Light

When light reaches an object it can do one, or some combination of, the following:

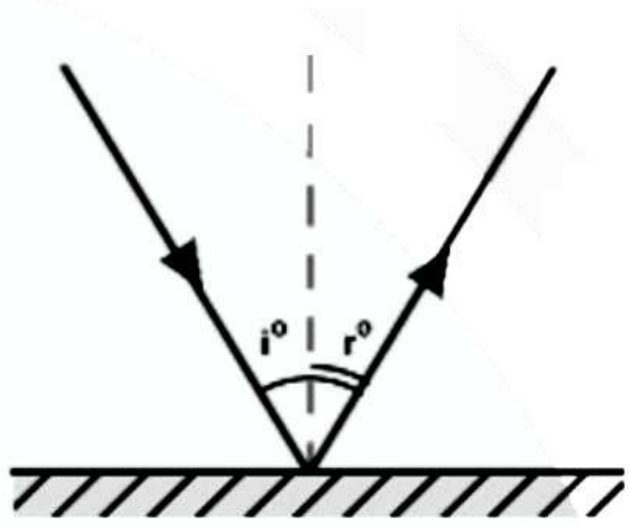
Absorption Light energy goes into the object itself. Because the light goes into the object rather than leaving the surface of the object - and then some of that light entering the eye - the object is not "seen" as very bright.

Instead, it is perceived to be dark (meaning that little light is traveling from that object into the eye).

However, the object might still be obvious to a viewer, e.g. a dull matt-black object would still be seen if observed on a clean white surface. In that case the contrast makes the presence of the dark object obvious.

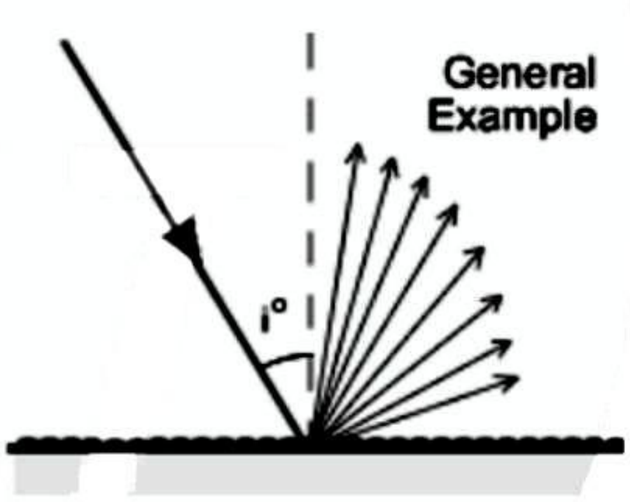
Reflection Light reaches the surface of a very shiny object and "bounces" off the object in the same way as a hard ball would bounce off an even flat surface (e.g. as in the game of snooker).

That is, when it is **reflected**, light leaves the surface of an object at a particular angle relative to the angle at which it reached that surface.



Scatter On reaching the surface of an object, light leaves that surface **not** in any one particular direction, but in many directions spreading over a wide range of angles. This applies particularly to non highly-polished surfaces, such as paper, or walls painted matt white.

Scatter is the most common of these possibilities when visible light is incident on ordinary everyday solid/opaque objects.



Refraction This is another case of light entering the object instead of leaving the surface of the object.

Refraction only applies to objects that light can pass through, such as blocks of glass or plastic, windows, water, and spectacles. It is mentioned here for completeness.

In the context of explaining how light reaches a person's eye from objects in the real world in front of him/her, refraction is less important than the other possibilities described above.

(However, note that **refraction** plays a very important role in the eye/visual system for other reasons, such as focusing images onto the retina - and is therefore explained on other pages later in this section.)

REFLECTION OF LIGHT

When a ray of light falls on any surface, a part of the light is sent back to the same medium. This phenomenon where the incident light falling on a surface is sent back to the same medium is known as reflection.

