Cosmo School

Sub: Science **Chapter-9 (Phenomenon of light)**

Class-6 **Subject teacher- Syeeda Sultana**

What is light

Light is made up packets of energy called photons that move from the source of light in a stream at a very fast speed. The speed of light is about 3 lac kilometers per second. Since light is an energy, it has the capability to work.

Light or visible light is electromagnetic radiation (waves) within the portion of the electromagnetic spectrum that can be perceived by the human eye.

How light propagates

Light travels in straight line path. The straight line traversed by light is known as the ray of light. The propagation of light is called rectilinear propagation of light. Rectilinear means straight line path. Light do not travel in a curvilinear or zigzag way. Once light has been produced, it will keep travelling in a straight line until it hits something else.

Evidence of light travelling in straight lines

Shadows are evidence of light travelling in straight lines. An object blocks light so that it can't reach the surface where we see the shadow. Light fills up all of the space before it hits the object, but the whole region between the object and the surface is in shadow. Shadows don't appear totally dark because there is still some light reaching the surface that has been reflected off other objects.

Ray of light

The straight line traversed by light is known as the ray of light.

Reflection of light

When a ray of light falls on an object, if it is obstructed and bounces back to opposite direction, it is called the reflection of light.

Absorption of light

When light falls on an object and do not comes back then that is called absorption of light.

- Once light has hit another surface or particles, it is then absorbed, reflected (bounces off), scattered (bounces off in all directions), refracted (direction and speed changes) or transmitted (passes straight through).

How do we see

We can see things because of reflection of light. When light from any light sources (sun, electric bulb etc.) falls on an object it gets obstructed and reflects back to our eyes which make us see the object. We see an object not because of the fact that light from our eyes fall on that object. And that's why we cannot see anything in dark.

Types of light sources

Luminous objects

Objects that emit light on their own are called luminous objects. Best examples of luminous objects are the sun, stars, firefly, candle, light bulb etc.

Non-Luminous objects

Objects that do not have their own lights but they reflect lights of other sources are known as non luminous objects. Examples of non luminous objects are wood, plastics, metals etc.
Almost everything around us is non-luminous. The reason we are able to see any non-luminous objects around us is because of reflection of light.
Some objects do not reflect the light falling on them. They rather absorb all the light. Such objects look black.

Moon is a non-luminous object

The moon does not emit its own light at all. Instead, we are able to see the moon because it reflects the light taking from the sun and emits light in our surrounding and our environment. So, the moon is an example of a non-luminous object, meaning that it is able to reflect light and can therefore be seen. The sun reflects direct into our eyes.

How does light give objects their color

Light is made up of wavelengths of light, and each wavelength (light) is a particular color. Objects appear different colors because they absorb some colors (wavelengths) and reflected other colors. The color we see is a result of which lights (wavelengths) are reflected back to our eyes.
White light is actually made of all of the colors of the rainbow because it contains all wavelengths of visible light. Light from a torch or the sun is a good example of this.

- White objects appear white because they reflect all colors. Black objects absorb all colors so no light is reflected.

Why does a red object appear red in light?

A red object appears to be red in white light because it absorbs all the other visible lights present in white light and only reflects red light wave.

- A white object on the other hand reflects all the visible light waves, and appears brighter, which our eyes perceive as white color.

How can we see the writings printed on the page

Any black body or any black writing absorbs light coming from any source. But our eyes receive the light reflected from the white paper. As a result, we can see the printed black words from the white paper.

- Bright colors absorb more light than the light color.

Why the blind people cannot see

When light coming from an object and falls on normal eyes only then the object is seen. Eyes of the blinds are not normal so they cannot receive the light reflecting from the object to their eyes.

Explanation of reflection of light

Incident ray: The light ray that strikes a reflecting surface is called the incident ray.

Reflected ray: The light ray that bounces back from the surface is called the reflected ray.

Incidence: The fall of light ray on a surface is called incidence.

Point of incidence: The point at which the incident ray strikes the reflecting surface is called point of incidence.

Normal: The perpendicular drawn to the surface at the point of incidence.

Angle of incidence: The angle created by the incident ray with the normal at the point of incidence is called angle of incidence. It is denoted by letter 'i' and 'θi'.

Angle of reflection: The angle created by the reflected ray with the normal at the point of incidence is called angle of incidence. It is denoted by letter 'r' and 'θr'.

Plane of incidence: The plane containing the incident ray, the normal and the reflected ray is called the plane of incidence.

The figure below shows the reflection of an incident ray on a plane mirror.

