पुणा International School

Shree Swaminarayan Gurukul, Zundal

Class – X

Physics

Year 2021-22

Index

CHAPTER – 10

LIGHT-REFLECTION & REFRACTION

Light is a **form of energy,** which enable us to see the object.

In this chapter we will study the phenomena of reflection and refraction using the property of light i.e. straight line propagation (Light wave travel from one point to another, along a straight line).

Reflection of Light

When the light is allowed to fall on highly polished surface, such as mirror, most of the light gets reflected.

Laws of Reflection

1. The angle of incidence is always equal to angle of reflection.
   $i = r$
2. The incident ray, reflected ray and the normal to the reflecting surface at the point of incidence lie in the same plane.

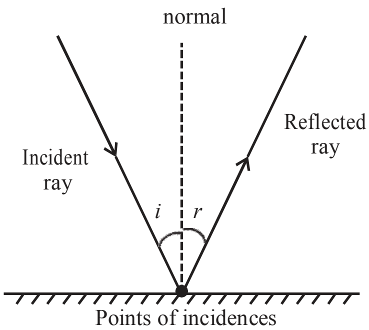
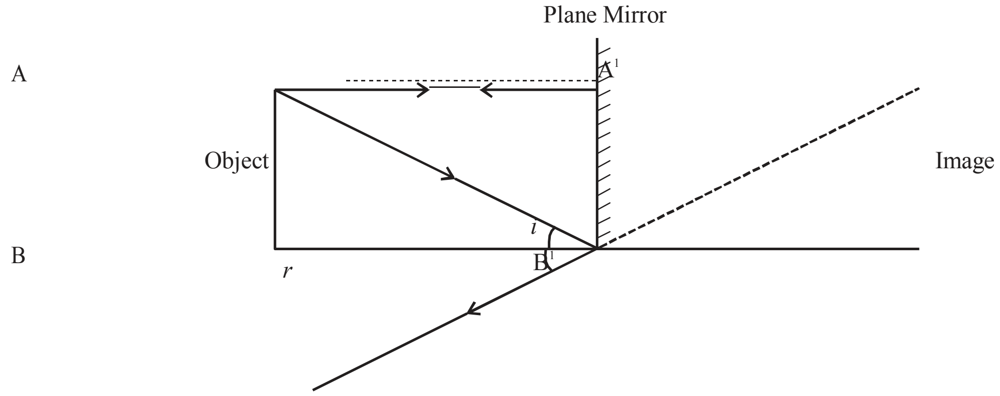


Image formed by Plane Mirror (Plane reflecting surface)



1) Virtual (imaginary) & **Erect (Virtual** The image that do not form on screen.)
2) Laterally inverted (The left side of object appear on right side of image)
3) The size of image is equal to that of object

4. The image formed is as for behind the mirror as the object is in front of it.

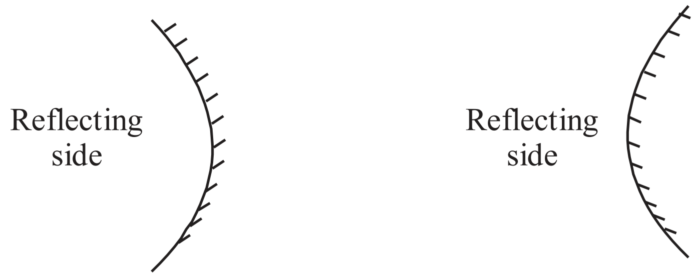
Reflection of light by spherical Mirrors

Mirrors, whose reflecting surface are curved inward or outward spherically are called spherical mirror.

For example - Spoon } The curved surface of shinning spoon can be considered as curvedmirror.

If it is curved inward Act as concave mirror

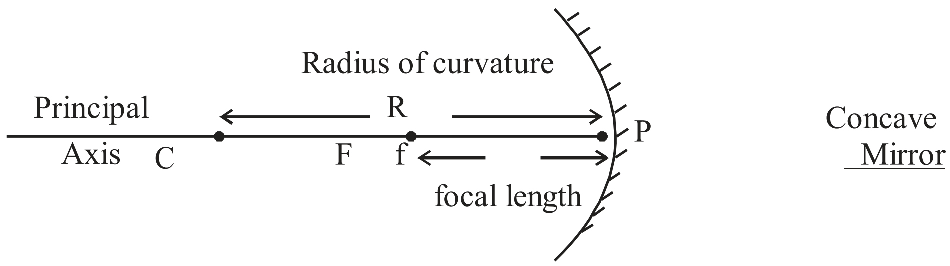
If it is curved outward Act as a convex mirror.

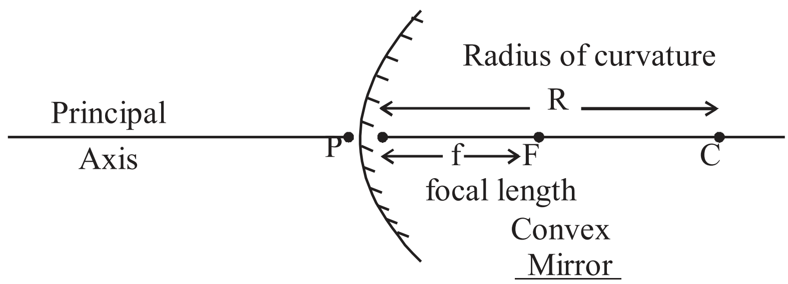


Concave Mirror OR CONVERGING MIRROR

Convex mirror OR DIVERGING MIRROR

Few Basic terms related to Spherical Mirror





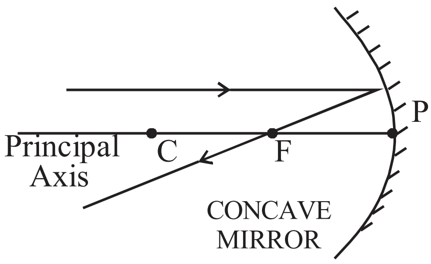
1. **Principal axis :** Line joining the pole and centre of curvature of the spherical mirror.
2. **Pole :** The geometrical central point of the reflecting spherical surface. (aperture), denoted by (P).
3. **Aperture :** The width of reflecting spherical surface.
4. **Centre of curvature :** The reflecting surface of a spherical mirror form a part of sphere. It has a centre, which is known as centre of curvature, denoted by (C)
5. **Radius of curvature :** The separation between the pole and the centre of curvature. ie. $\boxed{PC = R}$
6. **Focus point :** The point on the principal axis, where all parallel rays meet after reflection, denoted by (F)
7. **Focal length :** The length between the pole and focus point i.e. $\boxed{PF = f}$
8. **Relationship between focal length** and **Radius of curvature**.

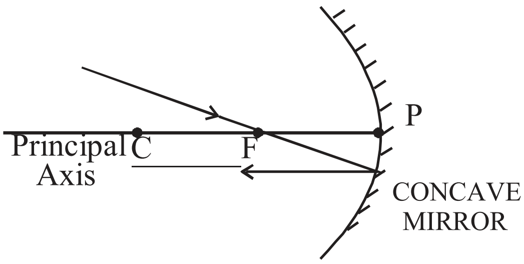
$$F = \frac{R}{2}$$

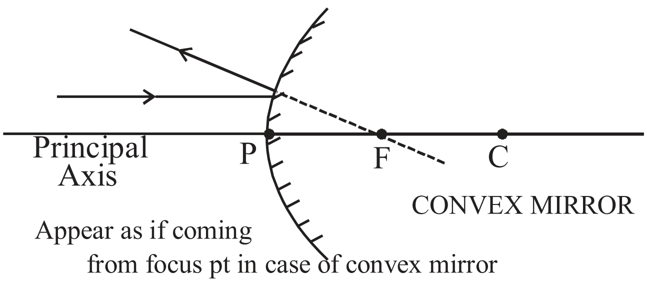
Image formation by spherical Mirror

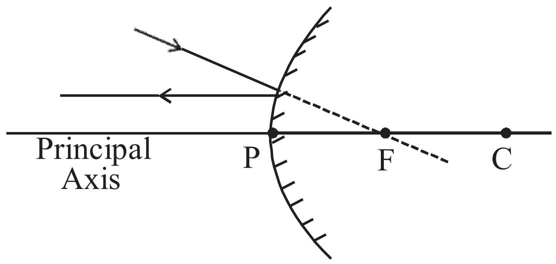
Before we learn the formation of image or ray diagram, let us go through few tips

a) Remember, A say of light which is parallel to principle axis always pass through focus (meet at focus) or **vice-versa**

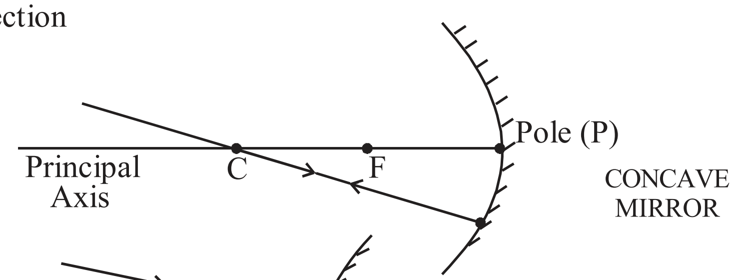


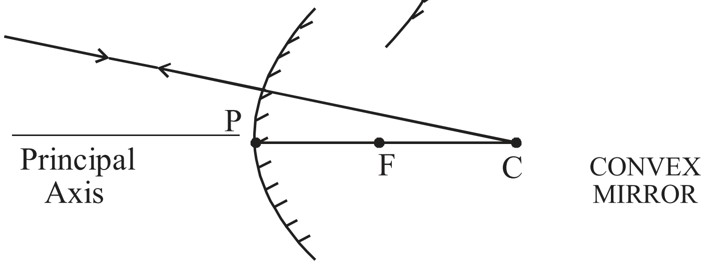




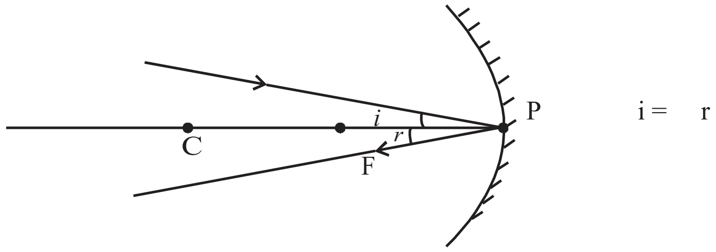


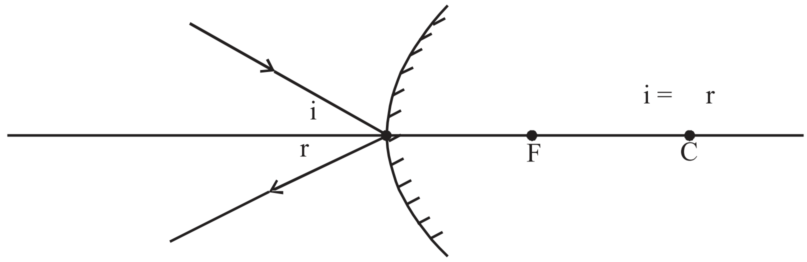
b) A ray of light which passes through centre of curvature (it is also known as normal at the point of incidence on spherical mirror) will retrace their path after reflection



