

# D.A.V PUBLIC SCHOOL

SECTOR -3 DHURWA, RANCHI -4

CLASS-XII(Science)

SUBJECT - PHYSICS

## Holiday Homework & Assignments

### Ray Optics and optical Instruments

1. A small candle, 2.5 cm in size is placed at 27 cm in front of a concave mirror of radius of curvature 36 cm. At what distance from the mirror should a screen be placed in order to obtain a sharp image? Describe the nature and size of the image. If the candle is moved closer to the mirror, how would the screen have to be moved?\_

2. 4.5 cm needle is placed 12 cm away from a convex mirror of focal length 15 cm. Give the location of the image and the magnification. Describe what happens as the needle is moved farther from the mirror.

3. 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 again?

4. Figures 9.34(a) and (b) show refraction of a ray in air incident at  $60^\circ$  with the normal to a glass-air and water-air interface, respectively. Predict the angle of refraction in glass when the angle of incidence in water is  $45^\circ$  with the normal to a water-glass interface [Fig. 9.34(c)].

5. 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  $40^\circ$ . What is the refractive index of the material of the prism? The refracting angle of the prism is  $60^\circ$ . If the prism is placed in water (refractive index 1.33), predict the new angle of minimum deviation of a parallel beam of light.

6. A small bulb is placed at the bottom of a tank containing water to a depth of 80 cm. What is the area of the surface of water through which light from the bulb can emerge out? Refractive index of water is 1.33. (Consider the bulb to be a point source.)

7. Double-convex lenses are to be manufactured from a glass of refractive index 1.55, with both faces of the same radius of curvature. What is the radius of curvature required if the focal length is to be 20 cm?

8. 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 convex lens of focal length 20 cm, and
  - a concave lens of focal length 16 cm?
9. An object of size 3.0 cm is placed 14 cm in front of a concave lens of focal length 21 cm. Describe the image produced by the lens. What happens if the object is moved further away from the lens?
10. What is the focal length of a convex lens of focal length 30 cm in contact with a concave lens of focal length 20 cm? Is the system a converging or a diverging lens? Ignore thickness of the lenses
11. 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
- the least distance of distinct vision (25cm), and
  - at infinity? What is the magnifying power of the microscope in each case?
12. A person with a normal near point (25 cm) using a compound microscope with objective of focal length 8.0 mm and an eyepiece of focal length 2.5 cm can bring an object placed at 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 small telescope has an objective lens of focal length 144 cm and an eyepiece of focal length 6.0 cm. What is the magnifying power of the telescope? What is the separation between the objective and the eyepiece?
14. (a) A giant refracting telescope at an observatory has an objective lens of focal length 15 m. If an eyepiece of focal length 1.0 cm is used, what is the angular magnification of the telescope?
- If this telescope is used to view the moon, what is the diameter of the image of the moon formed by the objective lens? The diameter of the moon is  $3.48 \times 10^6$  m, and the radius of lunar orbit is  $3.8 \times 10^8$  m.
15. Use the mirror equation to deduce that:
- an object placed between  $f$  and  $2f$  of a concave mirror produces a real image beyond  $2f$ .
  - a convex mirror always produces a virtual image independent of the location of the object.
  - the virtual image produced by a convex mirror is always diminished in size and is located between the focus and the pole.
- an object placed between the pole and focus of a concave mirror produces a

virtual and enlarged image. [Note: This exercise helps you deduce algebraically properties of images that one obtains from explicit ray diagrams.]

16. 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? Refractive index of glass = 1.5. Does the answer depend on the location of the slab?
- a) Figure 9.35 shows a cross-section of a 'light pipe' made of a glass fibre of refractive index 1.68. The outer covering of the pipe is made of a material of refractive index 1.44. What is the range of the angles of the incident rays with the axis of the pipe for which total reflections inside the pipe take place, as shown in the figure.
- ⓐ What is the answer if there is no outer covering of the pipe?

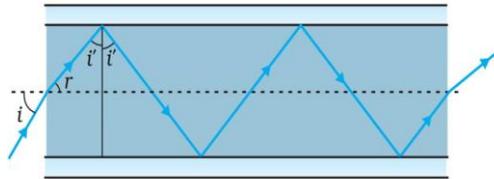


FIGURE 9.35

17. Answer the following questions:
- (a) You have learnt that plane and convex mirrors produce virtual images of objects. Can they produce real images under some circumstances? Explain.
- (b) A virtual image, we always say, cannot be caught on a screen. Yet when we 'see' a virtual image, we are obviously bringing it on to the 'screen' (i.e., the retina) of our eye. Is there a contradiction?
- (c) A diver under water, looks obliquely at a fisherman standing on the bank of a lake. Would the fisherman look taller or shorter to the diver than what he actually is?
- (d) Does the apparent depth of a tank of water change if viewed obliquely? If so, does the apparent depth increase or decrease?
- (e) The refractive index of diamond is much greater than that of ordinary glass. Is this fact of some use to a diamond cutter?

18. The image of a small electric bulb fixed on the wall of a room is to be obtained on the opposite wall 3 m away by means of a large convex lens. What is the maximum possible focal length of the lens required for the purpose?

19. 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.

20. (a) Determine the 'effective focal length' of the combination of the two lenses in Exercise 9.10, 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?

(b) An object 1.5 cm in size is placed on the side of the convex lens in the arrangement (a) above. 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.

21. At what angle should a ray of light be incident on the face of a prism of refracting angle  $60^\circ$  so that it just suffers total internal reflection at the other face? The refractive index of the material of the prism is 1.524.