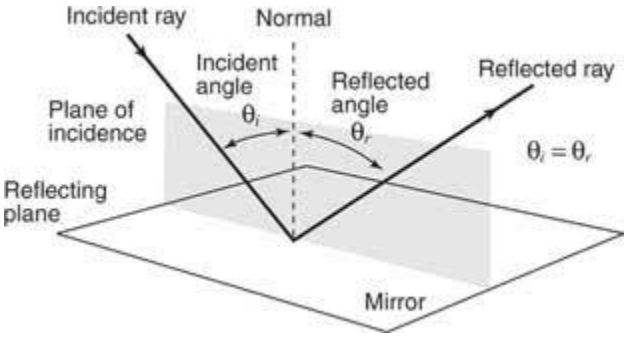


Figure- Incidence and reflection of light

When a ray of light approaches a surface and the light ray bounces back, it is called the reflection of light. The incident light ray which lands upon the surface is said to be reflected off the surface. The ray that bounces back is called the reflected ray. If a perpendicular were to be drawn on reflecting surface, it would be called normal. Here, the angle of incidence and angle of reflection are with respect to normal to the reflective surface.

Laws of reflection of light

Law-1:

The angle between the incident ray and the normal is equal to the angle between the reflected ray and the normal.

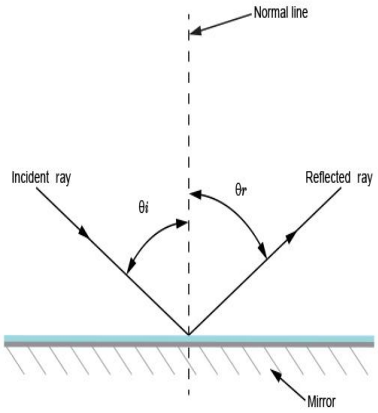


Figure-1

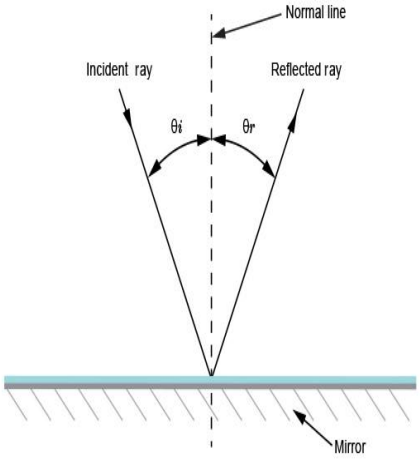


Figure-2

This means that θi equals θr

Or, $\theta i = \theta r$ where, θi = angle of incidence and θr = angle of reflection

In figure-1, as the angle of incidence (θi) increases, the angle of reflection (θr) also increases and they are always equal to each other.

Law -2: The incident ray, the normal and the reflected ray are all in the same plane.