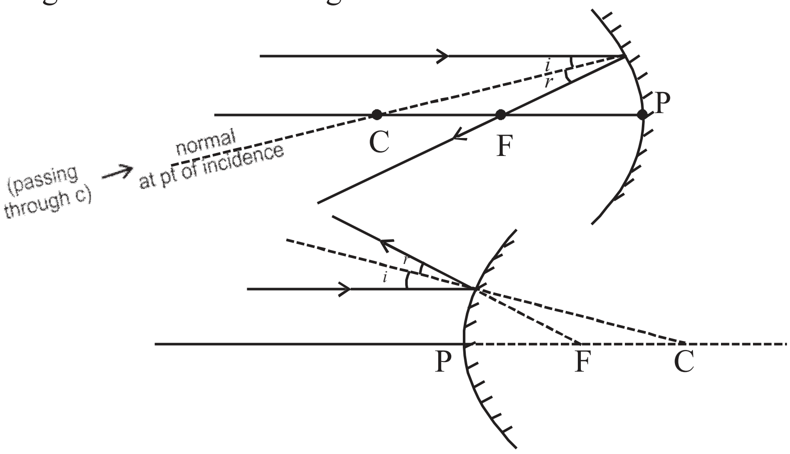


c) Aray of light falling on pole get reflected at the same angle on the other side of principal axis.



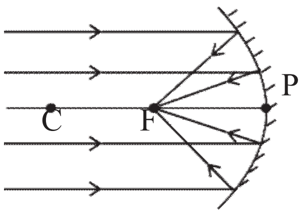


Note : A ray of light passes through centre of cus-valerie reflecting spherical surface is always act as normal at the point of incidence. If we know the normal we can draw angle of incidence and angle of reflection



Note : The image will only form when two or more rays meets at apoint. Image formation by a concave mirror for different position of the object

1. <u>Object</u>
At infinity

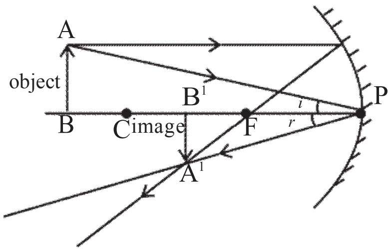


<u>Position of Image</u>
At focus

<u>Size of Image</u>
Highly diminished (point size)

<u>Nature</u>
Real and Inverted

2. <u>Object</u>
Beyond C

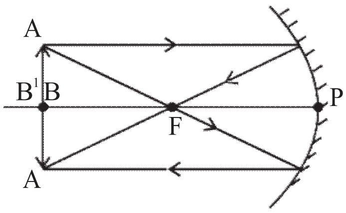


<u>Position of Image</u>
Between F&C

<u>Size of Image</u>
Small

<u>Nature</u>
Real and Inverted

3. <u>Object</u>
At C

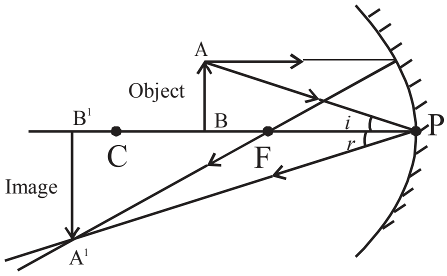


<u>Position of Image</u>
At C

<u>Size of Image</u>
Same Size of object

<u>Nature</u>
Real and Inverted

4. Object
Between C&F



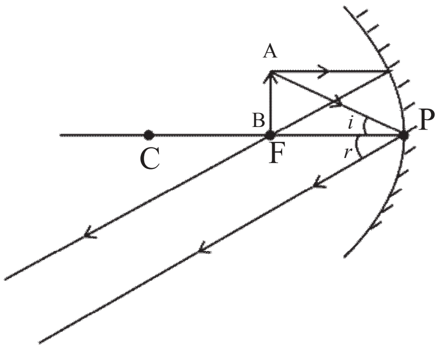
$i = r$

Position of Image
Beyond C

Size of Image
Enlarged

Nature
Real and Inverted

5. Object
At F



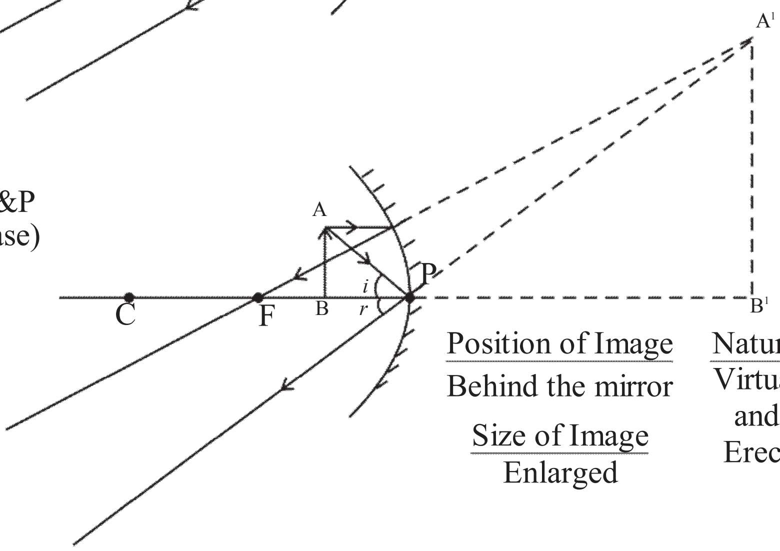
$i = r$

Position of Image
At (infinity)

Size of Image
Highly enlarged

Nature
Real and Inverted

6. Object
Between F&P
(Special Case)



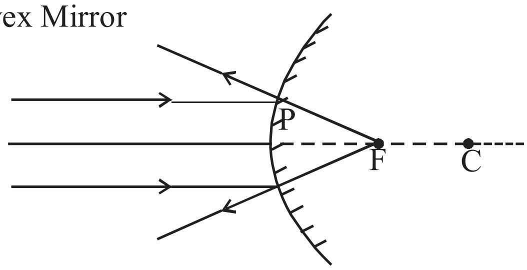
Position of Image
Behind the mirror

Size of Image
Enlarged

Nature
Virtual and Erect

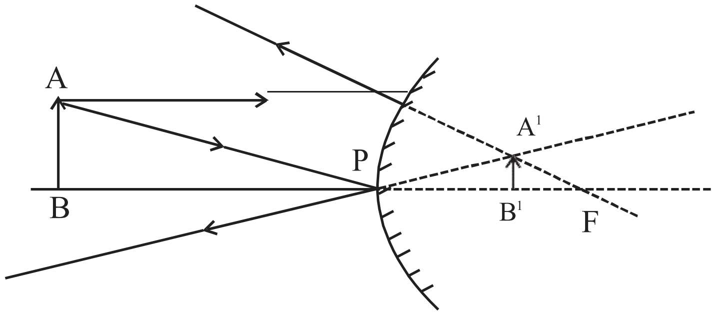
Image formation by Convex Mirror

1. Object
At infinity



Position of Image	Size of Image	Nature
At focus	Highly diminished	Virtual & erect

1. Object
Anywhere between infinity and pole of the mirror



Position of Image	Size of Image	Nature
Between P & F	Very small	Virtual & erect

Uses of Concave Mirror

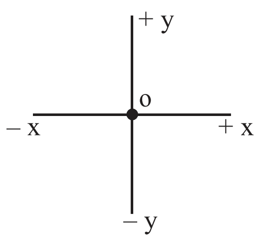
1. Used in torches, search light and headlight of vehicle.
2. Used to see large image of face as shaving mirror
3. Used by dentist to see large images of the teeth
4. Large concave mirror used to focus sunlight (heat) in solar furnaces.

Uses of Convex Mirror

1. Used as rear-view mirror in vehicles because it gives erect image. It also helps the driver to view large area.

Sign Convention for Reflection by Spherical Mirror

1. The object is always placed to the left side of mirror.
2. All distance should be measured from pole (P); parallel to principal axis.
3. Take **'P'** as **origin.** Distances measured
   Right of the origin (+ x - Axis) are **taken positive**
   Left of the origin (– x-Axis) are **taken negative**
   Perpendicular to and above principal axis (+y-Axis) are **taken positive**
   Perpendicular to and below principal axis (–y-Axis) are **taken negative**



(Cartesian system)

MIRROR FORMULA

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

where $f = \frac{R}{2}$

f distance between F and Pole
v distance of image from Pole
u distance of object from Pole
R distance between centre of curvature and pole.

MAGNIFICATION

It is expressed as the ratio of the height of the image to height of the object

$$m = \frac{\text{height of image}}{\text{height of object}} = \frac{h^1}{h} \quad \text{——— (1)}$$

It is also related to 'u' and 'v'

$$m = \frac{-v}{u} \quad \text{——— (2)}$$

∴ from 1 and 2 equation

$$m = \frac{h^1}{h} = \frac{-v}{u}$$

where h^1 image height from principle axis
h^1 Object height from principle axis.

It magnitude	$m > 1$ ______	Image is magnified
	$m = 1$ ______	Image is of same size
	$m < 1$ ______	Image is dimirushed

Few tips to remember sign convention for Spherical mirror

Object height (h) always positive | Image height (h^1) { Real - negative, Virtual - positive }

Object distance from pole (u) is always negative

Image distance from pole (v) { Real - Image always negative; Virtual - Image always positive }

Focal length (f) { Concave mirror – always negative; Convex mirror – always positive }

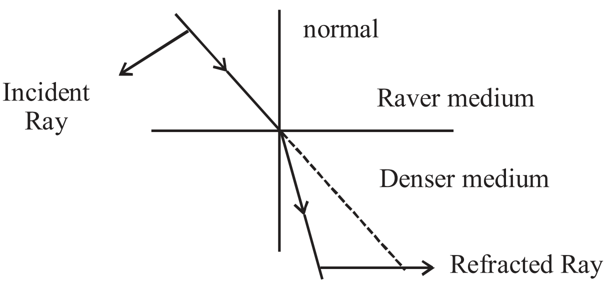
REFRACTION OF LIGHT

Refraction of Light : Happens in Transparent medium when a light travels from one medium to another, refraction takes place.

