CBSE TEST PAPER-05

Class - 12 Physics (Ray Optics and optical Instruments)

1. An object is placed at a distance of 10 cm from a co-axial combination of two lenses A and B in contact. The combination forms a real image three times the size of the object. If lens B is concave with a focal length of 30 cm, what is the nature and focal length of lens A?
   a. Convex, 12 cm
   b. Convex, 6 cm
   c. Concave, 12 cm
   d. Convex, 18 cm
2. Refraction is
   a. Change of direction of propagation of light at the interface of two media as light passes from one medium to another
   b. None of these
   c. The change in frequency of light
   d. Reversal of direction of propagation of light at the interface of two media as light passes from one medium to another
3. Blue colour of clear sky is due to phenomenon of:
   a. Reflection
   b. Scattering
   c. Refraction
   d. Dispersion
4. A plano-convex lens acts like a concave mirror of 28 cm focal length when its plane surface is silvered and like a concave mirror of 10 cm focal length when its curved surface is silvered. What is the refractive index of the material of the lens?
   a. 1.65
   b. 1.60
   c. 1.55
   d. 1.50
5. According to Snell's law
   a. The ratio of the sine of the angle of incidence to the sine of angle of refraction is

constant

b. The ratio of the cosine of the angle of incidence to the cosine of angle of refraction is constant
c. The ratio of the angle of incidence to the angle of refraction is constant
d. The ratio of the tangent of the angle of incidence to the tangent of angle of refraction is constant

6. If a telescope is inverted, will it be able to work as a microscope?

7. Magnifying power of a simple microscope is inversely proportional to the focal length of the lens. What then stops us from using a convex lens of smaller and smaller focal length and achieving greater and greater magnifying power?

8. Which of the two main parts of an optical fibre has a higher value of refractive index?

9. What is the magnification produced by a single convex lens used as a simple microscope in normal use?

10. Does short sightedness (myopia) or long sightedness (hypermetropia) imply necessarily that the eye has partially lost its ability of accommodation? If not, what might cause these defects of vision?

11. A tank is filled with water to a height of 12.5 cm. The apparent depth of a needle lying at the bottom of the tank is measured by a microscope to be 9.4 cm. What is the refractive index of water? If water is replaced by a liquid of refractive index 1.63 up to the same height, by what distance would the microscope have to be moved to focus on the needle agains?

12. A person with a normal near point (25 cm) using a compound microscope with objective of focal length 8.0 mm and an eye piece of focal length 2.5 cm can bring an object placed 9.0 mm from the objective in sharp focus. What is the separation between the two lenses? Calculate the magnifying power of the microscope.

13. A prism is made of glass of unknown refractive index. A parallel beam of light is incident on a face of the prism. The angle of minimum deviation is measured to be 40°. What is the refractive index of the material of the prism? The refracting angle of the prism is 60°. If the prism is placed in water predict the new angle of minimum

deviation of a parallel beam of light.

14. A prism of refractive index of $\sqrt{2}$ has a refracting angle of 60°. At what angle must a ray be incident on it so that it suffers a minimum deviation?

15. Two convex lenses A and B of focal lengths 20 cm and 10 cm are placed coaxially 10 cm apart. An object is placed on the common axis at a distance of 10 cm from lens A. Find the position and magnification of the final image.

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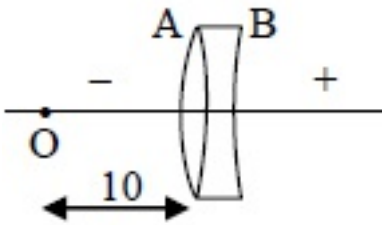
Answers

1. (b) Convex, 6 cm

   Explanation:

   f_B = -30 cm

   u = -10 cm

   m = -3

   v/u = -3, or v = -3u.

   $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{30} + \frac{1}{10} = \frac{4}{30}$

   $\frac{1}{f} = \frac{1}{f_A} - \frac{1}{f_B}\frac{4}{30} = \frac{1}{f_A} + \frac{1}{-30}$

   On solving, f_A = +6 cm. Hence lens is convex (since focal length is positive).

