

TOPICS COVERED

16.1 Reflection of Light: Laws and Types; Plane Mirror: Characteristics and Uses 16.2 Sunlight and Human Eye

IMPORTANT POINTS TO REMEMBER

- **Light** is a form of energy which gives us the sense of vision.
- When a ray of light falls on a shiny surface, there is a change in its direction. This is called **reflection of light**.
- A ray of light falling on a reflecting surface is called incident ray.
- A ray of light coming back from a reflecting surface is called reflected ray.
- The perpendicular on reflecting surface at the point of incidence is called normal.
- An angle between an incident ray and a normal is called angle of incidence.
- An angle between a reflected ray and a normal is called angle of reflection.
- **First Law of Reflection:** Angle of reflection is equal to angle of incidence.
- **Second Law of Reflection:** The incident ray, reflected ray and normal at the point of incidence; all lie in the same plane.
- When the incident rays fall on a smooth surface, all the reflected rays are parallel to each other. This is called **regular reflection**. A clear image is formed in case of regular reflection.
- When incident rays fall on a rough surface, reflected rays are not parallel to each other. This is called **irregular or diffused reflection**. A diffused image is formed in case of irregular reflection.
- When two reflecting surfaces are opposite to each other, they reflect back light rays from each other. This creates multiple reflections and multiple images of an object are formed.
- Sunlight is composed of seven colours, viz. violet, indigo, blue, green, yellow, orange and red. All the seven colours mix together to appear as white.
- The human eye has following main parts: cornea, iris, pupil, lens and retina. Image is formed on the retina.
- There is no nerve cell at the junction of retina and optic nerve. This spot is called **blind spot** because no image is formed at this spot.
- Light rays enter the eye through pupil and pass through lens. Lens focus light rays on retina. Real, inverted and smaller image is formed on retina. Optic nerve carries the message to the brain. The brain interprets the message and we get the sense of vision.
- An image stays on retina for $1/16$ of a second. This is called **persistence of vision**.

- A normal human being can clearly see up to infinity. The minimum distance for clear vision is 25 cm which means we cannot see clearly if an object is at less than 25 cm distance from our eyes.
- Some people are unable to clearly see nearby objects, while some others are unable to clearly see far off objects. It happens because of defects in eyes. These defects can be rectified with the help of spectacles of suitable lenses.
- In some old people, the cornea becomes foggy. This condition is called **cataract**. Cataract can now be cured with surgery and by implanting artificial lens in the eye.
- A person whose vision is highly impaired is called a visually challenged person. Some of them are partially blind while some others may be totally blind.
- There are two types of aids for visually challenged persons, viz. non-optical aids and optical aids.
- The **Braille system** was developed by **Louis Braille** in 1821. This system is composed of 63 characters which are patterns of dots.

16.1 REFLECTION OF LIGHT: LAWS AND TYPES; PLANE MIRROR – CHARACTERISTICS AND USES

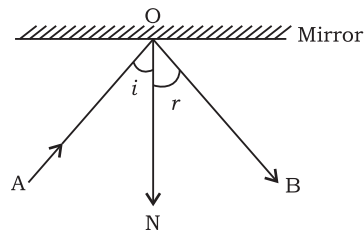
Light: Light is a form of energy. It enables us to see the world around us.

Reflection of Light: When light travelling in a medium falls on a surface, it returns back in the same medium. This process of sending the light rays back is known as *reflection of light*.

Reflection is the phenomenon of bouncing back of light in the same medium, in which it was travelling when it falls on a surface.

Laws of Reflection

1. The angle of incidence is equal to the angle of reflection, $\angle i = \angle r$.
2. The incident ray, the normal at the point of incidence and the reflected ray all lie in the same plane.



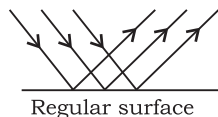
Characteristics of an Image Formed by a Plane Mirror

1. The image in a plane mirror is of the same size and shape as the object.
2. The image in a plane mirror is virtual and erect.
3. The image formed in a plane mirror is at the same distance.
4. The image is laterally inverted with respect to the object.

Types of Reflection

Regular and Irregular Reflection

The phenomenon due to which a parallel beam of light on striking a smooth and highly polished surface (like a plane



mirror) is reflected back as a parallel beam of light is called regular reflection of light.

