CBSE Test Paper-02

Class - 12 Physics (Ray Optics and Optical Instruments)

1. The graph drawn with object distance along abscissa & image as ordinate for a convex lens is
   a. straight
   b. circle
   c. rectangular hyperbola
   d. parabola
2. A concave lens of glass, refractive index 1.5, has both surfaces of the same radius of curvature R. On immersion in a medium of refractive index 1.75, it will behave as a
   a. divergent lens of focal length 3.5 R
   b. divergent lens of focal length 3.0 R
   c. convergent lens of focal length 3.0 R
   d. convergent lens of focal length 3.5 R
3. A lamp and a screen are set up 100 cm apart and a convex lens is placed between them. The two positions of the lens forming real images on the screen are 40 cm apart. What is the focal length of the lens?
   a. 15 cm
   b. 21 cm
   c. 18 cm
   d. 12 cm
4. An equi-convex thin lens (μ =1.5) of focal length in air as 30cm is sealed into an opening in one end of tank filled with water (μ =1.33). At the end of the tank opposite the lens is a plane mirror, 80 cm distant from the lens. The position of the image formed by the lens-water-mirror system of a small object outside the tank on the lens axis and 90cm to the left of the lens will be
   a. 54 cm to the left of the lens

b. 54 cm to the right of the lens
c. 45 cm to the left of the lens
d. 45 cm to the right of the lens

5. The focal length (f) of spherical mirror of radius curvature R is:

   a. $\frac{3}{2R}$
   b. 2 R
   c. R
   d. $\frac{R}{2}$

6. An object is placed at the focus of concave lens. Where will its image be formed?

7. Does the apparent depth of a tank of water change if viewed obliquely? If so, does the apparent depth increase or decrease?

8. Why prisms are used in many optical instruments?

9. A small pin fixed on a table top is viewed from above from a distance of 50 cm. By what distance would the pin appear to be raised if it is viewed from the same point through a 15 cm thick glass slab held parallel to the table? Refracting index of glass = 1.5. Does the answer depend on the location of the slab?

10. What is the physical principle on which the working of optical fibre is based?

11. What is the angle of a telescope in a normal adjustment?

12. A beam of light converges at a point P. Now a lens is placed in the path of the convergent beam 12 cm from P. At what point does the beam converge if the lens is

    a. a convex lens of a focal length 20 cm. and
    b. a concave lens of focal length 16 cm?

13. A 5 cm long needle is placed 10 cm from a convex mirror of focal length 40 cm. Find the position, nature and size of image of the needle. What happens to the size of the image when the needle is moved further away from the mirror?

14. a. At what distance should the lens be held in order to view the squares distinctly

with the maximum possible magnifying power?

b. What is the magnification in this case?
c. Is the magnification equal to the magnifying power in this case? Explain.

15. Determine the 'effective focal length' of the combination of the two lenses having focal lengths 30 cm and -20cm if they are placed 8.0 cm apart with their principal axes coincident. Does the answer depend on which side of the combination a beam of parallel light is incident? Is the notion of effective focal length of this system useful at all?

a. An object 1.5 cm in size is placed on the side of the convex lens in the arrangement above.
b. The distance between the object and the convex lens is 40 cm. Determine the magnification produced by the two-lens system, and the size of the image.

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Answers

1. c. rectangular hyperbola

Explanation:

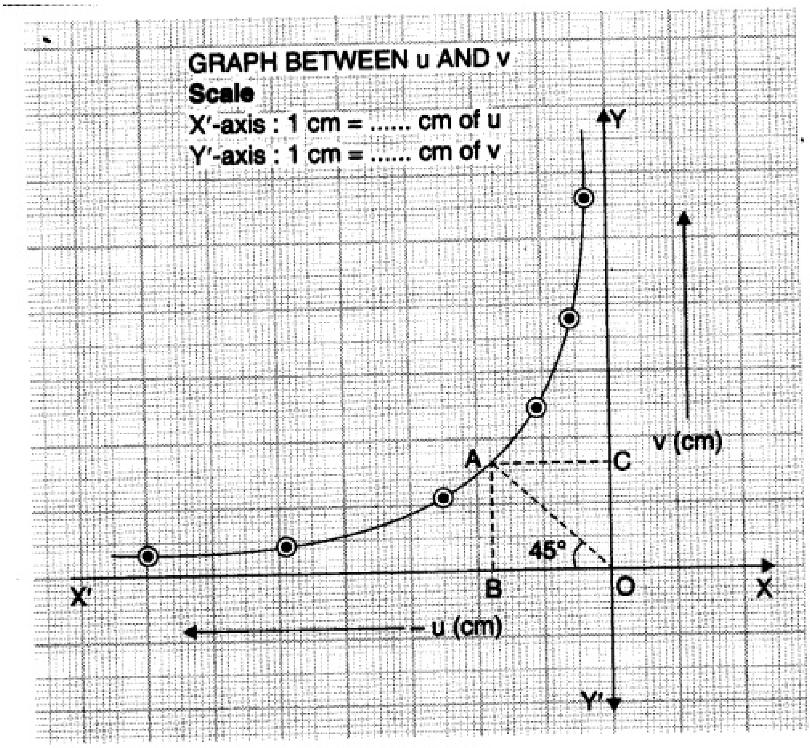

Fig. Graph between u and v. It is a rectangular hyperbola.