There are two types of reflection of light:

- Regular reflection
- Irregular reflection

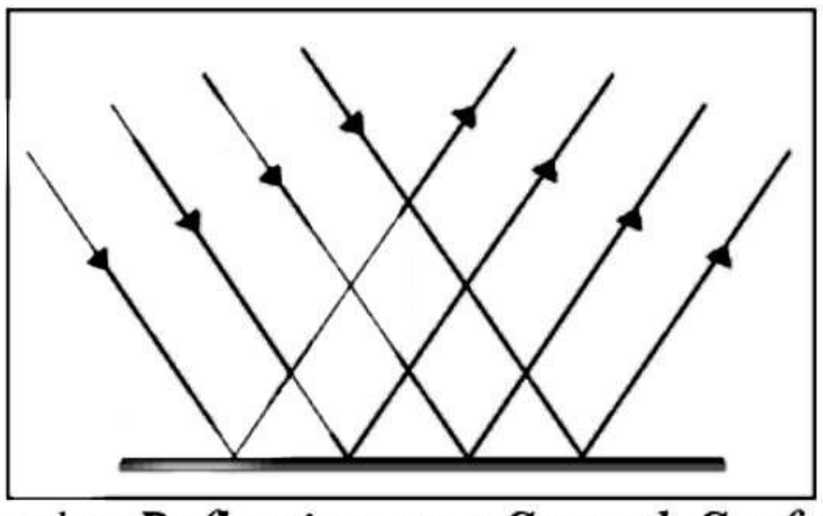
Laws of reflection of light:

If we know how light behaves when it is reflected we can use a mirror to change the direction in which the light is traveling. This happens when a mirror is placed at the entrance of a concealed drive to give warning of approaching traffic.

An ordinary mirror is made by depositing a thin layer of silver on one side of a piece of glass and protecting it with paint. The silver - at the back of the glass - acts as the reflecting traffic.

From the below explanation we can understand the law of reflection of light.

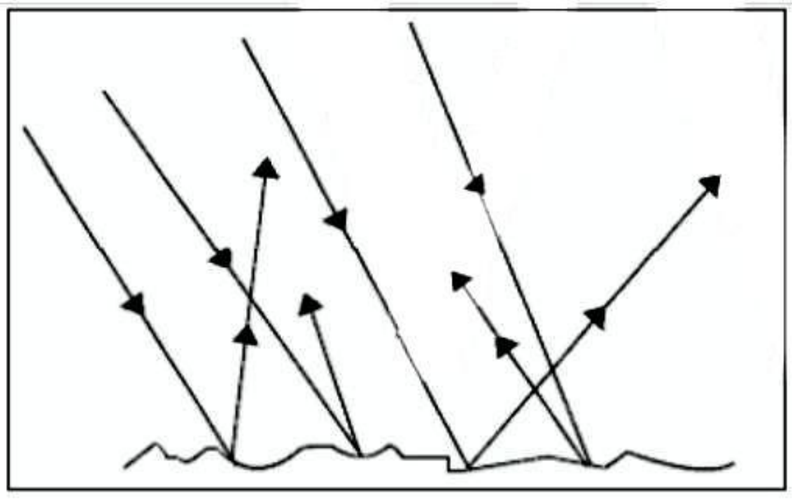
Regular Reflection



Regular Reflection on a Smooth Surface

Regular reflection takes place when a ray of light is incident on a polished smooth surface like a mirror. Here the reflected ray of light moves only in a fixed direction.

Irregular Reflection or Diffused Reflection



Diffused Reflection on a Rough Surface

The Laws of Reflection

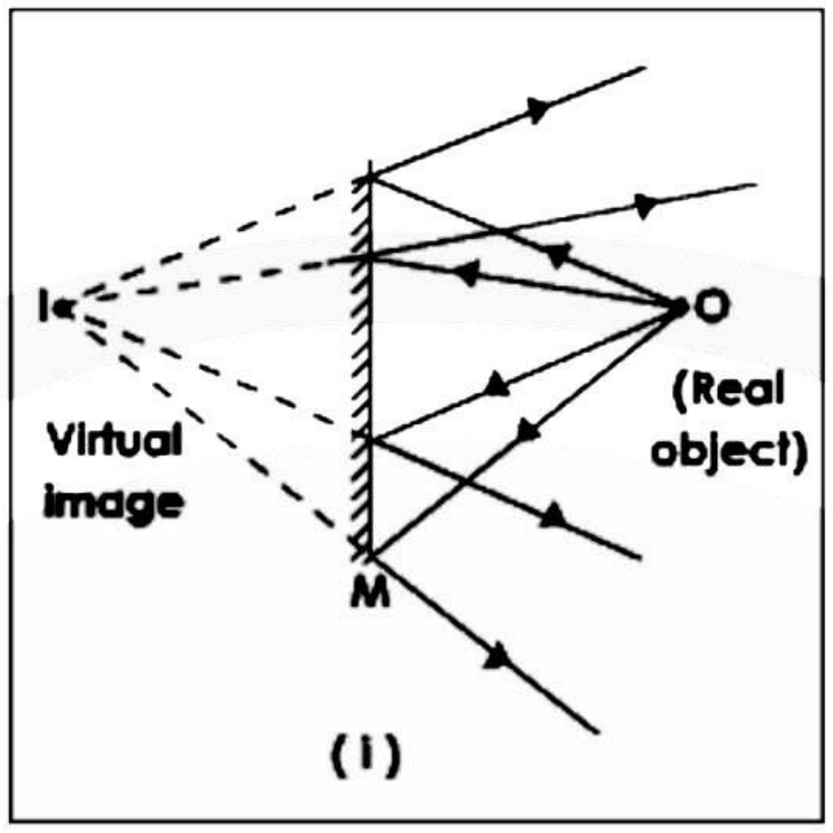
The reflection at any plane surface is found to obey the laws of reflection. The laws of reflection are:

