# PHYSICS

# NCERT - NCERT PHYSICS(HINGLISH)

# RAY OPTICS AND OPTICAL INSTRUMENTS

## Solved Examples

**1.** Suppose that the lower half of a concave mirror's reflecting surface is covered with an

opaque non-reflecting material. What effect will this have on the image of an object placed in front of the mirror ?

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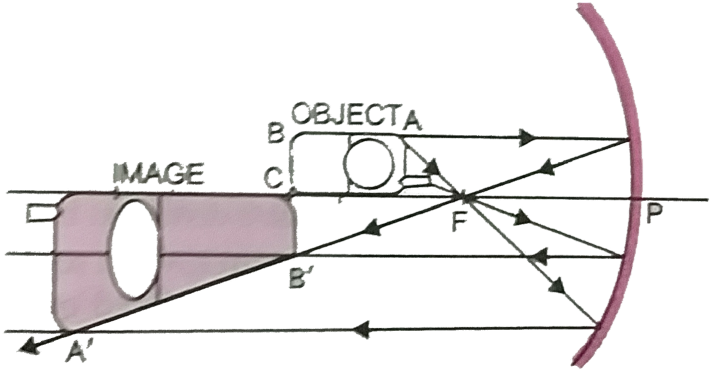
**2.** A mobile phone lies along the principal axis of a concave mirror as shown in Fig. Show by suitable diagram, the formation of its image. Explain why the magnification is not uniform, and distortion will occur depending on the location of the mobile with respect to the

mirror.

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**3.** An object is placed (i)$10cm$ (ii) $5cm$ in front of a convex mirror of radius of curvature $15cm$ . Find the position, nature and magnification of the image in each case.

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**4.** Suppose while sitting in a parked car, you notice a jogger approaching towards you in the rear view mirror of $R = 2m$. If the jogger is running at a speed of $5ms^{-1}$, how fast is the image of the jogger moving, when the jogger is

(a) 39 m

(b) 29 m

19 m and

(d) 9 m. away ?

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**5.** The earth takes $24$ hours to rotate once about its axis. How much time (in min) does the sun take to shift by $1^\circ$ when viewed from the earth?

A. 2 min

B. 4 min

C. 6 min

D. 8 min

**Answer: B**

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**6.** Light from a point source in air falls on a spherical glass surface. If $\mu = 1.5$, and radius of curvature $= 20cm$, the distance of light source from the glass surface is $100cm$ , at what position will the image be formed ? (NCERT Solved Example)

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**7.** A magician during a show makes a glass lens $\mu = 1.5$ disappear in a through of liquid. What is the refractive index of the liquid ? Is the liquid water ?

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**8.** (i) If $f = +0.5m$, what is the power of the lens ?

(ii) The radii of curvature of the faces of a double convex lens are $9cm$ and $15cm$. Its

focal length is $12cm$. What is the refractive index of glass ?

(iii) A convex lens has $20cm$ focal length in air. What is the focal length in water ? (Refractive index of air-water $= 1.33$, refractive index of air-glass $= 1.5$).

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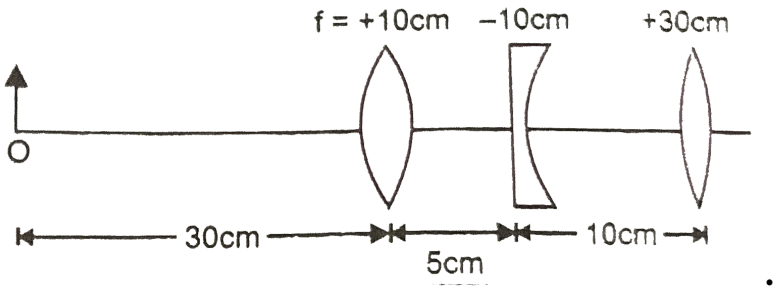
**9.** Find the position of the image formed by the lens combination given in Fig.

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## Exercise

**1.** A small candle $2.5cm$ in size is placed $27cm$ in front of a concave mirror of radius of curvature $36cm$. At what distance from the mirror should a screen be placed in order to

receive 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 ?

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**2.** A $4.5cm$ 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.

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

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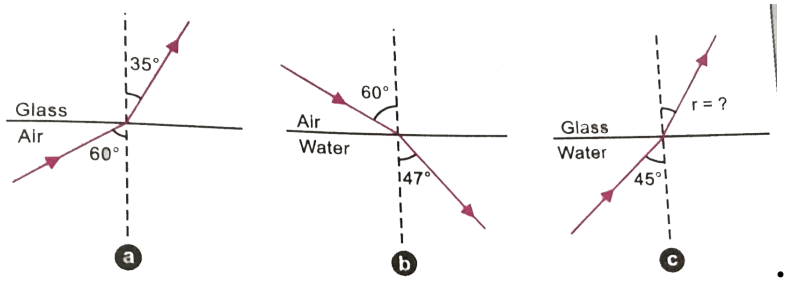
**4.** Fig. (a) and (b) show refraction of an incident ray in air at $60^\circ$ with the normal to a glass-air and water-air interface respectively. Predict the angle of refraction of an incident ray in water at $45^\circ$ with the normal to a water glass interface. Take $.^a\mu_g = 1.32$.

