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Chapter-1

Light - Reflection and Refraction

Notes

★ **Light**:- Light is a form of energy. Light is needed to see things around us. We detect light with our eyes. Light travels in straight lines. Light enables us to see objects from which it comes or from which it is reflected.

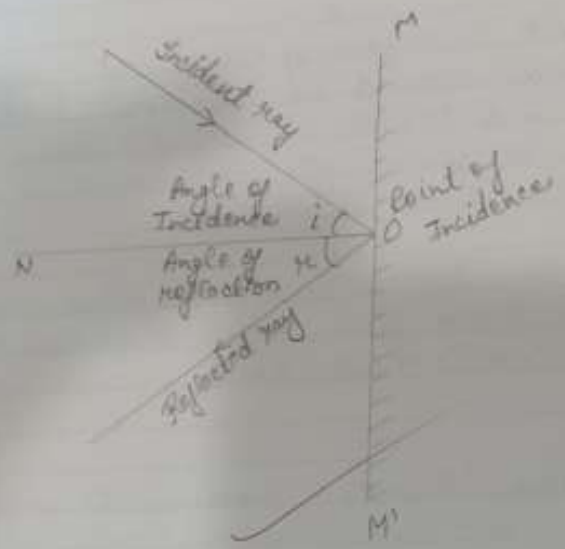
★ **Luminous Objects**:- Those objects which have their own light are called luminous objects. Eg. Sun, electric bulb, torch, candle and fire etc.

★ **Non-luminous Objects**:- Those objects which do not emit light themselves but only reflect the light which falls on them, are called non-luminous objects.

★ **Nature of Light**:- There are two theories about the nature of light: Wave theory of light and particle theory of light.

⇒ According to wave theory- Light consist of electromagnetic waves which do not require a material medium (solid, liquid, gas) for their propagation.

⇒ According to particle theory- Light is composed



Law Of Reflection Of Light

of particles which travel in a straight line at very high speed.

The modern theory of light called 'Quantum Theory of Light' combines both the wave and particle models of light.

★ Reflection Of Light:- The process of sending back light rays which falls on the surface of an object, is called reflection of light.

The objects having polished, shinning surfaces reflect more light than objects having unpolished, dull surfaces.

Ordinary mirrors are made by depositing a thin layer of silver metal on the back side of a plane glass sheet. The silver layer is then protected by a coat of red paint. The reflection of light in a plane mirror takes place at the silver surface in it.

★ Law Of Reflection of Light:-

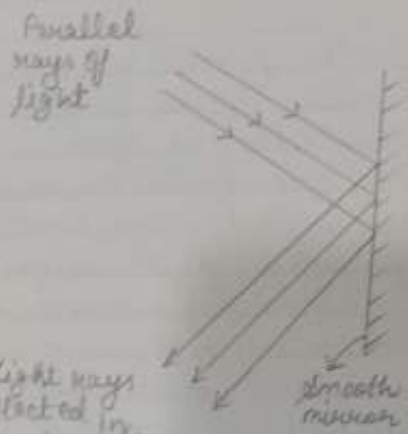
i) The incident ray, the reflected ray, and the normal (at the point of incidence), all lie in the same plane.

ii) The angle of reflection is always equal to the angle of incidence $\angle i = \angle r$

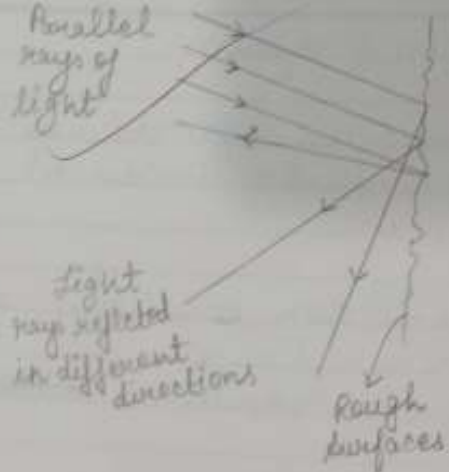
Second law is also known as

Or

$$\frac{\sin i}{\sin r} = \text{Constant} \quad /i/r$$



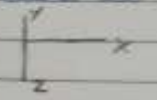
Regular Reflection



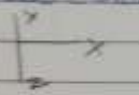
Diffuse Reflection

Important Terms:-

* Plane:- Plane means 2 dimensional means it consider 2 quadrants (xy, yz, zx)



* Space:- Space means three dimensional [3D]. It has three quadrants (x, yz)



* Regular Reflection & Diffuse Reflection of Light

i) Regular Reflection:-

In a regular reflection, a parallel beam of incident light is reflected as a parallel beam in one direction. Regular reflection of light occurs from smooth surfaces like that of a plane mirror. A plane mirror produces regular reflection of light.

ii) Diffuse Reflection:-

In diffuse reflection, a parallel beam of incident light is reflected in different directions. The diffuse reflection of light takes places from rough surfaces like that of paper, cardboard, chalk, tables and unpolished metal objects.