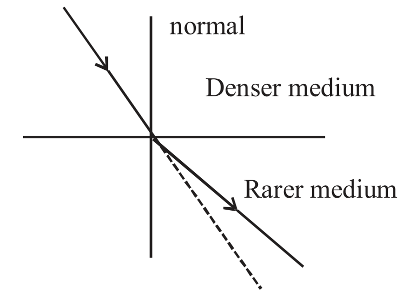
A ray of light bends as it moves from one medium to another

Refraction is due to **change in the speed of light** as it enters from one transparent medium to another.

Speed of light decreases as the beam of light travel from rarer medium to the denser medium.



When ray travel from Rarer to Denser it bends towards normal after refraction

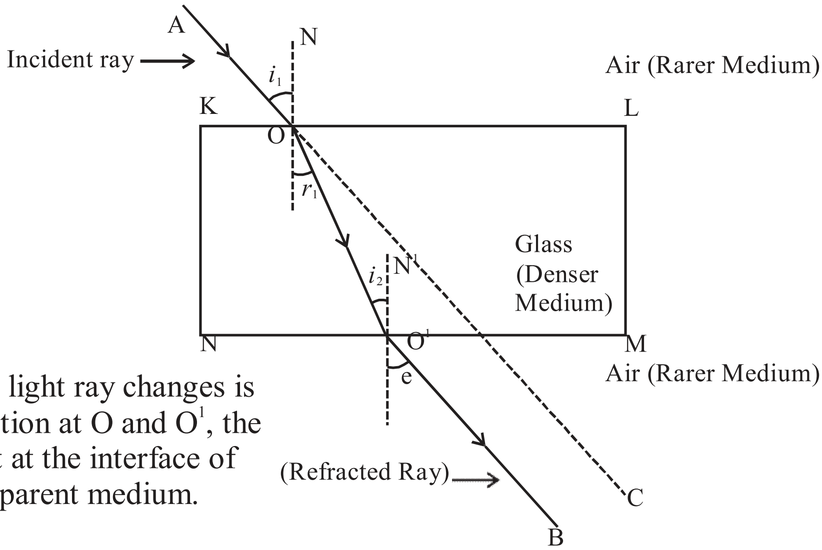


When ray travel from denser to rarer medium it bends away from normal

Some Commonly observed phenomenon due to Refraction

1. The stone at the bottom of water tub appear to be raised.
2. A fish kept in aquarium appear to be bigger than its actual size.
3. A pencil partially immersed in water appears to be displaced at the interface of air and water.

Refraction through a Rectangular Glass Slab



Here light ray changes is direction at O and O', the point at the interface of transparent medium.

When a incident ray of light AO passes from a rarer medium (air) to a denser medium (glass) at point. O on interface AB, it will bends towards the normal. At pt O^1, on interface DC the light ray entered from denser medium (glass) to rarer medium (air) here the light ray will bend away from normal OO^1 is a refracted ray OB is an emergent ray. If the incident ray is extended to C, we will observe that emergent ray O^1B is parallel to incident ray. The ray will slightly displaced laterally after refraction.

Note : When a ray of light is incident normally to the interface of two media it will go straight, without any deviation.

Laws of refraction of light-

1. The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
2. The ratio of sine of angle of incidence to the sine of angle of refraction is a constant ie.

$$\frac{\sin i}{\sin r} = \text{constant } (r)$$

for given colour and pair of media, this law is also known as Snells Law

Constant n is the refractive index for a given pair of medium. It is the refractive index of the second medium with respect to first medium.

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = n_{21}$$

Where 2 is for second medium and 1 is for first medium

Refractive Index

The refractive index of glass with respect is air is given by ratio of speed of light in air to the speed of light in glass.

$$n_{ga} = \frac{n_g}{n_a} = \frac{\text{Speed of light in air}}{\text{Speed of light in glass}} = \frac{c}{v}$$

C Speed of light in vacuum = 3×10^8 m/s

speed of light in air is marginally less, compared to that in vacuum.

Refractive index of air with respect to glass is given by

$$\begin{pmatrix} a & \text{air} \\ g & \text{glass} \end{pmatrix} \quad n_{ag} = \frac{n_a}{n_g} = \frac{\text{Speed of light in glass}}{\text{Speed of light in air}} = \frac{v}{c}$$

The absolute refractive index of a medium is simply called refractive index

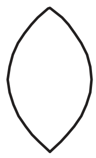
$$n_m = \frac{\text{Speed of light in air}}{\text{Speed of light in the medium}} = \frac{c}{v}$$

Refractive index of water (n_w) = 1.33
Refractive index of glass (n_g) = 1.52

Spherical Lens

A transparent material bound by two surface, of which one or both surfaces are spherical, forms a lens.

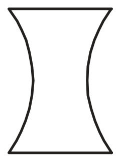
CONVEX LENS



A lens may have two spherical surfaces, bulging outwards, is called double convex lens (or simply convex lens.

It is also known as converging lens because it converges the light.

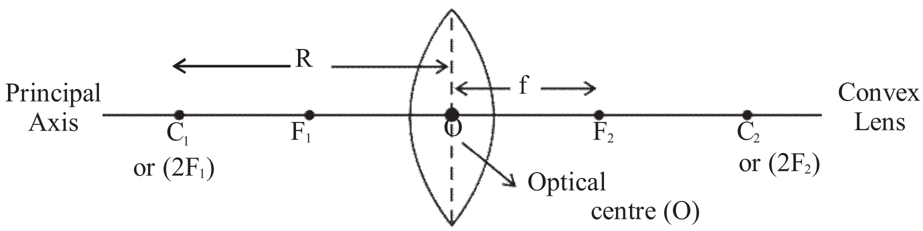
CONCAVE LENS

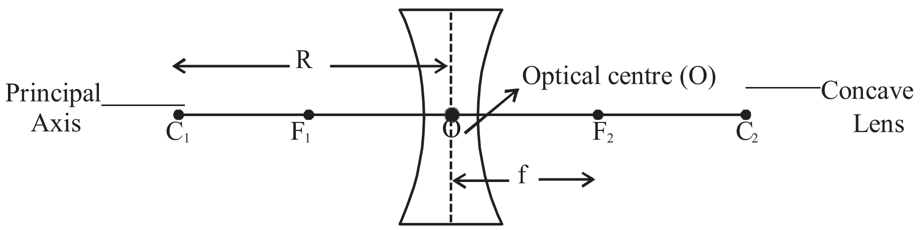


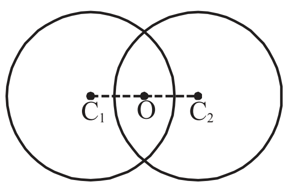
A lens bounded by two spherical surfaces, curved inwards is known as double concave lens (or simply concave lens)

It is also known as diverging lens because it diverges the light.

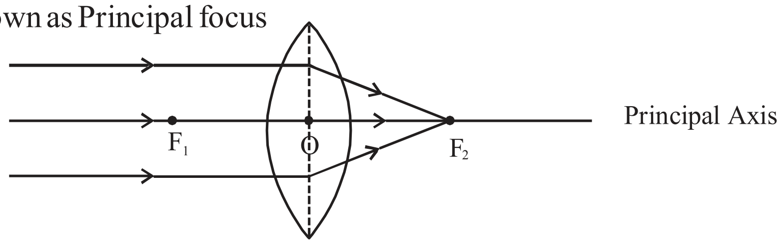
Few Basic Terms related to spherical lens.



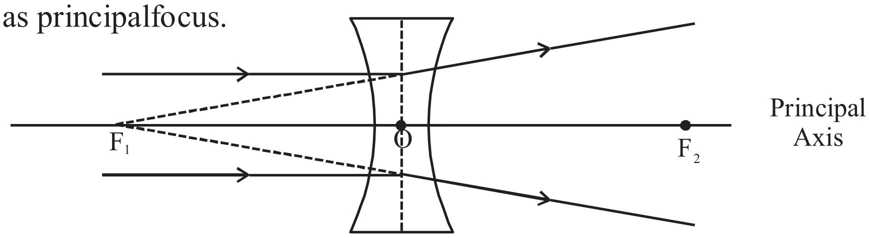




1. **Centre of curvature -** A lens, either a convex lens or a concave lens has two spherical surfaces. Each of these surfaces form a part of sphere. The centre of these two spheres are called centre of curvature represented by C_1 and C_2.
2. **Principal axis -** Imaginary straight line passing through the two centres of curvature
3. **Optical Centre -** The central point of lens is its optical centre (O). A ray of light, when passes through 'O' it remains undeviated i.e. it goes straight.
4. **Aperture -** The effective diameter of the circular outline of a spherical lens.
5. Focus of lens - Beam of light parallel is principal axis, after refraction from
   1) **Convex lens,** converge to the point on principal axis, denoted by F, known as Principal focus



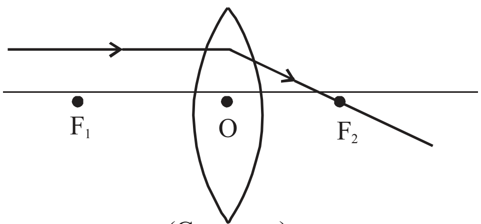
   2) Concave lens, appear to diverge from a point on the principal axis, known as principalfocus.



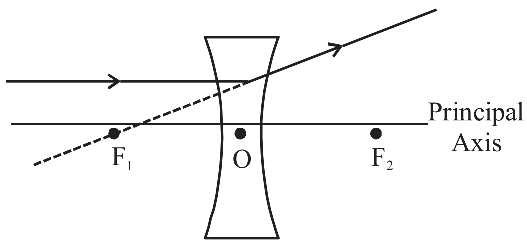
The distance OF_2 and OF_1 is called as focal length

Tips for drawing Ray diagram

a) After refraction, a ray parallel to principal axis will pass through F.