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**5.** A small bulb (assumed to be a point source) is placed at the bottom of a tank containing water to a depth of $80cm$. Find out the area of the surface of water through which light from the bulb can emerge. Take the value of refractive index of water to be $4/3$.

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**6.** A prism is made of glass of unknown refractive index. A parallel beam of light is

incident on a face of the prism. By rotating the prism, the minimum angle of deviation is measured to be $40^\circ$. What is the refractive index of the prism ? If the prism is placed in water $(\mu = 1.33)$, predict the new angle of minimum deviation of the parallel beam. The refracting angle of prism is $60^\circ$.

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**7.** A double convex lens is made of glass of refractive index $1.55$ with both faces of same

radius of curvature. Find the radius of curvature required, if focal length is $20cm$.

A. 22 cm

B. 44 cm

C. 11 cm

D. 33 cm

**Answer: A**

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

(a) a convex lens of focal length $20cm$. (b) a concave lens of focal length $16cm$ ?

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**9.** An object of size $3.0cm$ is placed $14cm$ in front of a concave lens of focal length $21cm$.

Describe the image produced by the lens. What happens if the object is moved further from the lens ?

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**10.** What is the focal length of a convex lens of focal length $30cm$ in contact with a concave lens of focal length $20cm$. Is the system a converging or a diverging lens ? Ignore thickness of the lenses.

A. 30 cm

B. 60 cm

C. -30 cm

D. -60 cm

**Answer: D**

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**11.** A compound microscope consists of an objects lens of focal length 2.0 cm and an eyepiece of focal length 20cm? If the system a

converging or a diverging lens? Ignore thickness of the lenses.

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

lenses ? Calculate the magnifying power of the microscope ?

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**13.** A small telescope has an objective lens of focal length $144cm$ and an eye-piece of focal length $6.0cm$. What is the magnifying power of the telescope ? What is the separation between the objective and the eye-piece ?

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**14.** (i) 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 angular magnification of the telescope ?

(ii) 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 $3.8 \times 10^8 m$.

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**15.** Use the mirror equation to deduct that :

(a) an object between $f$ and $2f$ of a concave mirror produces a real image beyond $2f$.

(b) a convax mirror always produces a virtual image independent of the location of the object.

( c) the virtual image produced by a convex mirror is always diminished in size and is located between the focus and the pole.

(d) an object placed between the pole and focus of a concave mirror produces a virtual and enlarged image.

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**16.** A small pin fixed on a table top is viewed from above from a distance of $50cm$. By what distance would the pin appear to be raised, if it be viewed from the same point through a $15cm$. Thick glass slab held parallel to the table ? $\mu$ of glass $1.5$ Does the answer depend on location of the slab ?

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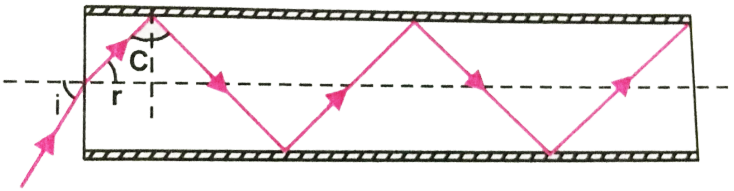
**17.** (a) Fig. shows a cross-section of a 'light pipe' made of a glass fiber of refractive index $1.68$. The outer covering of the pipe is made of a material of refractive index $1.44$. What is the axis of the pipe for which total reflection inside the pipe take place as shown.

(b) What is the answer if there is no outer covering if the pipe ?

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**18.** 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?

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

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**20.** A screen is placed $90cm$ from an object. The image of the object on the screen is

formed by a convex lens at two different location separated by $20cm$. Determine the focal length of the lens.

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**21.** a) Determine the effective focal length of the combination of the two lenses in Exercise, if they are placed 8.0cm apart with their principal axes coincident. Does the answer depend on which side of the combination a beam of paralel light is incident? Is the

notions 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 40cm. Determine the magnification produced by the two-lens system, and the size of the image.

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**22.** 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 prism is $1.524$.

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**23.** A card sheet divided into squares each of size $1mm^2$ is being viewed at a distance of $9cm$ through a magnifying glass (a converging

lens of focal length $10cm$) held close to the eye.

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

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**24.** (i) At what distance should the lens be held from the card sheet in order to view the squares distinctly with the maximum possible magnifying power ?