2. d. convergent lens of focal length 3.5 R

Explanation: $\frac{1}{f}=(\frac{\mu_2}{\mu_1}-1)(\frac{1}{R_1}-\frac{1}{R_2})$

R_1 = -R and R_2 = R, hence

$\frac{1}{f}=\left(\frac{1.5}{1.75}-1\right)\left(\frac{1}{-R}-\frac{1}{R}\right)=\left(\frac{1.5-1.75}{1.75}\right)\left(\frac{-2}{R}\right)=\frac{0.5}{1.75R}=\frac{1}{3.5R}$

or f = 3.5 R. Since focal length is positive, the lens acts as a converging lens.

3. b. 21 cm

Explanation:

Distance between two positions of lens, L_1L_2 = 40 cm and OI = 100cm

Let distance of object from L_1 = x, therefore u = -x, hence x + 40 + x = 100 or x = 30cm

for L_1 we have, u = -30 cm and v = 70 cm

Putting values in lens formula and solving we get f = +21 cm.

4. d. 45 cm to the right of the lens

Explanation: As one side of the lens is in air and another is in water. We should go as per the refraction at the curved surface formula. Focal length in air = 30cm.

Since it is equiconvex lens and refractive index of galss is 1.5, therefore magnitude of R = f = 30cm.

For refraction from the first curved surface (Air to glass)

$\frac{\mu_g}{v} - \frac{\mu_a}{u} = \frac{\mu_g - \mu_a}{R}$

Putting $\mu_g = \frac{3}{2}, u = -90cm, \mu_a = 1$, R = +30cm, we get v = +270 cm.

This image will behave as an object for the second surface so for refracting at second surface (glass to water)

$\frac{\mu_w}{v} - \frac{\mu_g}{u} = \frac{\mu_w - \mu_g}{R}$

Putting $\mu_g = \frac{3}{2}, u = +270cm, \mu_w = \frac{4}{3}$, R = -30cm, we get v = +120 cm.

This will behave as a virtual object for the plane mirror and will form a real image in front of the mirror at a distance of 40 cm in front of the mirror. This image will behave as an object for surface two of the lens.

For refraction at second surface, (water to glass)

$\frac{\mu_g}{v} - \frac{\mu_w}{u} = \frac{\mu_g - \mu_w}{R}$

Putting $\mu_g = \frac{3}{2}, u = +40cm, \mu_w = \frac{4}{3}$, R = -30cm,

We get v = +54 cm.

For refraction at first surface, (glass to air)

$\frac{\mu_a}{v} - \frac{\mu_g}{u} = \frac{\mu_a - \mu_g}{R}$

Putting $\mu_g = \frac{3}{2}, u = +54cm, \mu_a = 1$, R = +30cm,

We get v = +45 cm.

5. d. $\frac{R}{2}$

Explanation: Since for spherical mirror R = 2f. Therefore

6. Image is formed at infinity.

7. The apparent depth of oblique viewing decreases from its value for near normal viewing.

8. Since, prisms can tend the light rays by 90° and 180° by total internal reflection so, they are used in many optical instruments.

9. Image of pin appear through glass slab
$\mu = \frac{real\ depth}{apparent\ depth}$
Apparent depth $= \frac{real\ depth(thickness\ of\ glass\ slab)}{\mu}$
$= \frac{15}{1.5} = 10cm$
Image left up by = 15 -10 = 5cm
Location of slab will not affect the answer is any way.

10. An optical fiber is a cylindrical dielectric waveguide (nonconducting waveguide) that transmits light along its axis, by the process of total internal reflection. The fiber consists of a core surrounded by a cladding layer, both of which are made of dielectric materials. To confine the optical signal in the core, the refractive index of the core must be greater than that of the cladding.

11. Length of a telescope is given by the sum of the focal length of the objective and the eyepiece.
$L = f_o + f_e$
Where, f_o is the focal length of the objective and, f_e is the focal length of the eyepiece.

12. Here, the point P on the right of the lens acts as a virtual object,
u = 12 cm
(a) f = 20 cm
Since $\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$
$\therefore \frac{1}{v} = \frac{1}{20} + \frac{1}{12} = \frac{3+5}{60} = \frac{8}{60}$
or $v = \frac{60}{8} = 7.5cm$
Image is at 7.5 cm to the right of the lens, where the beam converges.
(b) f = -16cm u = 12 cm
$\therefore \frac{1}{v} = \frac{1}{f} + \frac{1}{u} = -\frac{1}{16} + \frac{1}{12} = \frac{-3+4}{48} = \frac{1}{48}$
v = 48 cm

Hence the image is at 48 cm to the right of the lens, where the beam would converge.

