

## LIGHT - SHADOW - REFLECTION

### LEARNING OBJECTIVES:

- ◆ Introduction of light
- ◆ Sources of light
- ◆ General definitions of light
- ◆ Rectilinear propagation of light
- ◆ Pinhole camera and its characteristics
- ◆ Shadows and its types
- ◆ Eclipse and its types
- ◆ Basic laws of reflections
- ◆ Reflection and its types
- ◆ General definition about reflection
- ◆ Laws of reflection
- ◆ Characteristics of image formed in plane mirror

### Applications in Real life:

1. Light matters in many ways. On the most fundamental level through photosynthesis, light is necessary to the existence of life itself. Toward sustainability, using sunlight to grow local foods is a major way to help the environment while growing healthful food for healthier living.
2. Light matters for clean energy. The energy from our sun that reaches the Earth can be converted into heat and electricity
3. Solar energy can provide a practically-inexhaustible resource for enhanced sustainability, reduced pollution and lowered cost of mitigating climate change.
4. Solar hot water heaters are used around the world to heat residential homes and especially pools.

### §§ Introduction:

1. Light is the form of energy which makes objects visible to our eye.
2. The branch of physics which deals with the nature of light, its sources, properties effect and vision is called optics.
3. Light is a form of energy which is propagated as electromagnetic waves.
4. It does not require a medium for its propagation.
5. Its speed in free space is  $3 \times 10^8$  m/s. It is transverse in nature. It is not deflected by electric and magnetic fields.
6. When light meets a surface which separates two media, reflection and refraction take place. An image or an array of images may be formed due to intersection of reflection or refracted rays.

¶¶ **Light:** It is an invisible energy which causes us sensation of sight (vision).

¶¶ **Sources of light:** Sun is the primary source of light.

¶¶ **Luminous bodies:** The bodies which give out light energy by themselves are called luminous bodies.

Ex: sun, stars, burning candle, glowing electric bulb, glow worm etc.



### ¶¶ **Non-Luminous bodies:**

The bodies which do not give light energy of their own, but reflect light energy falling on them are called non-luminous bodies.

Ex: wood, house, moon, furniture etc.

Speed of light is  $3 \times 10^8 \text{m/s}$  (or)  $3,00,000 \text{km/s}$  (or)  $3 \times 10^{10} \text{cm/s}$  (or)  $3 \times 10^{11} \text{mm/s}$



### §§ **General definitions of light:**

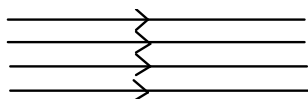
- Optical medium:** Any thing (material or non-materials), through which light energy passes wholly or partially, is called optical medium.  
Ex: vacuum, air, most of the gases, water, glass, plastics etc.
- Homogeneous medium:** An optical medium has a **uniform composition** through out is called homogeneous medium.  
Ex: vacuum distilled water, pure alcohol, glass, plastics, diamond etc.
- Heterogeneous medium:** An optical medium, which has **different composition at different points** is called heterogeneous medium.  
Ex: Air, muddy water, fog, mist etc.
- Transparent medium:** A medium which **allows most of the light energy to pass through it**, is called transparent medium.  
Ex: vacuum, clear air, thin layers of water etc.
- Translucent medium:** A medium which **partially allows the light energy to pass through** it is called translucent medium.  
Ex: Butter paper, oiled paper, tissue paper, ground glass... etc.
- Opaque bodies:** Those bodies which **do not allow the light energy to pass through them** are called opaque bodies.  
Ex: bricks, wood, stones, metals etc.
- Point source of light:** A source of light which is of the size of pinhead is called point source of light.
- Extended source of light:** Any source of light, which is **bigger than point source of light**, is called extended source of light.  
Ex: A bulb, a tube light, a burning candle. etc.
- Ray of light:** The path along which light energy travels in a given direction is called ray of light.



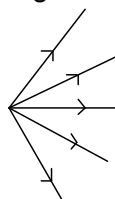
Ray of light

A ray of light is represented as a straight line. The arrow head on it gives the direction of light.