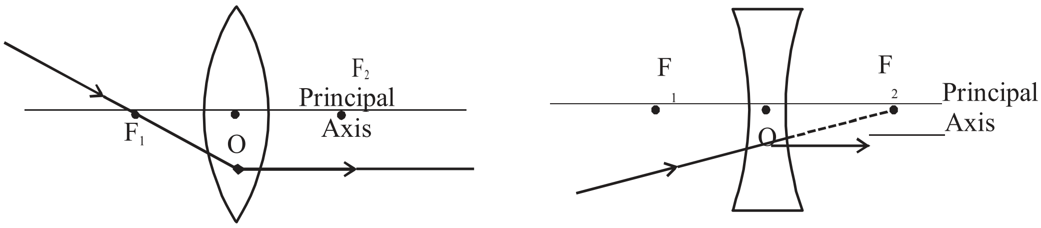


(Converge)



(Diverge)

b) A ray passes through F, after refraction will emerge parallel to principal axis.



c) A ray passes through optical centre 'O', paeses without any deviation.

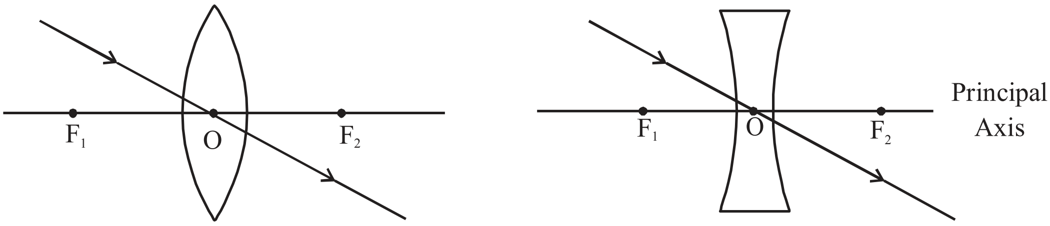
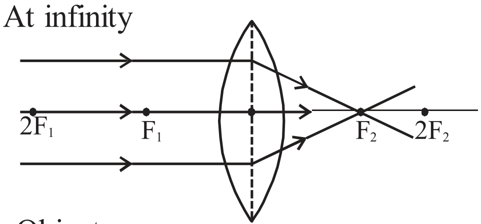


Image formation by a convex lens for various position of object

1. <u>Object</u>
At infinity

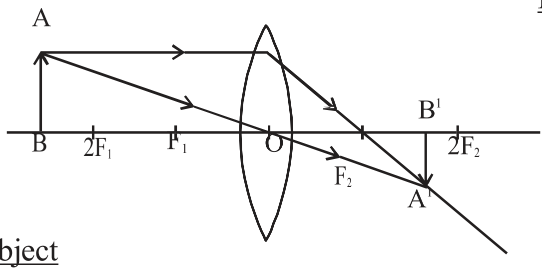


<u>Position of Image</u>
At focus
F_2

<u>Size of Image</u>
Highly diminished (point size)

<u>Nature</u>
Real & inverted

2. <u>Object</u>
Beyond $2F_1$

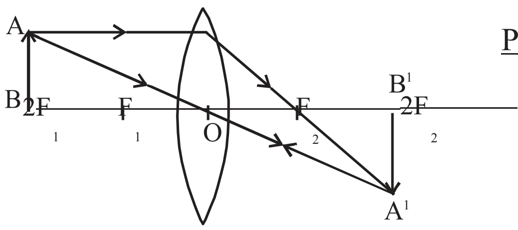


<u>Position of Image</u>
Between F_2 & $2F_2$

<u>Size of Image</u>
Small

<u>Nature</u>
Real & inverted

3. <u>Object</u>
At $2F_1$

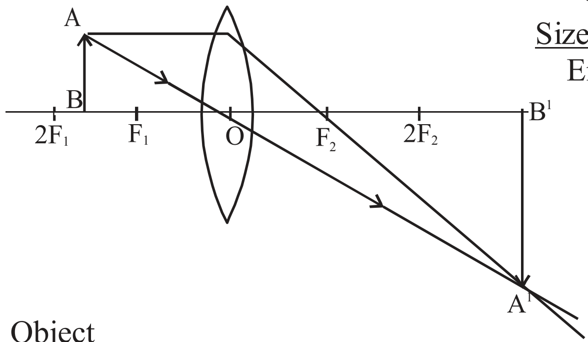


<u>Position of Image</u>
At $2F_2$

<u>Size of Image</u>
Same size of object

<u>Nature</u>
Real & inverted

4. Object
Between F_1 & $2F_1$

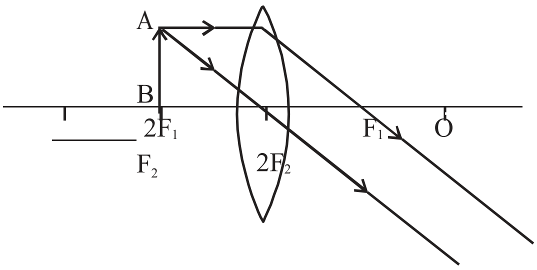


Position of Image
Beyond $2F_2$

Size of Image
Enlarged

Nature
Real & inverted

5. Object
At focus F_1



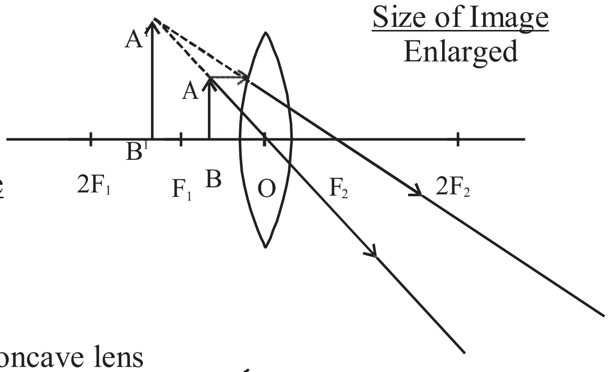
Position of Image
at infinity

Size of Image
Highly Enlarged

Nature
Real & inverted

6. (Special Case)
Object
Between F_1 and optical centre 'O'

Position of Image
On the same side of the object

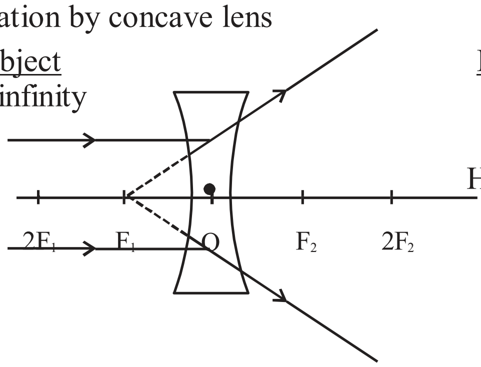


Size of Image
Enlarged

Nature
Virtual & Erect

Image formation by concave lens

1. Object
Alt infinity



Position of Image
At F_1

Size of Image
Highly Diminished

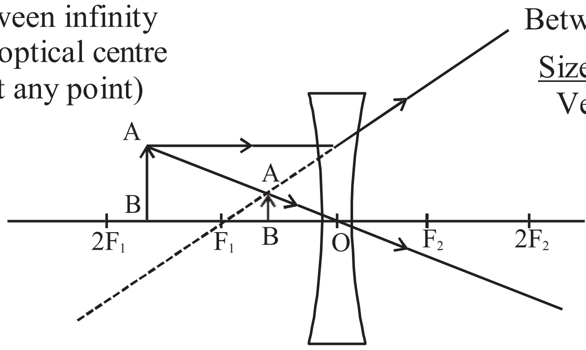
Nature
Virtual & Erect

2. **Object**: Between infinity and optical centre (at any point)

Position of Image: Between F_1 & O

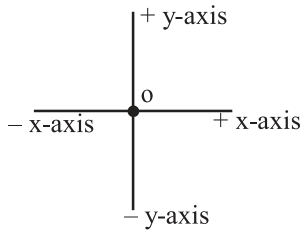
Size of Image: Very small

Nature: Virtual & Erect



Sign Convention for Refraction by spherical lens

Similar to that of spherical mirror, only the difference is that all the measurement are made from optical centre 'O'



LENS FORMULA

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

$$f = \frac{R}{2}$$

'O' optical centre

f - distance between F and 'O'

u - distance of object from 'O'

v - distance of image from 'O'

r - distance between centre of curvature & 'O'

MAGNIFICATION

It is defined as the ratio of the height of image to the height of object.

$$m = \frac{\text{height of image}}{\text{height of object}} = \frac{h^1}{h} \quad (1)$$

from principal axis

h – image height from principal axis

h^1 – object height

It is also related to 'u' & 'v'

$$m = \frac{v}{u} \quad (2)$$

From equation (1) & (2)

$$m = \frac{h^1}{h} = \frac{v}{u}$$

If magnitude of	$m > 1$	Image is magnified
	$m = 1$	Image is of same size
	$m < 1$	Image is deminished

Few tips to remember sign convention for spherical lens

Object height (h) is always **positive**

Image height (h^1) Real is always **negative**; Virtual is always **positive**

Object distance from optical centre (u) is **always negative**

Image distance from optical centre (v) Real **positive**; virtual **negative**

Focal length (v) Convex lens is always **positive**; Concave lens is always **negative**

Power of Lens

The degree of convergence or divergence of light ray achieved by a lens is known as **power of a lens**.