13. For mirror,
$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$
$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$
$= \frac{1}{40} - \frac{1}{-10} = \frac{1+4}{40} = \frac{5}{40}$
or $v = \frac{40}{5} = 8cm$
Magnification, $m = -\frac{v}{u}$
When needle moves further away from the convex mirror, the image moves further behind the mirror towards the focus and size decreases. When it is far off, it appears almost as a point image of the object.

14. a. Maximum magnifying power is obtained when the image is at the near point (25 cm). Thus,
v = -25cm, f = + 10 cm, u = ?
As $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
$\therefore \frac{1}{u} = \frac{1}{v} - \frac{1}{f}$
$= \frac{1}{-25} - \frac{1}{10} = \frac{-2-5}{50} = \frac{-7}{50}$
or $u = -\frac{50}{7} = -7.14cm$
So the lens should be held 7.14 cm away from the figure.
b. Magnitude of magnification is
$m = \frac{v}{u} = \frac{25}{\frac{50}{7}} = 3.5$
c. Magnifying power, $M = \frac{D}{u} = \frac{25}{\frac{50}{7}} = 3.5$
Yes, the magnifying power is equal to the magnitude of magnification because the image is formed at the least distance of distinct vision.

15. a. i. Here, f_1 = 30cm, f_2 = -20cm, d = 8.0 cm
Let a parallel beam be incident on the convex lens first. If second lens were absent, then
$\therefore u_1 = \infty$ and f_1 = 30 cm
As $\frac{1}{v_1} - \frac{1}{u_1} = \frac{1}{f_1}$
$\therefore \frac{1}{v_1} - \frac{1}{\infty} = \frac{1}{30}$
or v_1 = 30 cm

This image would now act as virtual object for second lens.

$\therefore$ u_2 = +(30 - 8) = + 22 cm

f_2 = -20cm

Since, $\frac{1}{v_2}=\frac{1}{f_2}+\frac{1}{u_2}\therefore\frac{1}{v_2}=\frac{1}{-20}+\frac{1}{22}$

$=\frac{-11+10}{220}=\frac{-1}{220}$

v2 = -220 cm

$\therefore$ Parallel incident beam would appear to diverge from a point 220-4 = 216 cm from the centre of the two lens system.

ii. Assume that a parallel beam of light from the left is incident first on the concave lens.

$\therefore u_1=-\infty$, f_1 = -20 cm

As $\frac{1}{v_1}-\frac{1}{u_1}=\frac{1}{f_1}$

$\therefore\frac{1}{v_1}=\frac{1}{\mathrm{f}_1}+\frac{1}{\mathrm{u}_1}=\frac{1}{-20}+\frac{1}{-\infty}=-\frac{1}{20}$

v1 = -20cm

This image acts as a real object for the second lens

u_2 = -(20 + 8) = -28cm, f_2 = 30 cm

Since, $\frac{1}{v_2}-\frac{1}{u_2}=\frac{1}{f_2}$

$\therefore\frac{1}{v_2}=\frac{1}{f_2}+\frac{1}{u_2}=\frac{1}{30}-\frac{1}{28}=\frac{14-15}{420}$

v_2 = -420 cm

The parallel beam appears to diverge from a point 420 - 4 = 416 cm, on the left of the centre of the two lens system.

We finally conclude that the answer depends on the side of the lens system where the parallel beam is incident. Therefore, the notion of effective focal length does not seem to be meaningful here.

b. For convex lens

u = -40cm, f = 30 cm, O = 1.5 cm

Using lens formula

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

We get

$\frac{1}{v}-\frac{1}{-40}=\frac{1}{30}$

or $\frac{1}{v}=\frac{1}{30}-\frac{1}{40}=\frac{1}{120}$

v = 120 cm (for real object)

From relation,

$\mathrm{m} = -\frac{\mathrm{v}}{\mathrm{u}}$, we get

$m = -\frac{120}{-40}$ = + 3

The image formed by the convex lens becomes object for concave lens at a distance of 120 - 8 = 112 cm on the other side.

For concave lens, f = -20cm, u = + 112 cm (on the other side)

v = ?

Using lens formula, we get

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

Now, $\frac{1}{v} - \frac{1}{112} = \frac{1}{-20}$

or $\frac{1}{v} = -\frac{1}{20} + \frac{1}{112} = -\frac{23}{560}$

$v = -\frac{560}{23}$cm (for virtual object)

From relation, $m = \frac{v}{u}$, we get

$m = -\frac{560/23}{-112} = -\frac{560}{23} \times \frac{1}{112} = -\frac{5}{23}$

Net magnification $= 3 \times \left(\frac{-5}{23}\right) = -\frac{15}{23}$

= 0.652 (negative due to virtual image)

As $\mathrm{m} = \frac{1}{0}$

$I = m \times 0 = 0.652 \times 1.5$

= 0.98 cm (size of final image)