* Real Images:-

The image which can be obtained on a screen is called a real image. The image formed on a cinema screen is an example

of real images.

★ Virtual Images:-

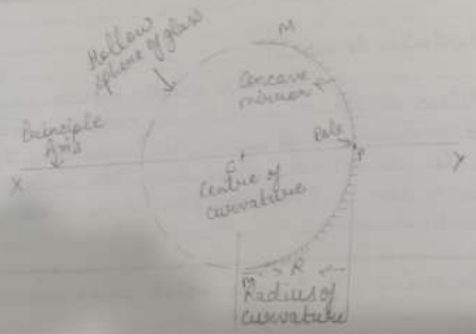
The images which cannot be obtained on a screen is called a ~~real~~ virtual image. A virtual image can be seen only by looking into a mirror or a lens. The image of our face in a plane mirror is an example of virtual image.

★ Formation of Image in a plane mirror:-

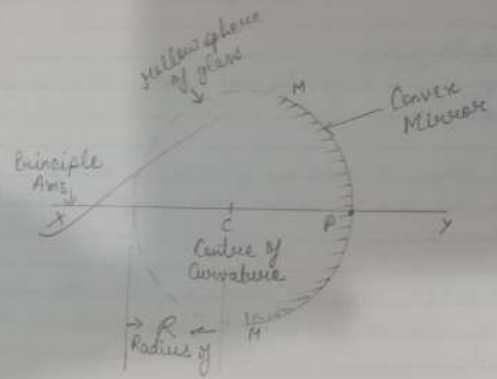
- Let us consider a small object O placed in front of a plane mirror MM'. The mirror will form an image I.

Explanation

- The object O gives out light rays in all directions.
- A ray OA coming from the object O incident on the plane mirror & it gets reflected in direction AX.
- Another ray OB coming from the object strikes the mirror and gets reflected in direction BY.
- The two reflected rays are diverging so the cannot meet on the left side.
- Produce the two reflected rays backwards.



Concave Mirror



Convex Mirror

They meet at point I behind the mirror.

- When the reflected rays AX & BY enter the eye of a person at position, the eye sees the rays of light in the straight line direction in which the reflected rays enter.

- So the person looking into the mirror sees the reflected rays as if they are coming from point I behind the mirror.

* Lateral Inversion :-

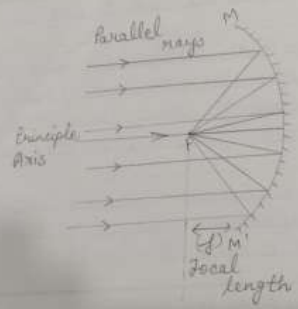
When we look into the mirror, the right hand of our body becomes left hand and left hand becomes right hand of the image. This is due to Lateral Inversion.

"When an object is placed in front of a plane mirror, then the right side of the object appears to become the left side of the image and the left side of the object appears to become right side. This phenomenon is called Lateral Inversion.

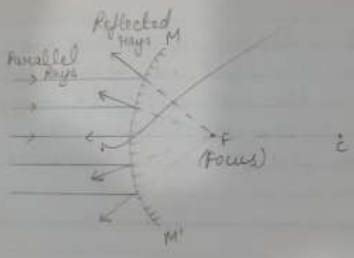
★ Spherical Mirrors

- A spherical mirror is that mirror whose reflecting surface is the part of a hollow sphere of glass.

- The spherical mirrors are of two types -



Concave Mirror



Convex Mirror

i) Concave Mirror :- It is that spherical mirror in which the reflection of the light takes place at the concave surface (are bent in surface)

ii) Convex Mirror :- It is that spherical mirror in which reflection of light takes place at the convex surface (or bulging-out surface).

★ Centre Of Curvature :- The centre of sphere of glass of which the mirror is a part is called the centre of curvature of spherical mirror.

