OUR OWN HIGH SCHOOL, AL WARQA'A, DUBAI
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GRADE : X   PHYSICS   - LIGHT: REFLECTION AND REFRACTION

1. Light: It is a form of electromagnetic radiation which is considered as waves. These waves are electromagnetic and non mechanical that do not require any material medium for propagation

2. Speed of light: The speed of light depends upon the nature of the medium it is traveling. In spacer or vacuum its speed is $3x10^8$m/s.

3. Real image: The image is said to be real if the rays actually meet. A real image can be obtained on the screen.

4. Virtual image. The image is said to be virtual when rays do not actually meet, but appear to meet when produced backward.

5. Reflection of light: When light traveling from one medium falls on the surface of another medium, a portion of the incident light is turned back into the first medium. This is called reflection of light.

6. Laws of reflection of light:

- The angle of incidence is equal to the angle of reflection.
- The incident ray, the reflected ray and the normal to the mirror at the point of incidence all lie in the same plane.

7. Terms related to Spherical Mirrors

- *Spherical mirror*: It is a mirror whose reflecting surface forms a part of a hollow sphere
- *Concave mirror*: It is the spherical mirror in which the reflection of light takes place from the inner hollow surface
- *Convex mirror*. It is the spherical mirror in which the reflection of light takes place from the outer bulged surface
- *Pole(P)*. It is the middle point of the spherical mirror.
- *Centre of curvature(C).* It is the centre of the sphere of which the mirror forms a part.
- *Radius of curvature(R).* It is the radius of the sphere of which the mirror forms a part.
- *Principal axis*. The line passing through the pole and the centre of curvature of the mirror is called its radius of curvature
- *Principal focus(F)*. It is the point on the principal axis where a beam parallel to the principal axis either actually converges to or appears to diverge from, after reflection from the mirror
- *Focal length(f)*. It is the distance between the focus and the pole of the mirror.
- Plane mirrors form images which are virtual, erect, same sized and laterally inverted

- Convex mirrors form images which are virtual diminished and erect.
- Concave mirrors form images which can be real/virtual ,inverted/erect, and diminished/same sized/enlarged depending upon the position the object
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8. Reflection by spherical Mirrors

The position of the image formed by spherical mirrors can be studied by considering any two of the following rays of light coming from a point on the object

i. The ray parallel to the principal axis passes through the focus F of a concave mirror after reflection .Whereas it appears to pass through the principal focus of a convex mirror

ii. A ray passing through the principal focus in a concave mirror or a ray which is directed towards it (in a convex mirror) is reflected parallel to the principal axis.

iii. A ray passing through the centre of curvature falls on the concave or convex is reflected back along its own path.

9. Image formed by Concave mirror

- The nature, size and the position of the image formed by a concave mirror changes with the distance of the object from the mirror.
- If the object is beyond C, the image is always diminished and for object within C the image is always enlarged.
- If the object is at C, the image of the same size is obtained. In this case
$$u = v = R = 2f$$
- Virtual and erect image is obtained only when the object b/w F and P.
- Convex mirrors are used as shaving mirrors, used in search lights, torch lights and car head lights. Used to concentrate heat radiations from sun in solar furnaces

10. Image formed by Convex mirror

- Only virtual, erect and diminished images can be formed by the convex mirror.
- Concave mirrors are used as rear view mirrors in vehicles.

11. The new Cartesian sign convention - for spherical mirrors and lenses

- All distances are measured from the pole of the mirror/optic centre of the lens.
- The object is always placed to the left of the mirror/lens and the light always travel from left to right.
- Distances measured to the right from the pole of the mirror/optic centre of the lens and upwards from the principal axis are positive.
- Distances measured to the left from the pole of the mirror /optic centre of the lens   and downwards from the principal axis are negative.
- Distances measured perpendicular to and above the principal axis are taken positive the distances below are negative.

12. Mirror formula

It is the relation between object distance (u) image distance (v) and focal length of the mirror

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

13. Magnification (m).
It is the ratio of the size of the image to the size of the object.

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

14. Lens Formula
It is the equation connecting object distance (u) image distance (.v) and the focal length of the lens (f).

