10^{11})^2} = \frac{10000}{(0.3)^2}$

$\Rightarrow L = \frac{2.25\times10^{22}\times10^4}{9\times10^{-2}} = 25\times10^{26}$ *Cd*

41. (c) $I_1 = \frac{L}{r_1^2} = \frac{L}{16}$ and $I_2 = \frac{L}{r_2^2} = \frac{L}{9}$

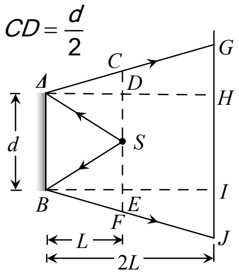
% increase in illuminance

$= \frac{I_2 - I_1}{I}\times100 = \left(\frac{16}{9} - 1\right)\times100 \approx 78\%$

Critical Thinking Questions

1. (d) According to the following ray diagram $HI = AB = d$

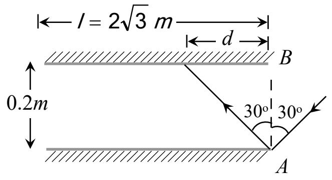
and $DS = CD = \frac{d}{2}$



$\because AH = 2AD \Rightarrow GH = 2CD = \frac{2d}{2} = d$

Similarly $IJ = d$ so $GJ = GH + HI + IJ$
$= d + d + d = 3d$

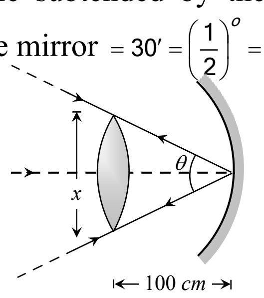
2. (b) From the following ray diagram



$d = 0.2\tan 30° = \frac{0.2}{\sqrt{3}} \Rightarrow \frac{l}{d} = \frac{2\sqrt{3}}{0.2/\sqrt{3}} = 30$

Therefore maximum number of reflections are 30.

3. (b) The angle subtended by the image of the sun at the mirror $= 30' = \left(\frac{1}{2}\right)^o = \frac{\pi}{360}\ rad$



If x be the diameter of the image of the sun, then

$\frac{\text{Arc}}{\text{Radius}} = \frac{x}{100} = \frac{1}{2}.\frac{2\pi}{360} = \frac{\pi}{360} \Rightarrow x = \frac{100\pi}{360} = 0.87\ cm$

4. (a) $m = \frac{I}{O} = \frac{f}{u-f} = \frac{10}{25-10} = \frac{10}{15} = \frac{2}{3}$

$m^2 = \frac{A_i}{A_o} \Rightarrow A_i = m^2 \times A_o = \left(\frac{2}{3}\right)^2 \times (3)^2 = 4\ cm^2$

5. (d) From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ .....(i)

Differentiating equation (i), we obtain

$0 = -\frac{1}{v^2}dv - \frac{1}{u^2}du \Rightarrow dv = -\left(\frac{v}{u}\right)^2 du$ .....(ii)

Also from equation (i) $\frac{v}{u} = \frac{f}{u-f}$ .....(iii)

From equation (ii) and (iii) we get $dv = -\left(\frac{f}{u-f}\right)^2 . I$

Therefore size of image is $\left(\frac{f}{u-f}\right)^2 I$.