The phenomenon due to which a parallel beam of light on striking a rough surface (cardboard) gets reflected in various directions is called irregular or diffused reflection.

Luminous Objects: Objects which emit light are called luminous objects. *Examples:* sun, stars, burning candle, lighted electric bulb.

Non-luminous Objects: Objects which do not emit light of their own but reflect the light of a luminous source are called non-luminous objects. *Examples:* chair, table, earth, birds etc.

Multiple Images: By varying the angle between two mirrors, multiple images can be obtained. This is because the image formed in one mirror acts as the object for the other. Many images formed in this manner are called multiple images.

Kaleidoscope: It is a device based on the principle of multiple reflections. It consist of mirrors inclined to each other. The mirrors form multiple images of objects in front of them. This creates beautiful patterns which change when the kaleidoscope is rotated or shaken.

Uses of Plane Mirrors

1. As looking glass
2. As reflectors in solar cookers
3. For the construction of Kaleidoscope, periscope etc.

Exercise 16.1

I. Very Short Answer Type Questions (1 Mark)

1. Give one word for the following:

- (a) A mirror used in solar cookers. _____
- (b) A kind of reflection in which reflected rays travel parallel to one another. _____

(c) The kind of reflection taking place from the walls of a room. _____

(d) The smooth polished surface which can turn back the rays of light in the same medium. _____

(e) Image which cannot be obtained on a screen. _____

2. Fill in the blanks:

(a) Light is a form of _____ which causes in us a sensation of vision.

(b) The angle between the reflected ray and the normal is called _____.

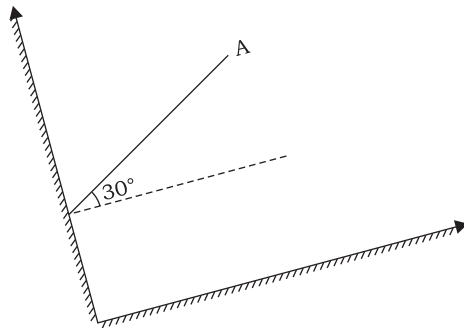
(c) The image formed by a plane mirror is _____.

(d) In a plane mirror, the size of the image is _____ as the object.

(e) In a _____, three plane mirrors are inclined at an angle of 60° .

II. Short Answer Type Questions-1 (2 Marks)

3. Give two differences between real and virtual image.
4. How many images are formed when two plane mirrors are (a) facing each other, (b) inclined at an angle of 90° , (c) inclined at an angle of 60° ?
5. What is regular reflection? State one advantage of regular reflection.
6. State four characteristics of an image formed by plane mirror.
7. What is the angle of incidence of a ray if the reflected ray is at an angle of 90° to the incident ray? (NCERT)
8. How many images of a candle are formed if it is placed between two parallel mirror separated by 40 cm. (NCERT)
9. Two mirror meet at right angles. A ray of light is incident on one at an angle of 30° . Draw the reflected ray from the second mirror. (NCERT)

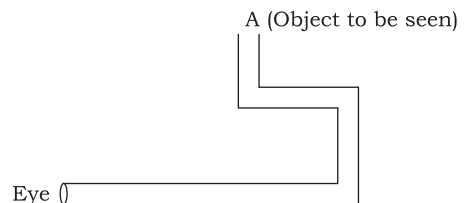


III. Short Answer Type Question-2 (3 Marks)

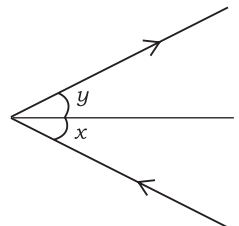
10. What do you mean by 'reflection of light' state the laws of reflection of light?

