Unit 6

Light

6.1 Definition, Sources and Propagation of Light

Definition of Light

Light is an electromagnetic wave which is emitted from a hot body. The visible light is found in between the infrared and ultraviolet waves within the electromagnetic wave spectrum. Light helps us see things around us.

Objects that produce and emit light energy of their own are sources of light. These objects are called *luminous*. Sun, fire, burning lamps and burning candles are luminous bodies.

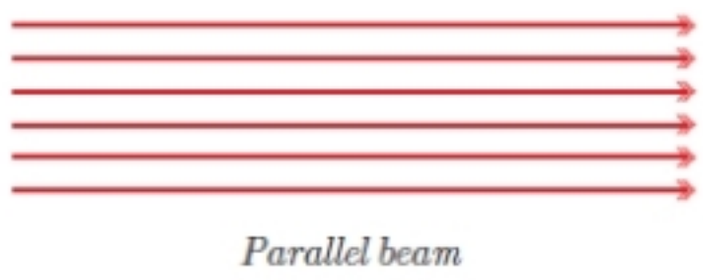
Propagation of Light

Light travels in a straight line. It can travel through vacuum and through transparent materials like air, water and glass.

Beam of Light: There are different types of beam of light: parallel, diverging and converging beams.



Ray of light



Parallel beam

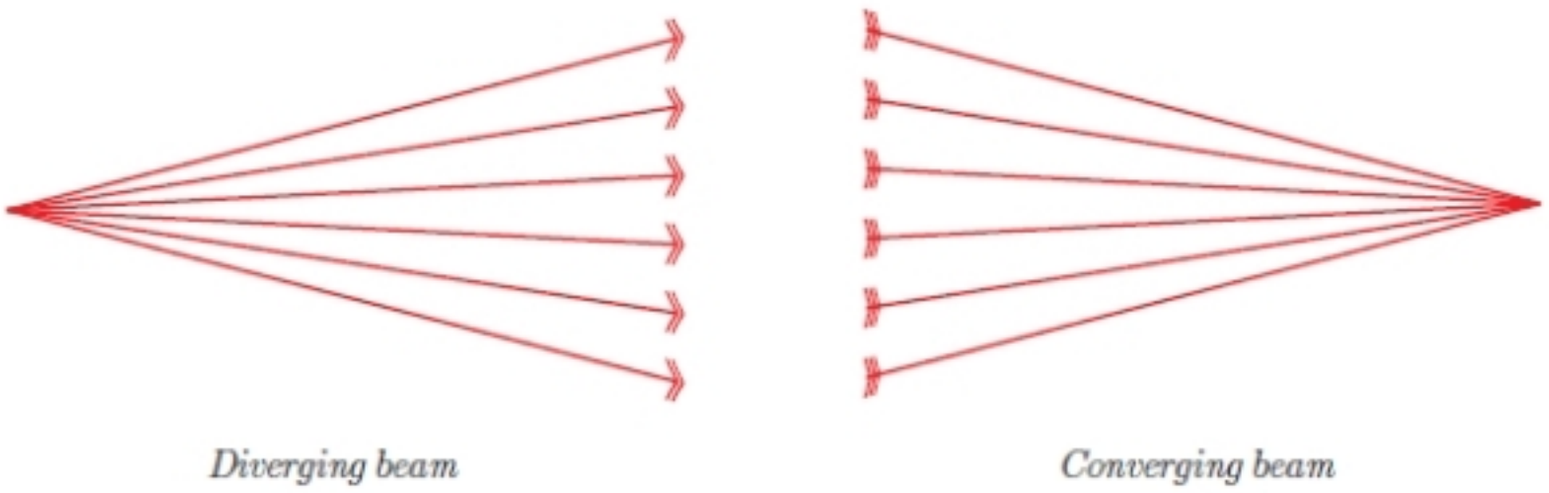


Figure 6.1

Kinds of materials in relation to light transmission:

- ☑ Some objects like a wall do not allow light to pass through them at all. Such objects are called *opaque*.
- ☑ Some objects allow light to pass through them partially. Such objects are called *translucent*.
- ☑ Materials like air and ordinary window glasses allow light to pass through them. Such objects are called *transparent*.

Shadows: When an opaque object is placed between a source of light and a screen, a shadow is formed.