22. You are given prisms made of crown glass and flint glass with a wide variety of angles. Suggest a combination of prisms which will

(a) deviate a pencil of white light without much dispersion.

(b) disperse (and displace) a pencil of white light without much deviation.

23. For a normal eye, the far point is at infinity and the near point of distinct vision is about 25 cm in front of the eye. The cornea of the eye provides a converging power of about 40 dioptres, and the least converging power of the eye-lens behind the cornea is about 20 dioptres. From this rough data estimate the range of accommodation (i.e., the range of converging power of the eye-lens) of a normal eye.

24. 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?

25. A myopic person has been using spectacles of power  $-1.0$  dioptre for distant vision. During old age he also needs to use separate reading glass of power

$+2.0$  dioptres. Explain what may have happened.

26. A person looking at a person wearing a shirt with a pattern comprising vertical and horizontal lines is able to see the vertical lines more distinctly than the horizontal ones. What is this defect due to? How is such a defect of vision corrected?

27. A man with normal near point (25 cm) reads a book with small print using a magnifying glass: a thin convex lens of focal length 5 cm.

(a) What is the closest and the farthest distance at which he should keep the lens from the page so that he can read the book when viewing through the magnifying glass?

(b) What is the maximum and the minimum angular magnification

(magnifying power) possible using the above simple microscope?

28. A card sheet divided into squares each of size  $1 \text{ mm}^2$  is being viewed at a distance of 9 cm through a magnifying glass (a converging lens of focal length 10 cm) held close to the eye.

(a) What is the magnification produced by the lens? How much is the area of each square in the virtual image?

(b) What is the angular magnification (magnifying power) of the lens?

(c) Is the magnification in (a) equal to the magnifying power in (b)?

Explain. (Note: Data in the question is modified to get the proper answers)

29. (a) At what distance should the lens be held from the figure in Exercise 9.29 in order to view the squares distinctly with the maximum possible magnifying power?

(b) What is the magnification in this case?

Is the magnification equal to the magnifying power in this case? Explain.

30. What should be the distance between the object in Exercise 9.30 and the magnifying glass if the virtual image of each square in the figure is to have an area of  $6.25 \text{ mm}^2$ . Would you be able to see the squares distinctly with your eyes very close to the magnifier? [Note: Exercises 9.29 to 9.31 will help you clearly understand the difference between magnification in absolute size and the angular magnification (or magnifying power) of an instrument.]

31. An angular magnification (magnifying power) of 30X is desired using an objective of focal length 1.25 cm and an eyepiece of focal length 5 cm. How will you set up the compound microscope?

32. A small telescope has an objective lens of focal length 140 cm and an eyepiece of focal length 5.0 cm. What is the magnifying power of the telescope for viewing distant objects when

(a) the telescope is in normal adjustment (i.e., when the final image is at infinity)?

(b) the final image is formed at the least distance of distinct vision (25cm)?

# Wave Optics

1. Monochromatic light of wavelength 589 nm is incident from air on a water surface. What are the wavelength, frequency and speed of

- (a) reflected, and
- (b) refracted light? Refractive index of water is 1.33

2. Light diverging from a point source.

Light emerging out of a convex lens when a point source is placed at its focus.

The portion of the wavefront of light from a distant star intercepted by the Earth.

3. The refractive index of glass is 1.5. What is the speed of light in glass?  
(Speed of light in vacuum is  $3.0 \times 10^8 \text{ m s}^{-1}$ )

Is the speed of light in glass independent of the colour of light? If not, which of the two colours red and violet travels slower in a glass prism?

4. Young's double-slit experiment, the slits are separated by 0.28 mm and the screen is placed 1.4 m away. The distance between the central bright fringe and the fourth bright fringe is measured to be 1.2 cm. Determine the wavelength of light used in the experiment

5. In Young's double-slit experiment using monochromatic light of wavelength  $\lambda$ , the intensity of light at a point on the screen where path difference is  $\lambda$ , is K units. What is the intensity of light at a point where path difference is  $\lambda/3$ ?

6. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes in a Young's double-slit experiment.

- (a) Find the distance of the third bright fringe on the screen from the central maximum for wavelength 650 nm.

(b) What is the least distance from the central maximum where the bright fringes due to both the wavelengths coincide

7. In a double-slit experiment the angular width of a fringe is found to be  $0.2^\circ$  on a screen placed 1 m away. The wavelength of light used is 600 nm. What will be the angular width of the fringe if the entire experimental apparatus is immersed in water? Take refractive index of water to be  $4/3$ .

8. Light of wavelength  $5000 \text{ \AA}$  falls on a plane reflecting surface. What are the wavelength and frequency of the reflected light? For what angle of incidence is the reflected ray normal to the incident ray

9. A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1 m away. It is observed that the first minimum is at a distance of 2.5 mm from the centre of the screen. Find the width of the slit

10. Let us list some of the factors, which could possibly influence the speed of wave propagation:

- (i) nature of the source.
- (ii) direction of propagation.
- (iii) motion of the source and/or observer.
- (iv) wavelength.
- (v) intensity of the wave.

On which of these factors, if any, does

- (a) the speed of light in vacuum,
- (b) the speed of light in a medium (say, glass or water), depend?

11. In double-slit experiment using light of wavelength 600 nm, the angular width of a fringe formed on a distant screen is  $0.1^\circ$ . What is the spacing between the two slits?

12. A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1 m away. It is observed that the first minimum is at a distance of 2.5 mm from the centre of the screen. Find the width of the slit.

13. What is the Brewster angle for air to glass transition? (Refractive index of glass = 1.5)

