Numerical based Refraction by thin lens (Level-I)

1. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 0.76. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

   SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$

   Using the mentioned formula we have :

   ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(*3×10^8 *)/ 0.76 = 3.947368×*10^8 *m/sec.*

2. The refractive index of media1 w.r.t air is 1.65 and of media2 w.r.t air is 0.65 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

   SOLUTION: As we know the formula for relation, refractive index of media2 w.rt media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 0.65 / 1.65 = 0.39*

3. The refractive index of media1 w.r.t air is 0.95 and refractive index of media1 w.r.t media2 is 1.95 . What is refractive index of media2 w.r.t air.

   SOLUTION: As we know the formula for relation, refractive index of media2 w.rt media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow$ ${}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 1.95 = 0.95/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 0.95 / 1.95 = 0.49*

4. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 17.5cm and refractive index of the material of lens material w.r.t air is 3.25

   SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *3.25 ,* $R_1 =$ *infinity ,*$R_2 =$ *? and f = 17.5 cm : So using the mentioned formula we have : (3.25 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/17.5 ⇒ 2.25/R2 = 1/17.5 So*R_2 *= 39.375cm. = 39.375cm.*

5. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

   SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *? ,* $R_1 =$ *+f ,*$R_2 =$ *-f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* $\mu =$ *(1 +(1/2)) = 3/2 = 1.5 ....Ans.*

6. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 1.3What should be the radius of curvature for the focal length of the lens to be 21.5 cm.?

   SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *1.3 ,* $R_1 =$ *+R ,*$R_2 =$ *-R and the focal length = 21.5 cm. So using the mentioned formula we have : (1.3 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/21.5 ⇒ 0.3×*$\left(\frac{2}{R}\right)$ *= (1/21.5) ⇒ R = 12.9cm. Radius of curvature of both faces is equal to 12.9cm.*

7. The focal length of a convex lens in air is 20.5 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25 (iii) 1.125 (iv) 2.25

   SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times {}_a\mu^m}{({}_a\mu^g - {}_a\mu^m)} \times f_a$ *:*

   ⇒ (1) f_m *= [(1.5 -1) × 1.25/(1.5 - 1.25)] × 20.5 ⇒* f_m *= 51.25cm. ⇒ So focal length in the media will be given as : 51.25cm.*

(2) f_m = [(1.5 -1) × 3.25/(1.5 - 3.25)] × 20.5 ⇒ f_m = -19.03572cm. ⇒ So focal length in the media will be given as : -19.03572cm.
(3) f_m = [(1.5 -1) × 1.125/(1.5 - 1.125)] × 20.5 ⇒ f_m = 30.75cm. ⇒ So focal length in the media will be given as : 30.75cm.
(4) f_m = [(1.5 -1) × 2.25/(1.5 - 2.25)] × 20.5 ⇒ f_m = -30.75cm. ⇒ So focal length in the media will be given as : -30.75cm.

8. The radius of curvatures of a double convex lens are 48 cm. and 32 cm respectively while refractive index of the material of lens w.r.t air is 3. Find it's focal length?

   SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 3$ *,* $R_1 = 48$ *cm. ,*$R_2 =$ *-32 cm. So using the mentioned formula we have : [(3 -1)(1/(+48) - 1/(-32))] =* $\frac{1}{f}$ *⇒ f = [(48 × 32)/((3 -1) × (48 + 32))] after solving it we get f = 9.6*

9. The radius of curvatures of a double convex lens are 27 cm , 30 cm respectively and focal length19.5 cm. Find refractive index of the material of lens w.r.t ?

   SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 27$ *cm. ,*$R_2 =$ *-30 cm.and focal length f = 19.5 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+27) - 1/(-30)) = 1/19.5] ⇒ (* μ *-1) = [(27 × 30)/((19.5) × (27 + 30))] after solving it we get* $\mu = 1.728745$

10. If the ratio of radius of curvatures of a biconvex lens is 2 : 5 and focal length is 14 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 20 cm.

    SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 =$ *2R = 40cm.,*$R_2 =$ *-5R = -100cm. and focal length f = 14 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+40) - 1/(-100))] = 1/14 ⇒ (* μ *-1) = [((2 × 5)/(2 + 5)) × 20 × 1 / 14] ⇒* μ *= [((2 × 5)/(2 + 5)) × 20 × 1 / 14] + 1 after solving it we get* $\mu = 3.040816$

11. If the ratio of radius of curvatures of a biconvex lens is 4 : 5 and refractive index of the material of lens w.r.t air is 2.4 while curvature of first surface is 21 cm. Find the focal length of the lens

    SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 2.4$ *,* $R_1 =$ *4R = 84cm.,*$R_2 =$ *-5R = -105cm. and focal length f = ? So using the mentioned formula we have : [(2.4 -1)(1/(+84) - 1/(-105))] =* $\frac{1}{f}$ *⇒ f = [((4 × 5 × 21)/((4 + 5) × (2.4- 1))] after solving it we get f = 33.33333*

12. An object 5 cm high is placed 33 cm in front of a convex lens of focal length 22 cm. What is the position and height of the image?

    SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -33 cm. , f = 22 cm. and height of the object h = 5cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 22 = 1/v - 1/ -33 ⇒ v = [(33 × 22)/(33 - 22)] = 66cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |66/33| = |Im/5| ⇒ Im = 10 cm.*

13. An object 5 cm high is placed 41 cm in front of a concave lens of focal length -16 cm. What is the position and height of the image?

    SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -41 cm. , f = -16 cm. and height of the object h = 5cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -16 = 1/v - 1/ -41 ⇒ v = [(41 × -16)/(41 + 16)] = -11.50877cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-11.50877/41| = |Im/5| ⇒ Im = 1.403509 cm.*

14. An object placed 30 cm. from a lens produces a virtual/real image at 22 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 3cm.

    SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -30 cm. , v = 22 cm. and height of the object h = 3cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/22 - 1/ -30 ⇒ f = [(30 × 22)/(30 + 22)] = 12.69231cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |22/30| = |Im/3| ⇒ Im = 2.2 cm. Next case: (b)image is unreal u = -30 cm. , v = -22 cm. and height of the object h = 3cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-22) - 1/ (-30) ⇒ f = [(30 × -22)/(30 + -22)] = -82.5cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-22/30| = |Im/3| ⇒ Im = 2.2 cm.*

15. An object is placed 88 cm from a screen. A converging lens with a 19 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (88 - x) cm. while focal length given is f = 19 cm. Using the mentioned formula : 1/19 = 1/(88 - x) - 1/-x = 88 / ((88 - x) × x) . After Solving it we get x = 60.24808 cm. the distance from the object for the placement of the lens is = 60.24808 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ $\Rightarrow$ *|27.75192/60.24808| = 0.4606275*

16. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 1.52. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$

Using the mentioned formula we have : ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(3 ×* 10^8 *)/ 1.52 = 1.973684×*10^8 *m/sec.*

17. The refractive index of media1 w.r.t air is 2.2 and of media2 w.r.t air is 0.65 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.rt media1 ${}_{m_1}\mu^{m_2}$ *as :*${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 0.65 / 2.2 = 0.3*

18. The refractive index of media1 w.r.t air is 3.8 and refractive index of media1 w.r.t media2 is 2.6 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.rt media1 ${}_{m_1}\mu^{m_2}$ *as :*${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow$ ${}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 2.6 = 3.8/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2} =$ *3.8 / 2.6 = 1.46*

19. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 8.5cm and refractive index of the material of lens material w.r.t air is 3.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *3.25 ,* $R_1 =$ *infinity ,*$R_2 =$ *? and f = 8.5 cm : So using the mentioned formula we have : (3.25 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right) =$ *1/8.5* $\Rightarrow$ *2.25/R2 = 1/8.5 So*$R_2 =$ *19.125cm. = 19.125cm.*

20. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *? ,* $R_1 =$ *+f ,*$R_2 =$ *-f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* $\mu =$ *(1 +(1/2)) = 3/2 = 1.5 ....Ans.*

21. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 0.65What should be the radius of curvature for the focal length of the lens to be 10 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *0.65 ,* $R_1 =$ *+R ,*$R_2 =$ *-R and the focal length = 10 cm. So using the mentioned formula we have : (0.65 - 1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/10* $\Rightarrow$ *-0.35×* $\left(\frac{2}{R}\right)$ *= (1/10)* $\Rightarrow$ *R = -7cm. Radius of curvature of both faces is equal to -7cm.*

22. The focal length of a convex lens in air is 15.5 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25 (iii) 1.125 (iv) 2.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times {}_a\mu^m}{({}_a\mu^g - {}_a\mu^m)} \times f_a$ *:*

$\Rightarrow$ *(1)* f_m *= [(1.5 -1) × 1.25/(1.5 - 1.25)] × 15.5* $\Rightarrow$ f_m *= 38.75cm.* $\Rightarrow$ *So focal length in the media will be given as : 38.75cm.*

(2) f_m = [(1.5 -1) × 3.25/(1.5 - 3.25)] × 15.5 ⇒ f_m = -14.39286cm. ⇒ So focal length in the media will be given as : -14.39286cm.
(3) f_m = [(1.5 -1) × 1.125/(1.5 - 1.125)] × 15.5 ⇒ f_m = 23.25cm. ⇒ So focal length in the media will be given as : 23.25cm.
(4) f_m = [(1.5 -1) × 2.25/(1.5 - 2.25)] × 15.5 ⇒ f_m = -23.25cm. ⇒ So focal length in the media will be given as : -23.25cm.

23. The radius of curvatures of a double convex lens are 22 cm. and 38 cm respectively while refractive index of the material of lens w.r.t air is 2.25. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$. Where fa is focal length in air According to question $\mu = 2.25$, $R_1 = 22$ cm. ,$R_2 =$ -38 cm. So using the mentioned formula we have : [(2.25 -1)(1/(+22) - 1/(-38))] = $\frac{1}{f}$ ⇒ f = [(22 × 38)/((2.25 -1) × (22 + 38))] after solving it we get f = 11.14667

24. The radius of curvatures of a double convex lens are 25 cm , 32 cm respectively and focal length26 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$. Where fa is focal length in air According to question $\mu = ?$, $R_1 = 25$ cm. ,$R_2 =$ -32 cm.and focal length f = 26 cm. So using the mentioned formula we have : [(μ -1)(1/(+25) - 1/(-32)) = 1/26] ⇒ (μ -1) = [(25 × 32)/((26) × (25 + 32))] after solving it we get $\mu = 1.539811$

25. If the ratio of radius of curvatures of a biconvex lens is 2 : 4 and focal length is 14 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 38 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$. Where fa is focal length in air According to question $\mu = ?$, $R_1 =$ 2R = 76cm.,$R_2 =$ -4R = -152cm. and focal length f = 14 cm. So using the mentioned formula we have : [(μ -1)(1/(+76) - 1/(-152))] = 1/14 ⇒ (μ -1) = [((2 × 4)/(2 + 4)) × 38 × 1 / 14] ⇒ μ = [((2 × 4)/(2 + 4)) × 38 × 1 / 14] + 1 after solving it we get $\mu = 4.619048$

26. If the ratio of radius of curvatures of a biconvex lens is 3 : 5 and refractive index of the material of lens w.r.t air is 3.2 while curvature of first surface is 35 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$. Where fa is focal length in air According to question $\mu = 3.2$, $R_1 =$ 3R = 105cm.,$R_2 =$ -5R = -175cm. and focal length f = ? So using the mentioned formula we have : [(3.2 -1)(1/(+105) - 1/(-175))] = $\frac{1}{f}$
⇒ f = [((3 × 5 × 35)/((3 + 5) × (3.2- 1))] after solving it we get f = 29.82954

27. An object 1 cm high is placed 24 cm in front of a convex lens of focal length 17 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. Where f is focal length of the lens According to question u = -24 cm. , f = 17 cm. and height of the object h = 1cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 17 = 1/v - 1/ -24 ⇒ v = [(24 × 17)/(24 - 17)] = 58.28571cm.(b) And for height of Image we have$\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ ⇒ |58.28571/24| = |Im/1| ⇒ Im = 2.428571 cm.

28. An object 8 cm high is placed 46 cm in front of a concave lens of focal length -15 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. Where f is focal length of the lens According to question u = -46 cm. , f = -15 cm. and height of the object h = 8cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -15 = 1/v - 1/ -46 ⇒ v = [(46 × -15)/(46 + 15)] = -11.31148cm.(b) And for height of Image we have$\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ ⇒ |-11.31148/46| = |Im/8| ⇒ Im = 1.967213 cm.

29. An object placed 27 cm. from a lens produces a virtual/real image at 36 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 5cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. Where f is focal length of the lens According to question:(a) If image is real u = -27 cm. , v = 36 cm. and height of the object h = 5cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have $\frac{1}{f}$ = 1/36 - 1/ -27 ⇒ f = [(27 × 36)/(27 + 36)] = 15.42857cm. And for height of Image we have$\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ ⇒ |36/27| = |Im/5| ⇒ Im = 6.666667 cm. Next case: (b)image is unreal u = -27 cm. , v = -36 cm. and height of the object h = 5cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have $\frac{1}{f}$ = 1/(-36) - 1/ (-27) ⇒

f = [(27 × -36)/(27 + -36)] = 108cm.(b) And for height of Image we have $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right| \Rightarrow$ *|-36/27| = |Im/5|* $\Rightarrow$ *Im = 6.666667 cm.*

30. An object is placed 179 cm from a screen. A converging lens with a 29 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (179 - x) cm. while focal length given is f = 29 cm. Using the mentioned formula : 1/29 = 1/(179 - x) - 1/-x = 179 / ((179 - x) × x) . After Solving it we get x = 142.5966 cm. the distance from the object for the placement of the lens is = 142.5966 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right| \Rightarrow$ *|36.4034/142.5966| = 0.2552894*

31. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 2.28. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} = (3 \times 10^8\ )/\ 2.28 = 1.31579 \times 10^8$ *m/sec.*

32. The refractive index of media1 w.r.t air is 0.55 and of media2 w.r.t air is 1.3 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 1.3 / 0.55 = 2.36*

33. The refractive index of media1 w.r.t air is 1.9 and refractive index of media1 w.r.t media2 is 1.3 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow {}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 1.3 = 1.9/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 1.9 / 1.3 = 1.46*

34. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 18.5cm and refractive index of the material of lens material w.r.t air is 2.6

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 2.6 ,* R_1 *= infinity ,*R_2 *= ? and f = 18.5 cm : So using the mentioned formula we have : (2.6 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/18.5* $\Rightarrow$ *1.6/R2 = 1/18.5 So*R_2 *= 29.6cm. = 29.6cm.*

35. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= ? ,* R_1 *= +f ,*R_2 *= -f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* μ *= (1 +(1/2)) = 3/2 = 1.5 ....Ans.*

36. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 1.3What should be the radius of curvature for the focal length of the lens to be 6.5 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 1.3 ,* R_1 *= +R ,*R_2 *= -R and the focal length = 6.5 cm. So using the mentioned formula we have : (1.3 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/6.5* $\Rightarrow$ *0.3×*$\left(\frac{2}{R}\right)$ *= (1/6.5)* $\Rightarrow$ *R = 3.899999cm. Radius of curvature of both faces is equal to 3.899999cm.*

37. The focal length of a convex lens in air is 12 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25 (iii) 1.125 (iv) 2.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal* *length in media dividing equation (1) by (2) we get:* $f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :* $f_m = \frac{({}_a\mu^g - 1) \times {}_a\mu^m}{({}_a\mu^g - {}_a\mu^m)} \times f_a$ *:*

⇒ (1) f_m *= [(1.5 -1) × 1.25/(1.5 - 1.25)] × 12 ⇒* f_m *= 30cm. ⇒ So focal length in the media will be given as : 30cm.*

(2) f_m *= [(1.5 -1) × 3.25/(1.5 - 3.25)] × 12 ⇒* f_m *= -11.14286cm. ⇒ So focal length in the media will be given as : -11.14286cm.*

(3) f_m *= [(1.5 -1) × 1.125/(1.5 - 1.125)] × 12 ⇒* f_m *= 18cm. ⇒ So focal length in the media will be given as : 18cm.*

(4) f_m *= [(1.5 -1) × 2.25/(1.5 - 2.25)] × 12 ⇒* f_m *= -18cm. ⇒ So focal length in the media will be given as : -18cm.*

38. The radius of curvatures of a double convex lens are 43 cm. and 39 cm respectively while refractive index of the material of lens w.r.t air is 0.75. Find it's focal length?

    SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 0.75$ *,* $R_1 = 43$ *cm. ,*$R_2 = -39$ *cm. So using the mentioned formula we have : [(0.75 -1)(1/(+43) - 1/(-39))] =* $\frac{1}{f}$ *⇒ f = [(43 × 39)/((0.75 -1) × (43 + 39))] after solving it we get f = -81.80488*

39. The radius of curvatures of a double convex lens are 49 cm , 32 cm respectively and focal length18.5 cm. Find refractive index of the material of lens w.r.t ?

    SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 49$ *cm. ,*$R_2 = -32$ *cm.and focal length f = 18.5 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+49) - 1/(-32)) = 1/18.5] ⇒ (* μ *-1) = [(49 × 32)/((18.5) × (49 + 32))] after solving it we get* $\mu = 2.04638$

40. If the ratio of radius of curvatures of a biconvex lens is 2 : 4 and focal length is 12 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 31 cm.

    SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 2R$ *= 62cm.,*$R_2 = -4R$ *= -124cm. and focal length f = 12 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+62) - 1/(-124))] = 1/12 ⇒ (* μ *-1) = [((2 × 4)/(2 + 4)) × 31 × 1 / 12] ⇒* μ *= [((2 × 4)/(2 + 4)) × 31 × 1 / 12] + 1 after solving it we get* $\mu = 4.444445$

41. If the ratio of radius of curvatures of a biconvex lens is 3 : 4 and refractive index of the material of lens w.r.t air is 1.6 while curvature of first surface is 29 cm. Find the focal length of the lens

    SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 1.6$ *,* $R_1 = 3R$ *= 87cm.,*$R_2 = -4R$ *= -116cm. and focal length f = ? So using the mentioned formula we have : [(1.6 -1)(1/(+87) - 1/(-116))] =* $\frac{1}{f}$ *⇒ f = [((3 × 4 × 29)/((3 + 4) × (1.6- 1))] after solving it we get f = 82.85714*

42. An object 4 cm high is placed 58 cm in front of a convex lens of focal length 24 cm. What is the position and height of the image?

    SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -58 cm. , f = 24 cm. and height of the object h = 4cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 24 = 1/v - 1/ -58 ⇒ v = [(58 × 24)/(58 - 24)] = 40.94118cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |40.94118/58| = |Im/4| ⇒ Im = 2.823529 cm.*

43. An object 4 cm high is placed 33 cm in front of a concave lens of focal length -31 cm. What is the position and height of the image?

    SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -33 cm. , f = -31 cm. and height of the object h = 4cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -31 = 1/v - 1/ -33 ⇒ v = [(33 × -31)/(33 + 31)] = -15.98438cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-15.98438/33| = |Im/4| ⇒ Im = 1.9375 cm.*

44. An object placed 28 cm. from a lens produces a virtual/real image at 27 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 4cm.

    SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -28 cm. , v = 27 cm. and height of the object h = 4cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/27 - 1/ -28 ⇒ f = [(28 × 27)/(28 + 27)] = 13.74545cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |27/28| = |Im/4| ⇒ Im = 3.857143 cm. Next case: (b)image is unreal u = -28 cm. , v = -27 cm. and* *height of the object h = 4cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-27) - 1/ (-28)* $\Rightarrow$ *f = [(28 × -27)/(28 + -27)] = -756cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\, g}{Ob}\right|$ $\Rightarrow$ *|-27/28| = |Im/4|* $\Rightarrow$ *Im = 3.857143 cm.*

45. An object is placed 161 cm from a screen. A converging lens with a 21 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (161 - x) cm. while focal length given is f = 21 cm. Using the mentioned formula : 1/21 = 1/(161 - x) - 1/-x = 161 / ((161 - x) × x) . After Solving it we get x = 136.1709 cm. the distance from the object for the placement of the lens is = 136.1709 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\, g}{Ob}\right|$ $\Rightarrow$ *|24.82909/136.1709| = 0.1823377*

46. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 3.04. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as :${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(3 × 10⁸)/ 3.04 = 9.868421E+07 m/sec.*

47. The refractive index of media1 w.r.t air is 0.55 and of media2 w.r.t air is 1.95 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.rt media1 ${}_{m_1}\mu^{m_2}$ *as :*${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 1.95 / 0.55 = 3.55*

48. The refractive index of media1 w.r.t air is 0.95 and refractive index of media1 w.r.t media2 is 0.65 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.rt media1 ${}_{m_1}\mu^{m_2}$ *as :*${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow {}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 0.65 = 0.95/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 0.95 / 0.65 = 1.46*

49. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 6.5cm and refractive index of the material of lens material w.r.t air is 3.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 3.25 ,* R_1 *= infinity ,*R_2 *= ? and f = 6.5 cm : So using the mentioned formula we have : (3.25 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/6.5* $\Rightarrow$ *2.25/R2 = 1/6.5 So*R_2 *= 14.625cm. = 14.625cm.*

50. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= ? ,* R_1 *= +f ,*R_2 *= -f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* μ *= (1 +(1/2)) = 3/2 = 1.5 ....Ans.*

51. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 0.65What should be the radius of curvature for the focal length of the lens to be 18 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 0.65 ,* R_1 *= +R ,*R_2 *= -R and the focal length = 18 cm. So using the mentioned formula we have : (0.65 - 1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/18* $\Rightarrow$ *-0.35×* $\left(\frac{2}{R}\right)$ *= (1/18)* $\Rightarrow$ *R = -12.6cm. Radius of curvature of both faces is equal to -12.6cm.*

52. The focal length of a convex lens in air is 15 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 2 (11) 4 (iii) 1.5 (iv) 3

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa* *is focal length in air Similarly focal length in media will be given as :* $({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:* $f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :* $f_m = \frac{({}_a\mu^g - 1) \times {}_a\mu^m}{({}_a\mu^g - {}_a\mu^m)} \times f_a$ *:*

⇒ (1) f_m *= [(1.5 -1) × 2/(1.5 - 2)] × 15 ⇒* f_m *= -30cm. ⇒ So focal length in the media will be given as : -30cm.*
(2) f_m *= [(1.5 -1) × 4/(1.5 - 4)] × 15 ⇒* f_m *= -12cm. ⇒ So focal length in the media will be given as : -12cm.*
(3) f_m *= [(1.5 -1) × 1.5/(1.5 - 1.5)] × 15 ⇒* f_m *= Infinitycm. ⇒ So focal length in the media will be given as : Infinitycm.*
(4) f_m *= [(1.5 -1) × 3/(1.5 - 3)] × 15 ⇒* f_m *= -15cm. ⇒ So focal length in the media will be given as : -15cm.*

53. The radius of curvatures of a double convex lens are 27 cm. and 36 cm respectively while refractive index of the material of lens w.r.t air is 3. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 3$ *,* $R_1 = 27$ *cm. ,*$R_2 =$ *-36 cm. So using the mentioned formula we have : [(3 -1)(1/(+27) - 1/(-36))] =* $\frac{1}{f}$ *⇒ f = [(27 × 36)/((3 -1) × (27 + 36))] after solving it we get f = 7.714286*

54. The radius of curvatures of a double convex lens are 35 cm , 34 cm respectively and focal length25 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 35$ *cm. ,*$R_2 =$ *-34 cm.and focal length f = 25 cm. So using the mentioned formula we have : [(μ -1)(1/(+35) - 1/(-34)) = 1/25] ⇒ (μ -1) = [(35 × 34)/((25) × (35 + 34))] after solving it we get* $\mu = 1.689855$

55. If the ratio of radius of curvatures of a biconvex lens is 4 : 3 and focal length is 13 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 34 cm.

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 4R = 136$*cm.,*$R_2 = -3R = -102$*cm. and focal length f = 13 cm. So using the mentioned formula we have : [(μ -1)(1/(+136) - 1/(-102))] = 1/13 ⇒ (μ -1) = [((4 × 3)/(4 + 3)) × 34 × 1 / 13]*
⇒ μ *= [((4 × 3)/(4 + 3)) × 34 × 1 / 13] + 1 after solving it we get* $\mu = 5.483517$

56. If the ratio of radius of curvatures of a biconvex lens is 2 : 4 and refractive index of the material of lens w.r.t air is 3.2 while curvature of first surface is 25 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 3.2$ *,* $R_1 = 2R = 50$*cm.,*$R_2 = -4R = -100$*cm. and focal length f = ? So using the mentioned formula we have : [(3.2 -1)(1/(+50) - 1/(-100))] =* $\frac{1}{f}$ *⇒ f = [((2 × 4 × 25)/((2 + 4) × (3.2- 1))] after solving it we get f = 15.15152*

57. An object 5 cm high is placed 15 cm in front of a convex lens of focal length 10 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -15 cm. , f = 10 cm. and height of the object h = 5cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 10 = 1/v - 1/ -15 ⇒ v = [(15 × 10)/(15 - 10)] = 30cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |30/15| = |Im/5| ⇒ Im = 10 cm.*

58. An object 7 cm high is placed 31 cm in front of a concave lens of focal length -36 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -31 cm. , f = -36 cm. and height of the object h = 7cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -36 = 1/v - 1/ -31 ⇒ v = [(31 × -36)/(31 + 36)] = -16.65672cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |-16.65672/31| = |Im/7| ⇒ Im = 3.761194 cm.*

59. An object placed 49 cm. from a lens produces a virtual/real image at 38 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 1cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -49 cm. , v = 38 cm. and height of the object h = 1cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/38 - 1/ -49 ⇒ f = [(49 × 38)/(49 + 38)] = 21.4023cm. And for height of*

Image we have $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ ⇒ *|38/49| = |Im/1| ⇒ Im = 0.7755102 cm. Next case: (b)image is unreal u = -49 cm. , v = -38 cm. and height of the object h = 1cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-38) - 1/(-49) ⇒ f = [(49 × -38)/(49 + -38)] = -169.2727cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ ⇒ *|-38/49| = |Im/1| ⇒ Im = 0.7755102 cm.*

60. An object is placed 105 cm from a screen. A converging lens with a 24 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

    SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (105 - x) cm. while focal length given is f = 24 cm. Using the mentioned formula : 1/24 = 1/(105 - x) - 1/-x = 105 / ((105 - x) × x) . After Solving it we get x = 67.87042 cm. the distance from the object for the placement of the lens is = 67.87042 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ ⇒ *|37.12958/67.87042| = 0.5470657*

61. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 1.52. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

    SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as :${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(3 × 10^8)/ 1.52 = 1.973684×10^8 m/sec.*

62. The refractive index of media1 w.r.t air is 1.1 and of media2 w.r.t air is 2.6 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

    SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :*${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 2.6 / 1.1 = 2.36*

63. The refractive index of media1 w.r.t air is 2.85 and refractive index of media1 w.r.t media2 is 0.65 . What is refractive index of media2 w.r.t air.

    SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :*${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow {}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 0.65 = 2.85/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 2.85 / 0.65 = 4.38*

64. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 7.5cm and refractive index of the material of lens material w.r.t air is 2.6

    SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *2.6 ,* $R_1 =$ *infinity ,*$R_2 =$ *? and f = 7.5 cm : So using the mentioned formula we have : (2.6 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/7.5 ⇒ 1.6/R2 = 1/7.5 So*$R_2 =$ *12cm. = 12cm.*

65. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

    SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *? ,* $R_1 =$ *+f ,*$R_2 =$ *-f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* $\mu =$ *(1 +(1/2)) = 3/2 = 1.5 ....Ans.*

66. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 2.6What should be the radius of curvature for the focal length of the lens to be 20 cm.?

    SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *2.6 ,* $R_1 =$ *+R ,*$R_2 =$ *-R and the focal length = 20 cm. So using the mentioned formula we have : (2.6 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/20 ⇒ 1.6×*$\left(\frac{2}{R}\right)$ *= (1/20) ⇒ R = 64cm. Radius of curvature of both faces is equal to 64cm.*

67. The focal length of a convex lens in air is 21.5 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25

(iii) 1.125 (iv) 2.25

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :* $({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.———(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:* $f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :* $f_m = \frac{({}_a\mu^g - 1) \times_a \mu^m}{({}_a\mu^g -_a \mu^m)} \times f_a$ *:*
⇒ (1) f_m *= [(1.5 -1) × 1.25/(1.5 - 1.25)] × 21.5 ⇒* f_m *= 53.75cm. ⇒ So focal length in the media will be given as : 53.75cm.*
(2) f_m *= [(1.5 -1) × 3.25/(1.5 - 3.25)] × 21.5 ⇒* f_m *= -19.96428cm. ⇒ So focal length in the media will be given as : -19.96428cm.*
(3) f_m *= [(1.5 -1) × 1.125/(1.5 - 1.125)] × 21.5 ⇒* f_m *= 32.25cm. ⇒ So focal length in the media will be given as : 32.25cm.*
(4) f_m *= [(1.5 -1) × 2.25/(1.5 - 2.25)] × 21.5 ⇒* f_m *= -32.25cm. ⇒ So focal length in the media will be given as : -32.25cm.*

68. The radius of curvatures of a double convex lens are 37 cm. and 32 cm respectively while refractive index of the material of lens w.r.t air is 2.25. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 2.25$ *,* $R_1 = 37$ *cm. ,*$R_2 =$ *-32 cm. So using the mentioned formula we have : [(2.25 -1)(1/(+37) - 1/(-32))] =* $\frac{1}{f}$ *⇒ f = [(37 × 32)/((2.25 -1) × (37 + 32))] after solving it we get f = 13.72754*

69. The radius of curvatures of a double convex lens are 35 cm , 37 cm respectively and focal length23.5 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu =$ *? ,* $R_1 = 35$ *cm. ,*$R_2 =$ *-37 cm.and focal length f = 23.5 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+35) - 1/(-37)) = 1/23.5] ⇒ (* μ *-1) = [(35 × 37)/((23.5) × (35 + 37))] after solving it we get* $\mu = 1.765366$

70. If the ratio of radius of curvatures of a biconvex lens is 4 : 5 and focal length is 11 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 31 cm.

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu =$ *? ,* $R_1 =$ *4R = 124cm.,*$R_2 =$ *-5R = -155cm. and focal length f = 11 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+124) - 1/(-155))] = 1/11 ⇒ (* μ *-1) = [((4 × 5)/(4 + 5)) × 31 × 1 / 11] ⇒* $\mu =$ *[((4 × 5)/(4 + 5)) × 31 × 1 / 11] + 1 after solving it we get* $\mu = 7.262626$

71. If the ratio of radius of curvatures of a biconvex lens is 2 : 3 and refractive index of the material of lens w.r.t air is 3.2 while curvature of first surface is 39 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 3.2$ *,* $R_1 =$ *2R = 78cm.,*$R_2 =$ *-3R = -117cm. and focal length f = ? So using the mentioned formula we have : [(3.2 -1)(1/(+78) - 1/(-117))] =* $\frac{1}{f}$
⇒ f = [((2 × 3 × 39)/((2 + 3) × (3.2- 1))] after solving it we get f = 21.27273

72. An object 2 cm high is placed 8 cm in front of a convex lens of focal length 22 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -8 cm. , f = 22 cm. and height of the object h = 2cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 22 = 1/v - 1/ -8 ⇒ v = [(8 × 22)/(8 - 22)] = -12.57143cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |-12.57143/8| = |Im/2| ⇒ Im = 3.142857 cm.*

73. An object 5 cm high is placed 26 cm in front of a concave lens of focal length -26 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -26 cm. , f = -26 cm. and height of the object h = 5cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -26 = 1/v - 1/ -26 ⇒ v = [(26 × -26)/(26 + 26)] = -13cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |-13/26| = |Im/5| ⇒ Im = 2.5 cm.*

74. An object placed 40 cm. from a lens produces a virtual/real image at 41 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object

is 5cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -40 cm. , v = 41 cm. and height of the object h = 5cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/41 - 1/ -40 ⇒ f = [(40 × 41)/(40 + 41)] = 20.24691cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |41/40| = |Im/5| ⇒ Im = 5.125 cm. Next case: (b)image is unreal u = -40 cm. , v = -41 cm. and height of the object h = 5cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-41) - 1/ (-40) ⇒ f = [(40 × -41)/(40 + -41)] = 1640cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-41/40| = |Im/5| ⇒ Im = 5.125 cm.*

75. An object is placed 80 cm from a screen. A converging lens with a 20 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (80 - x) cm. while focal length given is f = 20 cm. Using the mentioned formula : 1/20 = 1/(80 - x) - 1/-x = 80 / ((80 - x) × x) . After Solving it we get x = 40 cm. the distance from the object for the placement of the lens is = 40 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |40/40| = 1*

76. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 2.28. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(3 ×* 10^8 *)/ 2.28 = 1.31579×*10^8 *m/sec.*

77. The refractive index of media1 w.r.t air is 0.55 and of media2 w.r.t air is 2.6 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 2.6 / 0.55 = 4.73*

78. The refractive index of media1 w.r.t air is 0.95 and refractive index of media1 w.r.t media2 is 2.6 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow {}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 2.6 = 0.95/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 0.95 / 2.6 = 0.37*

79. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 8cm and refractive index of the material of lens material w.r.t air is 2.6

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu = 2.6$ *,* $R_1 =$ *infinity ,*$R_2 =$ *? and f = 8 cm : So using the mentioned formula we have : (2.6 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/8 ⇒ 1.6/R2 = 1/8 So*$R_2 =$ *12.8cm. = 12.8cm.*

80. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *? ,* $R_1 =$ *+f ,*$R_2 =$ *-f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* $\mu =$ *(1 +(1/2)) = 3/2 = 1.5 ....Ans.*

81. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 1.3What should be the radius of curvature for the focal length of the lens to be 23 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *1.3 ,* $R_1 =$ *+R ,*$R_2 =$ *-R and the focal length = 23 cm. So using the mentioned formula we have : (1.3 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$

= 1/23 ⇒ 0.3× $\left(\frac{2}{R}\right)$ *= (1/23) ⇒ R = 13.8cm. Radius of curvature of both faces is equal to 13.8cm.*

82. The focal length of a convex lens in air is 11.5 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 2 (11) 4 (iii) 1.5 (iv) 3

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :* $({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:* $f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :* $f_m = \frac{({}_a\mu^g - 1) \times_a \mu^m}{({}_a\mu^g -_a \mu^m)} \times f_a$ *:*
⇒ (1) f_m *= [(1.5 -1) × 2/(1.5 - 2)] × 11.5 ⇒* f_m *= -23cm. ⇒ So focal length in the media will be given as : -23cm.*
(2) f_m *= [(1.5 -1) × 4/(1.5 - 4)] × 11.5 ⇒* f_m *= -9.2cm. ⇒ So focal length in the media will be given as : -9.2cm.*
(3) f_m *= [(1.5 -1) × 1.5/(1.5 - 1.5)] × 11.5 ⇒* f_m *= Infinitycm. ⇒ So focal length in the media will be given as : Infinitycm.*
(4) f_m *= [(1.5 -1) × 3/(1.5 - 3)] × 11.5 ⇒* f_m *= -11.5cm. ⇒ So focal length in the media will be given as : -11.5cm.*

83. The radius of curvatures of a double convex lens are 29 cm. and 35 cm respectively while refractive index of the material of lens w.r.t air is 3. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 3$ *,* $R_1 = 29$ *cm. ,*$R_2 =$ *-35 cm. So using the mentioned formula we have : [(3 -1)(1/(+29) - 1/(-35))] =* $\frac{1}{f}$ *⇒ f = [(29 × 35)/((3 -1) × (29 + 35))] after solving it we get f = 7.929688*

84. The radius of curvatures of a double convex lens are 26 cm , 36 cm respectively and focal length21.5 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu =$ *? ,* $R_1 = 26$ *cm. ,*$R_2 =$ *-36 cm.and focal length f = 21.5 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+26) - 1/(-36)) = 1/21.5] ⇒ (* μ *-1) = [(26 × 36)/((21.5) × (26 + 36))] after solving it we get* $\mu = 1.702175$

85. If the ratio of radius of curvatures of a biconvex lens is 3 : 4 and focal length is 17 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 32 cm.