IV. Long Answer Type Questions (5 Marks)

11. Boojho planned an activity to observe an object A through pipes as shown in Fig., so that he could see objects which he could not directly see. (NCERT Exemplar)



- (i) How many mirrors should be use to see the objects?
 - (ii) Indicate the position of the mirrors in the figure.
 - (iii) What must be the angle with respect to incident light at which he should place the mirrors.
 - (iv) Indicate the direction of rays in the figure.
 - (v) If any of the mirror is removed, will he be able to see the objects.
12. Draw given figure shown the position of the plane mirror. Also label the angle of incidence and angle of reflection on it. (NCERT Exemplar)



ANSWERS

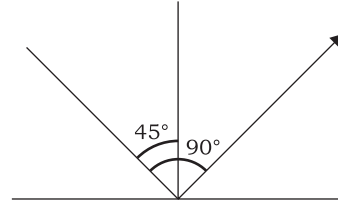
1. (a) Plane mirror
(b) Regular reflection
(c) Diffused reflection
(d) Mirror
(e) Virtual image
2. (a) energy
(b) angle of reflection
(c) virtual and erect
(d) same
(e) Kaliedoscope

Real Image	Virtual
It can be obtained on a screen	It cannot be obtained on a screen
It is always inverted, e.g. movies in cinema.	It is always erect, e.g. plane mirror

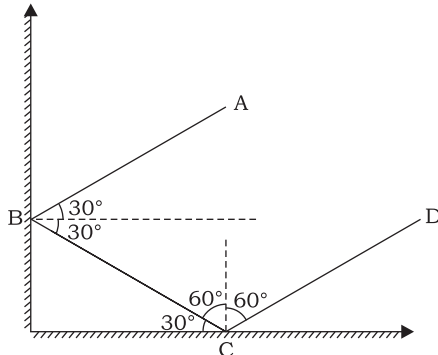
4. Number of image formed by two plane mirrors inclined at an angle

$$a = (360/a) - 1$$

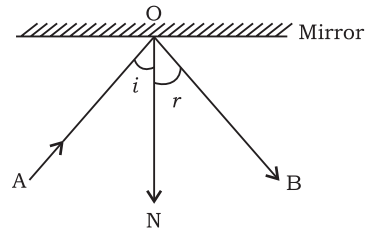
- (a) When mirrors are facing each other then angle between mirrors is zero. Thus, it produces infinite number of images.
- (b) When mirrors are inclined at 90° angle then number of images is $(360/90) - 1 = 4 - 1 = 3$.
- (c) When mirrors are inclined at 60° angle then number of images is $(360/60) - 1 = 6 - 1 = 5$.
5. The phenomenon due to which a parallel beam of light on striking a smooth and highly polished surface (like a plane mirror) is reflected back as a parallel beam of light is called regular reflection of light.
It is due to regular reflection that we can see our image perfectly in a plane mirror.
6. (i) The image in a plane mirror is of the same size and shape as the object.
(ii) The image in a plane mirror is virtual and erect.
(iii) The image formed in a plane mirror is at the same distance as that of object.
(iv) The image is laterally inverted with respect to the object.
7. Angle of incidence = 45°



8. Multiple images are formed. This is because image formed in one mirror acts as object for the other mirror and this process goes on and on.

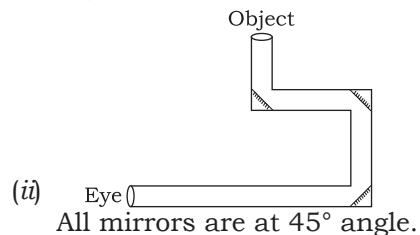


- 9.
10. Reflection is the phenomenon of bouncing back of light in the same medium, in which it was travelling when it falls on a surface.



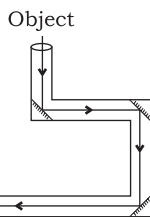
Laws of Reflection

- (a) The angle of incidence is equal to the angle of reflection, $\angle i = \angle r$.
- (b) The incident ray, the normal at the point of incidence and the reflected ray all lie in the same plane.
11. (i) Three mirrors should be use.



- (ii) All mirrors are at 45° angle.

(iii) At 45° angle

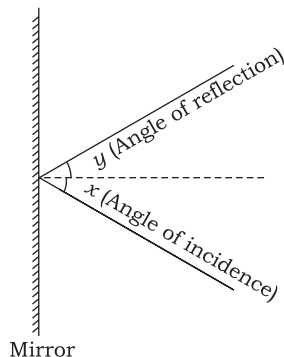


(iv)

Eye

(v) No, he will not be able to see the object as no reflection of object reaches to his eye.

12.