It is difined as the **reciprocal of its focal length Represented by P**

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

It f is given in meter, then

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

It f is given in cm, then

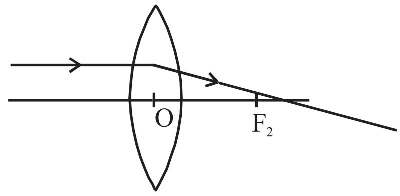
$$P = \frac{100}{f}$$

SI unit of power of a lens is "dioptre" denoted by 'D'

I dioptre or ID It is the power of lens whose focal length is 1m

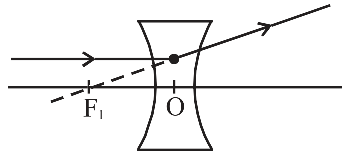
$$ID = \frac{1}{1m} \quad \text{OR} \quad ID = 1m^{-1}$$

Power convex lens or converging lens is always positive



$\because$ f is +ve

Power of concave lens or diverging lens is always negative



$\because$ f is –ve

If any optical instrument have many lens, then **net power** will be

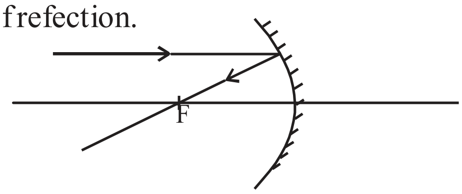
$$P = P_1 + P_2 + P_3 \ldots.$$

EXERCISE

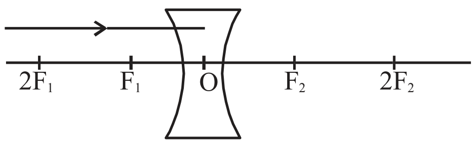
(Question Bank)

Very Short Answers Type Questions (1 Mark)

1. If the angle of incidence is O°, what is the angle of reflection?
2. What is the nature of image formed by concave mirror if the magnification produced by the mirror is +3?
3. Give two uses of concave mirror?
4. Find the focal length of a convex mirror, whose radius of curvature is 30 cm?
5. What do you understand by magnification of a spherical mirror?
6. An object is held at the principal focus of a concave lens of focal length f. Where the image will form?
7. Show the angle of incidence and angle of refection.



8. Complete the ray diagram.



9. Define the SI unit of power of lens.

10. When light undergoes refraction at the surface of seperation of two media, what happens to speed of light.

Short Answer Type Questions (2-3 Marks)

1. What do you understand by refraction of light. Draw the labelled ray diagram, when ray passes through glass slab.

2. The refractive index of glass is 1.54 and the speed of light in air is $3x10^8$ m/s. Calculate the speed of light in water?

3. A convex mirror used on an automobile has a focal length of 6m. If vehicle behind is at a distance of 12m. Find the nature and location of image.

   (4m, virtual erect small)

4. A concave lens of focal length 15cm, forms an image 10 cm from the lens. How far is the object placed from the lens? Draw the ray diagram?

5. Two thin lens of power +3.5D and - 2.5D are placed in contact. Find the power and focal length, if the lens are in combination. (p = + 10, f = 1m)

6. What are the law of refraction. Define refractive index of a medium.

Very Long Answer Type Questions (5 Marks)

1. Draw the ray diagram, showing the image formed by concave mirror, when object is placed at

   a) at infinity
   b) between F22F
   c) At 2F
   d) At F
   e) between F&P

2. Draw the ray diagram, showing the image formed by convex lens, when object is placed at.

   a) At infinity
   b) between F_1 &$2F_1$
   c) At $2F_1$
   d) Beyond $2F_1$
   e) between F_1 & optical centre'O'

CHAPTER – 11

The Hyman Eye and the Colourful World

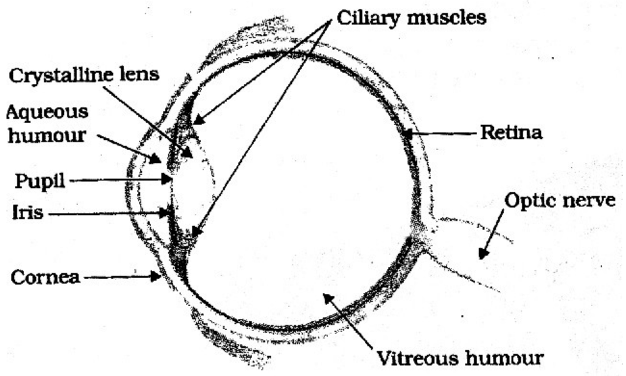
In this chapter we will study Human eye that uses the light and enable us to see the objects.

We will also use the idea of refraction of light in some optical phenomena in nature i.e. Rainbow formation, twinkling of star, blue and red colour of sky etc.

Human Eye : A Sensitive sense organ

It acts like a camera, enable us to capture the colourful picture of the surroundings.

It forms an inverted, real image on light sensitive surface Retina



The Various parts of eye and their functions

1. **Cornea :** It is a thin membrane through which light enters. It forms the transparent bulge on the front of eyeball. Most of the refraction occurs at the outer surface of the cornea.
2. **Eyeball :** it is approximately spherical in shape, with a diameter of about 2.3cm.
3. **Iris :** It is a dark muscular diaphragm that controls the size of pupil. It is behind the cornea.
4. **Pupil :** It regulates and control the amount of light entering the eye. It is the black opening between aqueous humour & lens.
5. **Crystalline eye lens :** Provide the focussed real & inverted image of the object on the retina. It is composed of a fibrous, jelly like material. This is convex lens that converges light at retina.

6. **Ciliary muscles :** It helps to change the curvature of eyelens and hence changes its focal length so that we can see the object clearly placed at different positon.
7. **Retina :** Thin membrane with large no. of sensitive cells.
8. When image formed at retina, light sensitive cells gets activated and generate electrical signal. These signals are sent to brain via optic nerue. Brain analyse these signals after which we perceive object as they are.

How pupil works ?

Example : You would have observed that when you come out of the cinema hall after watching movie in the bright sun light, your eyes get closed . And when you entered the hall from the bright light, you won't be able to see and after some time you would be able to see.

Here the pupil of an eye provide a variable aperture, whose size is controlled by iris

a) When the light is bright : Iris contracts the pupil, so that less light enters the eye.

b) When the light is din : Iris expand the pupil, so that more light enters the eye.

Pupil open completely, when iris is relaxed.

Persistence of Vision : It is the time for which the sensation of an object continue in the eye. It is about $1/16^{th}$ of a second.

Power of Accommodation :

The ability of eye lens to adjust it focal length is called accommodation with the help of ciliary muscles.

Ciliary Muslces

Relaxed	**Contract**
1. Eye lens becomethin	1. Eye lens become thick
2. Increases the focal length	2. Decreases the focal length
3. Enableusto seedistantobjectclearly	3. Enable us to see nearby object clearly

Near point of the Eye

It is 25cm for normal eye. The minimum distance at which object can be seen most distinctly without strain.

For point of the Eye

It is infinity for normal eye. It is the farthest point upto which the eye can see object clearly.

DEFECTS OF VISION AND THEIR CORRECTION

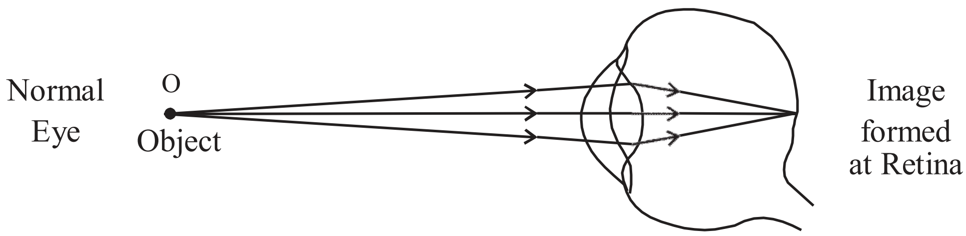
1. CATARACT : The image can not be seen distinctly because eye lens become milky and cloudy. This condition is known as cataract, it can cause complete or partial loss of vision.

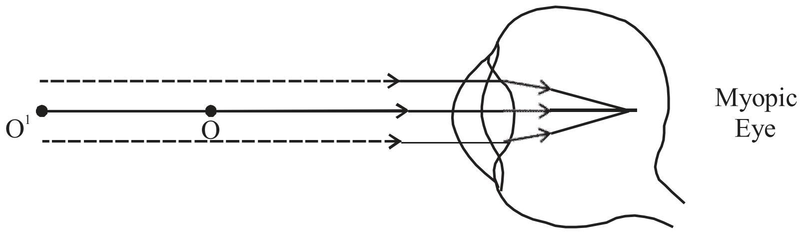
   This can be corrected by surgical removal of extra growth (cataract surgery)

2. **Myopia :** (Near Sightedness)

   A person can see nearby object clearly, but cannot see distant object distinctly.

   Image formed in front of the retina.



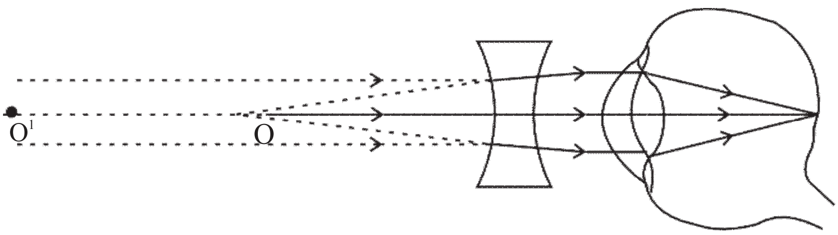


The Reason of defect

1. Excessive curvature of eye lens (thick, decrease focal length)
2. Elongation of the eye ball.

CORRECTION

Corrected by using a Concave Lens of appropriate power.

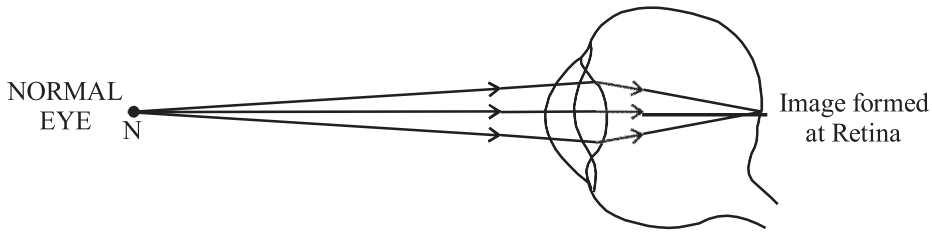


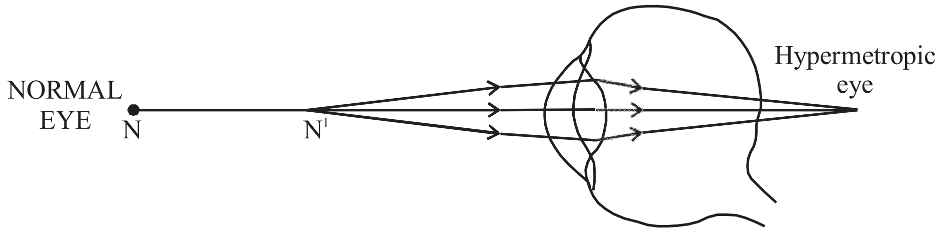
Correction of Myopita

(3) Hypermetropia (Far - Sightedness) –

Aperson cannot see nearby object clearly, but can see distant object distinctly.