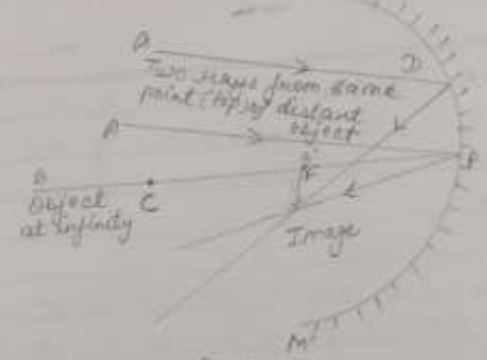
★ Pole :- The centre of a spherical mirror is called it's pole.

★ Principale Axis :- The straight line passing through the centre of curvature and pole of a spherical mirror is called it's Principle Axis.

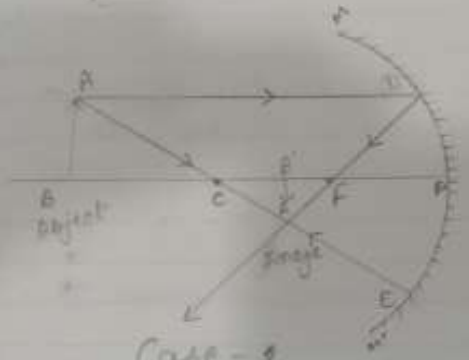
Formation Of Image on/by -

1. Concave Mirror :- Case I st

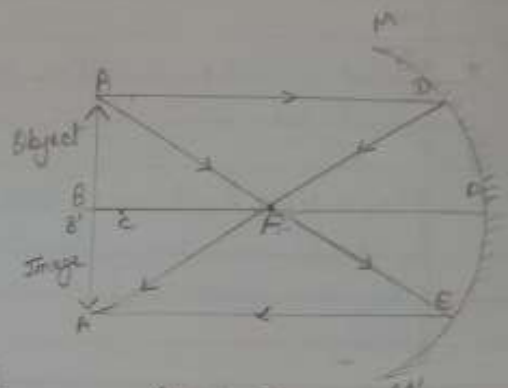
• When the object is at infinity.
When an object is at infinity from a concave mirror, the image formed is :-
→ at the focus
→ real & inverted



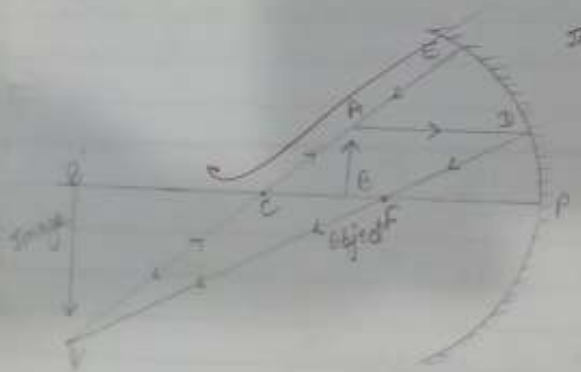
Case - I



Case - 2



Case - 3



Case - 4

→ highly diminished.

- Case 2nd

- When the object is beyond the centre of curvature.

When an object is placed beyond the centre of curvature, the image formed is —

→ between the focus and centre of curvature
→ real and inverted
→ smaller than the object

- Case 3rd

- When the object is placed at the centre of curvature of the concave mirror.

When the object is placed at the centre of curvature, the image formed is -

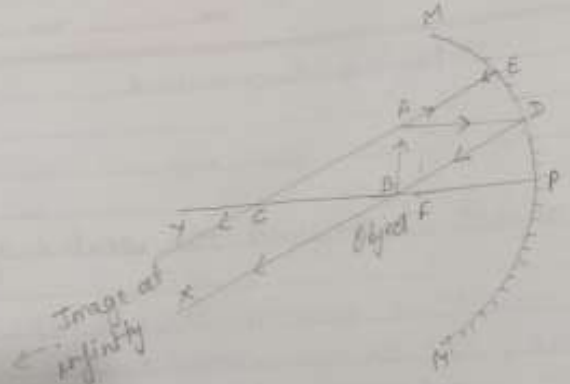
→ at the centre of curvature
→ real and inverted
→ same size as the object