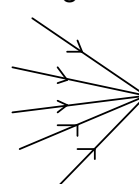
Parallel Ray



Divergent beam



Convergent beam



- 10. Beam of light:** A collection of number of rays of light is called beam of light. However, if the number of rays are too small then such a collection of rays is called pencil of light.
- 11. Parallel beam:** When the rays of light travel parallel to each other, then the collection of such rays is called parallel beam of light.  
Ex: When parallel rays are made to pass through a convex lens, they meet at a point. In such a case the collection of rays between convex lens and the point constitute convergent beam.
- 12. Divergent beam:**  
when the ray of light **originating from a point travels in various direction**, then the collection of such a ray is called divergent beam.
- 13. Convergent beam:**  
when the ray of light **coming from different direction, meet at a point**, then the collection of such a ray is called convergent beam.

**¶¶ Rectilinear propagation of light:**

Rectilinear propagation of light means that light energy travels in straight lines.

Ex: 1. When the sunlight enters through a small hole in a dark room, it appears to travel straight lines.

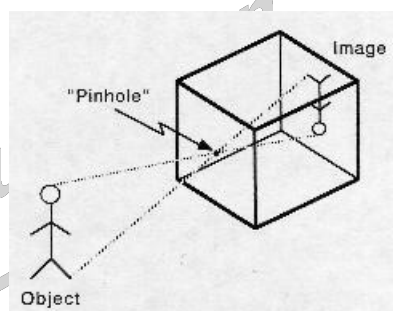
2. The light emitted by the head light of a scooter at night appears to travel in straight lines.

**§§ Pinhole camera:** It is used to take photographs of stationary objects.

**Principle:** Light travels in straight lines.

**¶¶ Characteristics of image formed in pinhole camera:**

- i) It is real i.e it should be on the screen.
- ii) It is inverted.
- iii) It is generally smaller than the size of object.



**§§ Shadows:**

**Shadow:** Dark patch formed behind an opaque body, when the opaque body is placed in the path of light is called shadow.



**¶¶ Conditions for the formation of shadow:**

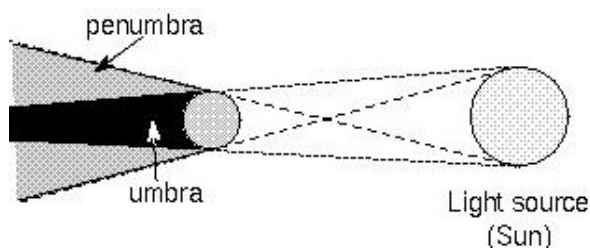
- 1) There must be source of light
- 2) There must be an opaque body to obstruct the path of light.
- 3) There must be an opaque screen to receive the shadow as it cannot be formed in air.

**§§ Kinds of shadow:**

**There are two kinds of shadow:**

- 1. Umbra:** A region of total darkness, formed behind an opaque body, is called umbra. No light rays of light reach in this region.
- 2. Penumbra:** A region of partial darkness, formed behind an opaque body, is called penumbra.

Some rays of light always reach in this region and partially illuminate it.



**Eclipse:** The shadow cast by the heavenly bodies on each other is called an eclipse.

- Lunar eclipse:** When the earth comes in between sun and the moon, lunar eclipse is formed. It is formed on "Full moon night".
- Solar eclipse:** When the moon comes in between the sun and the earth, solar eclipse is formed. It is formed on new moon day.



### TEACHING TASK

**Choose the correct answer:**

- The speed of light is  
 A)  $3 \times 10^{10}$  cm/s      B)  $3 \times 10^5$  m/s      C)  $3 \times 10^{10}$  m/s      D)  $3 \times 10^8$  cm/s
- The bodies which do not allow the light energy to pass through them are called  
 A) transparent      B) translucent      C) opaque      D) none
- Diamond is example for ..... substance  
 A) opaque      B) transparent      C) translucent      D) none
- Which of the following is a cool source of light  
 A) electric bulb      B) sun light      C) moon light      D) oil lamp
- At particular time on a day, the ratio of height of an object and the length of it's shadow is X. Using this how do you calculate the height of the tree if the length of the shadow of tree is L.  
 A)  $X/L$       B)  $X \times L$       C)  $X + L$       D)  $L - X$
- At particular time, the constant of ratio of length of the tree and the length of the shadow is found to be 0.5. Now, the length of shadow of a flag pole is 50 m. Calculate the length of the pole  
 A) 50 m.      B) 22.5 m      C) 25 m      D) 13.5 m
- Shadows are formed because  
 A) opaque bodies allow the light to pass through them  
 B) Light can bend around the opaque bodies  
 C) Light rays can not travel through the opaque bodies      D) none of these