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu =$ *? ,* $R_1 =$ *3R = 96cm.,*$R_2 =$ *-4R = -128cm. and focal length f = 17 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+96) - 1/(-128))] = 1/17 ⇒ (* μ *-1) = [((3 × 4)/(3 + 4)) × 32 × 1 / 17] ⇒* μ *= [((3 × 4)/(3 + 4)) × 32 × 1 / 17] + 1 after solving it we get* $\mu = 4.226891$

86. If the ratio of radius of curvatures of a biconvex lens is 2 : 3 and refractive index of the material of lens w.r.t air is 2.4 while curvature of first surface is 35 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 2.4$ *,* $R_1 =$ *2R = 70cm.,*$R_2 =$ *-3R = -105cm. and focal length f = ? So using the mentioned formula we have :*
[(2.4 -1)(1/(+70) - 1/(-105))] = $\frac{1}{f}$ *⇒ f = [((2 × 3 × 35)/((2 + 3) × (2.4- 1))] after solving it we get f = 30*

87. An object 5 cm high is placed 35 cm in front of a convex lens of focal length 20 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -35 cm. , f = 20 cm. and height of the object h = 5cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 20 = 1/v - 1/ -35 ⇒ v = [(35 × 20)/(35 - 20)] = 46.66667cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\, g}{Ob}\right|$ *⇒ |46.66667/35| = |Im/5| ⇒ Im = 6.666667 cm.*

88. An object 9 cm high is placed 43 cm in front of a concave lens of focal length -15 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -43 cm. , f = -15 cm. and height of the object h = 9cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -15 = 1/v - 1/ -43 ⇒ v = [(43 × -15)/(43 + 15)] = -11.12069cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\, g}{Ob}\right|$ *⇒ |-11.12069/43| = |Im/9| ⇒ Im = 2.327586 cm.*

89. An object placed 22 cm. from a lens produces a virtual/real image at 39 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 4cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -22 cm. , v = 39 cm. and height of the object h = 4cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/39 - 1/ -22 ⇒ f = [(22 × 39)/(22 + 39)] = 14.06557cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |39/22| = |Im/4| ⇒ Im = 7.090909 cm. Next case: (b)image is unreal u = -22 cm. , v = -39 cm. and height of the object h = 4cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-39) - 1/(-22) ⇒ f = [(22 × -39)/(22 + -39)] = 50.47059cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |-39/22| = |Im/4| ⇒ Im = 7.090909 cm.*

90. An object is placed 113 cm from a screen. A converging lens with a 18 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (113 - x) cm. while focal length given is f = 18 cm. Using the mentioned formula : 1/18 = 1/(113 - x) - 1/-x = 113 / ((113 - x) × x) . After Solving it we get x = 90.53307 cm. the distance from the object for the placement of the lens is = 90.53307 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |22.46693/90.53307| = 0.2481626*

91. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 1.52. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(3 × 10^8)/ 1.52 = 1.973684× 10^8 m/sec.*

92. The refractive index of media1 w.r.t air is 0.55 and of media2 w.r.t air is 1.3 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 1.3 / 0.55 = 2.36*

93. The refractive index of media1 w.r.t air is 0.95 and refractive index of media1 w.r.t media2 is 0.65 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow {}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 0.65 = 0.95/* ${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 0.95 / 0.65 = 1.46*

94. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 14.5cm and refractive index of the material of lens material w.r.t air is 3.25

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *3.25 ,* $R_1 =$ *infinity ,* $R_2 =$ *? and f = 14.5 cm : So using the mentioned formula we have : (3.25 -1)* $\left(\frac{1}{\infty} - \frac{1}{R_2}\right) =$ *1/14.5 ⇒ 2.25/R2 = 1/14.5 So* $R_2 =$ *32.625cm. = 32.625cm.*

95. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *? ,* $R_1 =$ *+f ,* $R_2 =$ *-f (where f is the focal length) So using the mentioned formula we have :* $(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* $\mu =$ *(1 +(1/2)) = 3/2 = 1.5 ....Ans.*

96. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive

index 1.3What should be the radius of curvature for the focal length of the lens to be 19.5 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu = 1.3$ *,* $R_1 = +R$ *,* $R_2 =$ *-R and the focal length = 19.5 cm. So using the mentioned formula we have : (1.3 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/19.5 ⇒ 0.3×*$\left(\frac{2}{R}\right)$ *= (1/19.5) ⇒ R = 11.7cm. Radius of curvature of both faces is equal to 11.7cm.*

97. The focal length of a convex lens in air is 23 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25 (iii) 1.125 (iv) 2.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.———(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times_a \mu^m}{({}_a\mu^g -_a \mu^m)} \times f_a$ *:*

⇒ (1) f_m *= [(1.5 -1) × 1.25/(1.5 - 1.25)] × 23 ⇒* f_m *= 57.5cm. ⇒ So focal length in the media will be given as : 57.5cm.*
(2) f_m *= [(1.5 -1) × 3.25/(1.5 - 3.25)] × 23 ⇒* f_m *= -21.35714cm. ⇒ So focal length in the media will be given as : -21.35714cm.*
(3) f_m *= [(1.5 -1) × 1.125/(1.5 - 1.125)] × 23 ⇒* f_m *= 34.5cm. ⇒ So focal length in the media will be given as : 34.5cm.*
(4) f_m *= [(1.5 -1) × 2.25/(1.5 - 2.25)] × 23 ⇒* f_m *= -34.5cm. ⇒ So focal length in the media will be given as : -34.5cm.*

98. The radius of curvatures of a double convex lens are 45 cm. and 39 cm respectively while refractive index of the material of lens w.r.t air is 3. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$*. Where fa is focal length in air According to question* $\mu = 3$ *,* $R_1 = 45$ *cm. ,*$R_2 =$ *-39 cm. So using the mentioned formula we have : [(3 -1)(1/(+45) - 1/(-39))] =* $\frac{1}{f}$ *⇒ f = [(45 × 39)/((3 -1) × (45 + 39))] after solving it we get f = 10.44643*

99. The radius of curvatures of a double convex lens are 29 cm , 38 cm respectively and focal length27 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$*. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 29$ *cm. ,*$R_2 =$ *-38 cm.and focal length f = 27 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+29) - 1/(-38)) = 1/27] ⇒ (* μ *-1) = [(29 × 38)/((27) × (29 + 38))] after solving it we get* $\mu = 1.609176$

100. If the ratio of radius of curvatures of a biconvex lens is 2 : 4 and focal length is 28 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 32 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$*. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 2R$ *= 64cm.,*$R_2 =$ *-4R = -128cm. and focal length f = 28 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+64) - 1/(-128))] = 1/28 ⇒ (* μ *-1) = [((2 × 4)/(2 + 4)) × 32 × 1 / 28] ⇒* μ *= [((2 × 4)/(2 + 4)) × 32 × 1 / 28] + 1 after solving it we get* $\mu = 2.523809$

101. If the ratio of radius of curvatures of a biconvex lens is 4 : 3 and refractive index of the material of lens w.r.t air is 2.4 while curvature of first surface is 29 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$*. Where fa is focal length in air According to question* $\mu = 2.4$ *,* $R_1 = 4R$ *= 116cm.,*$R_2 =$ *-3R = -87cm. and focal length f = ? So using the mentioned formula we have : [(2.4 -1)(1/(+116) - 1/(-87))] =* $\frac{1}{f}$ *⇒ f = [((4 × 3 × 29)/((4 + 3) × (2.4- 1))] after solving it we get f = 35.5102*

102. An object 1 cm high is placed 47 cm in front of a convex lens of focal length 14 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -47 cm. , f = 14 cm. and height of the object h = 1cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 14 = 1/v - 1/ -47 ⇒ v = [(47 × 14)/(47 - 14)] = 19.93939cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\, g}{Ob}\right|$ *⇒ |19.93939/47| = |Im/1| ⇒ Im = 0.4242424 cm.*

103. An object 2 cm high is placed 20 cm in front of a concave lens of focal length -20 cm. What is the position and

height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -20 cm. , f = -20 cm. and height of the object h = 2cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -20 = 1/v - 1/ -20 ⇒ v = [(20 × -20)/(20 + 20)] = -10cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-10/20| = |Im/2| ⇒ Im = 1 cm.*

104. An object placed 20 cm. from a lens produces a virtual/real image at 20 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 2cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -20 cm. , v = 20 cm. and height of the object h = 2cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/20 - 1/ -20 ⇒ f = [(20 × 20)/(20 + 20)] = 10cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |20/20| = |Im/2| ⇒ Im = 2 cm. Next case: (b)image is unreal u = -20 cm. , v = -20 cm. and height of the object h = 2cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-20) - 1/ (-20) ⇒ f = [(20 × -20)/(20 + -20)] = -Infinitycm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-20/20| = |Im/2| ⇒ Im = 2 cm.*

105. An object is placed 191 cm from a screen. A converging lens with a 26 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (191 - x) cm. while focal length given is f = 26 cm. Using the mentioned formula : 1/26 = 1/(191 - x) - 1/-x = 191 / ((191 - x) × x) . After Solving it we get x = 159.9535 cm. the distance from the object for the placement of the lens is = 159.9535 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |31.04652/159.9535| = 0.1940972*

106. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 1.52. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(3 ×* 10^8 *)/ 1.52 = 1.973684×*10^8 *m/sec.*

107. The refractive index of media1 w.r.t air is 0.55 and of media2 w.r.t air is 1.95 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 1.95 / 0.55 = 3.55*

108. The refractive index of media1 w.r.t air is 2.85 and refractive index of media1 w.r.t media2 is 1.95 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow {}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 1.95 = 2.85/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 2.85 / 1.95 = 1.46*

109. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 24.5cm and refractive index of the material of lens material w.r.t air is 1.3

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 1.3 ,* R_1 *= infinity ,*R_2 *= ? and f = 24.5 cm : So using the mentioned formula we have : (1.3 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right) =$ *1/24.5 ⇒ 0.3/R2 = 1/24.5 SoR*$_2$ *= 7.349999cm. = 7.349999cm.*

110. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= ? ,* R_1 *= +f ,*R_2 *= -f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) =$

$\frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ = (1/2): So μ = (1 +(1/2)) = 3/2 = 1.5 ....Ans.

111. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 0.65What should be the radius of curvature for the focal length of the lens to be 6.5 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu = 0.65$, $R_1 = +R$,$R_2 = -R$ *and the focal length = 6.5 cm. So using the mentioned formula we have : (0.65 - 1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/6.5 ⇒ -0.35×* $\left(\frac{2}{R}\right)$ *= (1/6.5) ⇒ R = -4.55cm. Radius of curvature of both faces is equal to -4.55cm.*

112. The focal length of a convex lens in air is 24 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 2 (11) 4 (iii) 1.5 (iv) 3

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.———(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times_a \mu^m}{({}_a\mu^g -_a \mu^m)} \times f_a$ *:*

⇒ (1) f_m *= [(1.5 -1) × 2/(1.5 - 2)] × 24 ⇒* f_m *= -48cm. ⇒ So focal length in the media will be given as : -48cm.*

(2) f_m *= [(1.5 -1) × 4/(1.5 - 4)] × 24 ⇒* f_m *= -19.2cm. ⇒ So focal length in the media will be given as : -19.2cm.*

(3) f_m *= [(1.5 -1) × 1.5/(1.5 - 1.5)] × 24 ⇒* f_m *= Infinitycm. ⇒ So focal length in the media will be given as : Infinitycm.*

(4) f_m *= [(1.5 -1) × 3/(1.5 - 3)] × 24 ⇒* f_m *= -24cm. ⇒ So focal length in the media will be given as : -24cm.*

113. The radius of curvatures of a double convex lens are 25 cm. and 32 cm respectively while refractive index of the material of lens w.r.t air is 0.75. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= 0.75 ,* R_1 *= 25 cm. ,*R_2 *= -32 cm. So using the mentioned formula we have : [(0.75 -1)(1/(+25) - 1/(-32))] =* $\frac{1}{f}$ *⇒ f = [(25 × 32)/((0.75 -1) × (25 + 32))] after solving it we get f = -56.14035*

114. The radius of curvatures of a double convex lens are 27 cm , 36 cm respectively and focal length16 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= ? ,* R_1 *= 27 cm. ,*R_2 *= -36 cm.and focal length f = 16 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+27) - 1/(-36)) = 1/16] ⇒ (* μ *-1) = [(27 × 36)/((16) × (27 + 36))] after solving it we get* μ *= 1.964286*

115. If the ratio of radius of curvatures of a biconvex lens is 2 : 4 and focal length is 23 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 23 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= ? ,* R_1 *= 2R = 46cm.,*R_2 *= -4R = -92cm. and focal length f = 23 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+46) - 1/(-92))] = 1/23 ⇒ (* μ *-1) = [((2 × 4)/(2 + 4)) × 23 × 1 / 23] ⇒* μ *= [((2 × 4)/(2 + 4)) × 23 × 1 / 23] + 1 after solving it we get* μ *= 2.333333*

116. If the ratio of radius of curvatures of a biconvex lens is 2 : 3 and refractive index of the material of lens w.r.t air is 3.2 while curvature of first surface is 34 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= 3.2 ,* R_1 *= 2R = 68cm.,*R_2 *= -3R = -102cm. and focal length f = ? So using the mentioned formula we have : [(3.2 -1)(1/(+68) - 1/(-102))] =* $\frac{1}{f}$ *⇒ f = [((2 × 3 × 34)/((2 + 3) × (3.2- 1))] after solving it we get f = 18.54545*

117. An object 4 cm high is placed 58 cm in front of a convex lens of focal length 22 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -58 cm. , f = 22 cm. and height of the object h = 4cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 22 = 1/v - 1/ -58 ⇒ v = [(58 × 22)/(58 - 22)] = 35.44444cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ *⇒ |35.44444/58| = |Im/4| ⇒ Im = 2.444444 cm.*

118. An object 9 cm high is placed 11 cm in front of a concave lens of focal length -32 cm. What is the position and

height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -11 cm. , f = -32 cm. and height of the object h = 9cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -32 = 1/v - 1/ -11* $\Rightarrow$ *v = [(11* $\times$ *-32)/(11 + 32)] = -8.186047cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ $\Rightarrow$ *|-8.186047/11| = |Im/9|* $\Rightarrow$ *Im = 6.697674 cm.*

119. An object placed 39 cm. from a lens produces a virtual/real image at 13 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 1cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -39 cm. , v = 13 cm. and height of the object h = 1cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/13 - 1/ -39* $\Rightarrow$ *f = [(39* $\times$ *13)/(39 + 13)] = 9.75cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ $\Rightarrow$ *|13/39| = |Im/1|* $\Rightarrow$ *Im = 0.3333333 cm. Next case: (b)image is unreal u = -39 cm. , v = -13 cm. and height of the object h = 1cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-13) - 1/ (-39)* $\Rightarrow$ *f = [(39* $\times$ *-13)/(39 + -13)] = -19.5cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ $\Rightarrow$ *|-13/39| = |Im/1|* $\Rightarrow$ *Im = 0.3333333 cm.*

120. An object is placed 106 cm from a screen. A converging lens with a 26 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (106 - x) cm. while focal length given is f = 26 cm. Using the mentioned formula : 1/26 = 1/(106 - x) - 1/-x = 106 / ((106 - x)* $\times$ *x) . After Solving it we get x = 60.28011 cm. the distance from the object for the placement of the lens is = 60.28011 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ $\Rightarrow$ *|45.71989/60.28011| = 0.7584573*

121. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 2.28. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(3* $\times$ 10^8 *)/ 2.28 = 1.31579*$\times 10^8$ *m/sec.*

122. The refractive index of media1 w.r.t air is 1.1 and of media2 w.r.t air is 0.65 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 0.65 / 1.1 = 0.59*

123. The refractive index of media1 w.r.t air is 0.95 and refractive index of media1 w.r.t media2 is 0.65 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow$ ${}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 0.65 = 0.95/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 0.95 / 0.65 = 1.46*

124. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 9cm and refractive index of the material of lens material w.r.t air is 0.65

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu = 0.65$ *,* $R_1 =$ *infinity ,*$R_2 =$ *? and f = 9 cm : So using the mentioned formula we have : (0.65 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/9* $\Rightarrow$ *-0.35/R2 = 1/9 So*$R_2 =$ *-3.15cm. = -3.15cm.*

125. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *? ,* $R_1 =$ *+f ,*$R_2 =$ *-f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) =$

$\frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ = (1/2): So μ = (1 +(1/2)) = 3/2 = 1.5 ....Ans.

126. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 2.6What should be the radius of curvature for the focal length of the lens to be 17 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu = 2.6$ *,* $R_1 = +R$ *,*$R_2 = -R$ *and the focal length = 17 cm. So using the mentioned formula we have : (2.6 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/17* $\Rightarrow$ *1.6*$\times\left(\frac{2}{R}\right)$ *= (1/17)* $\Rightarrow$ *R = 54.4cm. Radius of curvature of both faces is equal to 54.4cm.*

127. The focal length of a convex lens in air is 23.5 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25 (iii) 1.125 (iv) 2.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times {}_a\mu^m}{({}_a\mu^g - {}_a\mu^m)} \times f_a$ *:*

$\Rightarrow$ (1) f_m = [(1.5 -1) × 1.25/(1.5 - 1.25)] × 23.5 $\Rightarrow$ f_m = 58.75cm. $\Rightarrow$ So focal length in the media will be given as : 58.75cm.
(2) f_m = [(1.5 -1) × 3.25/(1.5 - 3.25)] × 23.5 $\Rightarrow$ f_m = -21.82143cm. $\Rightarrow$ So focal length in the media will be given as : -21.82143cm.
(3) f_m = [(1.5 -1) × 1.125/(1.5 - 1.125)] × 23.5 $\Rightarrow$ f_m = 35.25cm. $\Rightarrow$ So focal length in the media will be given as : 35.25cm.
(4) f_m = [(1.5 -1) × 2.25/(1.5 - 2.25)] × 23.5 $\Rightarrow$ f_m = -35.25cm. $\Rightarrow$ So focal length in the media will be given as : -35.25cm.

128. The radius of curvatures of a double convex lens are 27 cm. and 32 cm respectively while refractive index of the material of lens w.r.t air is 0.75. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 0.75$ *,* $R_1 = 27$ *cm. ,*$R_2 = -32$ *cm. So using the mentioned formula we have : [(0.75 -1)(1/(+27) - 1/(-32))] =* $\frac{1}{f}$ $\Rightarrow$ *f = [(27 × 32)/((0.75 -1) × (27 + 32))] after solving it we get f = -58.57627*

129. The radius of curvatures of a double convex lens are 45 cm , 38 cm respectively and focal length28 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 45$ *cm. ,*$R_2 = -38$ *cm.and focal length f = 28 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+45) - 1/(-38)) = 1/28]* $\Rightarrow$ *(* μ *-1) = [(45 × 38)/((28) × (45 + 38))] after solving it we get* $\mu = 1.7358$

130. If the ratio of radius of curvatures of a biconvex lens is 4 : 5 and focal length is 17 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 26 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 4R = 104$*cm.,*$R_2 = -5R = -130$*cm. and focal length f = 17 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+104) - 1/(-130))] = 1/17* $\Rightarrow$ *(* μ *-1) = [((4 × 5)/(4 + 5)) × 26 × 1 / 17]* $\Rightarrow$ μ *= [((4 × 5)/(4 + 5)) × 26 × 1 / 17] + 1 after solving it we get* $\mu = 4.398693$

131. If the ratio of radius of curvatures of a biconvex lens is 3 : 5 and refractive index of the material of lens w.r.t air is 1.6 while curvature of first surface is 25 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 1.6$ *,* $R_1 = 3R = 75$*cm.,*$R_2 = -5R = -125$*cm. and focal length f = ? So using the mentioned formula we have : [(1.6 -1)(1/(+75) - 1/(-125))] =* $\frac{1}{f}$ $\Rightarrow$ *f = [((3 × 5 × 25)/((3 + 5) × (1.6- 1))] after solving it we get f = 78.125*

132. An object 3 cm high is placed 31 cm in front of a convex lens of focal length 18 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -31 cm. , f = 18 cm. and height of the object h = 3cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 18 = 1/v - 1/ -31* $\Rightarrow$ *v = [(31 × 18)/(31 - 18)] = 42.92308cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ $\Rightarrow$ *|42.92308/31| = |Im/3|* $\Rightarrow$ *Im = 4.153846 cm.*

133. An object 2 cm high is placed 41 cm in front of a concave lens of focal length -18 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -41 cm. , f = -18 cm. and height of the object h = 2cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -18 = 1/v - 1/ -41 ⇒ v = [(41 × -18)/(41 + 18)] = -12.50847cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ *⇒ |-12.50847/41| = |Im/2| ⇒ Im = 0.6101695 cm.*

134. An object placed 29 cm. from a lens produces a virtual/real image at 40 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 5cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -29 cm. , v = 40 cm. and height of the object h = 5cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/40 - 1/ -29 ⇒ f = [(29 × 40)/(29 + 40)] = 16.81159cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ *⇒ |40/29| = |Im/5| ⇒ Im = 6.896552 cm. Next case: (b)image is unreal u = -29 cm. , v = -40 cm. and height of the object h = 5cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-40) - 1/(-29) ⇒ f = [(29 × -40)/(29 + -40)] = 105.4545cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ *⇒ |-40/29| = |Im/5| ⇒ Im = 6.896552 cm.*

135. An object is placed 153 cm from a screen. A converging lens with a 37 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (153 - x) cm. while focal length given is f = 37 cm. Using the mentioned formula : 1/37 = 1/(153 - x) - 1/-x = 153 / ((153 - x) × x) . After Solving it we get x = 90.32932 cm. the distance from the object for the placement of the lens is = 90.32932 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ *⇒ |62.67068/90.32932| = 0.6938023*

136. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 0.76. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(3 ×* 10^8 *)/ 0.76 = 3.947368×*10^8 *m/sec.*

137. The refractive index of media1 w.r.t air is 1.65 and of media2 w.r.t air is 0.65 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 0.65 / 1.65 = 0.39*

138. The refractive index of media1 w.r.t air is 2.85 and refractive index of media1 w.r.t media2 is 2.6 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow {}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 2.6 = 2.85/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2} =$ *2.85 / 2.6 = 1.1*

139. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 18cm and refractive index of the material of lens material w.r.t air is 0.65

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *0.65 ,* $R_1 =$ *infinity ,*$R_2 =$ *? and f = 18 cm : So using the mentioned formula we have : (0.65 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/18 ⇒ -0.35/R2 = 1/18 So*$R_2 =$ *-6.3cm. = -6.3cm.*

140. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive

index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu = ?$ *,* $R_1 = +f$*,*$R_2 = -f$ *(where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* μ *= (1 +(1/2)) = 3/2 = 1.5 ....Ans.*

141. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 1.3What should be the radius of curvature for the focal length of the lens to be 22 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu = 1.3$ *,* $R_1 = +R$ *,*$R_2 = -R$ *and the focal length = 22 cm. So using the mentioned formula we have : (1.3 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/22* $\Rightarrow$ *0.3*$\times\left(\frac{2}{R}\right)$ *= (1/22)* $\Rightarrow$ *R = 13.2cm. Radius of curvature of both faces is equal to 13.2cm.*

142. The focal length of a convex lens in air is 24 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25 (iii) 1.125 (iv) 2.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times_a \mu^m}{({}_a\mu^g -_a \mu^m)} \times f_a$ *:*

$\Rightarrow$ *(1)* f_m *= [(1.5 -1) × 1.25/(1.5 - 1.25)] × 24* $\Rightarrow f_m$ *= 60cm.* $\Rightarrow$ *So focal length in the media will be given as : 60cm.*
(2) f_m *= [(1.5 -1) × 3.25/(1.5 - 3.25)] × 24* $\Rightarrow f_m$ *= -22.28572cm.* $\Rightarrow$ *So focal length in the media will be given as : -22.28572cm.*
(3) f_m *= [(1.5 -1) × 1.125/(1.5 - 1.125)] × 24* $\Rightarrow f_m$ *= 36cm.* $\Rightarrow$ *So focal length in the media will be given as : 36cm.*
(4) f_m *= [(1.5 -1) × 2.25/(1.5 - 2.25)] × 24* $\Rightarrow f_m$ *= -36cm.* $\Rightarrow$ *So focal length in the media will be given as : -36cm.*

143. The radius of curvatures of a double convex lens are 32 cm. and 31 cm respectively while refractive index of the material of lens w.r.t air is 3. Find it's focal length?

SOLUTION*: As we know the formula for refraction by double refractive index is:*$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 3$ *,* $R_1 = 32$ *cm. ,*$R_2 = -31$ *cm. So using the mentioned formula we have : [(3 -1)(1/(+32) - 1/(-31))] =* $\frac{1}{f}$ $\Rightarrow$ *f = [(32 × 31)/((3 -1) × (32 + 31))] after solving it we get f = 7.873016*

144. The radius of curvatures of a double convex lens are 28 cm , 30 cm respectively and focal length25.5 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 28$ *cm. ,*$R_2 = -30$ *cm.and focal length f = 25.5 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+28) - 1/(-30)) = 1/25.5]* $\Rightarrow$ *(* μ *-1) = [(28 × 30)/((25.5) × (28 + 30))] after solving it we get* $\mu = 1.567951$

145. If the ratio of radius of curvatures of a biconvex lens is 3 : 4 and focal length is 10 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 35 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 3R$ *= 105cm.,*R_2 *= -4R = -140cm. and focal length f = 10 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+105) - 1/(-140))] = 1/10* $\Rightarrow$ *(* μ *-1) = [((3 × 4)/(3 + 4)) × 35 × 1 / 10]* $\Rightarrow \mu$ *= [((3 × 4)/(3 + 4)) × 35 × 1 / 10] + 1 after solving it we get* $\mu = 7$

146. If the ratio of radius of curvatures of a biconvex lens is 3 : 4 and refractive index of the material of lens w.r.t air is 1.6 while curvature of first surface is 35 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 1.6$ *,* $R_1 = 3R$ *= 105cm.,*R_2 *= -4R = -140cm. and focal length f = ? So using the mentioned formula we have : [(1.6 -1)(1/(+105) - 1/(-140))] =* $\frac{1}{f}$ $\Rightarrow$ *f = [((3 × 4 × 35)/((3 + 4) × (1.6- 1))] after solving it we get f = 99.99999*

147. An object 2 cm high is placed 29 cm in front of a convex lens of focal length 16 cm. What is the position and

height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -29 cm. , f = 16 cm. and height of the object h = 2cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 16 = 1/v - 1/ -29 ⇒ v = [(29 × 16)/(29 - 16)] = 35.69231cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ *⇒ |35.69231/29| = |Im/2| ⇒ Im = 2.461538 cm.*

148. An object 2 cm high is placed 40 cm in front of a concave lens of focal length -32 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -40 cm. , f = -32 cm. and height of the object h = 2cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -32 = 1/v - 1/ -40 ⇒ v = [(40 × -32)/(40 + 32)] = -17.77778cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ *⇒ |-17.77778/40| = |Im/2| ⇒ Im = 0.888889 cm.*

149. An object placed 46 cm. from a lens produces a virtual/real image at 11 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 6cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -46 cm. , v = 11 cm. and height of the object h = 6cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/11 - 1/ -46 ⇒ f = [(46 × 11)/(46 + 11)] = 8.877193cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ *⇒ |11/46| = |Im/6| ⇒ Im = 1.434783 cm. Next case: (b)image is unreal u = -46 cm. , v = -11 cm. and height of the object h = 6cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-11) - 1/ (-46) ⇒ f = [(46 × -11)/(46 + -11)] = -14.45714cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ *⇒ |-11/46| = |Im/6| ⇒ Im = 1.434783 cm.*

150. An object is placed 64 cm from a screen. A converging lens with a 16 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (64 - x) cm. while focal length given is f = 16 cm. Using the mentioned formula : 1/16 = 1/(64 - x) - 1/-x = 64 / ((64 - x) × x) . After Solving it we get x = 32 cm. the distance from the object for the placement of the lens is = 32 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\operatorname{Im} g}{Ob}\right|$ *⇒ |32/32| = 1*

151. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 1.52. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} = (3 \times 10^8)/ 1.52 = 1.973684 \times 10^8$ *m/sec.*

152. The refractive index of media1 w.r.t air is 1.1 and of media2 w.r.t air is 2.6 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 2.6 / 1.1 = 2.36*

153. The refractive index of media1 w.r.t air is 0.95 and refractive index of media1 w.r.t media2 is 1.95 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow {}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 1.95 = 0.95/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 0.95 / 1.95 = 0.49*

154. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 6.5cm and refractive index of the material of lens material w.r.t air is 0.65

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to* *question μ = 0.65 , R_1 = infinity ,R_2 = ? and f = 6.5 cm : So using the mentioned formula we have : (0.65 -1)$\left(\frac{1}{\infty}-\frac{1}{R_2}\right)$ = 1/6.5 ⇒ -0.35/R2 = 1/6.5 SoR_2 = -2.275cm. = -2.275cm.*

155. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)=\frac{1}{f}$ .According to question μ = ? , R_1 = +f ,R_2 = -f (where f is the focal length) So using the mentioned formula we have :$(\mu-1)\left(\frac{1}{+f}-\frac{1}{-f}\right)=\frac{1}{f}\Rightarrow(\mu-1)\left(\frac{2}{f}\right)=\frac{1}{f}\Rightarrow(\mu-1)$ = (1/2): So μ = (1 +(1/2)) = 3/2 = 1.5 ....Ans.

156. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 0.65What should be the radius of curvature for the focal length of the lens to be 19.5 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)=\frac{1}{f}$ .According to question μ = 0.65 , R_1 = +R ,R_2 = -R and the focal length = 19.5 cm. So using the mentioned formula we have : (0.65 -1)$\left(\frac{1}{+R}-\frac{1}{-R}\right)$ = 1/19.5 ⇒ -0.35× $\left(\frac{2}{R}\right)$ = (1/19.5) ⇒ R = -13.65cm. Radius of curvature of both faces is equal to -13.65cm.

157. The focal length of a convex lens in air is 15 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 2 (11) 4 (iii) 1.5 (iv) 3

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)=\frac{1}{f_a}$.——(1) Where fa is focal length in air Similarly focal length in media will be given as :$({}_m\mu^g-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)=\frac{1}{f_m}$.———(2) Where f_m is focal length in media dividing equation (1) by (2) we get:$f_m=\frac{{}_a\mu^g-1}{{}_m\mu^g-1}\times f_a$. Which can be rearrange as :$f_m=\frac{({}_a\mu^g-1)\times_a\mu^m}{({}_a\mu^g-_a\mu^m)}\times$ f_a :

⇒ (1) f_m = [(1.5 -1) × 2/(1.5 - 2)] × 15 ⇒ f_m = -30cm. ⇒ So focal length in the media will be given as : -30cm.
(2) f_m = [(1.5 -1) × 4/(1.5 - 4)] × 15 ⇒ f_m = -12cm. ⇒ So focal length in the media will be given as : -12cm.
(3) f_m = [(1.5 -1) × 1.5/(1.5 - 1.5)] × 15 ⇒ f_m = Infinitycm. ⇒ So focal length in the media will be given as : Infinitycm.
(4) f_m = [(1.5 -1) × 3/(1.5 - 3)] × 15 ⇒ f_m = -15cm. ⇒ So focal length in the media will be given as : -15cm.