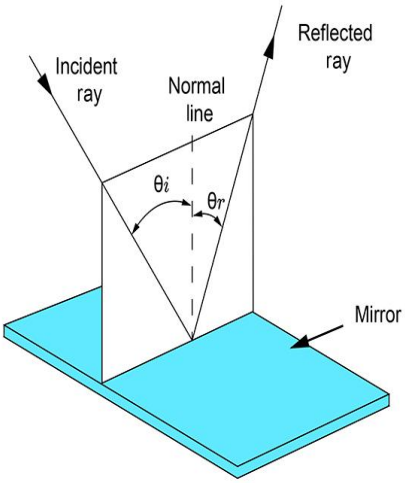


Figure-1

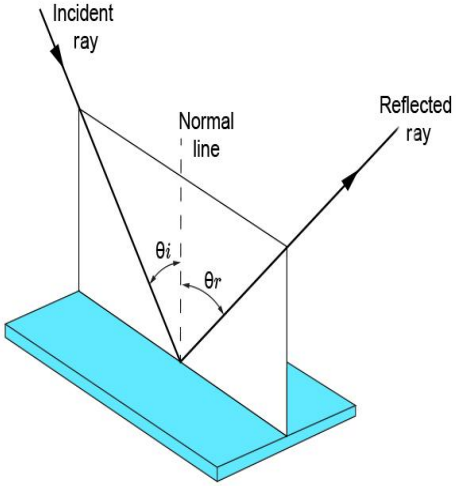


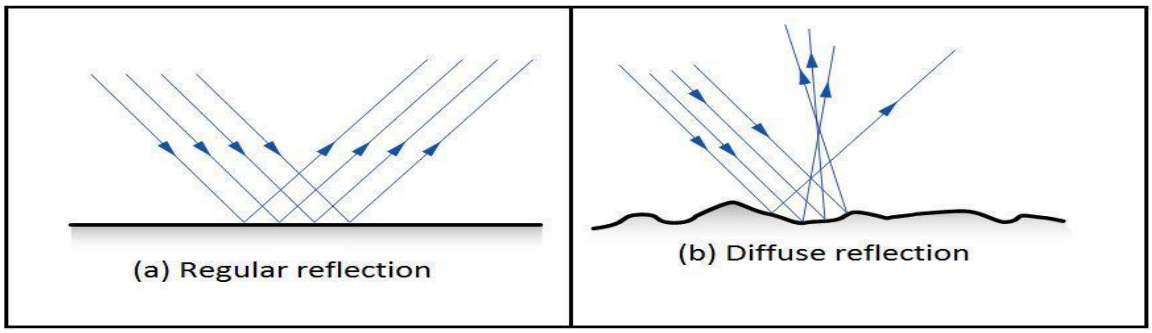
Figure-2

In figure-2, changing the direction of the incident ray changes the plane of incidence. Again the incident ray, the normal line and the reflected ray all lie in the same plane.

Types of reflection of light

There are two types of reflection of light.

1. Regular or specular reflection
2. Irregular or scattered or diffused reflection



Regular or specular reflection

Regular or specular reflection is the reflection of light from a smooth surface such that each incident ray is reflected at the same angle to the surface normal as the incident ray.

In this process the incident rays are parallel to each other as well as the reflected rays are parallel to each other.

The normal lines at the point of incidence are parallel for different rays as well as the angle of incidence and the angle of reflection for the different rays in the beam are same.

The reflection of light from the smooth or polished surfaces (mirror and steel plate) is maximum and the reflected light is brighter.

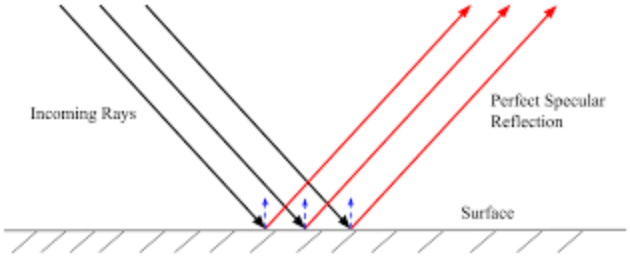


Figure- Reflection of light on smooth surface

Irregular or scattered or diffused reflection

Diffused reflection is the reflection of light from a rough surface such that the incident rays are reflected at many angles, rather than at just one angle as in the case of specular reflection.

In this process the incident rays are parallel to each other as well as the reflected rays are not parallel to each other.

The normal line at the point of incidence is different for different rays as well as the angle of incidence and the angle of reflection for the different rays in the beam are different.

The reflection of light from the rough surfaces (wood, paper and plastic plate) is least and the reflected light is less bright and faded.

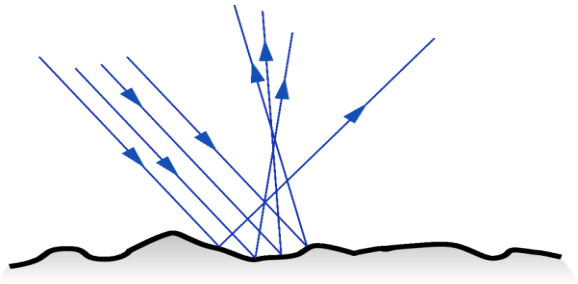


Figure- Reflection of light on rough surface

Why does a rough surface diffuse a beam of light?

For each type of reflection, each individual ray follows the law of reflection. However, the roughness of the material means that each individual ray meets a surface which has a different orientation. The normal line at the point of incidence is different for different rays as well as the angle of incidence for the different rays in the beam are different. Subsequently, when the individual rays reflect off the rough surface according to the law of reflection, they scatter in different directions making different angle of reflection. The result is that the incident rays are parallel to each other but the reflected rays are not parallel to each other and are diffused upon reflection.

The diagram below depicts this principle. Five incident rays (labeled A**,** B**,** C**,** D**,** and E) approach a surface. The normal line at each point of incidence is labeled with an **N**. In each case, the law of reflection is followed, resulting in five reflected rays (labeled A', B', C', D', and E').

