JSR IAS ACADEMY

GENERAL SCIENCE

PHYSICS

LIGHT - 1

Sources of Light.

Natural Sources of light

The Sun,Moon,Star

Bioluminescence.

Fireflies, jellyfish, glow worm, certain deep sea plants and some microorganisms can emit light naturally.

Artificial Sources of light

- flame of candle, incandescent lamp, neon lamp, Sodium lamp etc.

The different light sources that are able to produce light artificially can be put under **three broad categories.**

1. Incandescent Sources:

When certain objects are heated to a high temperature, they begin to emit light.

- The glowing of hot iron rod is a kind of Incandescent light.
- Example: Candle, incandescent lamp.

2. Gas Discharge Sources:

Passing electricity through certain gases at a very low pressure (discharging) can produce light .

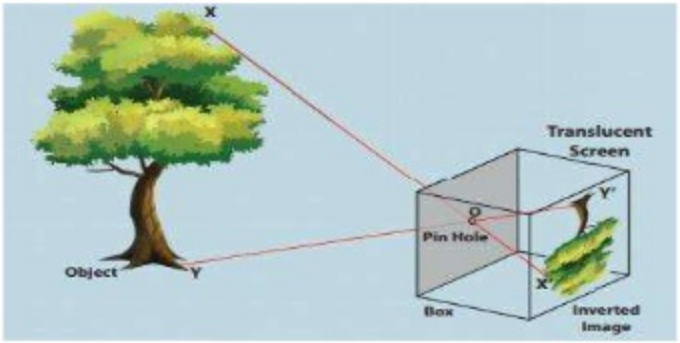
- Example: Neon lamp, Sodium lamp

DO YOU KNOW?

Al-hasan -Haytham was a scientific thinker who made important contribution to the understanding of vision, optics and light. He observed that light coming through a tiny hole travelled in straight lines and projected an image onto the opposite wall. Based on such experimentation, he concluded that vision is accomplished by rays coming from external luminous sources and entering the eye, rather than through rays emitted from the eye as was then commonly believed. He is the first one to experiment with light and found important properties like the rectilinear propagation of light.

DO YOU KNOW?

We often use a kind of gas-discharge lamp that uses fluorescence to produce visible light. The electric current in the gas excites mercury vapour, which produces short-wave ultraviolet light that then causes a phosphor coating on the inside of the lamp to glow in visible light.



DO YOU KNOW?

Before the advancement of camera, Pinhole camera was used to photograph movement of the sun over a long period of time. This type of photography is known as ***solography*** and also be used for observing and recording solar eclipses. And it was also used to take photograph of stationary objects.

PROPERTIES OF LIGHT

1. Light is a form of energy.

2. Light always travels along a straight line.

3. Light does not need any medium for its propagation. It can even travel through vacuum.

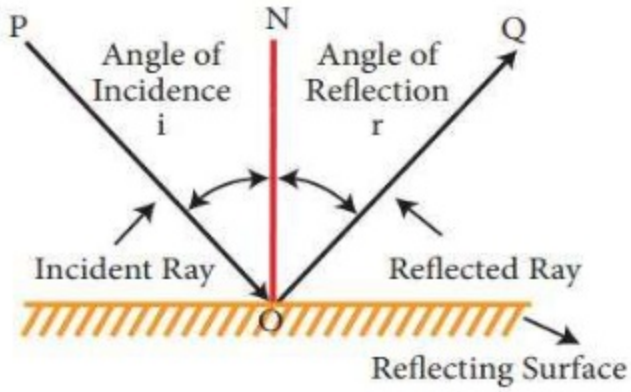
4. Th e speed of light in vacuum or air is, $c = 3 \times 108\ ms^{-1}$

5. Since, light is in the form of waves, it is characterized by a wavelength (λ) and a frequency (ν), which are related by the following equation: $c = \nu \lambda$ (c - velocity of light).