Example

Mention one example that illustrates light propagates in a straight line.

How to solve it!

Formation of a shadow can be good example for the fact that light propagates in a straight line.

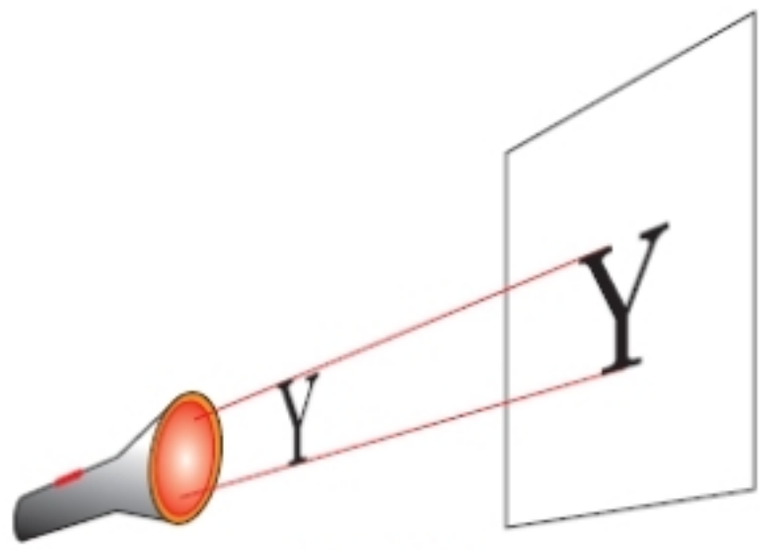


Figure 6.2

- ☑ Object Y is placed in between the source of light and the screen.
- ☑ Shadow of object Y is seen on the screen.
- ☑ The shadow is formed because light follows straight path. It does not turn around the object.

6.2 Law of Reflection

- ☑ Light travels in all direction from the source. This propagation of light is represented by rays of light.
- ☑ Some amount of light is observed by medium and some are turned back into the first medium.

Example

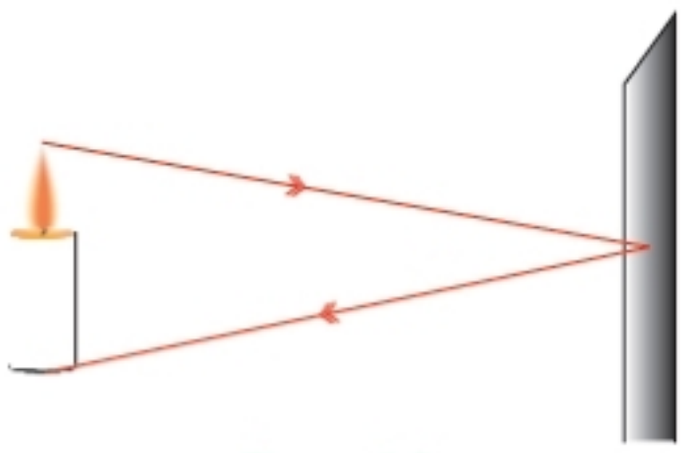


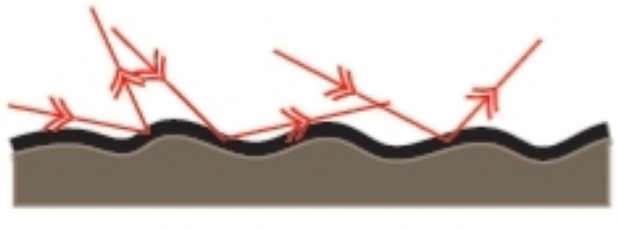
Figure 6.3

There are two kinds of reflections. These are regular and diffuse reflections.

Example



Mirror (Plane mirror)
Regular reflection



Mirror (Rough mirror)
Diffused reflection

Figure 6.4

The rays that strike the surface are incident rays while the rays bouncing back from the surface are reflected rays.