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

Image

An image can be real or virtual. A real image is formed when the rays of light actually intersect after reflection. A virtual image is formed when the light rays after reflection

do not actually intersect but appear to diverge from it (these rays of light intersect when produced backwards).

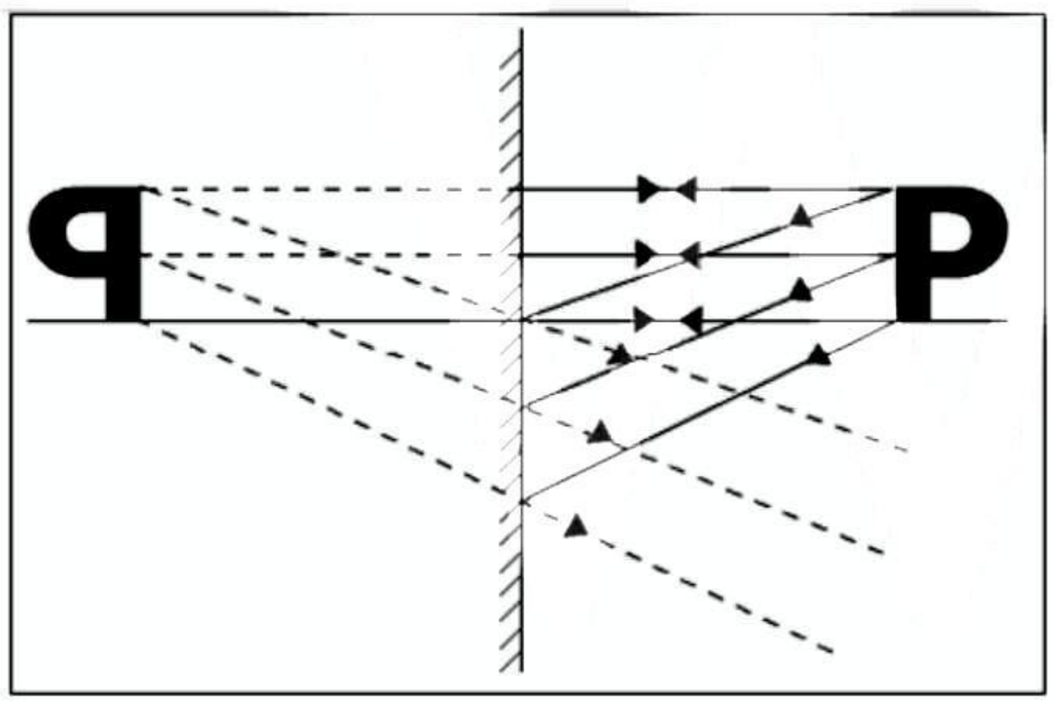


Virtual Image Formed by a Plane Mirror

In fig (i) we can see that the light beam from the point source O is a diverging beam. After reflection from the mirror it is still a diverging beam, which appears to come from I. The image formed by a plane mirror is virtual.

Formation of Image by a Plane Mirror - Ray Diagrams

The following rays are usually considered while constructing ray diagrams.



A Ray Diagram Showing the formation of an Image by a Plane Mirror

A ray of light incident on a plane mirror at 90° gets reflected from the mirror along the same path.

A ray of light falling on a plane mirror at any angle gets reflected from the mirror such that the angle of incidence is equal to the angle of reflection.