158. The radius of curvatures of a double convex lens are 29 cm. and 38 cm respectively while refractive index of the material of lens w.r.t air is 0.75. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)=\frac{1}{f_a}$. Where fa is focal length in air According to question μ = 0.75 , R_1 = 29 cm. ,R_2 = -38 cm. So using the mentioned formula we have : [(0.75 -1)(1/(+29) - 1/(-38))] = $\frac{1}{f}$ ⇒ f = [(29 × 38)/((0.75 -1) × (29 + 38))] after solving it we get f = -65.79105

159. The radius of curvatures of a double convex lens are 23 cm , 38 cm respectively and focal length21.5 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)=\frac{1}{f_a}$. Where fa is focal length in air According to question μ = ? , R_1 = 23 cm. ,R_2 = -38 cm.and focal length f = 21.5 cm. So using the mentioned formula we have : [(μ -1)(1/(+23) - 1/(-38)) = 1/21.5] ⇒ (μ -1) = [(23 × 38)/((21.5) × (23 + 38))] after solving it we get μ = 1.666412

160. If the ratio of radius of curvatures of a biconvex lens is 3 : 4 and focal length is 22 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 28 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)=\frac{1}{f_a}$. Where fa is focal length in air According to question μ = ? , R_1 = 3R = 84cm.,R_2 = -4R = -112cm. and focal length f = 22 cm. So using the mentioned formula we have : [(μ -1)(1/(+84) - 1/(-112))] = 1/22 ⇒ (μ -1) = [((3 × 4)/(3 + 4)) × 28 × 1 / 22] ⇒ μ = [((3 × 4)/(3 + 4)) × 28 × 1 / 22] + 1 after solving it we get μ = 3.181818

161. If the ratio of radius of curvatures of a biconvex lens is 2 : 5 and refractive index of the material of lens w.r.t air is 1.6 while curvature of first surface is 35 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)=\frac{1}{f_a}$. Where fa is focal length in air According to question μ = 1.6 , R_1 = 2R = 70cm.,R_2 = -5R = -175cm. and focal length f = ? So using the mentioned formula we have : [(1.6 -1)(1/(+70) - 1/(-175))] = $\frac{1}{f}$ ⇒ f = [((2 × 5 × 35)/((2 + 5) × (1.6- 1))] after solving it we get f = 83.33333

162. An object 5 cm high is placed 41 cm in front of a convex lens of focal length 14 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -41 cm. , f = 14 cm. and height of the object h = 5cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 14 = 1/v - 1/ -41 ⇒ v = [(41 × 14)/(41 - 14)] = 21.25926cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |21.25926/41| = |Im/5| ⇒ Im = 2.592593 cm.*

163. An object 6 cm high is placed 45 cm in front of a concave lens of focal length -20 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -45 cm. , f = -20 cm. and height of the object h = 6cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -20 = 1/v - 1/ -45 ⇒ v = [(45 × -20)/(45 + 20)] = -13.84615cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-13.84615/45| = |Im/6| ⇒ Im = 1.846154 cm.*

164. An object placed 18 cm. from a lens produces a virtual/real image at 13 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 9cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -18 cm. , v = 13 cm. and height of the object h = 9cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/13 - 1/ -18 ⇒ f = [(18 × 13)/(18 + 13)] = 7.548387cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |13/18| = |Im/9| ⇒ Im = 6.5 cm. Next case: (b)image is unreal u = -18 cm. , v = -13 cm. and height of the object h = 9cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-13) - 1/ (-18) ⇒ f = [(18 × -13)/(18 + -13)] = -46.8cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-13/18| = |Im/9| ⇒ Im = 6.5 cm.*

165. An object is placed 189 cm from a screen. A converging lens with a 32 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (189 - x) cm. while focal length given is f = 32 cm. Using the mentioned formula : 1/32 = 1/(189 - x) - 1/-x = 189 / ((189 - x) × x) . After Solving it we get x = 148.1866 cm. the distance from the object for the placement of the lens is = 148.1866 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |40.81342/148.1866| = 0.2754191*

166. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 1.52. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(3 × 10^8)/ 1.52 = 1.973684× 10^8 m/sec.*

167. The refractive index of media1 w.r.t air is 0.55 and of media2 w.r.t air is 2.6 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 2.6 / 0.55 = 4.73*

168. The refractive index of media1 w.r.t air is 1.9 and refractive index of media1 w.r.t media2 is 1.95 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow {}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 1.95 = 1.9/* ${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 1.9 / 1.95 = 0.97*

169. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 16.5cm and refractive index of the material of lens material w.r.t air is 3.25

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to* *question* $\mu = 3.25$, $R_1 =$ *infinity* ,$R_2 =$? *and f = 16.5 cm : So using the mentioned formula we have :* (3.25 -1)$\left(\frac{1}{\infty} - \frac{1}{R_2}\right) =$ 1/16.5 ⇒ 2.25/R2 = 1/16.5 So$R_2 = 37.125cm. = 37.125cm.$

170. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$? , $R_1 = +f$,$R_2 = -f$ *(where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ = (1/2): So μ = (1 +(1/2)) = 3/2 = 1.5 ....Ans.

171. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 0.65What should be the radius of curvature for the focal length of the lens to be 6.5 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu = 0.65$, $R_1 = +R$,$R_2 = -R$ *and the focal length = 6.5 cm. So using the mentioned formula we have :* (0.65 - 1)$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ = 1/6.5 ⇒ -0.35× $\left(\frac{2}{R}\right)$ = (1/6.5) ⇒ R = -4.55cm. *Radius of curvature of both faces is equal to -4.55cm.*

172. The focal length of a convex lens in air is 13.5 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25 (iii) 1.125 (iv) 2.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$.——(1) *Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$.——(2) *Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$. *Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times {}_a\mu^m}{({}_a\mu^g - {}_a\mu^m)} \times f_a$:

⇒ (1) f_m = [(1.5 -1) × 1.25/(1.5 - 1.25)] × 13.5 ⇒ f_m = 33.75cm. ⇒ *So focal length in the media will be given as :* 33.75cm.
(2) f_m = [(1.5 -1) × 3.25/(1.5 - 3.25)] × 13.5 ⇒ f_m = -12.53571cm. ⇒ *So focal length in the media will be given as :* -12.53571cm.
(3) f_m = [(1.5 -1) × 1.125/(1.5 - 1.125)] × 13.5 ⇒ f_m = 20.25cm. ⇒ *So focal length in the media will be given as :* 20.25cm.
(4) f_m = [(1.5 -1) × 2.25/(1.5 - 2.25)] × 13.5 ⇒ f_m = -20.25cm. ⇒ *So focal length in the media will be given as :* -20.25cm.

173. The radius of curvatures of a double convex lens are 47 cm. and 33 cm respectively while refractive index of the material of lens w.r.t air is 2.25. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$. *Where fa is focal length in air According to question* $\mu = 2.25$, $R_1 = 47$ cm. ,$R_2 = -33$ cm. *So using the mentioned formula we have :* [(2.25 -1)(1/(+47) - 1/(-33))] = $\frac{1}{f}$ ⇒ f = [(47 × 33)/((2.25 -1) × (47 + 33))] *after solving it we get f* = 15.51

174. The radius of curvatures of a double convex lens are 29 cm , 34 cm respectively and focal length26.5 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$. *Where fa is focal length in air According to question* $\mu =$? , $R_1 = 29$ cm. ,$R_2 = -34$ cm.*and focal length f = 26.5 cm. So using the mentioned formula we have :* [(μ -1)(1/(+29) - 1/(-34)) = 1/26.5] ⇒ (μ -1) = [(29 × 34)/((26.5) × (29 + 34))] *after solving it we get* $\mu = 1.590596$

175. If the ratio of radius of curvatures of a biconvex lens is 3 : 5 and focal length is 27 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 23 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$. *Where fa is focal length in air According to question* $\mu =$? , $R_1 = 3R$ = 69cm.,$R_2 = -5R$ = -115cm. *and focal length f = 27 cm. So using the mentioned formula we have :* [(μ -1)(1/(+69) - 1/(-115))] = 1/27 ⇒ (μ -1) = [((3 × 5)/(3 + 5)) × 23 × 1 / 27] ⇒ μ = [((3 × 5)/(3 + 5)) × 23 × 1 / 27] + 1 *after solving it we get* $\mu = 2.597222$

176. If the ratio of radius of curvatures of a biconvex lens is 3 : 4 and refractive index of the material of lens w.r.t air is 3.2 while curvature of first surface is 35 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$. *Where fa is focal length in air According to question* $\mu = 3.2$, $R_1 = 3R$ = 105cm.,$R_2 = -4R$ = -140cm. *and focal length f = ? So using the mentioned formula we have :* [(3.2 -1)(1/(+105) - 1/(-140))] = $\frac{1}{f}$ ⇒ f = [((3 × 4 × 35)/((3 + 4) × (3.2- 1))] *after solving it we get f* = 27.27273

177. An object 5 cm high is placed 41 cm in front of a convex lens of focal length 18 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -41 cm. , f = 18 cm. and height of the object h = 5cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 18 = 1/v - 1/ -41 ⇒ v = [(41 × 18)/(41 - 18)] = 32.08696cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |32.08696/41| = |Im/5| ⇒ Im = 3.913043 cm.*

178. An object 9 cm high is placed 35 cm in front of a concave lens of focal length -33 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -35 cm. , f = -33 cm. and height of the object h = 9cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -33 = 1/v - 1/ -35 ⇒ v = [(35 × -33)/(35 + 33)] = -16.98529cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-16.98529/35| = |Im/9| ⇒ Im = 4.367647 cm.*

179. An object placed 48 cm. from a lens produces a virtual/real image at 13 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 7cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -48 cm. , v = 13 cm. and height of the object h = 7cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/13 - 1/ -48 ⇒ f = [(48 × 13)/(48 + 13)] = 10.22951cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |13/48| = |Im/7| ⇒ Im = 1.895833 cm. Next case: (b)image is unreal u = -48 cm. , v = -13 cm. and height of the object h = 7cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-13) - 1/ (-48) ⇒ f = [(48 × -13)/(48 + -13)] = -17.82857cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-13/48| = |Im/7| ⇒ Im = 1.895833 cm.*

180. An object is placed 175 cm from a screen. A converging lens with a 18 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (175 - x) cm. while focal length given is f = 18 cm. Using the mentioned formula : 1/18 = 1/(175 - x) - 1/-x = 175 / ((175 - x) × x) . After Solving it we get x = 154.6286 cm. the distance from the object for the placement of the lens is = 154.6286 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |20.3714/154.6286| = 0.1317441*

181. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 3.04. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} = (3 \times 10^8)/3.04 = 9.868421 \times 10^7$ *m/sec.*

182. The refractive index of media1 w.r.t air is 2.2 and of media2 w.r.t air is 0.65 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} = 0.65/2.2 = 0.3$

183. The refractive index of media1 w.r.t air is 1.9 and refractive index of media1 w.r.t media2 is 0.65 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow$ ${}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 0.65 = 1.9/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 1.9 / 0.65 = 2.92*

184. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 20cm and

refractive index of the material of lens material w.r.t air is 1.95

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu = 1.95$ *,* $R_1 =$ *infinity ,*$R_2 = ?$ *and f = 20 cm : So using the mentioned formula we have : (1.95 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right) =$ *1/20* $\Rightarrow$ *0.95/R2 = 1/20 So*$R_2 =$ *19cm. = 19cm.*

185. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu = ?$ *,* $R_1 = +f$*,*$R_2 = -f$ *(where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* $\mu =$ *(1 +(1/2)) = 3/2 = 1.5 ....Ans.*

186. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 1.3What should be the radius of curvature for the focal length of the lens to be 6 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *1.3 ,* $R_1 = +R$ *,*$R_2 = -R$ *and the focal length = 6 cm. So using the mentioned formula we have : (1.3 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/6* $\Rightarrow$ *0.3*$\times\left(\frac{2}{R}\right)$ *= (1/6)* $\Rightarrow$ *R = 3.599999cm. Radius of curvature of both faces is equal to 3.599999cm.*

187. The focal length of a convex lens in air is 21.5 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 2 (11) 4 (iii) 1.5 (iv) 3

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times {}_a\mu^m}{({}_a\mu^g - {}_a\mu^m)} \times f_a$ *:*$\Rightarrow$*(1)* f_m *= [(1.5 -1)* $\times$ *2/(1.5 - 2)]* $\times$ *21.5* $\Rightarrow f_m$ *= -43cm.* $\Rightarrow$ *So focal length in the media will be given as : -43cm.*
(2) f_m *= [(1.5 -1)* $\times$ *4/(1.5 - 4)]* $\times$ *21.5* $\Rightarrow f_m$ *= -17.2cm.* $\Rightarrow$ *So focal length in the media will be given as : -17.2cm.*
(3) f_m *= [(1.5 -1)* $\times$ *1.5/(1.5 - 1.5)]* $\times$ *21.5* $\Rightarrow f_m$ *= Infinitycm.* $\Rightarrow$ *So focal length in the media will be given as : Infinitycm*
.(4) f_m *= [(1.5 -1)* $\times$ *3/(1.5 - 3)]* $\times$ *21.5* $\Rightarrow f_m$ *= -21.5cm.* $\Rightarrow$ *So focal length in the media will be given as : -21.5cm.*

188. The radius of curvatures of a double convex lens are 27 cm. and 38 cm respectively while refractive index of the material of lens w.r.t air is 2.25. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu =$ *2.25 ,* $R_1 =$ *27 cm. ,*$R_2 =$ *-38 cm. So using the mentioned formula we have : [(2.25 -1)(1/(+27) - 1/(-38))] =* $\frac{1}{f}$ $\Rightarrow$ *f = [(27* $\times$ *38)/((2.25 -1)* $\times$ *(27 + 38))] after solving it we get f = 12.62769*

189. The radius of curvatures of a double convex lens are 25 cm , 36 cm respectively and focal length25.5 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 =$ *25 cm. ,*$R_2 =$ *-36 cm.and focal length f = 25.5 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+25) - 1/(-36)) = 1/25.5]* $\Rightarrow$ *(* μ *-1) = [(25* $\times$ *36)/((25.5)* $\times$ *(25 + 36))] after solving it we get* $\mu =$ *1.578592*

190. If the ratio of radius of curvatures of a biconvex lens is 2 : 4 and focal length is 23 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 23 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 =$ *2R = 46cm.,*$R_2 =$ *-4R = -92cm. and focal length f = 23 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+46) - 1/(-92))] = 1/23* $\Rightarrow$ *(* μ *-1) = [((2* $\times$ *4)/(2 + 4))* $\times$ *23* $\times$ *1 / 23]* $\Rightarrow \mu =$ *[((2* $\times$ *4)/(2 + 4))* $\times$ *23* $\times$ *1 / 23] + 1 after solving it we get* $\mu =$ *2.333333*

191. If the ratio of radius of curvatures of a biconvex lens is 2 : 3 and refractive index of the material of lens w.r.t air is 1.6 while curvature of first surface is 28 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal* *length in air According to question $\mu = 1.6$, $R_1 = 2R = 56cm.$, $R_2 = -3R = -84cm.$ and focal length f = ? So using the mentioned formula we have : [(1.6 -1)(1/(+56) - 1/(-84))] = $\frac{1}{f}$ ⇒ f = [((2 × 3 × 28)/((2 + 3) × (1.6- 1))] after solving it we get f = 56*

192. An object 1 cm high is placed 43 cm in front of a convex lens of focal length 15 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. Where f is focal length of the lens According to question u = -43 cm. , f = 15 cm. and height of the object h = 1cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 15 = 1/v - 1/ -43 ⇒ v = [(43 × 15)/(43 - 15)] = 23.03572cm.(b) And for height of Image we have $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ ⇒ |23.03572/43| = |Im/1| ⇒ Im = 0.5357143 cm.

193. An object 7 cm high is placed 21 cm in front of a concave lens of focal length -36 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. Where f is focal length of the lens According to question u = -21 cm. , f = -36 cm. and height of the object h = 7cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -36 = 1/v - 1/ -21 ⇒ v = [(21 × -36)/(21 + 36)] = -13.26316cm.(b) And for height of Image we have $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ ⇒ |-13.26316/21| = |Im/7| ⇒ Im = 4.421052 cm.

194. An object placed 25 cm. from a lens produces a virtual/real image at 36 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 4cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. Where f is focal length of the lens According to question:(a) If image is real u = -25 cm. , v = 36 cm. and height of the object h = 4cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have $\frac{1}{f}$ = 1/36 - 1/ -25 ⇒ f = [(25 × 36)/(25 + 36)] = 14.7541cm. And for height of Image we have $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ ⇒ |36/25| = |Im/4| ⇒ Im = 5.76 cm. Next case: (b)image is unreal u = -25 cm. , v = -36 cm. and height of the object h = 4cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have $\frac{1}{f}$ = 1/(-36) - 1/ (-25) ⇒ f = [(25 × -36)/(25 + -36)] = 81.81818cm.(b) And for height of Image we have $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ ⇒ |-36/25| = |Im/4| ⇒ Im = 5.76 cm.

195. An object is placed 140 cm from a screen. A converging lens with a 18 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (140 - x) cm. while focal length given is f = 18 cm. Using the mentioned formula : 1/18 = 1/(140 - x) - 1/-x = 140 / ((140 - x) × x) . After Solving it we get x = 118.7852 cm. the distance from the object for the placement of the lens is = 118.7852 cm.(b) And for magnifications have $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ ⇒ |21.21476/118.7852| = 0.1785976

196. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 1.52. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ Using the mentioned formula we have : ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}}$ ⇒ V_{m_2} = (3 × 10^8)/ 1.52 = 1.973684× 10^8 m/sec.