Example

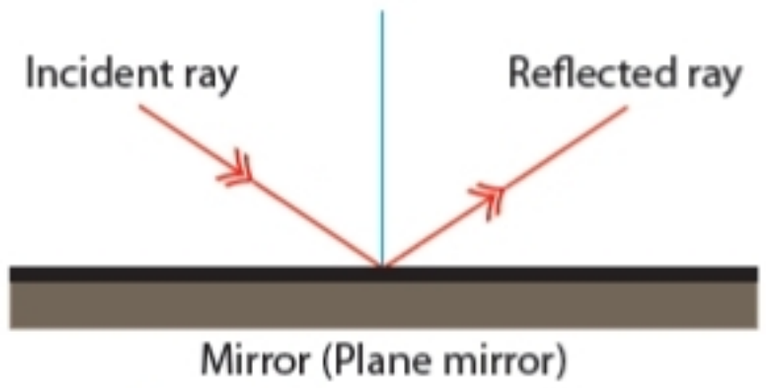


Figure 6.5: Laws of reflection

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

Example

From **Figure 6.6**, answer the following.

1. What is the angle of incident?
2. What is angle of θ?

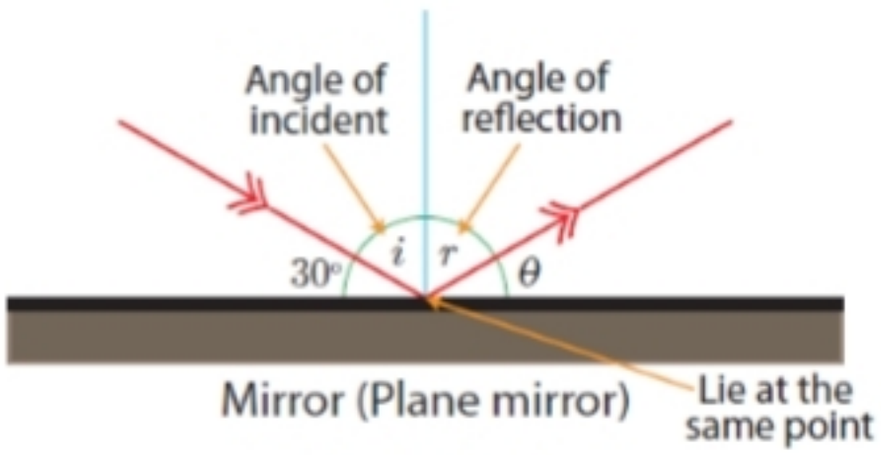


Figure 6.6

How to solve it!

1. The angle between the incident ray and the normal: $90^\circ - 30^\circ = 60^\circ$
2. Since, $90^\circ = \angle r + \angle\theta$,
   if $\angle r = 60^\circ$, $\angle\theta = 90^\circ - \angle r = 90^\circ - 60^\circ$
   $\angle\theta = 30^\circ$
   Therefore, angle $\theta = 30^\circ$.

Activate W
Go to Setting

6.3 Image Formation by a Plane Mirror

A plane mirror is a glass plate whose one side is black or silver painted.

The surface which is not painted is reflecting surface of the mirror. Rays of light falling on a mirror are reflected in different direction.

The reflection of an object in a mirror is called *image*.