Image formed at a point behind the retina



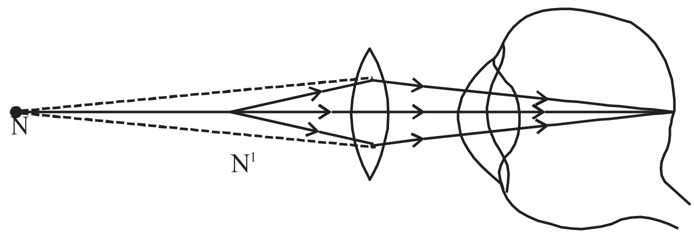


The Reason of defect

1. Increase in focal length of the eye lens (Thin eye lens)
2. Eye ball has become too small.

CORRECTION

Corrected byusing a Convex Lens of appropriatepower.



Correction of Hypermetropic eye

4. **Presbyopia**

As we become old, the power of accommodation of the eye usually decreases, the near point gradually recedes away.

This defect is called Presbyopia. Person may suffer from both myopia and hypermetropia.

Reason of defect- Gradual weakening of ciliary muscles and decreasing the flexibility of the eye lens.

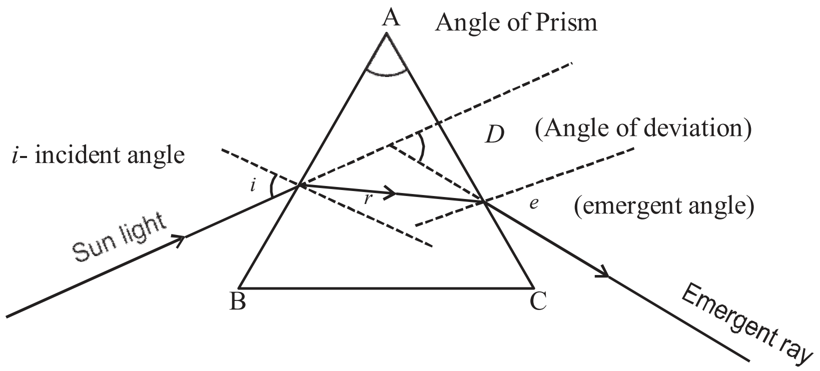
Correction- Using of ***Bifocal lens*** with appropriate power.

Bifocal lenses consist of both concave and convex lens, upper position consist of concave lens and lower portion consist of convex lens.

Refraction of light through a Prism

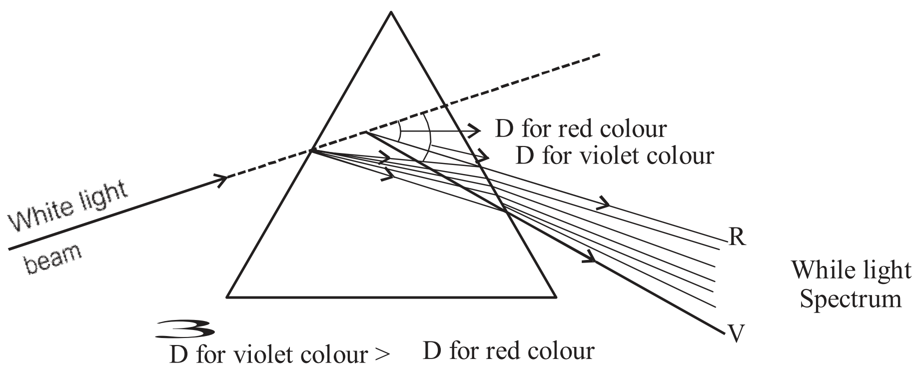
Prism- It has two triangular bases and three rectangular lateral surfaces.

These surfaces are inclines to each other. The angle between its two lateral faces is called **Angle of Prism**.



Angle of Deviation (D) → The angle between the incident ray and emergent ray.

Dispersion fo white light by a Glass Prism



∴ D for violet colour > D for red colour

Inclined refracting surfaces of glass prism show exciting phenomenon.

Splitting of White light into band of colours

The band of the coloured components of light beam as called **Spectrum** i.e. VIBGYOR

The splitting of light into its component colours is called **Dispersion.**

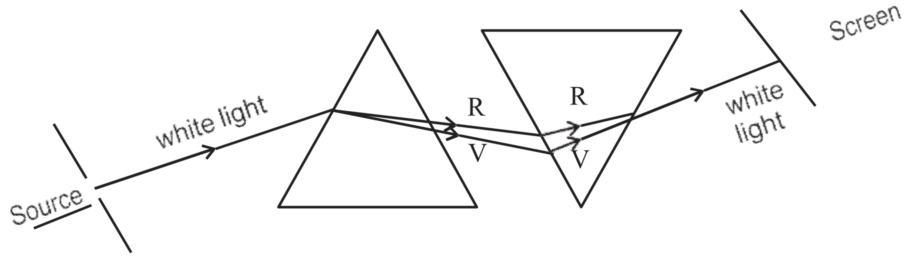
The different component colour of light bends at different angle with respect to incident angle the red light bends the least while the violet bends most.

ISSAC NEWTON —→ He was the first, who obtained spectrum of sunlight by using glass prism.

He tried to split the spectrum of white light more by using another similar prism, but he could not get any more colours.

He repeated the experiment using second prism in on inverted position with respect to the first prism.

Allowed all the colours of spectrum to pass through second prism. He found white light emerges on the other side of second prism.



He concluded that sun is made up of seven visible colour 'VIBGYOR'

RAINBOW —→ It is the spectrum of sunlight in nature It is formed due to the dispersion of sunlight by thetinywaterdroplet, present in atmosphere.

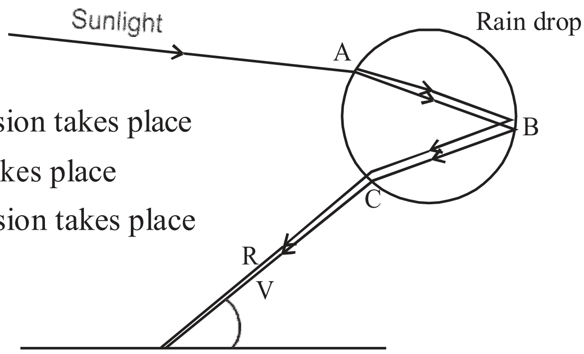
Water droplet act like prism.

It refract and disperse the incident sunlight, then reflect it internally (internal reflection) and finally refract it again, when it emerges out of the water droplet.

A rainbow is always form in a direction opposite to that of sun.

Due dispersion and internal reflection of light different colour reaches to observer's eye.

Red colour appear on top & violet at the bottom of rainbow



At 'A' — Refraction & dispersion takes place

At 'B' — Internal refraction takes place

At 'C' — Refraction & dispersion takes place

Atmospheric Refraction –

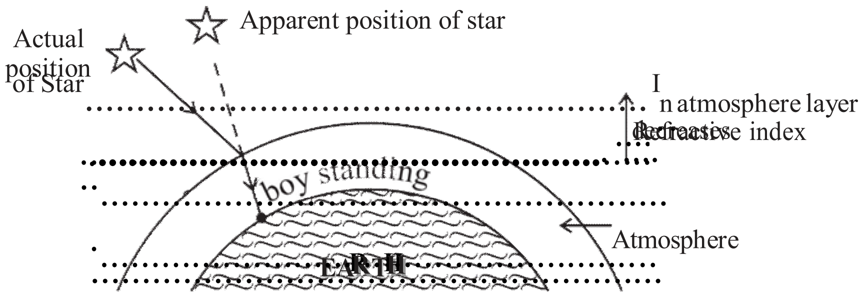
1. **Apparent Star Position–** It is due to atmospheric refraction of star light.

   The temperature and density of different layer of atmosphere keeps varying. Hence we have different medium.

   Distant star act as point source of light. When the starlight enter the earth's atmosphere it undergoes refraction continuously, due to changing refractive index i.e. from Rarer to denser. It bends towards the normal.

   Due to this the apparent position of the star is different from actual position.

   The star appear higher than its actual position.



2. **Twinkling of Star–** It is also due to atmospheric refraction

   Distant star act like a point source of light. As the beam of starlight keeps deviating from its path, the apparent position of star keeps on changing because physical condition of earth's atmosphere is not stationary

   Hence the amount of light enters our eyes fluctuate some time bright and some time faint.

   This is the "Twinkling effect of star"

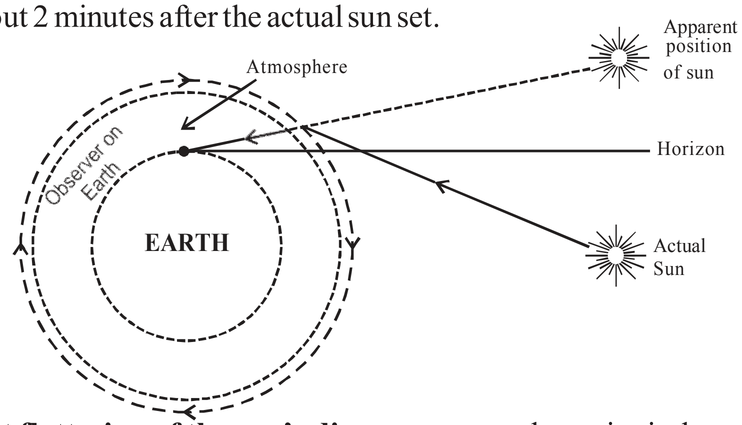
Q. **Why Planet do not twinkle?**

Ans. Planets are closer to earth and are seen as extended source of light i.e. the collection of large no: of point sized sources of light. Therefore the total amount of light entering our eyes from all individual point source will nullify thetwinkling effect.

(3) **Advance Sunrise and delayed sunset**

This is also due to atmospheric refraction.

Because of this sun is visible about 2 minutes earlier than actual sunrise and about 2 minutes after the actual sun set.



Apparent flattering of the sun's disc at sun set and sun rise is due to atmospheric refraction.

Scattering of Light

Tyndall Effect– When a beam of light strikes the minute particle of earth's atmosphere suspended particles of dust and molecule of air the path of beam become visible. The phenomenon of scattering of light by the colloidal particle gives rise to Tyndall Effect.

It can be observed when sunlight passes through a canopy of a dense forest.

The colour of the scattered light depends on the size of the scattering particles

Very fine particle (scatter mainly blue colour short wave length)	Large size particle (Scatter light of longer wave length i.e. red)	Very large enough (The sky appear white)

(1) **Why cloud Appear white–** The size of water droplet (scattering particle) is very large, hence scattered all wavelength of light almost equally.