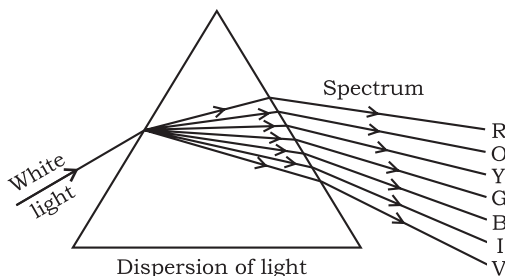
Mirror

16.2 SUNLIGHT AND HUMAN EYE

Sunlight: It consists of white light, infrared and ultraviolet rays. White light consists of seven colours.

Dispersion of Light: The phenomenon of splitting of white light into its component colours on passing through a transparent medium like a glass prism is called dispersion of light.

A band of seven colours formed on a white screen when white light passes through a prism is called *spectrum of white light*.



Human Eye: It is a light-sensitive organ which enables us to see the beautiful world around us.

Structure of Human Eye

- Sclera:** It is the outermost covering of the eye.
- Cornea:** It is transparent white portion of the eye which covers the transparent bulge on the surface of the eye ball. It allows the light to enter into the eyeball.
- Retina:** It is the innermost delicate membrane having a large number of cells called rods and cones. Cones are sensitive to bright light and sense colour. Rods are sensitive to dim light.
- Iris:** Behind the cornea is the iris. It tends colour to the eye.
- Pupil:** The iris has a central circular aperture called the pupil. The iris regulates the amount of light entering the eye by adjusting the size of the pupil.
- Crystalline lens:** It is a transparent crystalline convex lens situated just behind the iris. It is held in its position with the help of *ciliary muscles*.
- Ciliary muscles:** These muscles hold the eye lens in the proper place. The focal length of the eye lens can be changed with the help of ciliary muscles.
- Optic nerves:** Optic nerves consist of about one million separate nerves fibres that connect the rods and cones of the retina to the brain. It carry optical messages in the form of electric signals to the brain.

- (i) *Aqueous humour*: The space between cornea and eye lens is filled with a clear watering liquid, which is known as aqueous humour.
- (j) *Vitreous fluid*: The space between retina and lens is filled with a fluid called vitreous fluid. It keeps the eye wet.
- (k) *Blind spot*: At the junction of the optic nerve and the retina, there are no sensory cells. So no vision is possible at that spot. It is called blind spot.

Persistence of vision: When the light coming from an object falls on the retina of the eye, the impression of an image does not vanish immediately from the retina. The impression of an image lasts for $1/16^{\text{th}}$ of a second. So, when still (stationary) images of a moving object are flashed on the eye at a rate faster than 16 images per second, the eye perceives this object as moving. This is called persistence of vision.

Power of accommodation: The ability of the eye lens to adjust the focal length, so as to see the objects located anywhere is called the power of accommodation. The minimum distance at which the eye can see objects very clearly without strain is called the near point of the eye. This is about 25 cm.

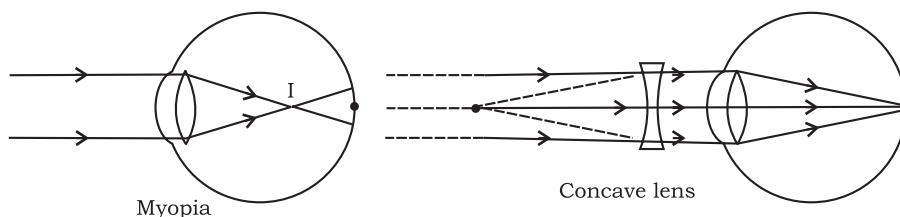
The farthest point upto which the eye can see objects clearly without strain is called the farpoint of the eye.

Defects of Vision and their Correction

The common defects of the eye are as follows:

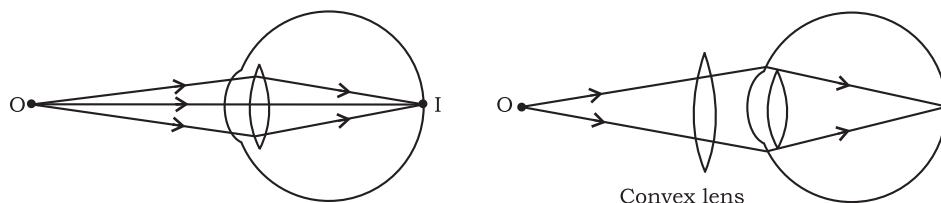
1. *Myopia (Near-sightedness)*: A person suffering from myopia can see nearby objects but cannot see distant objects distinctly. The image of an object is formed in front of the retina.