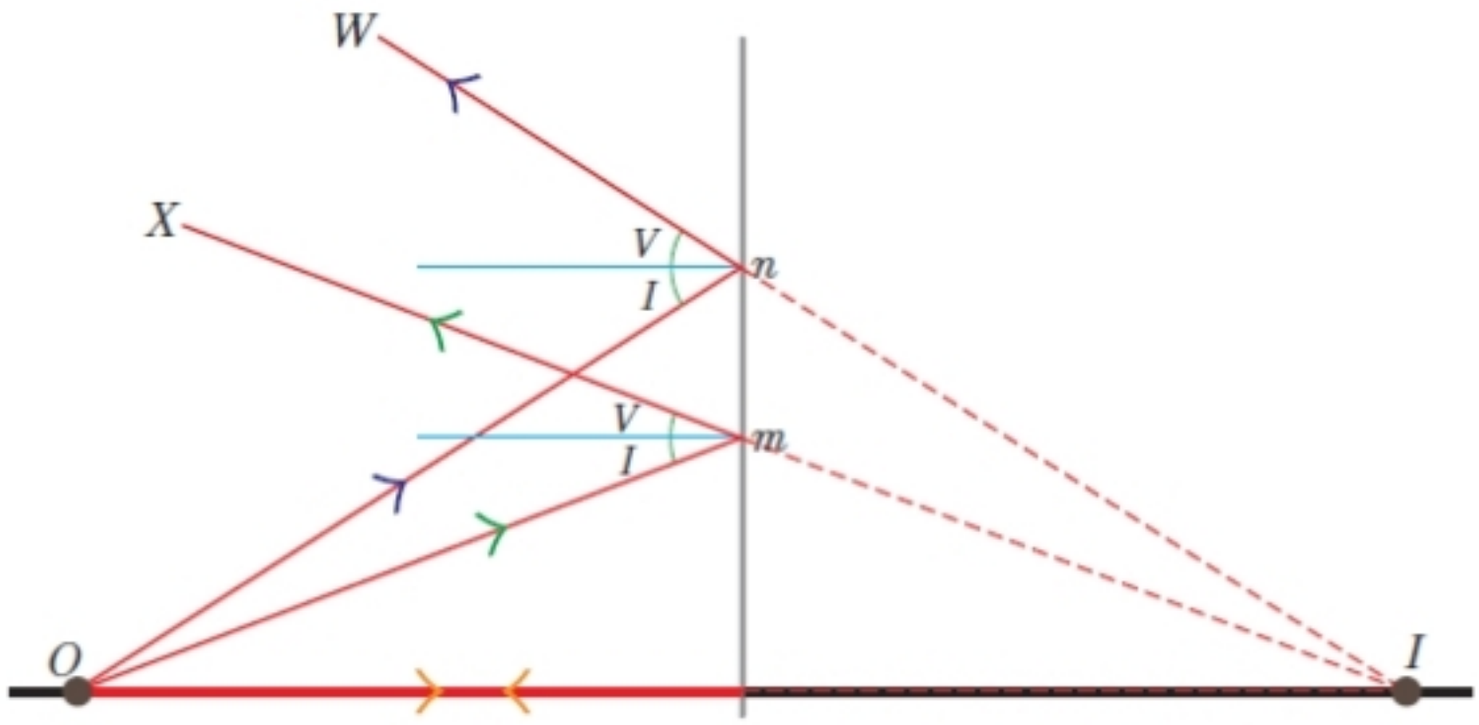


Figure 6.8

If we see from the point "W" and "X", the rays from the object appear to come to our eye as if they are originating from point "I" but no rays actually came from "I" where the image is.

The natures of the image formed by a plane mirror are:

- the same size of the object,
- upright,
- the same distance behind the mirror as the object in front ($object\ distance = image\ distance$) from the mirror,
- virtual,
- laterally inverted.

We can calculate the number of images formed by putting two mirrors at a certain angle "θ".

$$Number\ of\ images = \frac{360^{\circ}}{\theta} - 1$$

Example

How many images are formed by 90° inclination of two mirrors?

How to solve it!

Given:

$\theta = 90^{\circ}$

Required:

$Number\ of\ image = ?$

$$Number\ of\ images = \frac{360^{\circ}}{90^{\circ}} - 1$$
$$= \frac{360^{\circ} - 90^{\circ}}{90^{\circ}}$$
$$= 3$$

Let's Exercise

1. If an object is located at a distance of $2\ \mathrm{m}$ in front of plane mirror, what is the distance of the image formed from the mirror?
2. If the height of the object in front of the mirror is $1.7\ \mathrm{m}$, what is the height of the image formed by the plane mirror?
3. Calculate the number of images formed if an object is placed between two plane mirrors at an angle of 30°.

6.4 Images Formed by Concave Mirrors

Curved mirror are formed from spherical shaped body. If we reflect light from the outside of this curved mirror, the mirror is convex mirror and surface reflect light from the inside of curved mirror, this curved mirror is called *concave mirror*.

The image formed by the reflection of the curved mirror depends on the shape of the mirror (convex or concave mirror).

When we see the image formed by concave mirror it depends on the distance of the object placed in front of the concave mirror.

Here the points V, F, C are Vertex, Focal point, and Center of curvature respective from the following **Figure 6.9**.