197. The refractive index of media1 w.r.t air is 0.55 and of media2 w.r.t air is 2.6 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ as : ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ = 2.6 / 0.55 = 4.73

198. The refractive index of media1 w.r.t air is 2.85 and refractive index of media1 w.r.t media2 is 2.6 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ as : ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ ⇒ ${}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ = 2.6 = 2.85/ ${}_a\mu^{m_2}$: So ${}_a\mu^{m_2}$ = 2.85 / 2.6 = 1.1

199. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 7cm and refractive index of the material of lens material w.r.t air is 1.95

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 1.95 ,* R_1 *= infinity ,*R_2 *= ? and f = 7 cm : So using the mentioned formula we have : (1.95 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/7* $\Rightarrow$ *0.95/R2 = 1/7 So*R_2 *= 6.650001cm. = 6.650001cm.*

200. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= ? ,* R_1 *= +f ,*R_2 *= -f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* μ *= (1 +(1/2)) = 3/2 = 1.5 ....Ans.*

201. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 1.95What should be the radius of curvature for the focal length of the lens to be 14.5 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 1.95 ,* R_1 *= +R ,*R_2 *= -R and the focal length = 14.5 cm. So using the mentioned formula we have : (1.95 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/14.5* $\Rightarrow$ *0.95*$\times\left(\frac{2}{R}\right)$ *= (1/14.5)* $\Rightarrow$ *R = 27.55cm. Radius of curvature of both faces is equal to 27.55cm.*

202. The focal length of a convex lens in air is 24 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 2 (11) 4 (iii) 1.5 (iv) 3

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times_a \mu^m}{({}_a\mu^g -_a \mu^m)} \times f_a$ *:*

$\Rightarrow$ *(1)* f_m *= [(1.5 -1)* $\times$ *2/(1.5 - 2)]* $\times$ *24* $\Rightarrow$ f_m *= -48cm.* $\Rightarrow$ *So focal length in the media will be given as : -48cm.*
(2) f_m *= [(1.5 -1)* $\times$ *4/(1.5 - 4)]* $\times$ *24* $\Rightarrow$ f_m *= -19.2cm.* $\Rightarrow$ *So focal length in the media will be given as : -19.2cm.*
(3) f_m *= [(1.5 -1)* $\times$ *1.5/(1.5 - 1.5)]* $\times$ *24* $\Rightarrow$ f_m *= Infinitycm.* $\Rightarrow$ *So focal length in the media will be given as : Infinitycm.*
(4) f_m *= [(1.5 -1)* $\times$ *3/(1.5 - 3)]* $\times$ *24* $\Rightarrow$ f_m *= -24cm.* $\Rightarrow$ *So focal length in the media will be given as : -24cm.*

203. The radius of curvatures of a double convex lens are 33 cm. and 35 cm respectively while refractive index of the material of lens w.r.t air is 2.25. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= 2.25 ,* R_1 *= 33 cm. ,*R_2 *= -35 cm. So using the mentioned formula we have : [(2.25 -1)(1/(+33) - 1/(-35))] =* $\frac{1}{f}$ $\Rightarrow$ *f = [(33* $\times$ *35)/((2.25 -1)* $\times$ *(33 + 35))] after solving it we get f = 13.58823*

204. The radius of curvatures of a double convex lens are 42 cm , 31 cm respectively and focal length11 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= ? ,* R_1 *= 42 cm. ,*R_2 *= -31 cm.and focal length f = 11 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+42) - 1/(-31)) = 1/11]* $\Rightarrow$ *(* μ *-1) = [(42* $\times$ *31)/((11)* $\times$ *(42 + 31))] after solving it we get* μ *= 2.62142*

205. If the ratio of radius of curvatures of a biconvex lens is 4 : 5 and focal length is 20 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 39 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= ? ,* R_1 *= 4R = 156cm.,*R_2 *= -5R = -195cm. and focal length f = 20 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+156) - 1/(-195))] = 1/20* $\Rightarrow$ *(* μ *-1) = [((4* $\times$ *5)/(4 + 5))* $\times$ *39* $\times$ *1 / 20]* $\Rightarrow$ μ *= [((4* $\times$ *5)/(4 + 5))* $\times$ *39* $\times$ *1 / 20] + 1 after solving it we get* μ *= 5.333333*

206. If the ratio of radius of curvatures of a biconvex lens is 4 : 5 and refractive index of the material of lens w.r.t air

is 2.4 while curvature of first surface is 27 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 2.4$ *,* $R_1 = 4R$ *= 108cm.,* $R_2 = -5R$ *= -135cm. and focal length f = ? So using the mentioned formula we have : [(2.4 -1)(1/(+108) - 1/(-135))] =* $\frac{1}{f}$ *⇒ f = [((4 × 5 × 27)/((4 + 5) × (2.4- 1))] after solving it we get f = 42.85714*

207. An object 4 cm high is placed 8 cm in front of a convex lens of focal length 28 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -8 cm. , f = 28 cm. and height of the object h = 4cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 28 = 1/v - 1/ -8 ⇒ v = [(8 × 28)/(8 - 28)] = -11.2cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |-11.2/8| = |Im/4| ⇒ Im = 5.6 cm.*

208. An object 3 cm high is placed 18 cm in front of a concave lens of focal length -17 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -18 cm. , f = -17 cm. and height of the object h = 3cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -17 = 1/v - 1/ -18 ⇒ v = [(18 × -17)/(18 + 17)] = -8.742857cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |-8.742857/18| = |Im/3| ⇒ Im = 1.457143 cm.*

209. An object placed 29 cm. from a lens produces a virtual/real image at 21 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 2cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -29 cm. , v = 21 cm. and height of the object h = 2cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/21 - 1/ -29 ⇒ f = [(29 × 21)/(29 + 21)] = 12.18cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |21/29| = |Im/2| ⇒ Im = 1.448276 cm. Next case: (b)image is unreal u = -29 cm. , v = -21 cm. and height of the object h = 2cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-21) - 1/ (-29) ⇒ f = [(29 × -21)/(29 + -21)] = -76.125cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |-21/29| = |Im/2| ⇒ Im = 1.448276 cm.*

210. An object is placed 162 cm from a screen. A converging lens with a 23 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (162 - x) cm. while focal length given is f = 23 cm. Using the mentioned formula : 1/23 = 1/(162 - x) - 1/-x = 162 / ((162 - x) × x) . After Solving it we get x = 134.2447 cm. the distance from the object for the placement of the lens is = 134.2447 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |27.75528/134.2447| = 0.2067514*

211. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 0.76. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}}$ *⇒* V_{m_2} *= (3 × 10⁸)/ 0.76 = 3.947368×10⁸ m/sec.*

212. The refractive index of media1 w.r.t air is 1.65 and of media2 w.r.t air is 1.3 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 1.3 / 1.65 = 0.79*

213. The refractive index of media1 w.r.t air is 0.95 and refractive index of media1 w.r.t media2 is 1.95 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *⇒*

$_{m_2}\mu^{m_1} = \frac{_a\mu^{m_1}}{_a\mu^{m_2}}$ = 1.95 = 0.95/$_a\mu^{m_2}$: So $_a\mu^{m_2}$ = 0.95 / 1.95 = 0.49

214. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 16.5cm and refractive index of the material of lens material w.r.t air is 2.6

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ = 2.6 , R_1 = *infinity* ,R_2 = ? *and f = 16.5 cm : So using the mentioned formula we have : (2.6 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ = *1/16.5* ⇒ *1.6/R2 = 1/16.5 So*R_2 = *26.4cm. = 26.4cm.*

215. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ = ? , R_1 = +f ,R_2 = -f *(where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ = *(1/2): So* μ = *(1 +(1/2)) = 3/2 = 1.5 ....Ans.*

216. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 1.3What should be the radius of curvature for the focal length of the lens to be 20.5 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ = *1.3* , R_1 = +R ,R_2 = -R *and the focal length = 20.5 cm. So using the mentioned formula we have : (1.3 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/20.5* ⇒ *0.3*×$\left(\frac{2}{R}\right)$ *= (1/20.5)* ⇒ *R = 12.3cm. Radius of curvature of both faces is equal to 12.3cm.*

217. The focal length of a convex lens in air is 23 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 2 (11) 4 (iii) 1.5 (iv) 3

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{_a\mu^g - 1}{_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{(_a\mu^g - 1) \times_a \mu^m}{(_a\mu^g -_a \mu^m)} \times f_a$ *:*

⇒ *(1)* f_m *= [(1.5 -1) × 2/(1.5 - 2)] × 23* ⇒ f_m *= -46cm.* ⇒ *So focal length in the media will be given as : -46cm.*

(2) f_m *= [(1.5 -1) × 4/(1.5 - 4)] × 23* ⇒ f_m *= -18.4cm.* ⇒ *So focal length in the media will be given as : -18.4cm.*

(3) f_m *= [(1.5 -1) × 1.5/(1.5 - 1.5)] × 23* ⇒ f_m *= Infinitycm.* ⇒ *So focal length in the media will be given as : Infinitycm.*

(4) f_m *= [(1.5 -1) × 3/(1.5 - 3)] × 23* ⇒ f_m *= -23cm.* ⇒ *So focal length in the media will be given as : -23cm.*

218. The radius of curvatures of a double convex lens are 28 cm. and 37 cm respectively while refractive index of the material of lens w.r.t air is 0.75. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ = *0.75* , R_1 = *28 cm.* ,R_2 = *-37 cm. So using the mentioned formula we have : [(0.75 -1)(1/(+28) - 1/(-37))] =* $\frac{1}{f}$ ⇒ *f = [(28 × 37)/((0.75 -1) × (28 + 37))] after solving it we get f = -63.75385*

219. The radius of curvatures of a double convex lens are 49 cm , 38 cm respectively and focal length17 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ = ? , R_1 = *49 cm.* ,R_2 = *-38 cm.and focal length f = 17 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+49) - 1/(-38)) = 1/17]* ⇒ *(* μ *-1) = [(49 × 38)/((17) × (49 + 38))] after solving it we get* μ = *2.258959*

220. If the ratio of radius of curvatures of a biconvex lens is 2 : 3 and focal length is 25 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 31 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ = ? , R_1 = *2R = 62cm.*,R_2 = *-3R = -93cm. and focal length f = 25 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+62) - 1/(-93))] = 1/25* ⇒ *(* μ *-1) = [((2 × 3)/(2 + 3)) × 31 × 1 / 25]* ⇒ μ = *[((2 × 3)/(2 + 3)) × 31 × 1 / 25] + 1 after solving it we get* μ = *2.488*

221. If the ratio of radius of curvatures of a biconvex lens is 2 : 5 and refractive index of the material of lens w.r.t air is 1.6 while curvature of first surface is 28 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= 1.6 ,* $R_1 = 2R$ *= 56cm.,*$R_2 =$ *-5R = -140cm. and focal length f = ? So using the mentioned formula we have : [(1.6 -1)(1/(+56) - 1/(-140))] =* $\frac{1}{f}$ *⇒ f = [((2 × 5 × 28)/((2 + 5) × (1.6- 1))] after solving it we get f = 66.66666*

222. An object 2 cm high is placed 59 cm in front of a convex lens of focal length 16 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -59 cm. , f = 16 cm. and height of the object h = 2cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 16 = 1/v - 1/ -59 ⇒ v = [(59 × 16)/(59 - 16)] = 21.95349cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |21.95349/59| = |Im/2| ⇒ Im = 0.7441861 cm.*

223. An object 8 cm high is placed 23 cm in front of a concave lens of focal length -24 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -23 cm. , f = -24 cm. and height of the object h = 8cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -24 = 1/v - 1/ -23 ⇒ v = [(23 × -24)/(23 + 24)] = -11.74468cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |-11.74468/23| = |Im/8| ⇒ Im = 4.085106 cm.*

224. An object placed 42 cm. from a lens produces a virtual/real image at 35 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 1cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -42 cm. , v = 35 cm. and height of the object h = 1cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/35 - 1/ -42 ⇒ f = [(42 × 35)/(42 + 35)] = 19.09091cm. And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |35/42| = |Im/1| ⇒ Im = 0.8333333 cm. Next case: (b)image is unreal u = -42 cm. , v = -35 cm. and height of the object h = 1cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-35) - 1/(-42) ⇒ f = [(42 × -35)/(42 + -35)] = -210cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |-35/42| = |Im/1| ⇒ Im = 0.8333333 cm.*

225. An object is placed 164 cm from a screen. A converging lens with a 34 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (164 - x) cm. while focal length given is f = 34 cm. Using the mentioned formula : 1/34 = 1/(164 - x) - 1/-x = 164 / ((164 - x) × x) . After Solving it we get x = 115.8821 cm. the distance from the object for the placement of the lens is = 115.8821 cm.(b) And for magnifications have*$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ *⇒ |48.11785/115.8821| = 0.4152309*

226. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 3.04. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as :${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(3 ×* 10^8 *)/ 3.04 = 9.868421E+07 m/sec.*

227. The refractive index of media1 w.r.t air is 0.55 and of media2 w.r.t air is 0.65 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.rt media1 ${}_{m_1}\mu^{m_2}$ *as :*${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 0.65 / 0.55 = 1.18*

228. The refractive index of media1 w.r.t air is 2.85 and refractive index of media1 w.r.t media2 is 2.6 . What is

refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 $_{m_1}\mu^{m_2}$ *as* :$_{m_1}\mu^{m_2} = \frac{_a\mu^{m_2}}{_a\mu^{m_1}} \Rightarrow$ $_{m_2}\mu^{m_1} = \frac{_a\mu^{m_1}}{_a\mu^{m_2}}$ *= 2.6 = 2.85/*$_a\mu^{m_2}$ *: So* $_a\mu^{m_2}$ *= 2.85 / 2.6 = 1.1*

229. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 21cm and refractive index of the material of lens material w.r.t air is 1.3

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 1.3 ,* R_1 *= infinity ,*R_2 *= ? and f = 21 cm : So using the mentioned formula we have : (1.3 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/21* $\Rightarrow$ *0.3/R2 = 1/21 So*R_2 *= 6.299999cm. = 6.299999cm.*

230. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= ? ,* R_1 *= +f ,*R_2 *= -f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* μ *= (1 +(1/2)) = 3/2 = 1.5 ....Ans.*

231. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 1.95What should be the radius of curvature for the focal length of the lens to be 10 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 1.95 ,* R_1 *= +R ,*R_2 *= -R and the focal length = 10 cm. So using the mentioned formula we have : (1.95 - 1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/10* $\Rightarrow$ *0.95×*$\left(\frac{2}{R}\right)$ *= (1/10)* $\Rightarrow$ *R = 19cm. Radius of curvature of both faces is equal to 19cm.*

232. The focal length of a convex lens in air is 11.5 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25 (iii) 1.125 (iv) 2.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times_a \mu^m}{({}_a\mu^g -_a \mu^m)} \times f_a$ *:*

$\Rightarrow$ *(1)* f_m *= [(1.5 -1) × 1.25/(1.5 - 1.25)] × 11.5* $\Rightarrow$ f_m *= 28.75cm.* $\Rightarrow$ *So focal length in the media will be given as : 28.75cm.*

(2) f_m *= [(1.5 -1) × 3.25/(1.5 - 3.25)] × 11.5* $\Rightarrow$ f_m *= -10.67857cm.* $\Rightarrow$ *So focal length in the media will be given as : -10.67857cm.*

(3) f_m *= [(1.5 -1) × 1.125/(1.5 - 1.125)] × 11.5* $\Rightarrow$ f_m *= 17.25cm.* $\Rightarrow$ *So focal length in the media will be given as : 17.25cm.*

(4) f_m *= [(1.5 -1) × 2.25/(1.5 - 2.25)] × 11.5* $\Rightarrow$ f_m *= -17.25cm.* $\Rightarrow$ *So focal length in the media will be given as : -17.25cm.*

233. The radius of curvatures of a double convex lens are 44 cm. and 36 cm respectively while refractive index of the material of lens w.r.t air is 0.75. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= 0.75 ,* R_1 *= 44 cm. ,*R_2 *= -36 cm. So using the mentioned formula we have : [(0.75 -1)(1/(+44) - 1/(-36))] =* $\frac{1}{f}$ $\Rightarrow$ *f = [(44 × 36)/((0.75 -1) × (44 + 36))] after solving it we get f = -79.2*

234. The radius of curvatures of a double convex lens are 25 cm , 31 cm respectively and focal length20 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= ? ,* R_1 *= 25 cm. ,*R_2 *= -31 cm.and focal length f = 20 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+25) - 1/(-31)) = 1/20]* $\Rightarrow$ *(* μ *-1) = [(25 × 31)/((20) × (25 + 31))] after solving it we get* μ *= 1.691964*

235. If the ratio of radius of curvatures of a biconvex lens is 3 : 4 and focal length is 16 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 29 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= ? ,* R_1 *= 3R = 87cm.,*R_2 *= -4R = -116cm. and focal length f = 16 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+87) - 1/(-116))] = 1/16* $\Rightarrow$ *(* μ *-1) = [((3 × 4)/(3 + 4)) × 29 × 1 / 16]*

$\Rightarrow \mu$ = [((3 × 4)/(3 + 4)) × 29 × 1 / 16] + 1 after solving it we get $\mu = 4.107143$

236. If the ratio of radius of curvatures of a biconvex lens is 3 : 5 and refractive index of the material of lens w.r.t air is 2.4 while curvature of first surface is 29 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 2.4$, $R_1 = 3R$ = 87cm., R_2 = -5R = -145cm. *and focal length f = ? So using the mentioned formula we have :* [(2.4 -1)(1/(+87) - 1/(-145))] = $\frac{1}{f}$

$\Rightarrow$ f = [((3 × 5 × 29)/((3 + 5) × (2.4- 1))] *after solving it we get* f = 38.83928

237. An object 5 cm high is placed 54 cm in front of a convex lens of focal length 15 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -54 cm. , f = 15 cm. and height of the object h = 5cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have* 1/ 15 = 1/v - 1/ -54 $\Rightarrow$ v = [(54 × 15)/(54 - 15)] = 20.76923cm.*(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ $\Rightarrow$ |20.76923/54| = |Im/5| $\Rightarrow$ Im = 1.923077 cm.