Correction: The person suffering from myopia has to use a concave lens.



2. *Hypermetropia (Far-sightedness)*: A person suffering from hypermetropia can see distant objects clearly but cannot see nearby objects distinctly. The image of the object is formed behind the retina.

Correction: A person has to use a convex lens to see nearby objects clearly.



3. *Cataract*: It is a leading cause of blindness in old age. The eye lens becomes cloudy. Because of this cloudiness, light rays do not enter easily through the lens to focus on the retina. This is called cataract.

This lens can now be removed and replaced by an artificial lens by expert surgeons. Modern technology has made this procedure simpler and safer.

Care of the Eyes

- Do not look at the sun directly or a powerful light directly.
- Never rub your eyes. If particles of dust go into your eyes, wash your eyes with clean water.
- Always read at a normal distance for vision.
- Do not watch television for a long time.
- Wash your eyes frequently with clean water.
- Lack of vitamin A in diet is responsible for a series of eye problems which eventually lead to blindness. Food rich in vitamin A like leafy vegetables like spinach, carrots, broccoli, eggs, milk, fruits should be eaten for eyes.

Night-blindness: A person suffering from night-blindness is unable to see properly at night or in a dim light. This condition is called night-blindness.

Visually challenged persons: People who cannot see are called visually challenged or blind.

Braille System: Blind persons can read and write through Braille system. It is a combination of raised dots in a six dot cell making of different characters. The characters are read by touching them with fusion. This system was inserted by Louis Braille.

Exercise 16.2

I. Very Short Answer Type Questions (1 Mark)

1. Give one word for the following:

- (a) Image is always formed at the _____
- (b) It controls the amount of light entering the eye _____
- (c) The splitting of white light into seven colours is _____
- (d) A defect in the eye when a person can see nearby objects clearly. _____

- (e) A jelly like fluid found in the posterior part of the eye. _____
- (f) A special script designed for usually challenged people for reading. _____

2. Fill in the blanks:

- (a) The farthest point up to which the eye can see objects clearly without strain is called _____ of the eye.
- (b) A person suffering from _____ can see distant objects clearly but cannot see nearby objects clearly.
- (c) Hypermetropic eye can be corrected by using spectacles with a _____ lens.
- (d) _____ is a device that produces beautiful patterns when it is rotated.
- (e) _____ acts as the window to the world for visually challenged people.
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II. Short Answer Type Questions-1 (2 Marks)

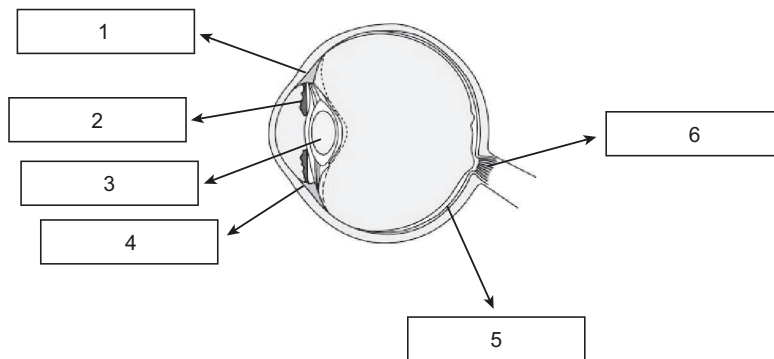
3. What is meant by power of accommodation?
4. What happens to light when it gets dispersed? Give example.
5. What is the 'near point of eye'.
6. How is vision of eye related to nutrition?
7. What is dispersion of light?
8. What is the full form of VIBGYOR?

III. Short Answer Type Questions-2 (3 Marks)

9. A student has difficulty in reading a book. What could be the defect the student is suffering from?
10. Why can't you see your surroundings clearly as you enter the darkened cinema hall?