6. Different coloured light has different wavelength and frequency.

7. Among the visible light, violet light has the lowest wavelength and red light has the highest wavelength.

Terms used in reflection of light.



Incident ray:

The ray of light that falls on the surface of the refl ection materials. In figure, **PO** is the incident ray.

Reflected ray:

Th e ray of light that comes from the point when the incident ray falls on the reflection material. In the fi gure, **OQ** is the refl ected ray.

Point of incidence :

The point of which are incident ray strikes the refl ecting surface is the point of incidence. In the fi gure **'O'** point of incidence.

Normal :

The perpendicular line drawn from the point of incidence to the plane of refl ecting surfacc is called normal. In fi gure, **ON** is the normal.

Angle of incidence:

The angle formed between the incident ray **PO** and the normal **'ON'** is angle of incidence. It is denoted by **i (i=<PON)**

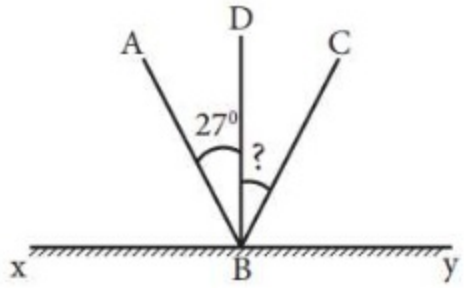
Angle of reflection:

The angle formed between the reflected ray **OQ** and the normal **ON** is angle of reflection. **(r=<NOQ)**

Laws of reflection:

1. The angle of incidence is always equal to the angle of reflection. **i = r**

2. The incident ray, the reflected ray and the normal at the point of incidence lie on the same plane.



Solution:

Angle of incidence = 27°

∴ According to the laws of refelection, the angle of refelection = Angle of incidence = 27°

A light ray strikes a reflective plane surface at an angle of 43° with the plane surface.

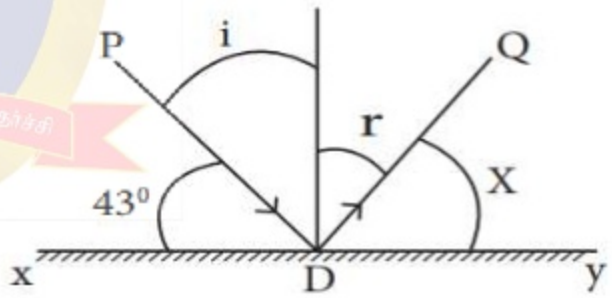
i. Find the angle of incidence.

ii. Find the angle of reflection.

iii. Find the angle between the incident and the reflected ray

iv. Find the angle between the reflected ray and the plane surface.

Solution:



a) Angle of incidence: i = 90 -43 = 47 °

b) angle of reflection r = i = 47°

c) i + r = 47 + 47 = 94 °

d) x = 90 - r = 90 - 47 = 43 °

Silver metal is the best reflector of light. That's why a thin layer of silver is deposited on the side of materials like plane glass sheets, to make mirrors.

Shadows

It is caused by opaque objects that stop light from propagating.

Properties of shadow

1. All objects do not form shadows. Only opaque objects form shadows

2. Shadows will be formed in the opposite side of light source

3. It cannot be determined the characteristics of an object by its shadow.

4. The shadow will be always darker, whatever may be the color of light rays

5. Light source, opaque object are shadow all are in a straight line.

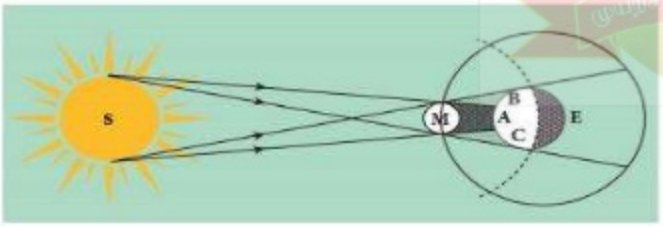
6. The size of shadow depends upon the distance between light source and object and the distance between object and the screen.