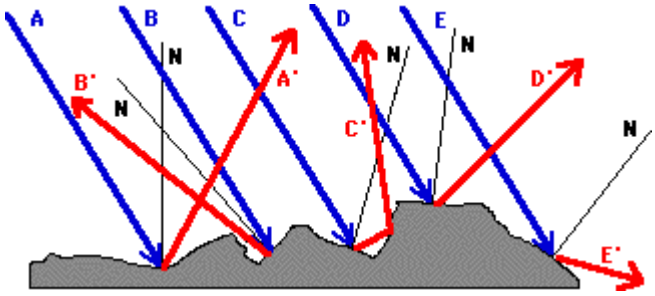


Figure- Reflection of light on rough surface (Diffused or irregular reflection)

Plane mirror

A plane mirror is a mirror with a flat (planar) reflective surface for which a object always produces an image that is virtual, erect and of the same size as the object.
A plane mirror is made using some highly reflecting and polished surface such as a silver or aluminium surface in a process called silvering.

How mirrors form images

A mirror is typically made of glass with a shiny metal backing that reflects all the light that strikes it. When a mirror reflects light, it forms an image. An **image** is a copy of an object that is formed by reflection.

A virtual image appears to be on the other side of the mirror. Of course, reflected rays don't actually go through the mirror to the other side, so a virtual image doesn't really exist. It just appears to exist to the human brain.
We will use the law of reflection to understand how mirrors form images. Figure 1 helps illustrate how a flat mirror forms an image. Two rays are shown emerging from the same point, striking the mirror, and being reflected into the observer's eye. The rays can diverge slightly, and both still get into the eye. If the rays are extrapolated backward, they seem to originate from a common point behind the mirror, locating the image. (The paths of the reflected rays into the eye are the same as if they had come directly from that point behind the mirror.) Using the law of reflection, the angle of reflection equals the angle of incidence, we can see that the image and object are the same distance from the mirror. This is a virtual image, the rays only appear to originate from a common point behind the mirror. Obviously, if we walk behind the mirror, we cannot see the image, since the rays do not go there. But in front of the mirror, the rays behave exactly as if they had come from behind the mirror, so that is where the image is situated.

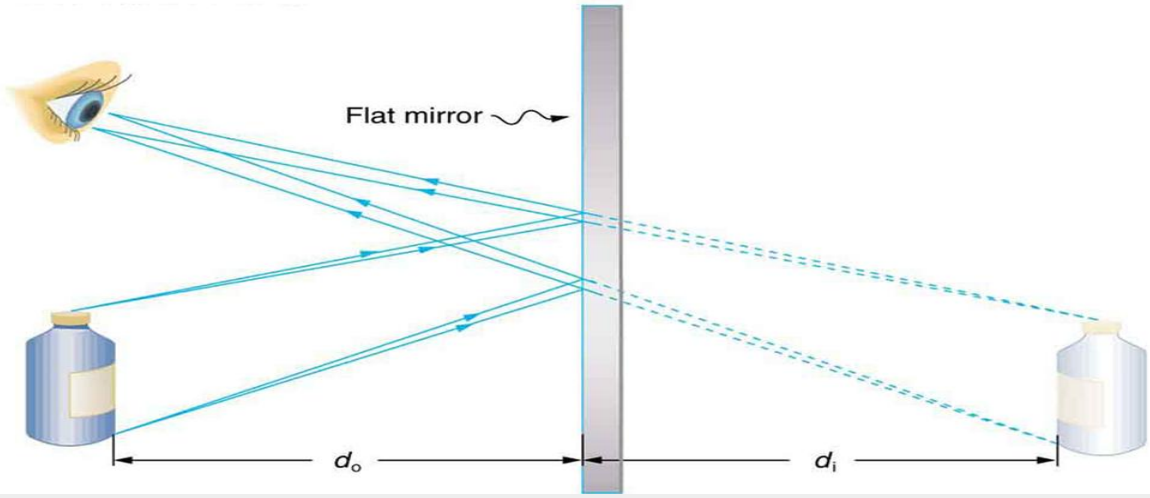


Figure-1. Two sets of rays from common points on an object are reflected by a flat mirror into the eye of an observer. The reflected rays seem to originate from behind the mirror, locating the image.

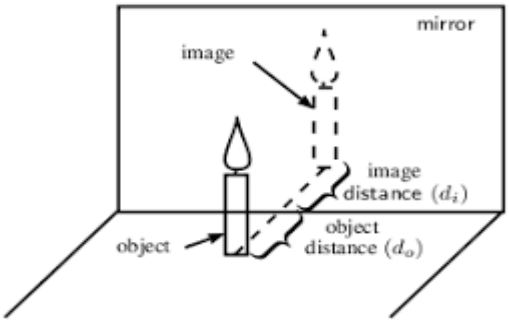


Figure- Formation of image

Properties of image formed by a plane mirror

- The image is virtual and erect.
- The size of image formed by the plane mirror is same as that of the real object.
- The image is as far as far behind the mirror as the object is in front of the mirror. That means the distance of the image from the plane mirror is equal to the distance of object from the mirror.
- Image is laterally inverted, that is right and left side exchanges their positions.