(2) **Why colour of sky is blue–** The molecules of air and other fine particles in the atmosphere have size smaller than the wavelength of visible light. Since the blue has shorter wavelength than red, hence it will scattered the most.

According to Rayleigh scattering

Scattering of light $\frac{1}{\ \ 4}$ –Wavelength)

Scattering of light decreases with increase in wavelength

Q. **If there is no earth's atmosphere? What will happen to scattering phenomenon?**

Ans. There will be no scattering and sky will appear dark.

(3) Colourof the Sun of Sunrise and Sunset

While sunset and sunrise, the colour of the sun and its surrounding appear red.

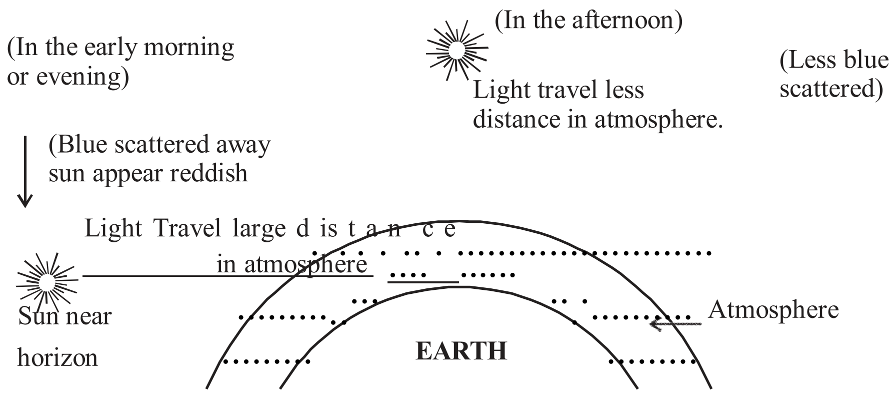
During sunset and sunrise, the sun is near horizon, and therefore the sunlight has to travel larger distance in atmosphere. Due to this most of the blue light (shorter wavelength) are scattered away by the particles. The light of longer wavelength (red colour) will reach our eye. This is why sun appear red in colour.

(4) Why the danger signal or sign are made of red colour.

Red colour scattered the least when strikes the small particle of fog and smoke because in has the maximum wavelength (visible spectrum). Hence at large distance also, we can see the red colour clearly.

(4) **At noon sun appear white–**

At noon the, sun is overhead and sunlight would travel shorter distance relatively through the atmosphere. Hence, at noon, the Sun appear while as only little of the blue and violet colours are scattered.



EXERCISE

(Question Bank)

Very Short Answers (1 Mark)

1. What is the phenomenon responsible for the blue colour of sky?
2. What is the near and far point of a normal eye?
3. Name the component of eye that is responsible for the adjustment of eyelens?
4. To an astronaut why does the sky appear dark instead of blue?
5. How can your remove the defect of vision 'Presbyopia'.
6. Name three primary colour? (Ans. RED, BLUE, GREEN)
7. Write the nature of image formed by our eye?
8. What do you understand by Dispersion of light?
9. What is Tyndall Effect?
10. A student has difficulty reading the black board while sitting in the last row. What is the defect of vision and how it can be corrected?

Short Answers (2 Marks)

1. Name the phenomenon responsible for formation of rainbow? Explain it with the help of diagram?
2. What is power of accommodation. How ciliary muscles helps in accommodation?
3. Why the sun appear red while sunset and sunrise. Explain?
4. Why the star twinkle but not earth?
5. Explain the function of
   (i) Iris (ii) Pupil (iii) Retina
6. Explain the refraction of light through glass prism with the help of diagram. Show angle of emergence and angle of deviation?

Long Answer Type Questions (5 Marks)

1. What is myopia. State the two causes of myopia? With the help oflabelled ray diagramshow
   (1) Eye defect
   (2) Correction ofmyopia
2. What is hypermetropia. State the two causes? With the help of labelledray diagram show
   (1) Eye defect
   (2) Correction ofhypermetropia.
3. Draw the labelled diagram of human eye and explain the image formation?

CHAPTER – 12

ELECTRICITY

Think life without "electricity" in this modern society. Is it possible to survive without electrical energy in world of technology. Since we are science student, so it is necessary to understand the basic concept behind the word "electricity"

Charge ⟶ **(q)**

It is a very small particles present in an atom it can be either negative (electron) or positive (proton)

"Coulomb" is the SI unit of charge, represented by C.

Net charge (Q)– Total charge

IC Net charge is equivalent to the charge contained in nearly electrons 6×10^{18}

$$\boxed{Q = ne} \quad \text{(n is no: of electron)}$$

If $Q = 1C$, $e = 1.6 \times 10^{-19}C$ (negative charge on electron)

$$n = \frac{Q}{e} = \frac{1}{1.6 \times 10^{-19}}$$

$$= \frac{100}{6.2 \times} \times 10^{18} =$$

$$\boxed{n = 6 \times 10^{18}}$$

10^{18} 16

Current (I)

Rate of flow of net charge is called current. Denoted by (I)

$$\boxed{I = \frac{Q}{t}} \quad \text{t is time}$$

SI unit of current is "Ampere" rep. by A.

Ampere ⟶ Defined as one coulomb of charge following per second.

$$\boxed{1A = \frac{1C}{1s}}$$

In an electric circuit the electric current flow in the opposite direction of the flow of electron (–ve charge) conventionally. It flows from the +ve terminal of battery or cell to –ve terminal.

Small quantity of current are expressed in

$$mA \text{ (milli Ampere)} = 10^{-3} A$$

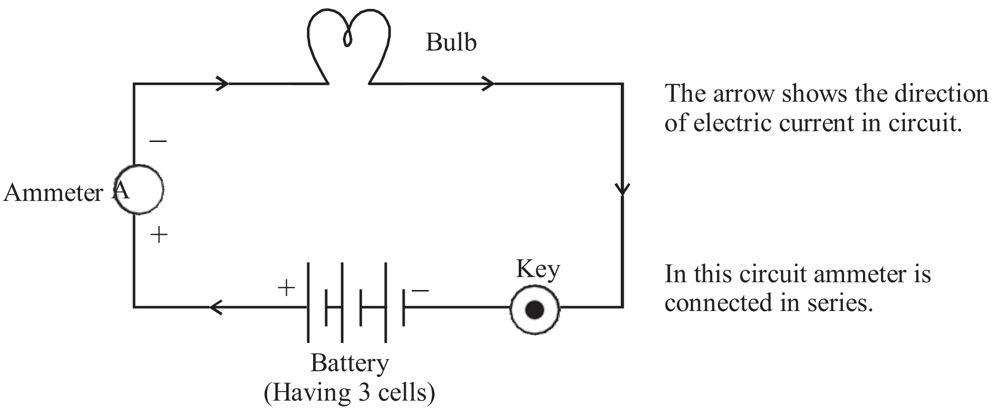
$$uA \text{ (micro Ampere)} = 10^{-6} A$$

Ammeter– It is an instrument used to measure the electric current in a circuit.

It is always connected in series m a circuit

It is represented by the symbol ——— + (A) – ——— in an electric circuit. It has low resistance.

Electric Circuit– It is a closed path along which an electric current flow.



The electron can only flow when there is difference of electric pressure. For example "water flowing through a tube" It is only possible when there high pressure at one side and low at another side, then it will move from high pressure to low pressure.

In case of electric current, the flow of charge is made possible due to chemical action with in a cell that generates the potential difference across the terminals of the cell.

8. Electric potential Difference– It is defined as the work done in carrying a unit charge from one point to another between the two points of an electric circuits.

$$V = \frac{W}{Q}$$

V – Potential Difference
W – Work
Q – Net Charge

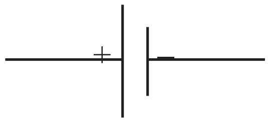
SI unit of potential difference – Volts rep. by "V"

One Volt ⟶ When 1 Joule of work is done to carry one coulomb (1C) of charge from one point to another of a current carrying conductor then the potential difference is send to be IV.

$$IV = \frac{1J}{1C}$$

Voltmeter ⟶ It is an instrument, used to measure the potential difference and represented by the symbol  in an electric circuit. It is always connected in parallel across the points between which the potential difference is to be measured. It has high resistance.

Symbols for some commonly used instrument in circuit diagrams

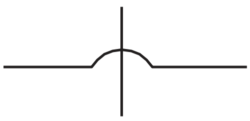
(1) Cell 

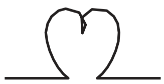
(2) Battery 

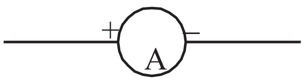
(3) Key (switch) open 

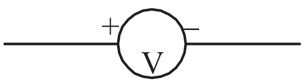
(4) Key (Close) 

(5) Joint wire 

(6) Wires with no join 

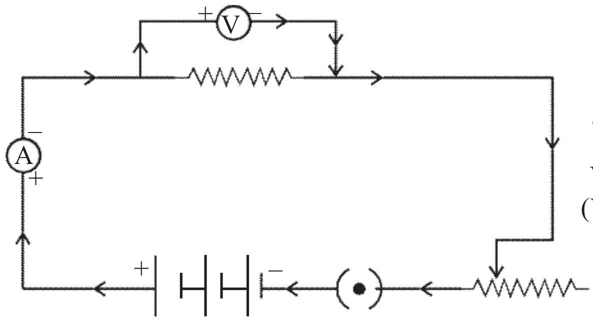
(7) Bulb 

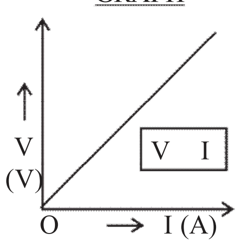
(8) Ammeter 

(9) Voltmeter 

Georg Simon Ohm (physicist) 1787 – 1854

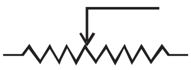
Found the relationship between the current (I) flowing through a conductor and potential difference (V) across the terminals of a conductor using the circuit diagram.





In this circuit diagram we come across two new symbols

 RESISTANCE (R)

 OR  RHEOSTAT (Variable Resistance)

Ohm's Law – ~~He stated~~ that the electric current flowing through a conductor is directly proportion at to the potential difference across its ends, provided the temperature remain constant

$$V \propto I$$
$$V = IR$$

Where "R" is the proportionality constant for the given metal at given temperature and is said to be resistance, the graph between V and I is always straight line.