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

15. Magnification produced by the lens

$$m = \frac{size\,of\,the\,image}{size\,of\,the\,object}.$$

16. Terms related to Spherical Lenses
  o *Lens*. It is the portion of a transparent medium bounded by two surfaces, at least one of which is a curved surface
  o *Concave lens*. It is thicker at the centre than at the edges. It converges a parallel beam of light on refraction through it. It has a real focus
  o *Concave lens*. It is thinner at the centre than at the edges. It diverges a parallel beam of light on refraction through it. It has a virtual focus
  o *Centre of curvature(C*. It is the centre of the sphere of which it forms a part. Because a lens has two surfaces, so it has two centre of curvature
  o *Radius of curvature(R)* The radius of curvature of the surface of a lens is the radius of the sphere of which the surface forms a part.
  o *Optical centre(O)* It is a point situated within the lens through which a ray of light passes undeviated
  o *Focal length(f)* I t is the distance between the principal focus and the optical centre of the lens
  o *Aperture.* I t is the diameter of the circular boundary of the lens.

17. Image formed by a convex lens

  • The nature, size and the position of the image formed by a convex lens changes with the distance of the object from the lens
  • If the object is beyond 2F, the image is always diminished and for object within 2F the image is always enlarged.
  • If the object is at 2F, the image of the same size is obtained. In this case

$$u = v = R = 2f$$

- Virtual and erect image is obtained only when the object b/w F and O.

18. Image formed by Concave lens

- Only virtual, erect and diminished images can be formed by the convex mirror.

Note: The focal length of a concave lens is positive and that of a convex lens negative.

19. POWER of a lens

The power of a lens is the reciprocal of its focal length expressed in meters.

$$P = \frac{1}{f}$$

Note:The power of converging lens (convex lens) is positive and that of a diverging lens (concave lens) is negative.

20. Dioptre: The S.I unit of power of a lens is Dioptre denoted by the symbol D. One dioptre is the power of a lens whose focal length is 1 meter.

21. Refraction of light: When light passes from one transparent medium to   another, the ray of light changes its path. This phenomenon is called refraction of light .It is due to the change in speed of light in going from one medium to another. Some phenomena observed in day today life due refraction are

- When a thick glass slab is placed over some printed matter the letters appear raised when viewed through the glass slab.
- A pencil partly immersed in water appears to be bent at the interface of water and air.
- A lemon kept in water in a glass tumbler appears to be bigger.

22. Laws of refraction of light

i) The incident ray, the refracted ray and the normal to the surface of separation of to media at the point of incidence all lie in the same plane.

ii)The ratio of sine of angle of incidence (i) to the sine of angle of refraction (r) is constant

$$\frac{\sin i}{\sin r} = n_{21}$$

where n_{21} is a constant which is refractive index of the second medium with respect to the first medium. This law is also known as **Snell's law of refraction of light**.

23. Refraction of light through a glass slab

- The ray of light undergoes two refractions one at the air-glass interface and then at the glass – air interface.
- The angle of incidence is equal to the angle of emergence.
- The incident ray and the emergent ray are parallel
- The perpendicular distance between the incident ray direction and the emergent ray is called lateral shift.

- Lateral shift or displacement depends on the refractive index of the glass, the angle of incidence and the thickness of the glass slab.

24. Refraction of light: The refractive index of the second medium is equal to speed of light in the first medium divided by speed of light in the second medium

$$n_{21} = \frac{\text{speed of light in the first medium}}{\text{speed of light in the second medium}} = \frac{v_2}{v_1}$$

25. Absolute refractive index: When the first medium is vacuum, then the refractive index of the second medium with respect to vacuum (known as absolute refractive index of the medium) is n

$$n = \frac{\text{speed of light in vacuum}}{\text{speed of light in the medium}} = \frac{c}{v}$$

IMPORTANT FORMULAE.

1. Focal length $f = \dfrac{R}{2}$

2. Mirror formula. $\dfrac{1}{f} = \dfrac{1}{u} + \dfrac{1}{v}$

3. Magnification $m = -\dfrac{v}{u} = \dfrac{h''}{h}$

4. Lens formula. $\dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u}$

5. Magnification $m = \dfrac{v}{u} = \dfrac{h''}{h}$

6. Power of a lens $P = \dfrac{1}{f_{in\,meters}} = \dfrac{100}{f_{in\,cm}}$

7. Refractive index $n_{21} = \dfrac{\text{speed of light in first medium}(v_1)}{\text{speed of light in the second medium}(v_2)}$

8. Absolute refractive index $n = \dfrac{\text{speed of light in vacuum}(c)}{\text{speed of light in the medium}(v)}$

9. Power for a combination of lens $P = P_1 + P_2 + P_3$

    where n_{21} is the refractive index of the medium 1 (water) with respect to medium2 (air).