Periscope

A periscope is an optical instrument that allows objects that are not in direct line of sight to be viewed.

Uses of a periscope

- Periscope is used to see the games in the stadium when it is too crowded.
- Periscope is used to see the positions of the soldiers hiding in the bunker.
- Periscope is used to locate targets on the surface of the sea from sub-marines and aid in navigation under water.

How to make a periscope

Periscope is made by placing two strips of plane mirrors at the two ends of a long narrow tube. Two mirrors are fitted with the wall of the tube at an angle of 45^0. They are placed parallel to each other facing the reflecting sides that divert the parallel lights falling on them at the angle of 90^0.

Working Principle of a periscope

A periscope works on the Laws of Reflection which states that the light from the object falls on one mirror at a 45^o angle from the object and is reflected. This reflected light then falls on another mirror and is again reflected until it reaches the human eye. And in this way we are able to see the object which could not seen directly.

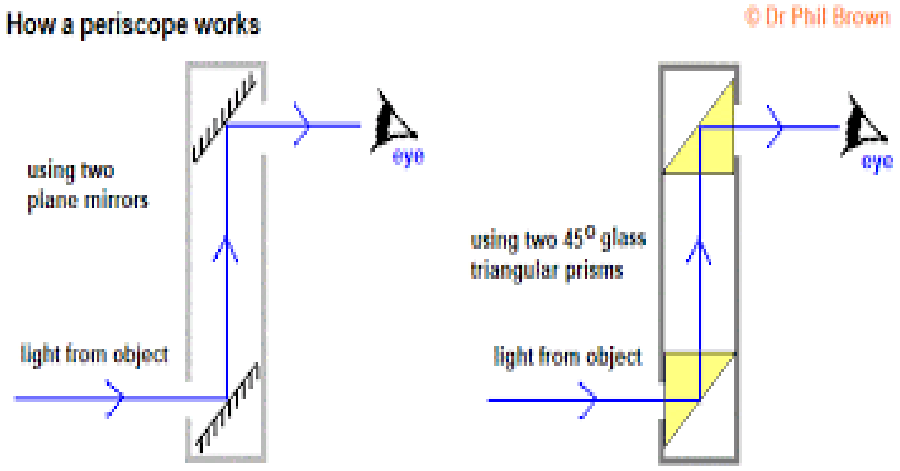


Figure- Periscope

Questions

[Students will write down the answers of the questions in their H.W.copy during vacation]

1. What is light? How does light propagate?

2. How do we see? Why can't we see anything at night in a dark room?

3. What are luminous and non-luminous objects?

4. Why moon is a non-luminous object?

5. Why the blind people cannot see?

6. Which color absorbs almost all the colors of light?

7. Which color reflects all the colors of visible light?

8. Why does a red object appear red in light?

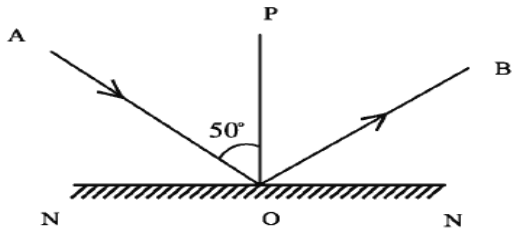
9. How can we see the writings printed on the page?

10. What is reflection of light and absorption of light?

11. Write down the laws of reflection.

12. From the figure below, i) find out the incident ray, the reflected ray, the normal, the point of incidence, the angle of incidence and it's value, the angle of reflection and it's value, the value of ∠ AON and ∠ BON

ii) if the incident ray falls along the line PO, what will be the value of the angle of reflection?



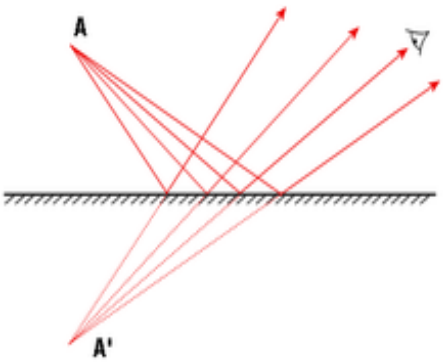
13. Discuss the reflection of light on smooth and rough surfaces with figure.

14. Distinguish between regular and irregular reflection.

15. What is an image? Mention the properties of image formed by a plane mirror.

16. Describe how an image is formed by a plane mirror.

17. In the figure below, find the location and characterize the orientation of an image created by a plane mirror.



18. What is a periscope? What is a periscope used for?

19. How do you explain the working principle of a periscope?