- **Image Formation When an Object is placed between Two Inclined Mirrors**

It has been found that if the mirrors are inclined at an angle θ then the number of images is given by the relation $\frac{360^\circ}{\theta} - 1$ If $\frac{360^\circ}{\theta}$ is not a whole number, then the number of

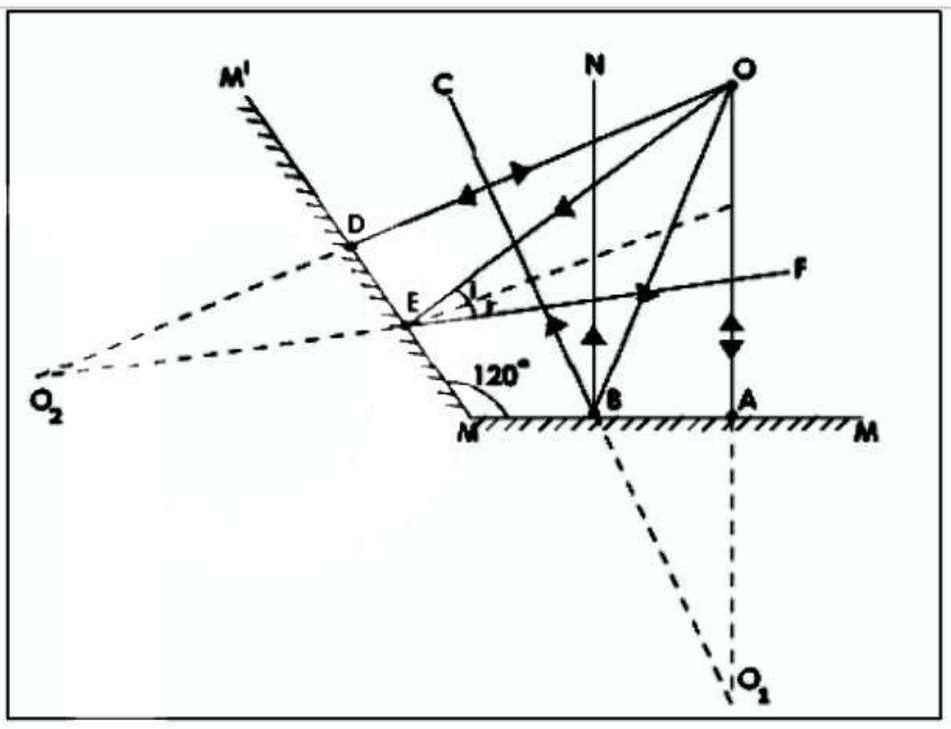
images will be rounded off to the nearest integer. This can be verified by actual drawing.

If the mirrors are inclined at 120° the number of images formed by the mirrors is given by the relation

$$n = \frac{360°}{\theta} - 1 = \frac{360°}{120°} - 1 = 3 - 1 = 2$$

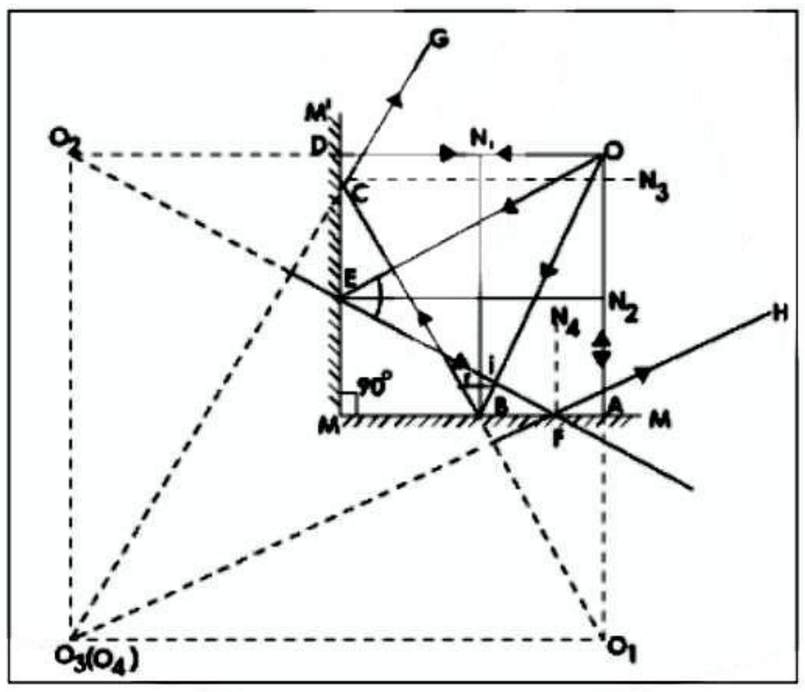
Case – I

Let MM and MM' be two plane mirrors inclined at an angle 120° and O be the object placed in between these mirrors. In this case there will be only two images viz., O_1 and O_2.



