JSR IAS ACADEMY

GENERAL SCIENCE

PHYSICS

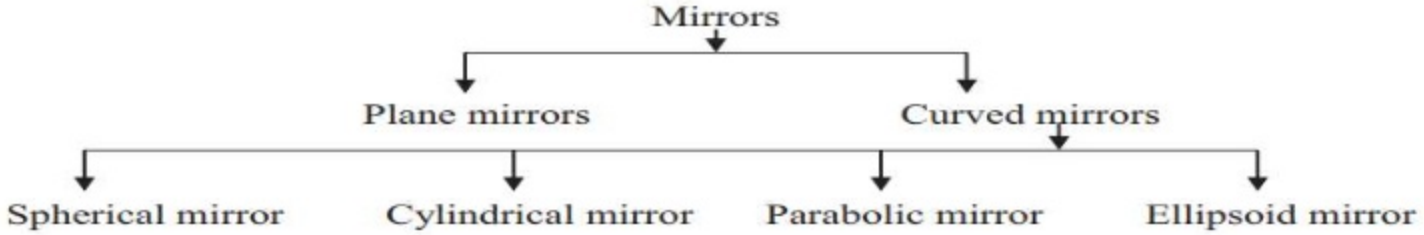
LIGHT - 2

Types of Mirrors

- The mirror is an optical device with a polished surface that reflects the light falling on it.
- A typical mirror is a glass sheet coated with aluminium or silver on one of its sides to produce an image.

Mirrors have a plane or curved surface.

- Plane mirrors form the perfect image of an object.
- curved mirrors produce images that are either enlarged or diminished.



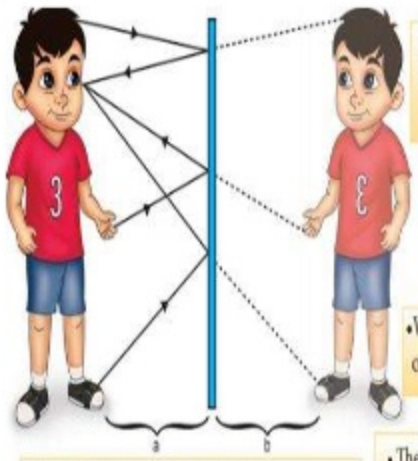
DO YOU KNOW?

Method of coating a glass plate with a thin layer of reflecting metals was in practice during the 16th century in Venice, Italy. They used an amalgam of tin and mercury for this purpose. Nowadays, a thin layer of molten aluminium or silver is used for coating glass plates that will then become mirrors.

Stand before the mirror in your dressing table or the mirror fixed in a steel almirah. Do you see your whole body? To see your entire body in a mirror, the mirror should be atleast half of your height. Height of the mirror= Your height/2.

Plane Mirror

- A plane mirror is a mirror with a flat reflective surface.



- The image is laterally inverted. The boy's left hand is his image's right hand.
- We can determine the position of an object's image by drawing light rays.
- The distance of the object from the mirror is equal to the distance of the image from the mirror (a=b).
- The image is upright.
- The image and the object are the same size.
- The image is virtual.

DO YOU KNOW?

Why is the word "AMBULANCE" written backwards in ambulance vehicle? This is due to lateral inversion .The phenomenon due to which the left side of an object appears to be right side of the object in its image in a reflecting medium (mirror). so that drivers see the word the right way around in their rear-view mirror

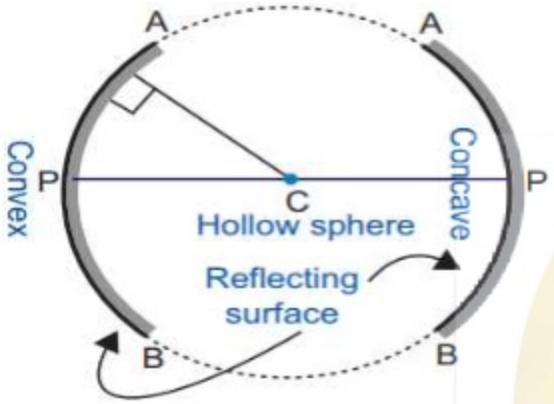
Difference between the images formed in Pinhole camera and Plane mirror	
Images formed by Pin hole camera	**Images formed in Plane mirror**
The image is real	The image is virtual
The image may not be equal to the size of the object	The image is equal to the size of the object
The image is inverted	The image is erect

Why danger lights in vehicles are red in colour?

1. Red color is scattered the least by air molecules.
2. Red color has the highest wavelength of all the other colors. So red color is able to travel the longest distance through air, fog.

Spherical mirrors

- Spherical mirrors are one form of curved mirrors. If the curved mirror is a part of a sphere, then it is called a 'spherical mirror'.
- One side of this mirror is silvered and the reflection of light occurs at the other side.



TERMS RELATED TO SPHERICAL MIRRORS

Center of Curvature- C

It is the center of the sphere from which the mirror is made.

Pole- P

It is the geometric centre of the spherical mirror

Radius of Curvature- R

It is the distance between the center of the sphere and the vertex. (The vertex is the point on the mirror's surface where the principal axis meets the mirror. It is also called as 'pole'.)