(ii) What is the magnification in this case ?

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

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**25.** What should be the distance between the object and magnifying glass if the virtual image of each square in the figure is to have an area of $6.25mm^2$.Would you be able to see the squares distinctly with your eyes very close to the magnifier ?

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**26.** a) The anlge subtended at the eye by an object is equal to the angle subtended at the

eye by the virtual image produced by a magnifying glass. In what sense then does a magnifying glass provide angular magnifications?

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

c) Magnifying power of a simple microscopes 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?

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

e) When viewing through a compound microscope, our eyes should be positioned not on the eyepiece but a short distance away from it fot best veiwing. Why? How much should be that short distance between the eye and eyepiece?

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

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**28.** 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 (25 cm )

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**29.** (a) For the telescope described what is the separation between the objective lens and eye piece ?

(b) If this telescope is used to view a $100m$ tall tower $3km$ away, what is the height of the

image of the tower formed by the objective lens ?

(c ) What is the height of the final image of the tower if it is formed at 25 cm` ?

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**30.** A Cassegrainian telescope uses two mirrors as shown in Fig. Such a telescope is built with the mirrors $20mm$ apart. If the radius of curvature of large mirror is $220mm$

and the small mirror is $40mm$, where will the final image of an object at infinity be ?

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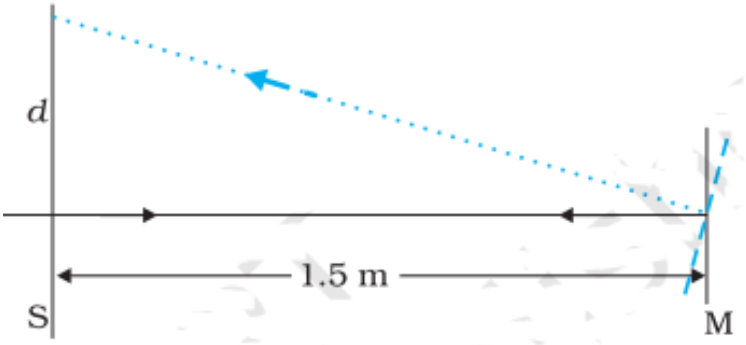
**31.** Light incident normally on a plane mirror attached to a galvanometer coil retraces backwards a shown in Fig. A current in the coil produces a deflection of $3.5^\circ$ in the mirror. What is the displacement of the reflected spot

of light on a screen placed $1.5m$ away ?

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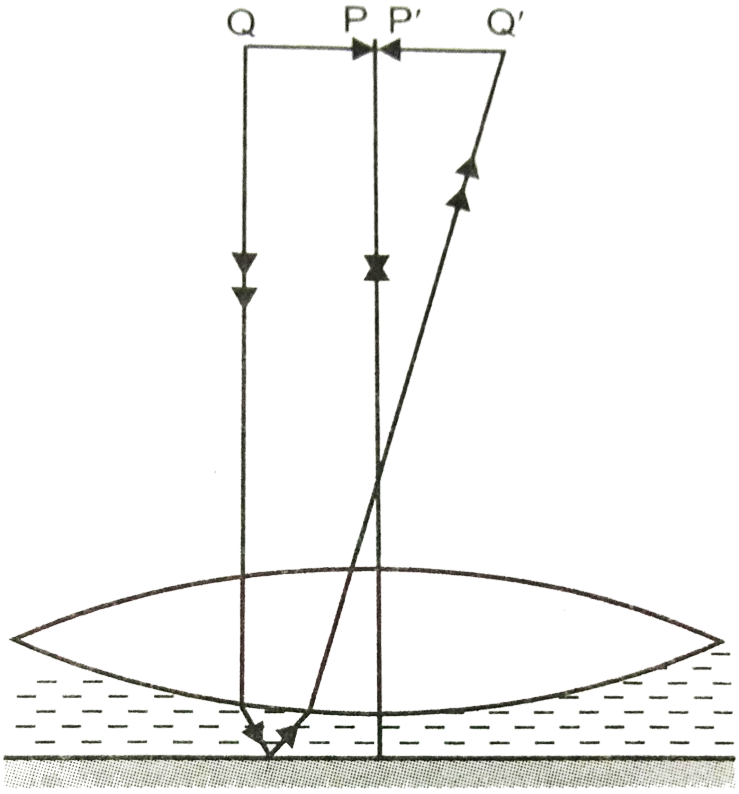
**32.** Fig. shows an equiconvex lens (of refractive index $1.5$) in contact with a liquid layer on top of a plane mirror. A small needle with its tip on the principal axis is moved along the axis until its inverted image is found at the position of

the needle. The distance of the needle from the lens is measured to be $45.0cm$. The liquid is removed and the experiment is repeated. The new distance is measured to be $30.0cm$. What is the refractive index of the liquid ?



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