Case II

Now let us consider the mirrors MM and MM' to be mutually perpendicular. In this case the number of images formed by the mirror is $\frac{360°}{90°} - 1 = 3$



The Angle of Inclination Between the Mirrors is 90^o.

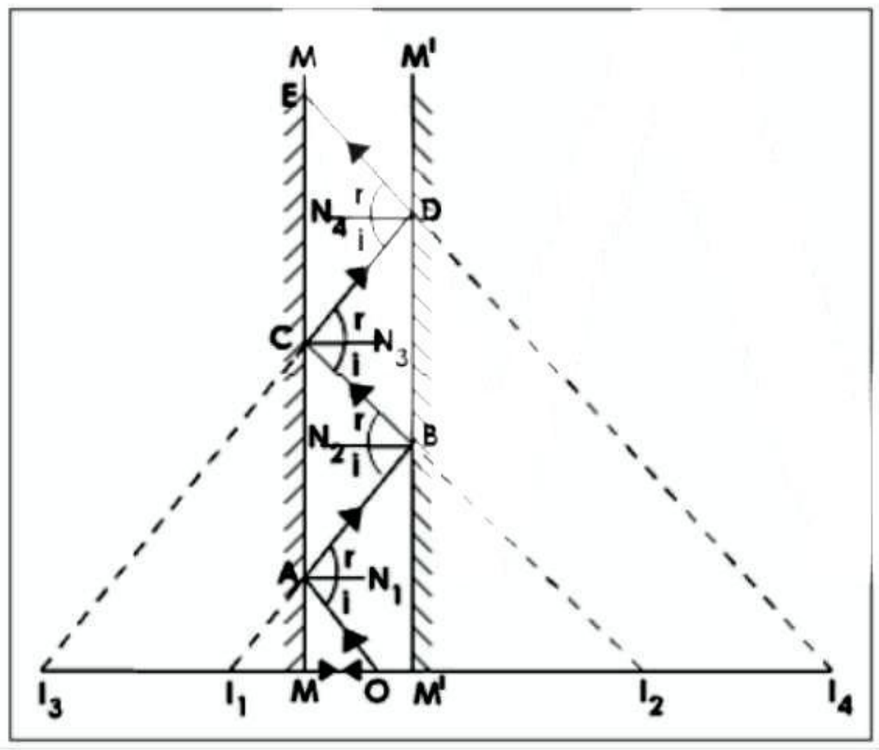
- Place the mirrors MM' perpendicular to MM.
- An object O is kept in between these mirrors.
- OA and OB are the two rays, which are incident on the mirror MM.
-

- OA being normal to the surface retraces its path.

- OB makes an angle i with the normal N and gets reflected along BC according to the laws of reflection.
- Extend the rays OA and BC backwards.
- They meet at O_1, which is the virtual image of O.
- OD and OE represent the rays which are incident on the mirror MM'.
- OD is perpendicular to the mirror MM' and hence gets reflected along the same path.
- OE is the incident ray and N_2 is the normal at the point of incidence and OE gets reflected along the path EF.
- Extend OD and EF backwards. They meet at O_2, which is the virtual image of O.
- The reflected ray BC gets internally reflected by the mirror MM' along CG.
- The ray DG appears to comes from O_3, which is the image of O_1.
- Similarly EF the reflected ray gets internally reflected by the mirror MM along FH.
- The ray FH appears to come from O_4, which is the image of O_2.
- The position of O_3 and O_4 coincide.
- Thus when the angle of inclination between the mirrors is 90^0 we get three images.

Case III

Let us now calculate the number of images formed if the two mirrors are placed parallel to each other i.e., the angle of inclination between them is 0^0.



- Place the mirrors MM and MM' parallel to each other.
- An object O is kept between these mirrors.
- OA and OO' represent the rays which are incident on the mirror MM.
- OO' being normal retraces its path.
- OA makes an angle i with the normal N_1 and gets reflected along AB according to the laws of reflection
- Extend the rays AB and OM backwards.
- They meet at I_1, which is the virtual image of the object O.
- The reflected ray AB gets reflected by the mirror MM' and forms an image I_2.
- Similarly I_3, I_4 etc. are formed.
- The light from I_1, I_2, I_3, I_4 etc. gets reflected and forms their images.