Principal Axis:

The line joining the pole of the mirror and its center of curvature is called principal axis.

Focal length:

The distance between the pole and the principal focus is called focal length (f) of a spherical mirror.

That is, **focal length = Radius of curvature/2** .

The radius of curvature of a spherical mirror is 20 cm. Find its focal length.

Solution:

Radius of curvature = 20 cm

$$\text{Focal length (f)} = \frac{\text{Radius of curvature}}{2}$$

$$= \frac{R}{2} = \frac{20}{2} = 10 \text{ cm}$$

Images formed by spherical mirrors are of two types:

i) real image and

ii) virtual image.

Real images can be formed on a screen, while **virtual images** cannot be formed on a screen.

Concave mirrors

- A spherical mirror, in which the reflection of light occurs at its concave surface, is called a concave mirror.
- These mirrors magnify the object placed close to them.
- The most common example of a concave mirror is the make-up mirror.

Convex mirror

- A spherical mirror, in which the reflection of light occurs at its convex surface, is called a convex mirror.
- The image formed by these mirrors is smaller than the object.
- Most common convex mirrors are rear viewing mirrors used in vehicles.

APPLICATIONS OF CURVED MIRRORS

Uses of concave mirror

Dentist's head mirror:

In dentist's head mirror, a parallel beam of light is made to fall on the concave mirror. Th is mirror focuses the light beam on a small area of the body (such as teeth, throat etc.).

Make-up mirror:

When a concave mirror is held near the face, an upright and magnified image is seen. Here, our face will be seen magnified.

Other applications:

- Concave mirrors are also used as reflectors in torches, head lights in vehicles and search lights to get powerful beams of light.
- They are used in torches, search lights and head lights as they direct the light to a long distance.
- They can collect the light from a larger area and focus it into a small spot. Hence, they are used in solar cookers.
- They are also used in reflecting telescopes.

DO YOU KNOW? Stellar objects are at an infinite distance. Therefore, the image formed by a concave mirror would be diminished, and inverted. Yet, astronomical telescopes use concave mirrors.

Uses of convex mirrors

- Convex mirrors are used as rear-view mirrors in vehicles. It always forms a virtual, erect, small-sized image of the object.
- As the vehicles approach the driver from behind, the size of the image increases. When the vehicles are moving away from the driver, then image size decreases.
- Convex mirrors are installed on public roads as traffic safety device.
- They are used in acute bends of narrow roads such as hairpin bends in mountain passes where direct view of oncoming vehicles is restricted.
- It is also used in blind spots in shops.

DO YOU KNOW? Convex mirrors used in vehicles as rear-view mirrors are labeled with the safety warning: 'Objects in the mirror are closer than they appear' to warn the drivers. This is because inside the mirrors, vehicles will appear to be coming at a long distance.

Parabolic mirrors

- A parabolic mirror is one type of curved mirror, which is in the shape of a parabola.
- entire incident beam of light to converge at its focal point.
- Parabolic mirrors, also known as parabolic reflectors, are used to collect or project energy such as light, heat, sound and radio waves.
- They are used in reflecting telescopes, radio telescopes and parabolic microphones. They are also used in solar cookers and solar water heaters.

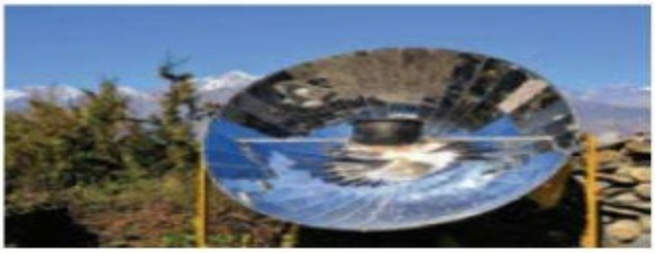


Figure 3.3 Parabolic mirror

DO YOU KNOW? The principle behind the working of a parabolic mirror has been known since the Greco-Roman times. The first mention of these structures was found in the book, 'On Burning Mirrors', written by the mathematician Diocles. They were also studied in the 10th century, by a physicist called Ibn Sahl. The first parabolic mirrors were constructed by Heinrich Hertz, a German physicist, in the form of reflector antennae in the year 1888.

TYPES OF REFLECTION

Based on the nature of the surface, reflection can be classified into two types namely,

i) regular reflection

ii) irregular reflection.

Regular reflection

- When a beam of light (collection of parallel rays) falls on a smooth surface, it gets reflected.
- After reflection, the reflected rays will be parallel to each other.
- Here, the angle of incidence and the angle of reflection of each ray will be equal.
- Hence, the law of reflection is obeyed in this case and thus a clear image is formed. This reflection is called 'regular reflection' or 'specular reflection'.

Example: Reflection of light by a plane mirror and reflection of light from the surface of still water.