- Case 4th

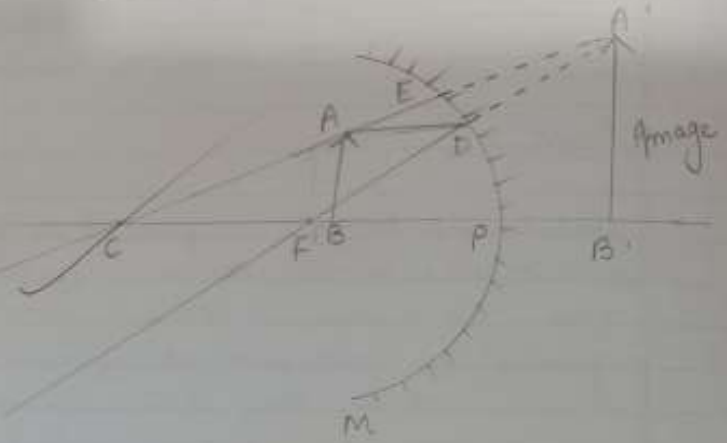
- When the object is placed between focus and centre of curvature.

If an object is placed between focus and centre of curvature the image formed is -

→ beyond the centre of curvature
→ real and inverted
→ larger than the object



Case-5



- Case 5th

- When the object is placed at the focus of the concave mirror.
When an object is placed at the focus, the image formed is -
→ at infinity
→ real & inverted
→ highly magnified

- Case-6th

- When the object is placed between pole & focus of the concave mirror.
The image formed is -
→ behind the mirror
→ virtual and erect
→ larger than the object

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★ Uses Of Concave Mirrors -:

i) Concave mirrors are used as shaving mirrors to see a large image of the face.

ii) It is used by dentists to see the large image of the teeth of patients.

iii) It is used as reflectors in torches, vehicle headlights and search lights to get powerful beams of light.

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iv) Doctor's head-mirrors to focus light coming from a lamp on to the body parts of a patient to be examined by the doctor.

v) TV dish antennas to receive TV signals from the distant communication satellites.

vi) Field of solar energy to focus sun's rays for heating solar furnaces.

★ Sign Convention for Spherical Mirrors :-

- All the distances measured from the pole (P) of mirror to the right side will be considered positive.
- All the distances measured from pole (P) of mirror to the left side will be negative.
- The object distance (u) is always negative.
- If an image distance (v) is behind a concave mirror (right side) the (v) is positive but if (v) is formed in front of mirror (left side) then (v) is negative. ← Concave Mirror
- Image distance (v) for convex mirror taken as positive always.
- Focal length of concave mirror taken as always negative & positive of convex mirror.

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- The height of all the virtual & erect images is considered positive while height of all real & inverted images taken as negative.

★ **Mirror Formula -:**

A formula which gives the relationship between image distance (v), object distance (u), and focal length (f) of a spherical mirror is known as the mirror formula.

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

where, v = distance of image from mirror
u = distance of object from mirror
f = Focal length of mirror

★ **Linear Magnification Produced By Mirrors -:**

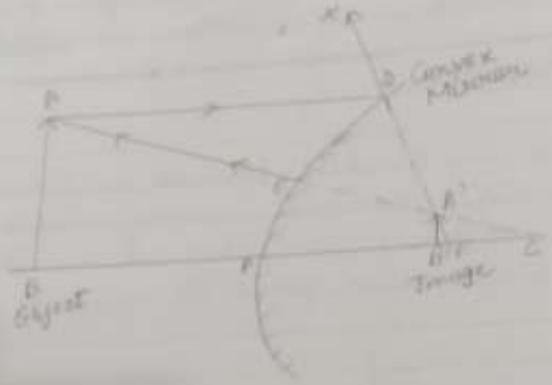
The ratio of the hight of image to the height of object is known as linear magnification.

$$m = \frac{h_2}{h_1}$$

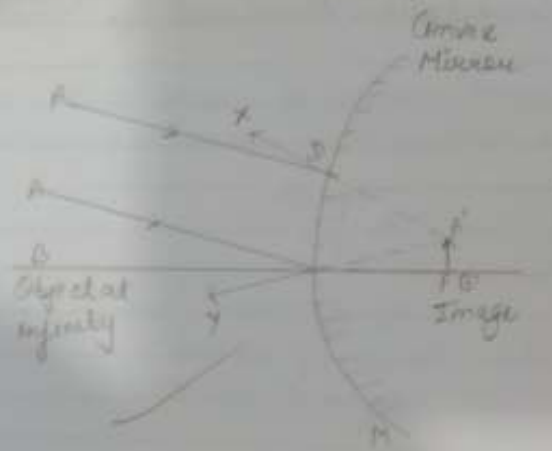
where, m = magnification
h_2 = height of image
h_1 = height of object

Note point -:

- The height (h_1) of the object will always be positive.
- But h_2 of virtual & erect image is always



Case - I



Case II

positive while (h_2) of real & inverted image will be negative.

