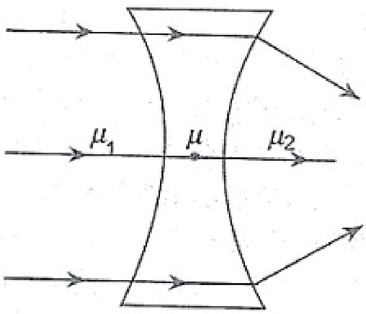
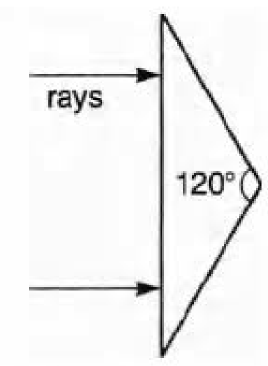
CBSE Test Paper-03

Class - 12 Physics (Ray Optics and Optical Instruments)

1. In a compound microscope, maximum magnification is obtained when the final image
   a. coincides with the objective by comparing on both sides,
   b. is formed at the least distance of distinct vision
   c. coincides with the object
   d. is formed at infinity
2. What is the relation between refractive indices μ, μ_1 and μ_2 if the behavior of light rays is as shown in the following figure?



   By comparing on both sides,
   a. $\mu < \mu_2; \mu = \mu_1$
   b. $\mu < \mu_2 < \mu_1$
   c. $\mu > \mu_2 > \mu_1$
   d. $\mu_2 < \mu_1; \mu = \mu_2$
3. An isosceles prism of angle 120° has a refractive index of 1.44. Two parallel monochromatic rays enter the prism parallel to each other in air as shown. The rays emerging from the opposite faces-



   a. make an angle of 2 $\sin^{-1}$ (0.72) with each other

b. are diverging
c. make an angle of 2 [$\sin^{-1}(0.72) - 30°$] with each other
d. are parallel to each other

4. Accommodation of the human eye is
   a. Ability to change the intensity of incoming light
   b. Ability to see close by objects
   c. Ability to see an erect image
   d. Ability to change the focal length
5. A person with defective eyesight is unable to see objects clearly nearer than 1.5 m. He wants to read a book placed at a distance of 30 cm from his eyes. Find the power of the lens he requires for his spectacles
   a. -2.5 D
   b. + 2.5 D
   c. + 2.67 D
   d. -2.67 D

6. A lens of glass is immersed in water. What will be its effect on the power of the lens?

7. A glass lens of refractive index 1.5 is placed in a trough of liquid. What must be the refractive index of the liquid in order to mark the lens disappear?

8. A ray of light falls on a mirror normally. What are the values of angle of incidence and the angle of reflection.

9. In viewing through a magnifying glass, one usually positions one's eye very close to the lens. Does angular magnification change if the eye is moved back?

10. The magnifying power of an astronomical telescope in the normal adjustment position is 100. The distance between the objective and the eyepiece is 101 cm. Calculate the focal lengths of the objective and of the eyepiece.

11. A screen is placed 90 cm from an object. The image of the object on the screen is formed by a convex lens at two different locations separated by 20 cm. Determine the focal length of the lens.

12. A compound microscope consists of an objective lens of focal length 2.0 cm and an

eyepiece of focal length 6.25 cm separated by a distance of 15 cm. How far from the objective should an object be placed in order to obtain the final image at

a. the least distance of distinct vision (25 cm), and
b. at infinity? What is the magnifying power of the microscope in each case?

13. Why must both the objective and eyepiece of a compound microscope have short focal lengths?

14. The focal length of objective and eyepiece of an astronomical telescope are 25 cm and 2.5 cm respectively. The telescope is focused on an object 1.5 m from objective, the final image is at 25 cm from the eye of the observer. Calculate the length of the telescope.

15. A magnifying lens has a focal length of 10 cm.

i. Where should the object be placed if the image is to be 30 cm from the lens?
ii. What will be the magnification?

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Answers

1. (b) is formed at the least distance of distinct vision

   Explanation: magnification of compound microscope is given by: $\left(\frac{v_o}{u_o}\right)\left(1+\frac{D}{f_e}\right)$, when final image is formed at near point, whereas it is $\left(\frac{v_o}{u_o}\right)\left(\frac{D}{f_e}\right)$ when final image is formed at infinity.