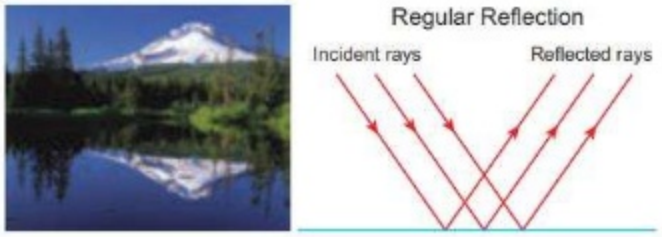


Figure 3.8 Regular reflection

Irregular reflection

- In the case of a body having a rough or irregular surface, each region of the surface is inclined at different angles.
- When light falls on such a surface, the light rays are refl ected at diff erent angles.
- In this case, the angle of incidence and the angle of refl ection of each ray are not equal.
- Hence, the law of refl ection is not obeyed in this case and thus the image is not clear.
- Such a reflection is called 'irregular refl ection' or 'diff used refl ection'.

Example: Reflection of light from a wall.

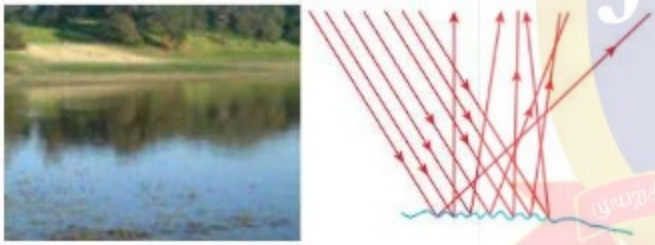
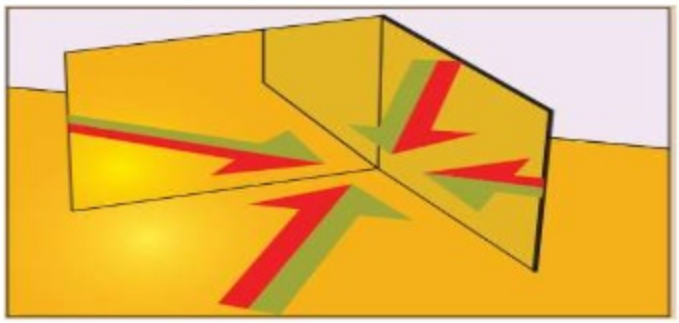


Figure 3.8 Irregular reflection

MULTIPLE REFLECTIONS



- The image formed by the first mirror acts as an object for the second mirror and the image formed by the second mirror acts as an object for the first mirror.
- The number of images formed, depends on the angle of inclination of the mirrors.
- As you decrease this angle, the number of images formed increases. When they are parallel to each other, the number of images formed becomes infinite.

If two plane mirrors are inclined to each other at an angle of 90°, find the number of images formed.

Solution:

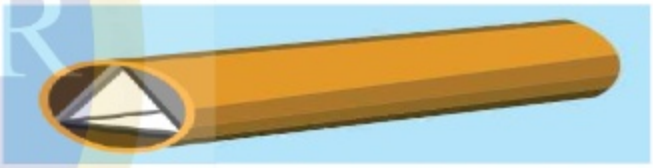
Angle of inclination = 90°

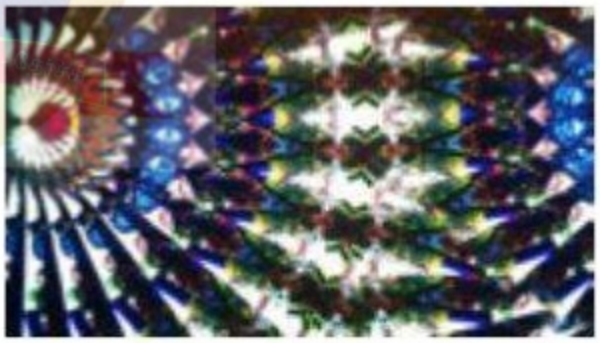
Number of images formed =

$$\frac{360^\circ}{\theta} - 1 = \frac{360^\circ}{90^\circ} - 1 = 4 - 1 = 3$$

Kaleidoscope

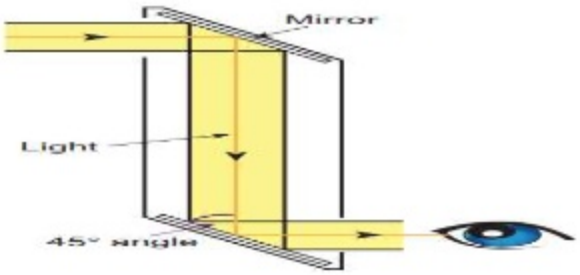
- It is a device, which functions on the principle of multiple reflection of light, to produce numerous patterns of images.
- It has two or more mirrors inclined with each other.





Periscope

- It is an instrument used for viewing bodies or ships, which are over and around another body or a submarine.
- It is based on the principle of the law of reflection of light.
- It consists of a long outer case and inside this case mirrors or prisms are kept at each end, inclined at an angle of 45°.



Uses

- ❖ It is used in warfare and navigation of the submarine.
- ❖ In military it is used for pointing and firing guns from a 'bunker'.
- ❖ Photographs of important places can be taken through periscopes without trespassing restricted military regions.
- ❖ Fibre optic periscopes are used by doctors as endoscopes to view internal organs of the body