2. (a) Change of direction of propagation of light at the interface of two media as light passes from one medium to another

   Explanation: Refraction is a phenomenon that often occurs when light travel from a medium with a given refractive index to a medium with another at an oblique angle. At the boundary between the media, velocity of light is altered, usually causing a change in direction.

3. (b) Scattering

   Explanation: Particles of atmosphere in clear sky are very small in size.

   According to Rayleigh's criteria for scattering, scattering $\propto \frac{1}{\lambda^4}$

   Since wavelength of violet, indigo and blue are very short hence they are scattered the most, resulting in blue appearance of sky.

4. (c) 1.55

   Explanation: A plano-convex lens behaves as a concave mirror if its one surface (curved) is silvered. The rays refracted from plane surface are reflected from curved surface and again refract from plane surface. Therefore, in this lens two refractions and one reflection occur. Let the focal length of silvered lens is F and focal length of

mirror is f(m)

1/F = 1/f + 1/f +1/f(m)

Plano-convex lens silvered on plane side has f(m) = infinity

1/F = 2/f + 1/ infinity

1/F = 2/f

f = 28$\times$2 = 56 cm

Plano-convex lens silvered on convex side has f(m) = R/2

1/F = 2/f + 2/ R

1/10 = 2/56 + 2/R

R = 280/9 cm

Now

$1/f = \frac{(\mu–1)}{R}$

if we put all value

$\mu = 1.55$

5. (a) The ratio of the sine of the angle of incidence to the sine of angle of refraction is constant

   Explanation: The ratio of sine of angle of incidence and sine of angle of refraction is constant for a given pair of media for a given wavelength of light.

6. The objective and eyepiece of the microscope should have small focal lengths. But the objective of the telescope has large focal length and larger aperture than the eyepiece. Therefore, the inverted telescope would not work as a microscope.

7. First, grinding lenses of very small focal lengths is not easy. More important, if you decrease focal length, aberrations become more pronounced. So, in practice, you can't get a magnifying power of more than 3 or so with a simple convex lens. However, using an aberration corrected lens system, one can increase this limit by a factor of 10 or so.

8. The two main parts of the optical fibre are:

   i) core and,

   ii) cladding.

   The refractive index of core is greater than that of cladding.

9. The magnification produced by a single convex lens is,

M = $1 + \frac{D}{f}$.

Where, M is the magnification,f is the focal length.

10. No, a person may have normal ability of accommodation and yet he may be myopic or hypermetropic.

    In fact, myopia arises when length of eye ball (from front to back) gets elongated and hypermetropic arises when length of eye ball gets shortened.

    However, when eye ball has normal length, but the eye lens losses partially its power of accommodation, the defect is called presbiopia.

11. Case I: Given, real depth = 12.5 cm apparent depth = 9.4 cm

    As, $\mu = \frac{real\ depth}{apparent\ depth}$

    or $\mu = \frac{12.5}{9.4} = 1.33$

    Case II : $\mu = 1.63$ real depth = 12.5 cm

    Apparent depth $= \frac{\text{Re}al\ depth}{\mu}$

    $A.D. = \frac{12.5}{1.63} = 7.67cm$

    Distance through which microscope has to be moved downward.

    $= (9.4 - 7.67)cm = 1.73cm$

12. Here, u_0 = -0.9cm, f_0 = 0.8cm

    As, $\frac{1}{v_0} - \frac{1}{u_0} = \frac{1}{f_0}$

    $\therefore \frac{1}{v_0} = \frac{1}{f_0} + \frac{1}{u_0} = \frac{1}{0.8} - \frac{1}{0.9} = \frac{1}{7.2}$

    or v_0 = 7.2 cm

    Now for the eyepiece, we have

    f_e = 2.5cm, v_e = -D, ue = ?