   Hence magnification is maximum when final image is formed at near point (least distance of distinct vision)

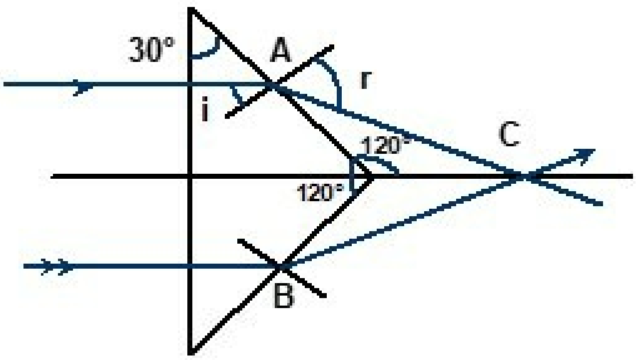
2. (a) $\mu < \mu_2; \mu = \mu_1$

   Explanation: Since light rays do not get refracted while entering the lens, hence $\mu = \mu_1$

   After emerging from concave lens, light rays converge hence $\mu < \mu_2$

3. (c) make an angle of 2 [$\sin^{-1}$(0.72) – 30°] with each other

   Explanation:



   $\frac{\sin i}{\sin r} = \frac{1}{1.44}\ [\because i = 30^\circ]$

   $\sin r = \frac{1.44}{2} = 0.72$

   $\angle ACB = 2[180^\circ - (120^\circ + 90^\circ - r)]$

   $= 2(r - 30^\circ) = 2[\sin^{-1}(0.72) - 30^\circ]$

4. (d) Ability to change the focal length

   Explanation: ability to change the focal length of eye lens with the help of cilliary muscles so as to obtain sharp image of objects placed at various distances (from near point to far point).

5. (c) + 2.67 D

   Explanation: u = -30 cm, v= -1.5 m = -150 cm

   $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{-150} - \frac{1}{-30} = \frac{4}{150}$

Hence f = 37.5 cm

and P = 100/37.5 D = +2.67 D

6. Power increases.

7. The refractive index of liquid must be greater than or equal to 1.5.

8. Both angle of incidence and the angle of reflection is zero.

9. Yes, the angular magnification decreases a little because the angle subtended at the eye by the image is then slightly less than the angle subtended by the image at the lens. The angle subtended by the object at the eye is also less than that subtended by the object at the lens. However, this decrease is very small as compared to the case of image. Also, when the eye is separated from the lens the angles subtended at the eye by the object and its image are not equal. It may further be noted that if the image is a very large distance away, then the effect, on magnification, of moving the eye shall be negligible.

10. Here, $m = \frac{f_0}{f_e} = 100$

    or $f_0 = 100f_e$

    Since $f_0 + f_e = 101$

    Then, $100f_e + f_e = 101$

    $\therefore f_e = 1cm$ and $f_0 = 100$ cm

11. Here, distance between object and screen D = 90 cm

    Distance between two locations of convex lens d = 20 cm

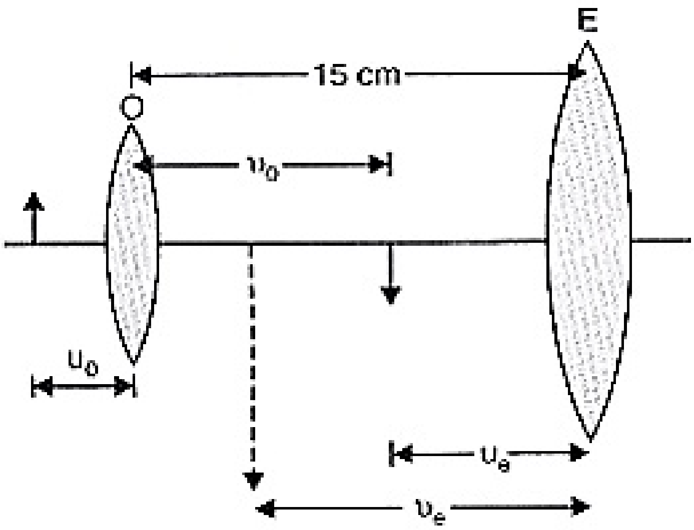
    Since, $f = \frac{D^2 - d^2}{4D}$

    $\therefore f = \frac{(90)^2 - (20)^2}{4 \times 90} = \frac{(90+20)(90-20)}{360} = \frac{110 \times 7}{36}$