238. An object 7 cm high is placed 21 cm in front of a concave lens of focal length -21 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -21 cm. , f = -21 cm. and height of the object h = 7cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have* 1/ -21 = 1/v - 1/ -21 $\Rightarrow$ v = [(21 × -21)/(21 + 21)] = -10.5cm.*(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ $\Rightarrow$ |-10.5/21| = |Im/7| $\Rightarrow$ Im = 3.5 cm.

239. An object placed 31 cm. from a lens produces a virtual/real image at 34 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 8cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -31 cm. , v = 34 cm. and height of the object h = 8cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ = 1/34 - 1/ -31 $\Rightarrow$ f = [(31 × 34)/(31 + 34)] = 16.21539cm. *And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ $\Rightarrow$ |34/31| = |Im/8| $\Rightarrow$ Im = 8.774194 cm. *Next case: (b)image is unreal u = -31 cm. , v = -34 cm. and height of the object h = 8cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ = 1/(-34) - 1/(-31) $\Rightarrow$ f = [(31 × -34)/(31 + -34)] = 351.3333cm.*(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ $\Rightarrow$ |-34/31| = |Im/8| $\Rightarrow$ Im = 8.774194 cm.

240. An object is placed 148 cm from a screen. A converging lens with a 25 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (148 - x) cm. while focal length given is f = 25 cm. Using the mentioned formula :* 1/25 = 1/(148 - x) - 1/-x = 148 / ((148 - x) × x) *. After Solving it we get x = 116.1426 cm. the distance from the object for the placement of the lens is = 116.1426 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ $\Rightarrow$ |31.85738/116.1426| = 0.2742954

241. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 2.28. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as : ${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2}$ = (3 × 10^8)/ 2.28 = 1.31579×10^8 m/sec.

242. The refractive index of media1 w.r.t air is 2.2 and of media2 w.r.t air is 1.95 . What is refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.rt media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ = 1.95 /

2.2 = 0.89

243. The refractive index of media1 w.r.t air is 0.95 and refractive index of media1 w.r.t media2 is 1.95 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow {}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 1.95 = 0.95/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 0.95 / 1.95 = 0.49*

244. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 16cm and refractive index of the material of lens material w.r.t air is 0.65

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 0.65 ,* R_1 *= infinity ,*R_2 *= ? and f = 16 cm : So using the mentioned formula we have : (0.65 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/16* $\Rightarrow$ *-0.35/R2 = 1/16 So*R_2 *= -5.6cm. = -5.6cm.*

245. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= ? ,* R_1 *= +f ,*R_2 *= -f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* μ *= (1 +(1/2)) = 3/2 = 1.5 ....Ans.*

246. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 1.95What should be the radius of curvature for the focal length of the lens to be 14 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 1.95 ,* R_1 *= +R ,*R_2 *= -R and the focal length = 14 cm. So using the mentioned formula we have : (1.95 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/14* $\Rightarrow$ *0.95×*$\left(\frac{2}{R}\right)$ *= (1/14)* $\Rightarrow$ *R = 26.6cm. Radius of curvature of both faces is equal to 26.6cm.*

247. The focal length of a convex lens in air is 8 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25 (iii) 1.125 (iv) 2.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times_a \mu^m}{({}_a\mu^g -_a \mu^m)} \times f_a$ *:*

$\Rightarrow$ *(1)* f_m *= [(1.5 -1) × 1.25/(1.5 - 1.25)] × 8* $\Rightarrow f_m$ *= 20cm.* $\Rightarrow$ *So focal length in the media will be given as : 20cm.*
(2) f_m *= [(1.5 -1) × 3.25/(1.5 - 3.25)] × 8* $\Rightarrow f_m$ *= -7.428571cm.* $\Rightarrow$ *So focal length in the media will be given as : -7.428571cm.*
(3) f_m *= [(1.5 -1) × 1.125/(1.5 - 1.125)] × 8* $\Rightarrow f_m$ *= 12cm.* $\Rightarrow$ *So focal length in the media will be given as : 12cm.*
(4) f_m *= [(1.5 -1) × 2.25/(1.5 - 2.25)] × 8* $\Rightarrow f_m$ *= -12cm.* $\Rightarrow$ *So focal length in the media will be given as : -12cm.*

248. The radius of curvatures of a double convex lens are 32 cm. and 31 cm respectively while refractive index of the material of lens w.r.t air is 2.25. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= 2.25 ,* R_1 *= 32 cm. ,*R_2 *= -31 cm. So using the mentioned formula we have : [(2.25 -1)(1/(+32) - 1/(-31))] =* $\frac{1}{f}$ $\Rightarrow$ *f = [(32 × 31)/((2.25 -1) × (32 + 31))] after solving it we get f = 12.59683*

249. The radius of curvatures of a double convex lens are 31 cm , 33 cm respectively and focal length29.5 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= ? ,* R_1 *= 31 cm. ,*R_2 *= -33 cm.and focal length f = 29.5 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+31) - 1/(-33)) = 1/29.5]* $\Rightarrow$ *(* μ *-1) = [(31 × 33)/((29.5) × (31 + 33))] after solving it we get* μ *= 1.541843*

250. If the ratio of radius of curvatures of a biconvex lens is 4 : 3 and focal length is 23 cm. Find the refractive index

of the material of lens w.r.t air while curvature of first surface is 33 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* R_1 *= 4R = 132cm.,*R_2 *= -3R = -99cm. and focal length f = 23 cm. So using the mentioned formula we have : [(μ -1)(1/(+132) - 1/(-99))] = 1/23 ⇒ (μ -1) = [((4 × 3)/(4 + 3)) × 33 × 1 / 23] ⇒ μ = [((4 × 3)/(4 + 3)) × 33 × 1 / 23] + 1 after solving it we get* $\mu = 3.459627$

251. If the ratio of radius of curvatures of a biconvex lens is 2 : 5 and refractive index of the material of lens w.r.t air is 1.6 while curvature of first surface is 26 cm. Find the focal length of the lens

   SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 1.6$ *,* R_1 *= 2R = 52cm.,*R_2 *= -5R = -130cm. and focal length f = ? So using the mentioned formula we have : [(1.6 -1)(1/(+52) - 1/(-130))] =* $\frac{1}{f}$ *⇒ f = [((2 × 5 × 26)/((2 + 5) × (1.6- 1))] after solving it we get f = 61.90476*

252. An object 3 cm high is placed 7 cm in front of a convex lens of focal length 22 cm. What is the position and height of the image?

   SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -7 cm. , f = 22 cm. and height of the object h = 3cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 22 = 1/v - 1/ -7 ⇒ v = [(7 × 22)/(7 - 22)] = -10.26667cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-10.26667/7| = |Im/3| ⇒ Im = 4.4 cm.*

253. An object 2 cm high is placed 32 cm in front of a concave lens of focal length -32 cm. What is the position and height of the image?

   SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -32 cm. , f = -32 cm. and height of the object h = 2cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -32 = 1/v - 1/ -32 ⇒ v = [(32 × -32)/(32 + 32)] = -16cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-16/32| = |Im/2| ⇒ Im = 1 cm.*

254. An object placed 33 cm. from a lens produces a virtual/real image at 28 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 9cm.

   SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -33 cm. , v = 28 cm. and height of the object h = 9cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/28 - 1/ -33 ⇒ f = [(33 × 28)/(33 + 28)] = 15.14754cm. And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |28/33| = |Im/9| ⇒ Im = 7.636364 cm. Next case: (b)image is unreal u = -33 cm. , v = -28 cm. and height of the object h = 9cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-28) - 1/(-33) ⇒ f = [(33 × -28)/(33 + -28)] = -184.8cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-28/33| = |Im/9| ⇒ Im = 7.636364 cm.*

255. An object is placed 101 cm from a screen. A converging lens with a 24 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

   SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (101 - x) cm. while focal length given is f = 24 cm. Using the mentioned formula : 1/24 = 1/(101 - x) - 1/-x = 101 / ((101 - x) × x) . After Solving it we get x = 61.7361 cm. the distance from the object for the placement of the lens is = 61.7361 cm.(b) And for magnifications have*$\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |39.2639/61.7361| = 0.6359957*

256. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 3.04. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

   SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as :${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$ *Using the mentioned formula we have :* ${}_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2}$ *= (3 ×* 10^8 *)/ 3.04 = 9.868421E+07 m/sec.*

257. The refractive index of media1 w.r.t air is 1.1 and of media2 w.r.t air is 0.65 . What is refractive index of media2

w.r.t media1 ${}_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}}$ *= 0.65 / 1.1 = 0.59*

258. The refractive index of media1 w.r.t air is 0.95 and refractive index of media1 w.r.t media2 is 0.65 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 ${}_{m_1}\mu^{m_2}$ *as :* ${}_{m_1}\mu^{m_2} = \frac{{}_a\mu^{m_2}}{{}_a\mu^{m_1}} \Rightarrow$ ${}_{m_2}\mu^{m_1} = \frac{{}_a\mu^{m_1}}{{}_a\mu^{m_2}}$ *= 0.65 = 0.95/*${}_a\mu^{m_2}$ *: So* ${}_a\mu^{m_2}$ *= 0.95 / 0.65 = 1.46*

259. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 7cm and refractive index of the material of lens material w.r.t air is 0.65

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 0.65 ,* R_1 *= infinity ,*R_2 *= ? and f = 7 cm : So using the mentioned formula we have : (0.65 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/7* $\Rightarrow$ *-0.35/R2 = 1/7 So*R_2 *= -2.45cm. = -2.45cm.*

260. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= ? ,* R_1 *= +f ,*R_2 *= -f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* μ *= (1 +(1/2)) = 3/2 = 1.5 ....Ans.*

261. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 2.6What should be the radius of curvature for the focal length of the lens to be 5.5 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 2.6 ,* R_1 *= +R ,*R_2 *= -R and the focal length = 5.5 cm. So using the mentioned formula we have : (2.6 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/5.5* $\Rightarrow$ *1.6*$\times\left(\frac{2}{R}\right)$ *= (1/5.5)* $\Rightarrow$ *R = 17.6cm. Radius of curvature of both faces is equal to 17.6cm.*

262. The focal length of a convex lens in air is 8 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25 (iii) 1.125 (iv) 2.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.———(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{{}_a\mu^g - 1}{{}_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{({}_a\mu^g - 1) \times_a \mu^m}{({}_a\mu^g -_a \mu^m)} \times f_a$ *:*

$\Rightarrow$ *(1)* f_m *= [(1.5 -1)* $\times$ *1.25/(1.5 - 1.25)]* $\times$ *8* $\Rightarrow$ f_m *= 20cm.* $\Rightarrow$ *So focal length in the media will be given as : 20cm.*
(2) f_m *= [(1.5 -1)* $\times$ *3.25/(1.5 - 3.25)]* $\times$ *8* $\Rightarrow$ f_m *= -7.428571cm.* $\Rightarrow$ *So focal length in the media will be given as : -7.428571cm.*
(3) f_m *= [(1.5 -1)* $\times$ *1.125/(1.5 - 1.125)]* $\times$ *8* $\Rightarrow$ f_m *= 12cm.* $\Rightarrow$ *So focal length in the media will be given as : 12cm.*
(4) f_m *= [(1.5 -1)* $\times$ *2.25/(1.5 - 2.25)]* $\times$ *8* $\Rightarrow$ f_m *= -12cm.* $\Rightarrow$ *So focal length in the media will be given as : -12cm.*

263. The radius of curvatures of a double convex lens are 48 cm. and 33 cm respectively while refractive index of the material of lens w.r.t air is 2.25. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= 2.25 ,* R_1 *= 48 cm. ,*R_2 *= -33 cm. So using the mentioned formula we have : [(2.25 -1)(1/(+48) - 1/(-33))] =* $\frac{1}{f}$ $\Rightarrow$ *f = [(48* $\times$ *33)/((2.25 -1)* $\times$ *(48 + 33))] after solving it we get f = 15.64444*

264. The radius of curvatures of a double convex lens are 21 cm , 39 cm respectively and focal length26 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= ? ,* R_1 *= 21 cm. ,*R_2 *= -39 cm.and focal length f = 26 cm. So using the mentioned formula* *we have : [(μ -1)(1/(+21) - 1/(-39)) = 1/26] $\Rightarrow$ (μ -1) = [(21 $\times$ 39)/((26) $\times$ (21 + 39))] after solving it we get $\mu = 1.525$*

265. If the ratio of radius of curvatures of a biconvex lens is 4 : 3 and focal length is 10 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 20 cm.

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$. Where fa is focal length in air According to question $\mu = ?$, R_1 = 4R = 80cm.,R_2 = -3R = -60cm. and focal length f = 10 cm. So using the mentioned formula we have : [(μ -1)(1/(+80) - 1/(-60))] = 1/10 $\Rightarrow$ (μ -1) = [((4 $\times$ 3)/(4 + 3)) $\times$ 20 $\times$ 1 / 10] $\Rightarrow$ μ = [((4 $\times$ 3)/(4 + 3)) $\times$ 20 $\times$ 1 / 10] + 1 after solving it we get $\mu = 4.428571$

266. If the ratio of radius of curvatures of a biconvex lens is 4 : 3 and refractive index of the material of lens w.r.t air is 3.2 while curvature of first surface is 20 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$. Where fa is focal length in air According to question μ = 3.2 , R_1 = 4R = 80cm.,R_2 = -3R = -60cm. and focal length f = ? So using the mentioned formula we have : [(3.2 -1)(1/(+80) - 1/(-60))] = $\frac{1}{f}$ $\Rightarrow$ f = [((4 $\times$ 3 $\times$ 20)/((4 + 3) $\times$ (3.2- 1))] after solving it we get f = 15.58442

267. An object 2 cm high is placed 54 cm in front of a convex lens of focal length 17 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. Where f is focal length of the lens According to question u = -54 cm. , f = 17 cm. and height of the object h = 2cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 17 = 1/v - 1/ -54 $\Rightarrow$ v = [(54 $\times$ 17)/(54 - 17)] = 24.81081cm.(b) And for height of Image we have$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ $\Rightarrow$ |24.81081/54| = |Im/2| $\Rightarrow$ Im = 0.9189189 cm.

268. An object 4 cm high is placed 31 cm in front of a concave lens of focal length -24 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. Where f is focal length of the lens According to question u = -31 cm. , f = -24 cm. and height of the object h = 4cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -24 = 1/v - 1/ -31 $\Rightarrow$ v = [(31 $\times$ -24)/(31 + 24)] = -13.52727cm.(b) And for height of Image we have$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ $\Rightarrow$ |-13.52727/31| = |Im/4| $\Rightarrow$ Im = 1.745455 cm.

269. An object placed 33 cm. from a lens produces a virtual/real image at 47 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 1cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. Where f is focal length of the lens According to question:(a) If image is real u = -33 cm. , v = 47 cm. and height of the object h = 1cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have $\frac{1}{f}$ = 1/47 - 1/ -33 $\Rightarrow$ f = [(33 $\times$ 47)/(33 + 47)] = 19.3875cm. And for height of Image we have$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ $\Rightarrow$ |47/33| = |Im/1| $\Rightarrow$ Im = 1.424242 cm. Next case: (b)image is unreal u = -33 cm. , v = -47 cm. and height of the object h = 1cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have $\frac{1}{f}$ = 1/(-47) - 1/(-33) $\Rightarrow$ f = [(33 $\times$ -47)/(33 + -47)] = 110.7857cm.(b) And for height of Image we have$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ $\Rightarrow$ |-47/33| = |Im/1| $\Rightarrow$ Im = 1.424242 cm.