    $\therefore \frac{1}{u_e} = \frac{1}{v_e} - \frac{1}{f_e} = -\frac{1}{25} - \frac{1}{2.5} = -\frac{11}{25}$

    or $u_e = -\frac{25}{11} = -2.27cm$

    Separation between the two lenses

    $= v_0 + |u_e|$

    = 7.2 + 2.27 = 9.47 cm

    Magnifying power, $M = M_0 \times M_e$

    $M = \frac{v_0}{u_0}\left(1 + \frac{D}{f_e}\right) = \frac{7.2}{0.9}\left(1 + \frac{25}{2.5}\right)$

    $= 8 \times 11 = 88$

13. A = 60°, $\delta m = 40^\circ$

$_a\mu_g = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin\frac{A}{2}}$

$_a\mu_g = \frac{\sin 50^\circ}{\sin 30^\circ} = \frac{0.766}{0.54} = 1.532$

After the prism is placed in water,

$_w\mu_g = \frac{\frac{\sin(A+\delta'_m)}{2}}{sin\frac{A}{2}}$

or $\frac{^a\mu_g}{_\alpha\mu_2} = \frac{\sin\left(\frac{60+\delta'_m}{2}\right)}{\sin 30^\circ}$

$\therefore \sin\left(30' + \frac{\delta'_m}{2}\right) = \frac{1}{2} \times \frac{1.532}{1.33} = 0.5759$

or $30^\circ + \frac{\delta_m}{2} = 35^\circ 10'$

on simplification $\delta'_m = 10^\circ 20'$.

14. For minimum deviation i = e.

Therefore, $A + \delta_m = i + r$

or $i = \frac{A+\delta_m}{2}$ for δ minimum i = r

Now, $\mu = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin\frac{A}{2}} = \frac{\sin i}{\sin\frac{A}{2}}$

or $\sin i = \mu \sin\frac{A}{2}$

$= \mu \sin\left(\frac{60^\circ}{2}\right) = \sqrt{2}\ \sin 30° = \frac{1}{\sqrt{2}}$

Hence, $i = 45^\circ$

15. From figure below, we have, for lens A

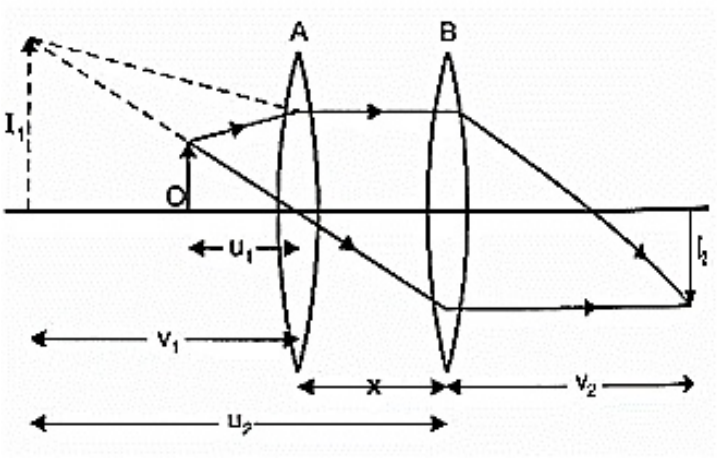
f_1 = +20cm and u_1 = -10cm

The image distance v_1 is given by

$\frac{1}{v_1} = \frac{1}{f_1} + \frac{1}{u_1} = \frac{1}{20} + \frac{1}{(-10)} = \frac{1}{20} - \frac{1}{10}$

which gives v_1 = -20 cm

Thus, a virtual image is formed at I_1 at a distance of 20 cm from lens A, if the lens B were absent. This image acts as a virtual object for lens B which forms the final image at I_2 at a distance v_2 from lens B. For lens B we have,



x = 10 cm, u_2 = -(20 + 10) = -30 cm f_2 = + 10 cm

The image distance v_2 is given by

$$\frac{1}{v_2} = \frac{1}{f_2} + \frac{1}{u_2} = \frac{1}{10} - \frac{1}{30} = \frac{1}{15}$$

Which gives v_2 = +15cm

Thus, a real image I_2 is formed at a distance of 15 cm from lens B.

Magnification due to A $(m_1) = \frac{v_1}{u_1} = \frac{-20}{-10} = +2$

Magnification due to B $(m_2) = \frac{v_2}{u_2} = \frac{15}{-30} = -\frac{1}{2}$

Magnification of the final image is

$$m = m_1 \times m_2 = 2 \times \left(\frac{-1}{2}\right) = -1$$

This shows that the final image is inverted and is of the same size as the object.