IV. Long Answer Type Questions (5 Marks)

11. What do you mean by dispersion of lights? Explain with the help of a diagram.
12. Draw the structure of human eye.
13. What are the defects of vision? How can they be corrected?
14. What do you mean by "persistence of vision". Give an example.
15. Name the following parts of the eye
 - (a) The part which allows light to enter the eye.
 - (b) The part which controls amount of light entering the eye.
 - (c) The part which receives the image of the object on the eye.
16. Write down the names of parts of the eye in the blank spaces shown in figure.



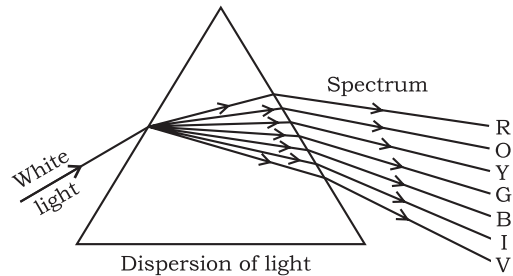
ANSWERS

- | | | |
|-------------------------|-----------|--------------------|
| 1. (a) retina | (b) pupil | 2. (a) near point |
| (c) Dispersion of light | | (b) hypermetropia |
| (d) Myopia | | (c) Convex lens |
| (e) Vitreous humour | | (d) Kaliedoscope |
| (f) Braille | | (e) Braille system |

3. The ability of the eye lens to adjust the focal length, so as to see the objects located anywhere is called the power of accommodation.
4. It splits into seven colours. E.g. Rainbow.
5. The minimum distance at which an eye can see objects very clearly without strain is called the near point of the eye. This is about 25 cm.
6. Food rich in vitamin A like leafy vegetables like spinach, carrots, broccoli, eggs, milk, fruits should be eaten for good health of eyes. Lack of vitamin A in diet is responsible for a series of eye problems which eventually lead to blindness.
7. The phenomenon of splitting of white light into its component colours on passing through a transparent medium like a glass prism is called dispersion of light.
8. VIBGYOR
 - V = Violet
 - I = Indigo
 - B = Blue
 - G = Green
 - Y = Yellow
 - O = Orange
 - R = Red
9. The student is suffering from Hypermetropia (far-sightedness). With this eye defect a person can see distance object clearly but cannot see nearby objects distinctly. Therefore the student had difficulty in reading a book.
10. Rods and cones are the two type of cells which are sensitive to dim and bright light respectively. When we move to a darkened cinema hall from outside where cones were active, rod takes time

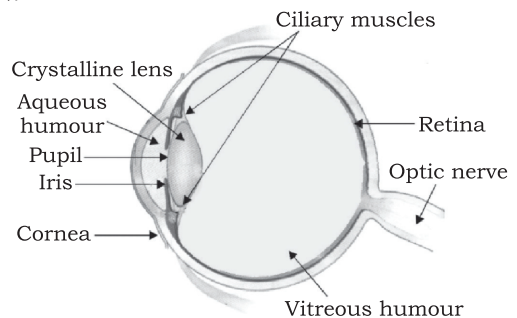
to get active for dim light and so we are not able to see our surroundings clearly in cinema hall.

11. The phenomenon of splitting of white light into its component colours on passing through a transparent medium like a glass prism is called dispersion of light.

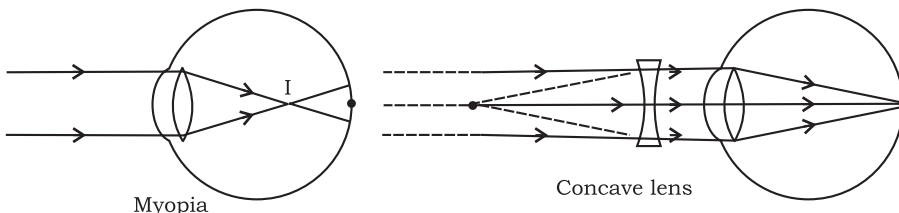


A band of seven colours formed on a white screen when white light passes through a prism is called *spectrum of white light*.

- 12.

