LIGHT - REFLECTION AND REFRACTION

Gist of the Lesson:

1) Light:

Light is a form of energy. It brings the sensation of sight. It is a form of electromagnetic radiation. It also provides us means of communication (fiber-optics).

2) Light Wave:

Light wave travels with a speed of 3×10^8 ms- in free space. Its speed depends on the medium.

3) Ray and Beam:

The straight line indicating the path of the light (arrow- direction is called a ray. A bundle of rays originating from the same source of light in a particular direction is called a Beam of Light.

4) Reflection:

When light falls on a surface and gets back the same medium, it is called Reflection.

5) Image:

The point of convergence or the point form where the light appears to diverge after reflection or refraction is called Image.

6) Angle of Incidence:

The angle between the incident ray and the normal at the point of incidence is called Angle Of Incidence.

7) Angle of Reflection:

The angle between the reflected ray and the normal at the point of reflection is called Angle Of Reflection.

8) Laws of Reflection:

1) The incidence rays the reflected ray and the normal at the point of incidence, all lie in the same plane.
2) The angle of reflection and the angle of incidence are equal.

9) Aperture:

The width of the reflecting surface is called aperture.

10) Focus:

The point on the principle axis where all parallel rays meet after reflection is called Principle Focus.

11) Focal Length:

The length or separation between the pole and the focus is called focal length (PF = f)

12) In order to draw ray diagram, two rules are used:

1) The rays of light passing parallel to the principle axis will coverage at the focus after reflection.
2) The rays of light passing through the focus will emerge parallel to the principle axis after reflection.
3) The rays of light passing through the center of curvature will all retrace their both after reflection. (As it is normal at the point of incidence)
4) The rays of light falling at the pole get reflected at the same angle on the other side of principle axis.(Laws of reflection)

13) Relation between radius of curvature and focal length:

It is two times the focal length i.e. R=2f.

14) Mirror Formula:

1/f= 1/v +1/u where f, v and u are the focal length, image distance and object distance.

15) Lens Formula:

If u. v and f are the object distance, image distance and focal length respectively Then 1/f=1/v-1/u

16) Magnification of a lens:

M= size of image (h1)/ size of object (h{,) also m= (h_1)/ (h_0) = v/u.

One Mark Questions (One word or one sentence)

1. Write two uses of convex mirror?

A. Convex mirror is used:

(a) As a rear view mirror in vehicles.

(b) For making sun glasses and telescopes.

2. Define 'principal focus' of concave mirror. The distance between the centre of curvature and the pole of a concave mirror is 20 cm. Calculate the focal length of the mirror?

A.

- Point on the principal axis where all the rays parallel to principal axis meet after reflection from a concave mirror is called principal focus of the concave mirror.
- Distance between C and P = Radius of curvature.

  R = – 20 cm

  $f = \frac{R}{2} = -10\,cm$

  Focal length = 10 cm

3. A ray of light strikes the glass slab at an angle of 90º. What are the angle of incidence and the angle of refraction?

A.

- Angle of incidence = 0º
- Angle of refraction = 0º

4. What is meant by refractive index? If the speed of light in a medium is 2/3rd of the speed of light in vacuum, find the refractive index of that medium?

A.

- Refractive index of a medium is the ratio between the speed of light in vacuum to the speed of light in the medium
- Refractive index = $\frac{c}{v}$

  $= \frac{c}{(2/3)of\ c} = 1.5$

Two Marks Questions (30 words)

1. A converging lens has a focal length of 250 mm. Calculate its power and express it according to sign convention?

A. Focal length of lens = 250 mm = 0.25 m

Power of lens $= \frac{1}{0.25} = 4D$

Since it is a converging lens, so power of lens will be positive.

Power = + 4 D.

2. The absolute refractive indices of benzene and kerosene are 1.50 and 1.44 respectively. What is the refractive index of benzene with respect to kerosene?

A. Given, n_1 = 1.50, n_2 = 1.44, where n_1 and n_2 are absolute refractive indices of benzene and kerosene respectively.

$$n_{12} = \frac{n_2}{n_1} = \frac{1.44}{1.50} = 0.96$$

3. A concave mirror and convex lens arc held in water. What change, if any, do you expect to find in the focal length of either?