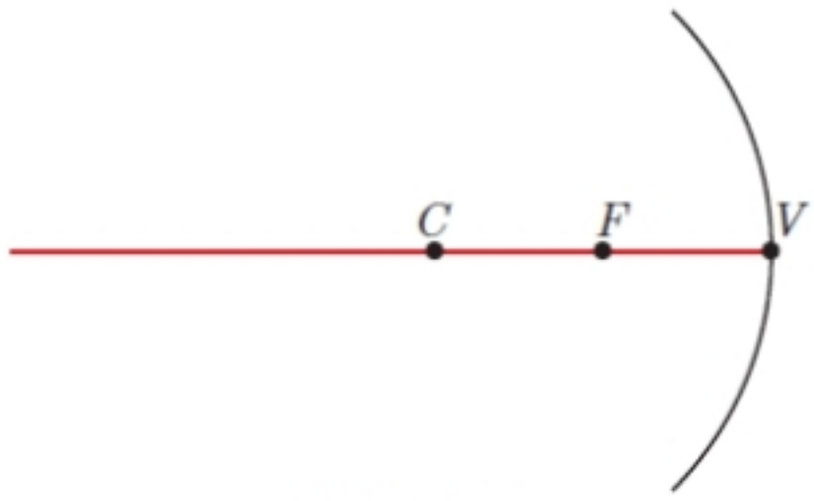


Figure 6.9

Example

Answer the following from **Figure 6.9** given above.

1. If the object is placed beyond point 'C', what are the nature of images formed? _____.

2. If the object is placed at point 'C', the nature of image formed are _____.

3. If the object is placed between 'C' and 'F', the nature of the image formed are _____.

4. If the object is placed at point 'F', the nature of the image formed is _____.

How to solve it!

1. Real, inverted, and diminished.
2. Real, inverted, and same size with the object.
3. Real, inverted, and magnified images are formed.
4. No image formed.

6.5 Images Formed by Convex Mirrors

In order to determine the location, size and nature of image formed by a convex mirror, the following rules should be considered.

i) Any incident ray traveling parallel to the principal axis towards the mirror will reflect in a manner that its extension will pass through the focal point. (*See* **Figure 6.11**)

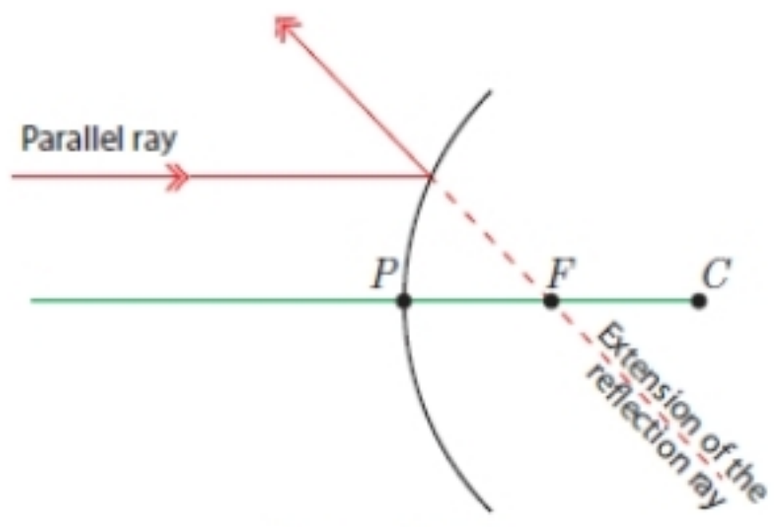


Figure 6.11

ii) Any incident ray traveling towards a convex mirror in such a way that its extension pass through the focal point will reflect and travel parallel to the principal axis. (*See* **Figure 6.12**)