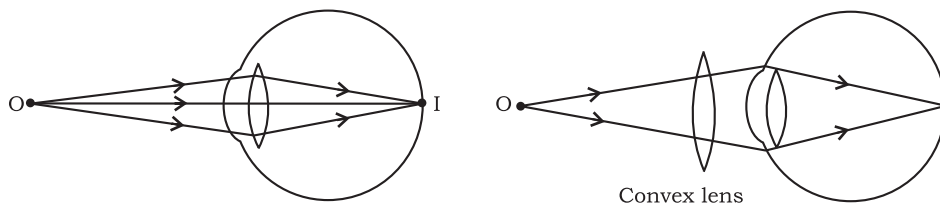


13. The common defects of the eye as
 - (a) *Myopia (Near-sightedness)*: A person suffering from myopia can see nearby objects but cannot see distant objects distinctly. The image of an object is formed in front of the retina.
Correction: The person suffering from myopia has to use a concave lens.



(b) *Hypermetropia (Far-sightedness)*: A person suffering from hypermetropia can see distant objects clearly but cannot see nearby objects distinctly. The image of the object is formed behind the retina.

Correction: A person has to use convex lens to see nearby objects clearly.

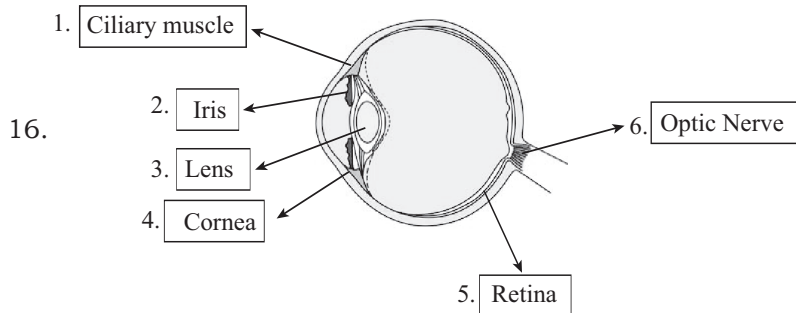


(c) *Cataract*: It is a leading cause of blindness in old age. The eye lens becomes cloudy. Because of this cloudiness, light rays do not enter easily through the lens to focus on the retina. This is called cataract.

This lens can now be removed and replaced by an artificial lens by expert surgeons. Modern technology has made this procedure simpler and safer.

14. When the light coming from an object falls on the retina of the eye, the impression of an image does not vanish immediately from the retina. The impression of an image lasts for $1/16$ th of a second. So, when still (stationary) images of a moving object are flashed on the eye at a rate faster than 16 images per second, the eye perceives this object as moving. This is called persistence of vision.

15. (a) Cornea, (b) Iris, (c) Lens



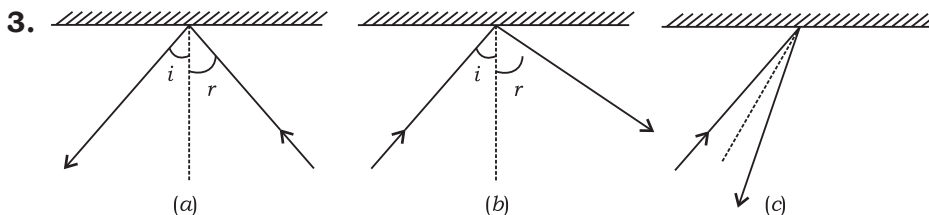
Did You Know?

- The principle of *diffused reflection* is used in cinema screen. A cinema screen is a rough surface. It receives light from the film projector and scatters it in all the directions in the cinema hall. Thus, the people sitting anywhere in the hall can see the picture focussed on the screen.
- **Persistence of vision**: The movies which we see on a cinema hall screen are due to persistence of vision. In actual practice, any scene consists of sequence in proper order. The image are made to move in front of the eye at a rate of 24 pictures per second. ($1\frac{1}{2}$ times faster than persistence of vision or 16 pictures per second). This gives a sense of continuity and hence we see the moving picture.

- Scientists have developed a contact lens that can deliver eye drops to the eye in measured doses for month or so longer and at the right time.
- An *owl* can see in dark night since its retina has a large number of rods and few cones.
- The eyes of a *crab* are quite small but they enable the crab to look all around. Due to this, a crab can notice an enemy, even if comes from behind.