* The linear magnification produced by a mirror is equal to the ratio of the image distance to the object distance, with a minus sign: i.e.—:

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

where, m = magnification
v = image distance
u = object distance

We know that

$$m = \frac{h_2}{h_1} \quad \text{---(i)} \quad ; \quad m = -\frac{v}{u} \quad \text{---(ii)}$$

Relate (i) & (ii)

$$\boxed{\frac{h_2}{h_1} = -\frac{v}{u}}$$

★ Formation Of Image By A Convex Mirror —:

i) When an object is placed anywhere between pole (P) and infinity in front of a convex mirror, the image formed is—
→ Behind the mirror, between Pole (P) and focus (F)
→ Virtual & erect
→ Diminished (smaller than the object

ii) When object is at infinity from a convex mirror, the image formed is—
→ Behind the mirror at focus (F)

→ Virtual & erect
→ Highly diminished (much smaller than object).

★ Distinguish Between a Plane Mirror, a Concave Mirror & a Convex Mirror —:

- A plane mirror will produce an image of the same size.
- A concave mirror will produce a magnified image.
- A convex mirror will produce a diminished image.

★ Refraction of Light —:

The change in direction of light when it passes from one medium to another obliquely, is called refraction of light. The bending of light when it goes from one medium to another obliquely is called 'Refraction of Light'

★ Cause of Refraction —:

The refraction of light due to the change in the speed of light on going from one medium to another.

Greater the difference in the speeds of light in the two media, greater will be the amount of refraction.

(or bending) of light.

Laws of Refraction of Light:-

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

ii) The ratio of sine of angle of incidence to the sine of angle of refraction is constant for a given pair of media.

$$\frac{\sin i}{\sin r} = \text{Constant}$$

Also known as Snell's Law. This constant also known as refractive index.

Refractive Index is ~~also known as~~ denoted by letter 'n'.

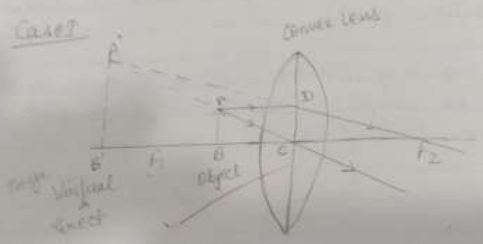
Formula:-

$$\text{Refractive Index} = \frac{\text{Speed of light in vaccum}}{\text{Speed of light in medium}}$$

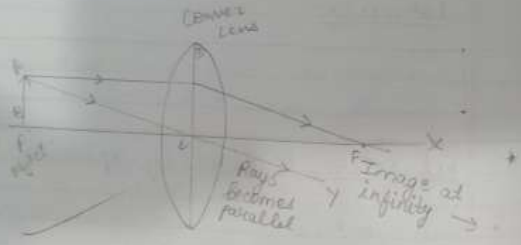
★ Refraction of Light By Spherical Lenses:-

- The working of a lens is based on the refraction of light rays when they pass through it.
- A lens is a piece of transparent glass bound by two spherical surfaces.

Case I



Case II



i) Convex lens:- A convex lens is thick at the centre but thinner at the edges. It also known as a converging lens because it converges (brings to a point), a parallel beam of light rays passing through it.

ii) Concave Lens:- A concave lens is thin in the middle but thicker at the edges. It is also known as divergeing lens because it diverges the light rays.

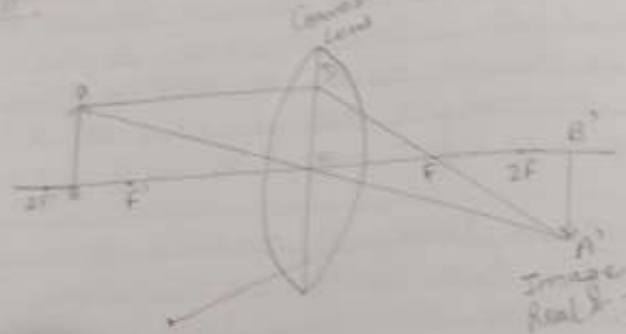
★ Optical Centre:- The centre point of a lens is known as its optical centre. The optical centre of a lens has a property that a ray of light passing through it does not suffer any deviation and goes straight. It is denoted by letter 'O'.