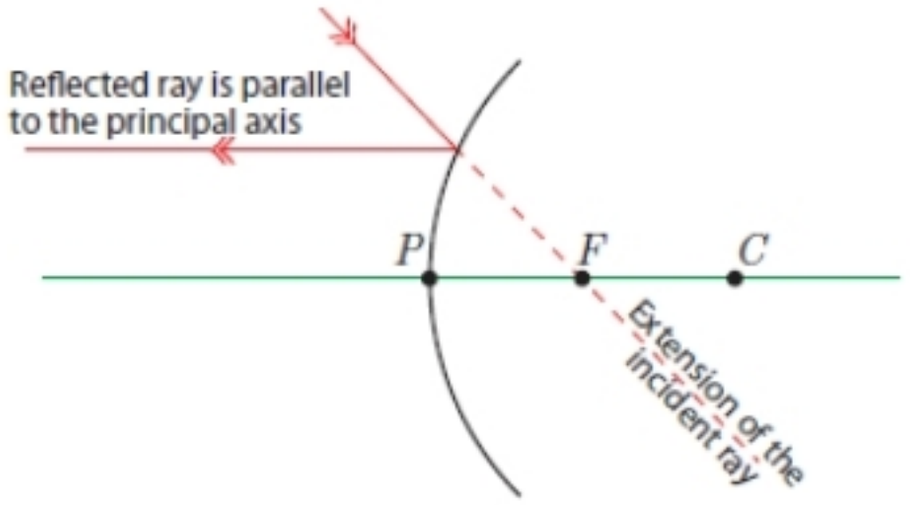


Figure 6.12

iii) Any incident ray traveling towards a convex mirror in such a way that its extension pass through the center will reflected straight backward. (*See* **Figure 6.13**)

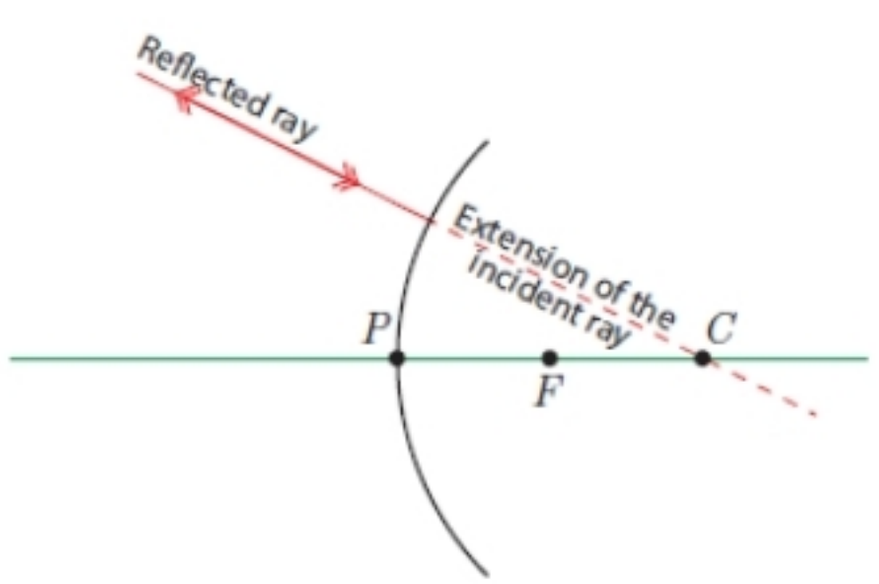


Figure 6.13

Note that:

When an object is placed anywhere in front of a convex mirror, an upright, virtual and diminished image is formed between F and the vertex. (*See* **Figure 6.14**)

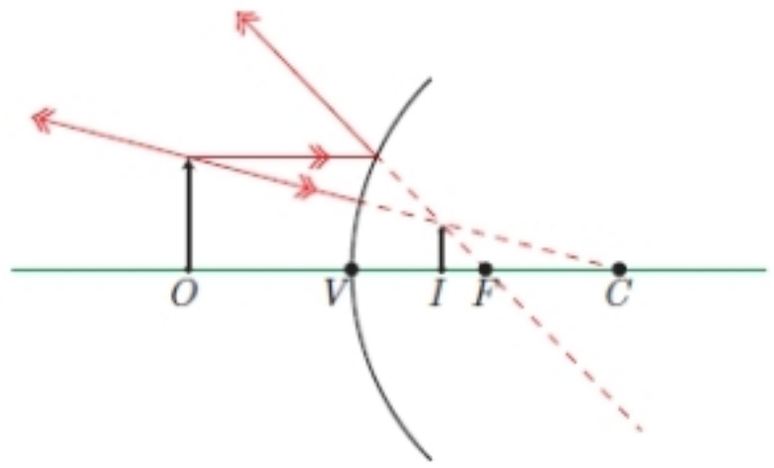


Figure 6.14

Example

1. Any incident ray traveling parallel to the principal axis on the way to a convex mirror will reflect in such a manner that its extension will pass through _____.

2. Any incident ray traveling towards a convex mirror such that its extension pass through the focal point will reflect and travel parallel to _____.

How to solve it!

1. Any ray parallel to the principal axis is reflected. So that it appears to come from the focal points.

2. Any ray going towards the principal focus is reflected parallel to the principal axis.

Let's Exercise

What is the nature of images formed by a convex mirror?

_____.