Resistance– It is the property of a conductor that opposes the flow of current. It is represented by 'R' and symbol is 

SI unit of resistance "Ohm" OR Ω

1 Ohm – The resistance of a conductor is said to be one Ohm, when the potential difference across the conductor is 1V and the current flowing through it is 1A.

$$V = IR$$
$$R = \frac{V}{I}$$

$$1 \text{ Ohm or } 1\ \Omega = \frac{1V}{1A}$$

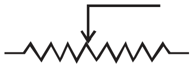
Rheostate–

As we know that

$$V = IR$$

$$I = \frac{V}{R}$$ {Shows that current through conductor resistor is inversely proportional is its resistance}

So to increase or decrease the current accordingly in the circuit a component is used is called "Rheostat", that regulates the current without changing potential difference. Represented by "Rh"

Its symbol is  OR 

it a conductor has less Resistance, then more current will flow through it.

FACTORS ON WHICH RESISTANCE OF A CONDUCTOR DEPENDS–

(1) On its length (l)

(2) On its cross sectional area (A)

(3) On the nature of material

(Resistance) $R \propto l$ (Directly prop. to length)

$R \propto \frac{1}{A}$ (inversely prop to cross-sectional area)

$$R \propto \frac{l}{A}$$

$$\boxed{R = \rho \frac{l}{A}}$$

Where "ρ" (rho) is a proportionality constant known as resistivity of the material of conductor.

11. **Resistivity** (ρ) – the resistance offered by a wire of unit length and unit cross-sectional area is called resistivity.

Its SI unit is $\boxed{\Omega m}$

Since $R = \rho \frac{l}{A}$

$$\rho = \frac{R.A}{l} = \frac{\Omega m^2}{m}$$

SI unit of $\rho = \Omega m$

For a material irrespective of length and area, the resistivity is a constant.

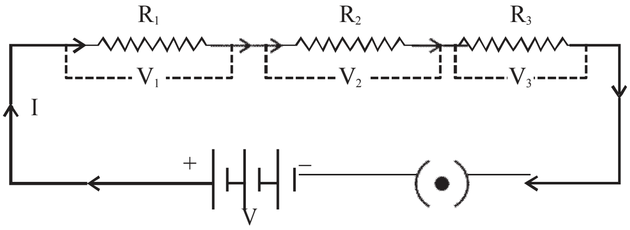
Resistantly of a material vary with temperature

Resistivity of an alloy (homogeneous mixture of metals) is generally higher than of its constituent metals. Example Constantan (alloy of Cu & Ni)

Alloys have high resistivity and do not oxidise (burn) readly at high temperature, for this reason they are commonly used in electrical heating devices, like electric iron, heater, toasters etc. For example "Tungsten" as filament of electric bulb.

Resistance in Series– (Maximum Effective Resistance)

Let us take three resistance R_1, R_2 and R_3 that are connected in series in a circuit.



Ohm's low stated

$$V = IR$$

The current (I) flowing through the resistance in series will remain same, where as the potential difference (V) across each resistor will be different.

$$V = IR$$

$$V_1 = IR_1,\ V_2 = IR_2,\ V_3 = IR_3$$

Total potential difference (V) = $V_1 + V_2 + V_3$

$$V = IR_1 + IR_2 + IR_3 \quad \Big\} \text{ Putting the value of } V, V_1, V_2 \,\&\, V_3$$

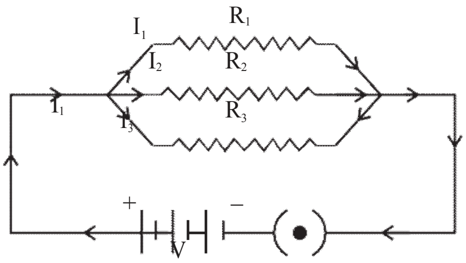
$$\cancel{I}R = \cancel{I}(R_1 + R_2 + R_3)$$

$$\boxed{R_{eff} = R_1 + R_2 + R_3}$$

Thus, we conclude that effective Resistance of the several resistors joined in series is equal to the sum of their individual resistance.

Resistance in Parallel (Minimum Effective Resistance)

Let us take three R_1, R_2 and R_3, that are connected in parallel in the electric circuit.



Now,

$$I_1 = \frac{V}{R_1},\ I_2 = \frac{V}{R_2},\ I_3 = \frac{V}{R_3}$$

Total current (I) = $I_1 + I_2 + I_3$

substitute the value of I_1, I_2, I_3 and I

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{\cancel{V}}{R} = \cancel{V}\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$$

$$\frac{1}{R_{eff}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Thus, we conclude that the reciprocal of total effective resistance of the several resistors connected in parallel is equal to the sum of the reciprocals of the individual resistance.

Disadvantage of series connection in on electric circuit :–

1. In series connection if any of the component fail to work, the circuit will break and then none of the component (ex. TV, bulb, fan..) will work.
2. It is not possible to connect a bulb and a heater in series, because they need different value of current to operate properly.

Hence, to overcome this problem we generally use parallel circuit.

<u>Heating effect of Electric Current :</u>

Explanation® Battery or a cell is a source of electrical energy.

Battery or Cell (Chemical reaction in it will produce potential difference at its two terminals) → Electron will come in motion to flow current through resistor → To maintain this current, the source has to keep expending its energy → Part of this energy is consumed in useful work (like rotating of fan) → Rest of energy of source is converted into heat, that raises the temperature of gadget. → This is known as heating effect of electric current → This effect is utilized in devices such as electric heater, iron etc.

Mathematical Expression :–

Let us suppose that current (I) is flowing through a resistor of resistance (R) for the time (t). The potential difference across the resistance is (V).

$$V = \frac{W}{Q}$$

Work done in morning the charge Q will be

$$W = VQ$$

Then power, $P = \frac{W}{t}$ [Rate of change of work done]

$$= \frac{VQ}{t}$$

$$P = VI \quad \left[\because I = \frac{Q}{t}\right] \quad -(1)$$

Heat energy supplied by the source for time t will be

$$H = P\,t \quad \left[\because P = \frac{\text{Energy or Work}}{\text{time}}\right] \quad -(2)$$

Put equation (i) in equation (2)

$$H = VIt$$

$$= (IR)\,It \quad [\because V = IR \text{ Ohm's Law}]$$

$$\boxed{H = I^2Rt}$$

This is known as Joule's Law

The law stated that the heat produced in a resistor is

(i) directly proportional to square of the current(I)

(ii) directly proportional to resistance (R) for given current

(iii) directly proportional to time (t) for which current flow through resistor.

Application of Heating Effect of Electric Current :–

(1) Used in electric iron, toaster, oven, heater etc.

(2) It is also used in bulb to produce light.

(Filament of bulb is made of strong metal with high melting point such as tungsten (m.pt = 3380°C). This filament can retain as much of the heat generated as possible, to become very hot and emit light)

(3) It is also used in the "fuse connected in an electric circuit {Fuse a safety device, protect the circuits and appliance by stopping the flow of high current. The wire of fuse is made of an alloy of metals for ex Aluminium Copper, Iron

lead etc. The alloy should be of low m.pt and high resistivity, fuse is always connected in series circuit. When large current flow through the circuit, the temperature of fuse wire will increase. This melts the fuse wire and break the circuit.

" Fuses" used for domestic purposes are rated as 1A, 2A, 3A, 5A, 10A etc. for various operation depending upon the power of appliance using.

Example- let us consider an appliance "electric Iron" which consume 1KW electric power, at 220V

$$P = VI$$

$$I = \frac{P}{V} = \frac{1KW}{220V} = \frac{1000W}{220V}$$

$$\boxed{I = 4.54A}$$

In this case a 5A fuse is required.

Electric Power :– In case of electricity, it is defined as the rate of change electrical energy dissipated or consumed in an electric electrical energy dissipated or consumed in an electric circuit.

$$P = VI$$

$$\text{or } P = I^2R \qquad (\because V = IR \text{ Ohm's Law})$$

$$\text{or } P = \frac{V^2}{R} \qquad (\because I = \frac{V}{R})$$

$$\text{or } P = \frac{\text{Electrical Energy (E)}}{\text{time (t)}}$$

SI unit of electric power is "Watt" (W).

1 Watt — Defined as the power consumed by a device, when 1A of current passes through it at the potential difference of 1V.

$$P = VI$$

$$\boxed{1 \text{ Watt} = 1 \text{ Volt} \times 1 \text{ Ampere}}$$

29 Electrical Energy–

$$P = \frac{E}{t} \qquad \left[\begin{array}{l} E - \text{Electrical Energy} \\ t - \text{time} \end{array}\right]$$

$$E = P \times t$$

SI unit of electrical energy = Ws or J

Commercial unit of electrical energy = KWh or One unit

$$E = P \times t$$

$$1\,KWh = 1KW \times 1h$$

$$= 1000W \times 3600\,s$$

$$= 36 \times 10^5\,Ws$$

$$= 3.6 \times 10^6\,J \quad \text{(SI unit Ws = J)}$$

$$\therefore 1\,KWh = 3.6 \times 10^6\,J$$

One horse power = 746W

EXERCISE

(Question Bank)

Very Short Answers (1 Mark)

1. Define the SI unit of (one mark each)
   - (a) Current
   - (b) Potential Difference
   - (c) Resistance
   - (d) Electric Power
   - (e) Electric Energy(Commercial)
2. What is the conventional direction of flow of current?
3. Define the term resistivity?
4. On what factors does the resistance of a conductor depend?
5. How is the voltmeter and ammeter connected in the electric circuit.
6. Heating effect of current carrying conductor is due to –

   (**Ans :** loss of kmectic energy of electron)
7. Why the filament of bulb has high melting point?
8. How does use of a fuse wire protect electrical appliance?
9. What is the relationship between power, current and potential difference

   (**Ans :** P = VI)
10. How many joules are there in 1 KWh?

Short Answer (2-3 marks) type Questions

1 Draw a schematic diagram of a circuit consisting of a battery of six cell of 1.5V each, three resistor each of 3i[illegible]es and a plug key.

2 State Ohm's law. Draw the graph between V&I?

3 What is joule's Heating effect of current, derive its expression?

4 A wire of length L and R is stretched so that its length's doubled and the area of cross section is halved. How will its
   - (i) Resistance change
   - (ii) Resistivity change.