A. The concave mirror behaves in the same way in water us in air, i.e., no change is observed in its focal length. But when the convex Lens is held in water, its focal length is found greater than that was in air. It happens so because water has higher refractive index than air.

4. Define the term magnification. Write the formula for magnification of mirror and lens explaining the symbols used in the formula?

A. Magnification produced by a mirror or lens is the relative extent by which the image of an object is magnified with respect to the object size.

- Magnification of mirror $(m) = \frac{h'}{h} = -\frac{v}{u}$

  and magnification of lens $(m) = \frac{h'}{h} = \frac{v}{u}$

Where h' = Height of object

h = Height of image

u = Object distance

v = Image distance

Three Marks Questions (50 words)

1. A spherical mirror produces an image of magnification –1.0 on a screen placed at a distance of 30 cm from the pole of the mirror?

(a) Write the type of mirror in this case

(b) What is the focal length of the mirror?

(c) What is the nature of the image formed?

(d) Draw the ray diagram to show the image formation in this case?

A. (a) It is a concave mirror.

(b) Magnification, m = – 1.0

$v = -30cm$ (Image is real, so v is negative)

$$m = \frac{-v}{u}$$

$$-1 = \frac{-(-30)}{u}$$

u = –30 cm

By using mirror formula,

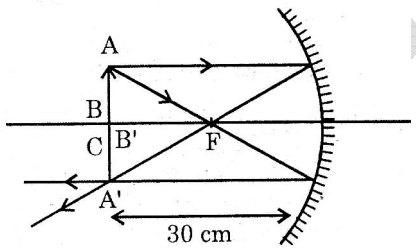
$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} = \frac{1}{-30} + \frac{1}{-30} = \frac{-2}{30}$$

$$f = \frac{-30}{2} = -15cm$$

So, focal length of mirror is 15 cm.

(c) Image is real and inverted.

(d)



2. (a) Mention the nature of image produced by a plane mirror?

(b) The magnification produced by a plane mirror is m = + 1. What does this mean?

A. (a) Image formed by plane mirror is virtual and erect but it is laterally inverted.

(b) If magnification produced by a plane mirror is m = +1, it means image produced is of same size as that of object and the object distance and image distance are equal.

3. Distinguish between a concave mirror and convex mirror. Write any three points?

A.

Concave Mirror	Convex Mirror
(a) Concave mirror is the mirror whose reflecting surface is curved inwards.	(a) Convex mirror is the mirror whose reflecting surface is curved outwards.
(b) All the incident rays parallel to principal axis converge to focus after reflection.	(b) All the incident rays parallel to principal axis appear to diverge from focus after reflection.
(c) It may form real as well as virtual image.	(c) It always forms virtual image.

4. An object 3 cm in length is held 25 cm away from a converging lens of focal length 15 cm. Find (a) position (b) size (c) nature of image formed?

A. Focal length, f = 15 cm

Object distance = – 25 cm

By using lens formula,

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

$$\frac{1}{v}-\frac{1}{-25}=\frac{1}{15}$$

$$\frac{1}{v}=\frac{1}{15}-\frac{1}{25}=\frac{5-3}{75}=\frac{2}{75}$$

$$v=\frac{75}{2}cm=37.5cm$$

$$m=\frac{v}{u}=\frac{h'}{h}\Rightarrow\frac{37.5}{-25}=\frac{h'}{3}$$

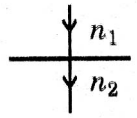
$$h'=-4.5cm$$

So image will be formed at 37.5 cm (between F_2 and $2F_2$). It will be real, inverted and its height will be 4.5 cm.

5. (a) State Snell's law of refraction.

(b) Using Snell's law and with the help of a diagram illustrate the path of a ray of light incident normally from a medium of refractive index n1 to medium of refractive index n_2.

A. **(a) Snell's Law:** The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given colour and for the given pair of media.



6. Define refractive index of a medium. Differentiate between relative and absolute refractive indices?

A. The extent of the change in direction of light ray when it travels obliquely from one transparent medium into another is expressed in terms of the refractive index.

Relative Refractive Index	Absolute Refractive Index
(1) It is the ratio of speed of light in two media. (2) It compares the optical density of the given pair of media.	(1) It is the ratio of speed of light in air to the given medium. (2) It compares the optical density of a medium with that of air.

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