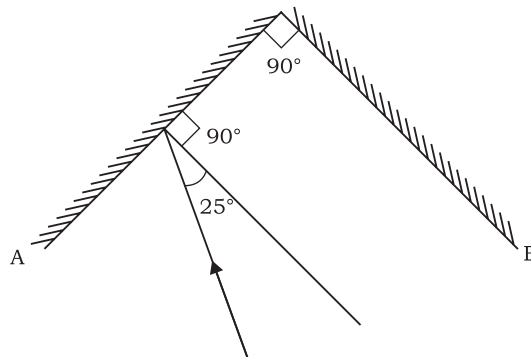
HOTS & VALUE BASED QUESTIONS

1. A light ray is incident normally on a plane mirror. What is the angle of incidence? **(HOTS)**
2. The distance between the object and its image formed by a plane mirror appears to be 24 cm. What is the distance between the mirror and the object? **(HOTS)**



There is a mistake in each of the above ray diagram. Make the necessary corrections. **(HOTS)**

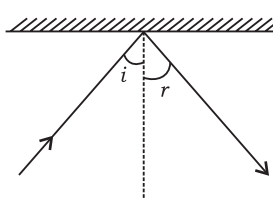
4. What kind of lens is there in our eyes? Where does it form the image of an object? **(HOTS)**
5. Eyes of the nocturnal birds have large cornea and a large pupil. How does this structure help them. **(HOTS)**
6. How in the phenomenon of reflection used in making a Kaleidoscope? What are the applications of a Kaleidoscope. **(HOTS)**
7. Two mirrors A and B are placed at right angles to each other. **(HOTS)**



A ray of light incident on mirror A at an angle of 25° falls on mirror B after reflection. The angle of reflection for the ray reflected from mirror B would be.

8. A student complained that he is not able to read the teacher's writing on the blackboard. While sitting in the last row. What eye defect is he suffering from? How can it be corrected? **(HOTS)**
9. Why are tall mirrors placed in small offices. **(HOTS)**
10. Two friends Rahul and Rohan are going to the school. In the morning, traffic is very slow but a van is moving very faster and everyone is giving space to it responsibly without any delay. Rahul feels surprised to see it. He tries but is unable to read what is written on it. Then Rohan told him that the word **ambulance** is written on it in the reverse to get it read clearly in rear mirror of the vehicles.
- (a) Why the word **ambulance** is written in opposite?
 (b) Why everyone on road is giving space to it?
 (c) Which values are shown by the people on the road? **(VBQ)**
11. Nikita meets with an accident and her eyes get injured. Doctors advise her that it is a curable blindness and ask her to wear black spectacles. Her friend Monika helps her in doing her work.
- (a) What is curable blindness?
 (b) Is it right to make fun of visually challenged people. What values are possessed by Monika. **(VBQ)**

ANSWERS

1. Angle of incidence = 0°
2. $2x = 24$, $x = 12$ cm.
3. (a) In Figure (a)  the incident ray should fall on the mirror and the reflected ray should move away from the mirror.
- (b) The angle of incidence = angle of reflection.
- (c) The normal ray is always perpendicular to the plane i.e. 90° .
4. (a) Crystalline lens
 It forms real, inverted and highly diminished image on retina.
 (b) Retina
5. Nocturnal birds need more light to have more clear night vision. Therefore these birds have large cornea to adjust the large change in light intensity and large pupil to receive large amount of light.
6. *Kaleidoscope*: It is a device based on the principle of multiple reflections. It consists of mirrors inclined to each

- other. The mirrors form multiple images of objects in front of them. This creates beautiful patterns which change when the kaleidoscope is rotated or shaken. It is used as a toy for entertainment by the children.
7. Angle of reflection will be 25° .
8. He is suffering from Myopia (Near-sightedness). This defect can be corrected by using a concave lens spectacles/eyeglass.
9. Tall mirrors are placed in small offices to make its false view of large office. The effective dimension of the room appears to be increased in length and breadth.
10. (a) Due to lateral inversion.
 (b) To save someone's life.
 (c) Kind, caring, gentle
11. (a) Curable blindness is a temporary blindness which can be cured either by medicine or surgery if needed.
 (b) It is not good to make fun of visually challenged people instead we should help them to lead a normal regular life. Monika is kind hearted, sympathetic and helpful.