Eclipses

An eclipse is an incident, when any astronomical object is partially or fully obscured due to the placement of another astronomical object in the presence of light.

Solar eclipse

- Solar eclipse occurs, when the moon arrives between the sun (S) and the earth(E).



Lunar eclipse:

- Lunar eclipse occurs, when the earth (E) comes between the sun (S) and the moon (M). T
- The earth prevents light coming from the sun and makes shadow on the moon. This is lunar eclipse

Real and Virtual Image

- If the light rays coming from an object actually meet, after reflection, the image formed will be a real iamage and it is always inverted.
- A real image can be produced on a screen.
- When the light rays coming from an object do not actually meet, but appear to meet when produced backwards, that image will be virtual image.
- The virtual image is always erect and cannot be caught on a screen

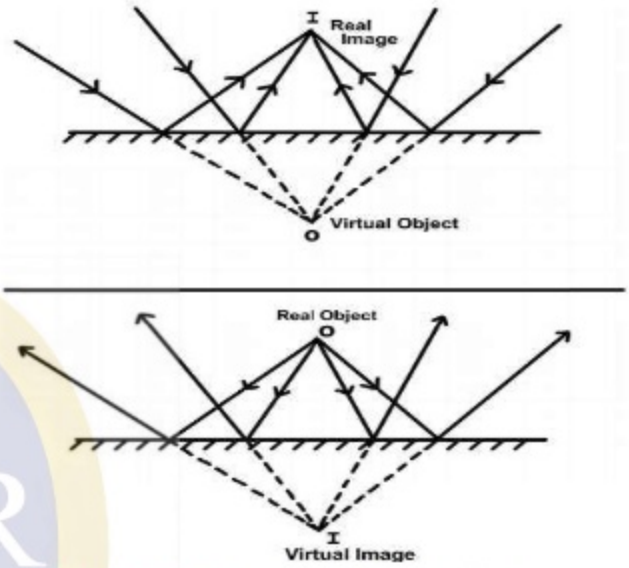


Figure 6.3 Real and virtual image

Colour

- Visible light is a spectrum of a number of waves with different wavelength range from 400nm to 700nm

The band of visible light is **VIBGYOR.**

V - Violet I - Indigo B - Blue G - Green Y - Yellow O - Orange R - Red

1. **Violet colour** has **shorter wavelength** and **red color** has **longer wavelength**.
2. When light ray of particular wavelength (Colour) strikes the retina of our eye, our brain perceives that specific colour.
3. white is not a colour at all. But, it is the combination of all the colors of the visible light spectrum.
4. If all the wavelength (colours) of visible light spectrum give appearance of white similarly, the observe of all there wavelength of visible light, will lead appearance of **black**

Prism

A prism is an object made up of a transparent material, like glass or plastic that has at least two flat surfaces that from an acute angle (less than 90^{O} degrees).

DISPERSION

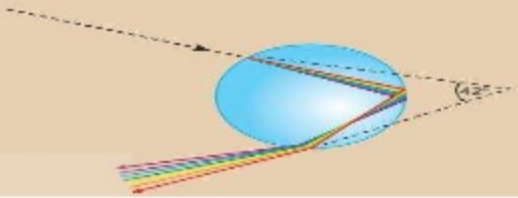
- the first prism splits the white light into seven coloured light rays and the second prism recombines them into white light, again.
- Thus, it is clear that white light consists of seven colours.
- Splitting of white light into its seven constituent colours (wavelength), on passing through a transparent medium is known as dispersion of light.

Place a prism on a table and keep a white screen near it. Now, with the help of a torch, allow white light to pass through the prism. What do you see? You can observe that white light splits into seven colored light rays namely, violet, indigo, blue, green, yellow, orange and red (VIBGYOR) on the screen. Now, place another prism in its inverted position, between the first prism and the screen. Now, what do you observe on the screen? You can observe that white light is coming out of the second prism.