    f = 21.4 cm

12. $f_0 = 2cm$, $f_e = 6.25cm$, $u_0 = ?$

    a. For eyepiece, $v_e = -25$ cm, $f_e = 6.25$ cm, $u_e = ?$



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

$\therefore \frac{1}{u_e}=\frac{1}{-25}-\frac{1}{6.25}=-\frac{1}{5}$

or u_e = -5cm

Now, v_0 = 15-$|u_e|$ = 10cm

For objective, $\frac{1}{v_0}-\frac{1}{u_0}=\frac{1}{f_0}$ or $\frac{1}{u_0}=\frac{1}{v_0}-\frac{1}{f_0}$

or $\frac{1}{u_0}=\frac{1}{10}-\frac{1}{2}=-\frac{2}{5}$ or $u_0=\frac{-5}{2}cm=-2.5cm$

$M=\frac{v_0}{u_0}\left(1+\frac{D}{f_e}\right)$

Magnifying power, $M=\frac{10}{-2.5}\left(1+\frac{25}{6.25}\right)=-20$

b. The final image will be formed at infinity only if the image formed by the objective is in the focal plane of the eyepiece.

$\therefore |u_e|=f_e=6.25cm$

$|v_0|$ = (15 - 6.25)cm = 8.75 cm

$\frac{1}{u_0}=\frac{1}{v_0}-\frac{1}{f_0}=\frac{1}{8.75}-\frac{1}{2}=\frac{-6.75}{8.75\times 2}$

$u_0=\frac{-8.75\times 2}{6.75}$ or $u_0=-2.59cm$

Magnifying power, M

$=\frac{8.75}{-2.59}\times\frac{25}{6.25}=-13.5$

13. Angular magnification of eyepiece is $\frac{25}{f_e}+1$(f_e in cm) which increases if f_e is smaller. Further magnification of the objective is given by

$\frac{v_0}{|u_0|}=\frac{1}{\frac{|u_0|}{f}-1}$

which is large when $|u_0|$ is slightly greater than f_0. Now the microscope is used for viewing very close objects. So $|u_0|$ is small, and so is f_0.

14. Here, f_0 = 25cm, f_e = 2.5 cm

    u_0 = -1.5 m = -150cm, v_e = 25cm

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

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

    $=\frac{1}{25}-\frac{1}{150}=\frac{5}{150}=\frac{1}{30}$

    v_0 = 30 cm

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

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

    $\Rightarrow -\frac{1}{u_e}=\frac{1}{2.5}-\frac{1}{25}=\frac{9}{25}$

    or $u_e=-\frac{25}{9}cm$

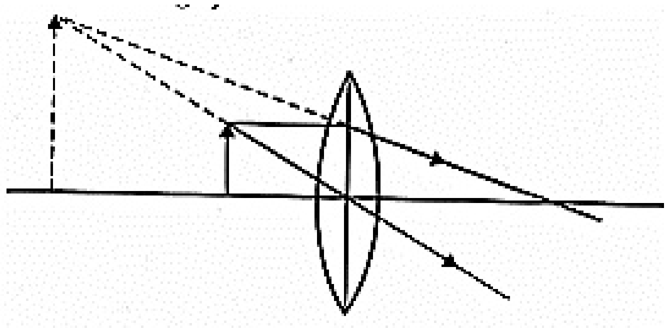
    $L=v_0+|u_e|=30+\frac{25}{9}=\frac{295}{9}$ = 32.8 cm

15. i. In case of magnifying lens, the lens is convergent and the image is erect, virtual and enlarged and between infinity and the object on the same side of the lens as shown in figure above diagram,

    So, here

    f = +10 cm, v = -30 cm

    Let 'x' be the object distance using lens formula



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

    We have,

    $\frac{1}{-30}-\frac{1}{(-x)}=\frac{1}{10}$

    $\Rightarrow$ x = 7.5 cm

    ii. $m=\frac{I}{O}=\frac{v}{u}=\frac{-30}{-8.5}=+4$

    Thus, the image is erect and virtual and four times of the object.