270. An object is placed 92 cm from a screen. A converging lens with a 21 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (92 - x) cm. while focal length given is f = 21 cm. Using the mentioned formula : 1/21 = 1/(92 - x) - 1/-x = 92 / ((92 - x) $\times$ x) . After Solving it we get x = 59.56466 cm. the distance from the object for the placement of the lens is = 59.56466 cm.(b) And for magnifications have$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ $\Rightarrow$ |32.43534/59.56466| = 0.54454

271. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 2.28. What is the speed of light in the media? Speed of light in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as :${}_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$

Using the mentioned formula we have : $_a\mu^m = \frac{V_a}{V_m} = \frac{(3\times10^8)}{V_{m_2}} \Rightarrow V_{m_2} = (3\times10^8)/2.28 = 1.31579\times10^8$ *m/sec.*

272. The refractive index of media1 w.r.t air is 1.1 and of media2 w.r.t air is 1.3 . What is refractive index of media2 w.r.t media1 $_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 $_{m_1}\mu^{m_2}$ *as :*$_{m_1}\mu^{m_2} = \frac{_a\mu^{m_2}}{_a\mu^{m_1}}$ *= 1.3 / 1.1 = 1.18*

273. The refractive index of media1 w.r.t air is 0.95 and refractive index of media1 w.r.t media2 is 1.95 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.r.t media1 $_{m_1}\mu^{m_2}$ *as :*$_{m_1}\mu^{m_2} = \frac{_a\mu^{m_2}}{_a\mu^{m_1}} \Rightarrow$ $_{m_2}\mu^{m_1} = \frac{_a\mu^{m_1}}{_a\mu^{m_2}}$ *= 1.95 = 0.95/*$_a\mu^{m_2}$ *: So* $_a\mu^{m_2}$ *= 0.95 / 1.95 = 0.49*

274. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 13.5cm and refractive index of the material of lens material w.r.t air is 1.3

SOLUTION: As we know the formula for refraction by double refractive index is:$(_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 1.3 ,* R_1 *= infinity ,*R_2 *= ? and f = 13.5 cm : So using the mentioned formula we have : (1.3 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right)$ *= 1/13.5* $\Rightarrow$ *0.3/R2 = 1/13.5 So*R_2 *= 4.049999cm. = 4.049999cm.*

275. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is:$(_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= ? ,* R_1 *= +f ,*R_2 *= -f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* μ *= (1 +(1/2)) = 3/2 = 1.5 ....Ans.*

276. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 1.95What should be the radius of curvature for the focal length of the lens to be 15.5 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$(_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* μ *= 1.95 ,* R_1 *= +R ,*R_2 *= -R and the focal length = 15.5 cm. So using the mentioned formula we have : (1.95 -1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/15.5* $\Rightarrow$ *0.95*$\times\left(\frac{2}{R}\right)$ *= (1/15.5)* $\Rightarrow$ *R = 29.45cm. Radius of curvature of both faces is equal to 29.45cm.*

277. The focal length of a convex lens in air is 9 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 2 (11) 4 (iii) 1.5 (iv) 3

SOLUTION: As we know the formula for refraction by double refractive index is:$(_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$(_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{_a\mu^g - 1}{_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{(_a\mu^g - 1)\times_a\mu^m}{(_a\mu^g -_a\mu^m)} \times f_a$ *:*

$\Rightarrow$ *(1)* f_m *= [(1.5 -1)* $\times$ *2/(1.5 - 2)]* $\times$ *9* $\Rightarrow$ f_m *= -18cm.* $\Rightarrow$ *So focal length in the media will be given as : -18cm.*

(2) f_m *= [(1.5 -1)* $\times$ *4/(1.5 - 4)]* $\times$ *9* $\Rightarrow$ f_m *= -7.2cm.* $\Rightarrow$ *So focal length in the media will be given as : -7.2cm.*

(3) f_m *= [(1.5 -1)* $\times$ *1.5/(1.5 - 1.5)]* $\times$ *9* $\Rightarrow$ f_m *= Infinitycm.* $\Rightarrow$ *So focal length in the media will be given as : Infinitycm.*

(4) f_m *= [(1.5 -1)* $\times$ *3/(1.5 - 3)]* $\times$ *9* $\Rightarrow$ f_m *= -9cm.* $\Rightarrow$ *So focal length in the media will be given as : -9cm.*

278. The radius of curvatures of a double convex lens are 29 cm. and 38 cm respectively while refractive index of the material of lens w.r.t air is 0.75. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$(_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* μ *= 0.75 ,* R_1 *= 29 cm. ,*R_2 *= -38 cm. So using the mentioned formula we have : [(0.75 -1)(1/(+29) - 1/(-38))] =* $\frac{1}{f}$ $\Rightarrow$ *f = [(29* $\times$ *38)/((0.75 -1)* $\times$ *(29 + 38))] after solving it we get f = -65.79105*

279. The radius of curvatures of a double convex lens are 42 cm , 31 cm respectively and focal length18.5 cm. Find

refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 42$ *cm. ,*$R_2 = -31$ *cm.and focal length f = 18.5 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+42) - 1/(-31)) = 1/18.5]* $\Rightarrow$ *(* μ *-1) = [(42* $\times$ *31)/((18.5)* $\times$ *(42 + 31))] after solving it we get* $\mu = 1.964087$

280. If the ratio of radius of curvatures of a biconvex lens is 2 : 5 and focal length is 27 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 36 cm.

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 2R = 72$*cm.,*$R_2 = -5R = -180$*cm. and focal length f = 27 cm. So using the mentioned formula we have : [(* μ *-1)(1/(+72) - 1/(-180))] = 1/27* $\Rightarrow$ *(* μ *-1) = [((2* $\times$ *5)/(2 + 5))* $\times$ *36* $\times$ *1 / 27]* $\Rightarrow$ μ *= [((2* $\times$ *5)/(2 + 5))* $\times$ *36* $\times$ *1 / 27] + 1 after solving it we get* $\mu = 2.904762$

281. If the ratio of radius of curvatures of a biconvex lens is 4 : 3 and refractive index of the material of lens w.r.t air is 2.4 while curvature of first surface is 38 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 2.4$ *,* $R_1 = 4R = 152$*cm.,*$R_2 = -3R = -114$*cm. and focal length f = ? So using the mentioned formula we have : [(2.4 -1)(1/(+152) - 1/(-114))] =* $\frac{1}{f}$ $\Rightarrow$ *f = [((4* $\times$ *3* $\times$ *38)/((4 + 3)* $\times$ *(2.4- 1))] after solving it we get f = 46.53061*

282. An object 2 cm high is placed 24 cm in front of a convex lens of focal length 29 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -24 cm. , f = 29 cm. and height of the object h = 2cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 29 = 1/v - 1/ -24* $\Rightarrow$ *v = [(24* $\times$ *29)/(24 - 29)] = -139.2cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ $\Rightarrow$ *|-139.2/24| = |Im/2|* $\Rightarrow$ *Im = 11.6 cm.*

283. An object 5 cm high is placed 14 cm in front of a concave lens of focal length -35 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -14 cm. , f = -35 cm. and height of the object h = 5cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -35 = 1/v - 1/ -14* $\Rightarrow$ *v = [(14* $\times$ *-35)/(14 + 35)] = -10cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ $\Rightarrow$ *|-10/14| = |Im/5|* $\Rightarrow$ *Im = 3.571429 cm.*

284. An object placed 30 cm. from a lens produces a virtual/real image at 36 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 4cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is:$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -30 cm. , v = 36 cm. and height of the object h = 4cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/36 - 1/ -30* $\Rightarrow$ *f = [(30* $\times$ *36)/(30 + 36)] = 16.36364cm. And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ $\Rightarrow$ *|36/30| = |Im/4|* $\Rightarrow$ *Im = 4.8 cm. Next case: (b)image is unreal u = -30 cm. , v = -36 cm. and height of the object h = 4cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-36) - 1/ (-30)* $\Rightarrow$ *f = [(30* $\times$ *-36)/(30 + -36)] = 180cm.(b) And for height of Image we have*$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ $\Rightarrow$ *|-36/30| = |Im/4|* $\Rightarrow$ *Im = 4.8 cm.*

285. An object is placed 113 cm from a screen. A converging lens with a 28 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (113 - x) cm. while focal length given is f = 28 cm. Using the mentioned formula : 1/28 = 1/(113 - x) - 1/-x = 113 / ((113 - x)* $\times$ *x) . After Solving it we get x = 61.81507 cm. the distance from the object for the placement of the lens is = 61.81507 cm.(b) And for magnifications have*$\left|\frac{v}{u}\right| = \left|\frac{\mathrm{Im}\,g}{Ob}\right|$ $\Rightarrow$ *|51.18493/61.81507| = 0.8280331*

286. If the refractive index of a media w.r.t air ${}_a\mu^m$ is 1.52. What is the speed of light in the media? Speed of light

in vacuum/air is 3×10^8 m/sec.

SOLUTION: As we know the formula for relation between velocity of light in different media and in air/vacuum as :$_{m_1}\mu^{m_2} = \frac{V_{m_1}}{V_{m_2}}$

Using the mentioned formula we have : $_a\mu^m = \frac{V_a}{V_m} = \frac{(3 \times 10^8)}{V_{m_2}} \Rightarrow V_{m_2} =$ *(*3×10^8 *)/ 1.52 = 1.973684*$\times 10^8$ *m/sec.*

287. The refractive index of media1 w.r.t air is 1.65 and of media2 w.r.t air is 0.65 . What is refractive index of media2 w.r.t media1 $_{m_1}\mu^{m_2}$.

SOLUTION: As we know the formula for relation, refractive index of media2 w.rt media1 $_{m_1}\mu^{m_2}$ *as :*$_{m_1}\mu^{m_2} = \frac{_a\mu^{m_2}}{_a\mu^{m_1}}$ *= 0.65 / 1.65 = 0.39*

288. The refractive index of media1 w.r.t air is 1.9 and refractive index of media1 w.r.t media2 is 2.6 . What is refractive index of media2 w.r.t air.

SOLUTION: As we know the formula for relation, refractive index of media2 w.rt media1 $_{m_1}\mu^{m_2}$ *as :*$_{m_1}\mu^{m_2} = \frac{_a\mu^{m_2}}{_a\mu^{m_1}} \Rightarrow$ $_{m_2}\mu^{m_1} = \frac{_a\mu^{m_1}}{_a\mu^{m_2}}$ *= 2.6 = 1.9/*$_a\mu^{m_2}$ *: So* $_a\mu^{m_2} =$ *1.9 / 2.6 = 0.73*

289. Find the radius of curvature of the convex surface of a Plano convex lens, whose focal length is 14.5cm and refractive index of the material of lens material w.r.t air is 1.3

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *1.3 ,* $R_1 =$ *infinity ,*$R_2 =$ *? and f = 14.5 cm : So using the mentioned formula we have : (1.3 -1)*$\left(\frac{1}{\infty} - \frac{1}{R_2}\right) =$ *1/14.5* $\Rightarrow$ *0.3/R2 = 1/14.5 So*$R_2 =$ *4.349999cm. = 4.349999cm.*

290. The radius of curvature of either surfaces of a convex lens is equal to it's focal length. What is the refractive index of the material ?

SOLUTION: (a) As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *? ,* $R_1 =$ *+f ,*$R_2 =$ *-f (where f is the focal length) So using the mentioned formula we have :*$(\mu - 1)\left(\frac{1}{+f} - \frac{1}{-f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)\left(\frac{2}{f}\right) = \frac{1}{f} \Rightarrow (\mu - 1)$ *= (1/2): So* $\mu =$ *(1 +(1/2)) = 3/2 = 1.5 ....Ans.*

291. A biconvex lens with both faces of the same radius of curvature is to be manufactured from a glass of refractive index 0.65What should be the radius of curvature for the focal length of the lens to be 13 cm.?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_1\mu^2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ *.According to question* $\mu =$ *0.65 ,* $R_1 =$ *+R ,*$R_2 =$ *-R and the focal length = 13 cm. So using the mentioned formula we have : (0.65 - 1)*$\left(\frac{1}{+R} - \frac{1}{-R}\right)$ *= 1/13* $\Rightarrow$ *-0.35*$\times \left(\frac{2}{R}\right)$ *= (1/13)* $\Rightarrow$ *R = -9.1cm. Radius of curvature of both faces is equal to -9.1cm.*

292. The focal length of a convex lens in air is 9 cm. and the refractive index of glass material w.r.t air is 1.5 . What will be it's focal length when it is immersed in a media whose refractive index w.r.t air is (i) 1.25 (11) 3.25 (iii) 1.125 (iv) 2.25

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *.——(1) Where fa is focal length in air Similarly focal length in media will be given as :*$({}_m\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_m}$ *.——(2) Where* f_m *is focal length in media dividing equation (1) by (2) we get:*$f_m = \frac{_a\mu^g - 1}{_m\mu^g - 1} \times f_a$ *. Which can be rearrange as :*$f_m = \frac{(_a\mu^g - 1) \times _a\mu^m}{(_a\mu^g - _a\mu^m)} \times f_a$ *:*

$\Rightarrow$ (1) f_m *= [(1.5 -1)* $\times$ *1.25/(1.5 - 1.25)]* $\times$ *9* $\Rightarrow f_m$ *= 22.5cm.* $\Rightarrow$ *So focal length in the media will be given as : 22.5cm.*
(2) f_m *= [(1.5 -1)* $\times$ *3.25/(1.5 - 3.25)]* $\times$ *9* $\Rightarrow f_m$ *= -8.357142cm.* $\Rightarrow$ *So focal length in the media will be given as : -8.357142cm.*
(3) f_m *= [(1.5 -1)* $\times$ *1.125/(1.5 - 1.125)]* $\times$ *9* $\Rightarrow f_m$ *= 13.5cm.* $\Rightarrow$ *So focal length in the media will be given as : 13.5cm.*
(4) f_m *= [(1.5 -1)* $\times$ *2.25/(1.5 - 2.25)]* $\times$ *9* $\Rightarrow f_m$ *= -13.5cm.* $\Rightarrow$ *So focal length in the media will be given as : -13.5cm.*

293. The radius of curvatures of a double convex lens are 23 cm. and 33 cm respectively while refractive index of the material of lens w.r.t air is 2.25. Find it's focal length?

SOLUTION: As we know the formula for refraction by double refractive index is:$({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu =$ *2.25 ,* $R_1 =$ *23 cm. ,*$R_2 =$ *-33 cm. So using the mentioned formula we have : [(2.25 -1)(1/(+23) - 1/(-33))] =* $\frac{1}{f} \Rightarrow$ *f = [(23* $\times$ *33)/((2.25 -1)* $\times$ *(23 + 33))] after solving it we get f = 10.84286*

294. The radius of curvatures of a double convex lens are 40 cm , 33 cm respectively and focal length11 cm. Find refractive index of the material of lens w.r.t ?

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 = 40$ *cm. ,*$R_2 =$ *-33 cm.and focal length f = 11 cm. So using the mentioned formula we have : [(μ -1)(1/(+40) - 1/(-33)) = 1/11] ⇒ (μ -1) = [(40 × 33)/((11) × (40 + 33))] after solving it we get* $\mu = 2.643836$

295. If the ratio of radius of curvatures of a biconvex lens is 2 : 4 and focal length is 11 cm. Find the refractive index of the material of lens w.r.t air while curvature of first surface is 21 cm.

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = ?$ *,* $R_1 =$ *2R = 42cm.,*$R_2 =$ *-4R = -84cm. and focal length f = 11 cm. So using the mentioned formula we have : [(μ -1)(1/(+42) - 1/(-84))] = 1/11 ⇒ (μ -1) = [((2 × 4)/(2 + 4)) × 21 × 1 / 11] ⇒* $\mu =$ *[((2 × 4)/(2 + 4)) × 21 × 1 / 11] + 1 after solving it we get* $\mu = 3.545455$

296. If the ratio of radius of curvatures of a biconvex lens is 3 : 5 and refractive index of the material of lens w.r.t air is 1.6 while curvature of first surface is 36 cm. Find the focal length of the lens

SOLUTION: As we know the formula for refraction by double refractive index is: $({}_a\mu^g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_a}$ *. Where fa is focal length in air According to question* $\mu = 1.6$ *,* $R_1 =$ *3R = 108cm.,*$R_2 =$ *-5R = -180cm. and focal length f = ? So using the mentioned formula we have : [(1.6 -1)(1/(+108) - 1/(-180))] =* $\frac{1}{f}$ *⇒ f = [((3 × 5 × 36)/((3 + 5) × (1.6- 1))] after solving it we get f = 112.5*

297. An object 3 cm high is placed 33 cm in front of a convex lens of focal length 24 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -33 cm. , f = 24 cm. and height of the object h = 3cm. , v = ? and height of image hI = ? . Now using the mentioned formula we have 1/ 24 = 1/v - 1/ -33 ⇒ v = [(33 × 24)/(33 - 24)] = 88cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |88/33| = |Im/3| ⇒ Im = 8 cm.*

298. An object 5 cm high is placed 40 cm in front of a concave lens of focal length -16 cm. What is the position and height of the image?

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question u = -40 cm. , f = -16 cm. and height of the object h = 5cm. v = ? , and height of image hI = ? . Now using the mentioned formula we have 1/ -16 = 1/v - 1/ -40 ⇒ v = [(40 × -16)/(40 + 16)] = -11.42857cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-11.42857/40| = |Im/5| ⇒ Im = 1.428571 cm.*

299. An object placed 32 cm. from a lens produces a virtual/real image at 19 cm. from the lens. (a) What is the focal length of the lens? (b) Is the lens convex or concave? (c) What is the height of the Image if the height of object is 5cm.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens According to question:(a) If image is real u = -32 cm. , v = 19 cm. and height of the object h = 5cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/19 - 1/ -32 ⇒ f = [(32 × 19)/(32 + 19)] = 11.92157cm. And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |19/32| = |Im/5| ⇒ Im = 2.96875 cm. Next case: (b)image is unreal u = -32 cm. , v = -19 cm. and height of the object h = 5cm. f = ? , and height of image hI = ? . Now using the mentioned formula we have* $\frac{1}{f}$ *= 1/(-19) - 1/ (-32) ⇒ f = [(32 × -19)/(32 + -19)] = -46.76923cm.(b) And for height of Image we have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |-19/32| = |Im/5| ⇒ Im = 2.96875 cm.*

300. An object is placed 98 cm from a screen. A converging lens with a 20 cm focal length is then placed between the object and the screen and used to form a focused image on the screen. Find (a) the distance from the object for the placement of the lens, (b) the magnification.

SOLUTION: As we know the formula for refraction by thin concave/convex lens is: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *. Where f is focal length of the lens (a)As image is real let u = -x cm. , So v = (98 - x) cm. while focal length given is f = 20 cm. Using the mentioned formula : 1/20 = 1/(98 - x) - 1/-x = 98 / ((98 - x) × x) . After Solving it we get x = 70 cm. the distance from the object for the placement of the lens is = 70 cm.(b) And for magnifications have* $\left|\frac{v}{u}\right| = \left|\frac{\text{Im}\,g}{Ob}\right|$ *⇒ |28/70| = 0.4*