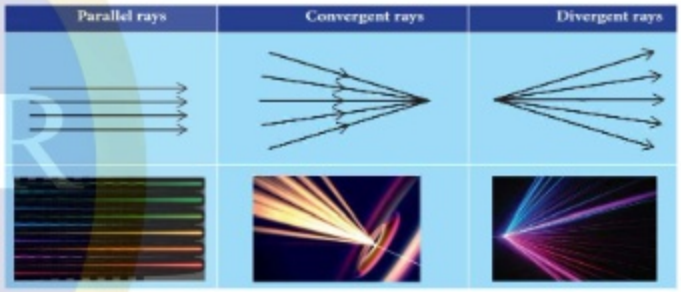
- Moreover, refraction of a light ray is inversely proportional to its wavelength.
- Thus, the red coloured light, which has a large wavelength, is deviated less while the violet coloured light, which has a short wavelength, is deviated more.

DO YOU KNOW?

The formation of rainbow is an example of dispersion of white light. This can be seen on the opposite side of the Sun. After a rainfall, large number of droplets still remain suspended in the air. When white light passes through them, it is split into seven colours. Dispersion of white light from a large number of droplets eventually forms a rainbow.

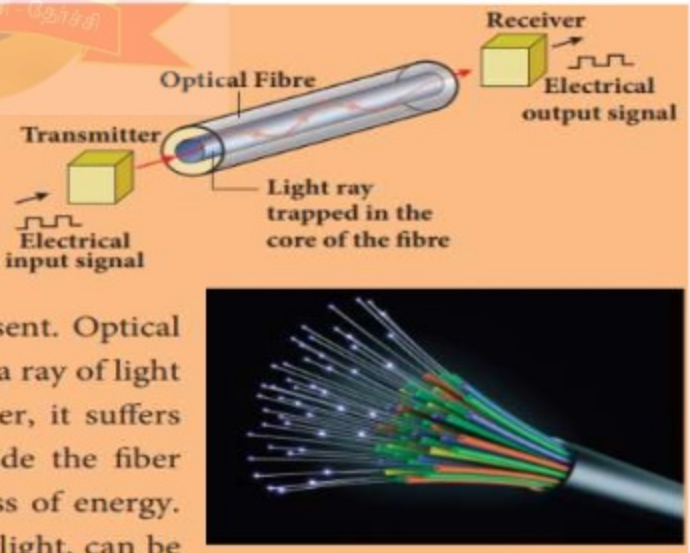


Types of reflection



DO YOU KNOW?

Optical fibre is a device that works on the principle of ***total internal reflection*** by which light signals (huge data) can be transmitted from one place to another place with a negligible loss of energy in a very short time. It consists of a cable having one or more thin flexible fibers with a glass core through which light signals can be sent. Optical fiber can be twisted and bent easily. When a light a ray of light is incident at one end of the core of optical fiber, it suffers total internal reflection at the many places inside the fiber and emerges at the other end with negligible loss of energy. The data or information in the form of pulses of light, can be sent through bundles of optical fibers. Optical fibers have become very important in high-speed communications, such as cable TV and high-speed broadband services. Fiber optic cables are able to carry more signals than traditional **copper** cable telephone lines.



Mirage Optical fibres:

- Optical fibres are bundles of high-quality composite glass/quartz fibres.
- Each fibre consists of a core and cladding.
- The refractive index of the material of the core is higher than that of the cladding.
- Optical fibres work on the phenomenon of total internal reflection.
- Optical fibres are extensively used for transmitting audio and video signals through long distances.
- Moreover, due to their flexible nature, optical fibers enable physicians to look and work inside the body through tiny incisions without having to perform surgery

An Indian-born physicist Narinder Kapany is regarded as the *Father of Fibre Optics.*