★ Formations of Image by a Convex Lens:-

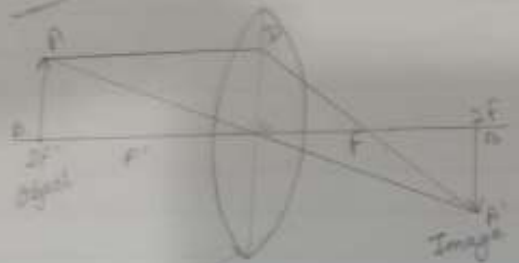
Case1: When the object is placed within the focus of a convex lens, the image formed is:
→ Behind the object
→ Virtual & erect
→ Longer than the object (enlarged & magnified)

Case2: When an object is placed at the focus of a convex lens, the image formed is:-
→ At infinity
→ Real & inverted
→ Highly enlarged

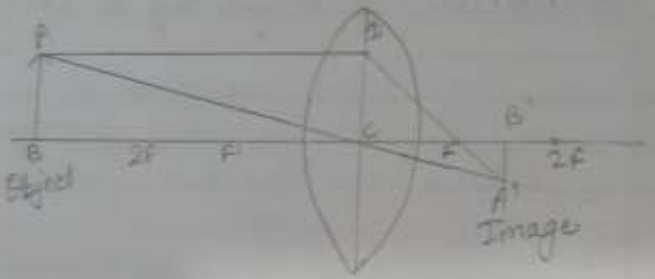
Case-III



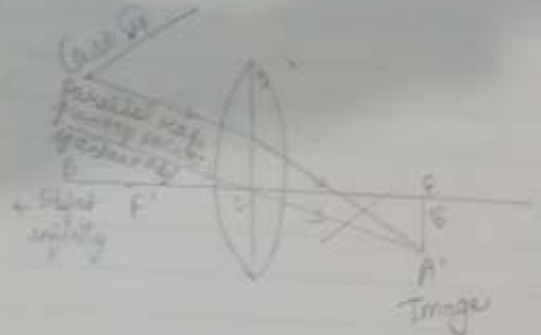
Case-IV



Case-V



Case VI



Case 3: When the object is between F' and 2F', then image formed is -
→ Beyond 2F'
→ Real & inverted
→ Larger than the object (or magnified)

Case 4 When an object is at 2F', then the image formed is -
→ Is at distance 2f on the other side of the lens
→ Real & Inverted
→ Of the same size as the object

Case-5 When an object is beyond 2F', then image formed is -
→ Between f and 2f on the other side of the lens
→ Real and inverted
→ Smaller than the object (or diminished)

Case 6 When the object is at infinity, then the image formed is -
→ At the focus
→ Real & inverted
→ Much smaller than the object (or highly diminished)

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★ Sign Convention for Spherical Lenses

- All the distances measured from the optical centre (C) of the lens to the right side will be considered positive.
- All the distances measured from the optical centre (C) of the lens to the ~~right~~ left side are considered negative.
- The focal length of a convex lens is considered positive while the focal length of concave lens is considered negative.

★ Lens Formula :-

A formula which gives the relationship between image distance (v), object distance (u), and focal length (f) of a lens is known as the lens formula.

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

where, v = Image distance
u = Object distance
f = Focal length

⇒ The linear magnification is the ratio of the height of the image to the height of the object.

$$m = \frac{h_2}{h_1}$$

where, m = magnification
h_2 = height of image
h_1 = height of object

⇒ The linear magnification produced by a lens is equal to the ratio of image distance to the object distance

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

where, m = magnification
v = Image distance
u = Object distance

★ **Power Of A Lens** –:

- The power of a lens is a measure of the degree of convergence or divergence of light rays falling on it.
- The power of the lens is defined as the reciprocal of its focal length in metres.

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

where, P = Power of lens
f = Focal length of lens.

Unit of power of lens is dioptre and denoted by letter D.

* **Dioptre** –: One dioptre is the power of a lens whose focal length is 1 metre.

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* Power of concave lens is negative while power of convex lens is positive.

★ Power of a Combination of Lenses :-

- If a number of lenses are placed in close contact, then the power of the combination of lenses is equal to the algebraic sum of the powers of individual lenses.

$$P = P_1 + P_2$$

Eg. Power of convex lens, +4D and power of concave lens, -10D, that are placed in contact with each other than the resultant Power P is :-

$$P = P_1 + P_2$$
$$P = +4 + (-10)$$
$$P = 4 - 10$$
$$P = -6D$$

Ans

18/02/2019