8. The umbra of a shadow
  - A) receives light from the top of the source
  - B) receives light from reflected light of the source
  - C) receives light from the outer portion of the source of light
  - D) does not receive any light at all
9. Umbra and penumbra are clearly visible when
  - A) The source of light is small and the abstracting objects big
  - B) The source of light is big and the abstracting object is small
  - C) both source of light and the object are big
  - D) all the above
10. A solar eclipse occurs when
  - A) the earth passes between the sun and the moon
  - B) the moon passes between the sun and the earth
  - C) the sun passes between the earth and the moon
  - D) when all these three come in a straight line in the order of the earth, the sun and the moon.
11. Which of the following things is not true about penumbra
  - A) penumbra is a lighter portion of the shadow
  - B) penumbra is out side the umbra
  - C) penumbra can be formed by a point source of light
  - D) you can observe partial lunar eclipse or partial solar eclipse from the penumbra
12. Shadow moves with
  - A) the change in the position of the object
  - B) the change in the position of the source of object
  - C) the change in the distance between the object and the source of light
  - D) all the above

**Fill in the blanks :**

13. ....object do not caste any shadow.
14. Moon is a .....object.
15. Shadows give us information about the .....of the object.
16. Solar and Lunar eclipse are examples of ..... formation in nature.
17. A ..... changes the direction of light that falls on it.

**More than one option :**

- ◆ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C), (D), out of which **ONE or MORE** is correct. Choose the correct options*

18. Extended source of light
 

a. bricks	b. sun	c. burning candle	d. bulb
A) a&b	B) a,b&c	C) b,c&d	D) All
19. opaque bodies are
 

a. wood	b. house	c. burning candle	d. bricks
A) a, b & d	B) a,b&c	C) b,c&d	D) All

**State whether the given statements are true or false and write correct statement.**

20. The image formed in a pinhole camera, is always erect.
21. Light is an invisible energy which causes in us the sensation of vision.
22. A bird flying high in the sky does not cast its shadow on ground.
23. Moon is a luminous body in the sky.
24. The size of image in the pinhole camera increases, if the object is moved towards pinhole.
25. The light produced by a bulb is called shadowless light.

**Find the odd one out. Give a reason for your choice:**

26. Electric bulb, Sun, Moon, Fire
27. Shadows, Eclipses, Expansion, Image
28. Umbra, Penumbra, shadows, Image.

29. Wood, Steel, Magnet, Mirror, Graphite  
 30. Wood, Brick, Glass, Cement  
 31. Pick out the luminous and non-luminous bodies from the list given below :  
 (i) a lighted cigarette, (ii) marble, (iii) dial of watch, (iv) sun, (v) fire flies,  
 (vi) diamond, (vii) red hot iron, (viii) bicycle, (ix) trees, (x) a radio set.

**Match the following**

◆ This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column-I** have to be matched with statements (p, q, r, s) in **Column-II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct matches are A-p, A-s, B-r, B-r, C-p, C-q and D-s, then the correct bubbled 4\*4 matrix should be as follows:

32. Column A	Column B
a. Moon	1. Non-luminous
b. Sun	2. Opaque
c. Brick	3. Translucent
d. Oil paper	4. Luminous
A) a - 1, b -4, c - 2, d - 3	B) a -4 , b -1, c -2, d - 3
C) a - 3, b - 4 , c - 1, d - 2	D) a - 2, b -3, c -1, d - 4

**Comprehension type**

◆ This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE** is correct. Choose the correct option.

A medium which allows most of the light energy to pass through it is called transparent medium. medium which partially allows the light energy to pass through it is called translucent medium. Those bodies which do not allow the light energy to pass through them are called opaque bodies.

- 33) House is a ..... medium  
 A) transparent B) translucent C) opaque D) all
- 34) Medium which allows total light through it .....is called  
 A) transparent B) translucent C) opaque D) none
- 35) Maddy water is .....type of medium  
 A) translucent B)transparent C) opaque D) all



◆ ■ ■ ◆ **BEGINNERS ( Level - I )** ◆ ■ ■ ◆

**Choose the correct answer:**

1. speed of light is \_\_\_\_\_ km/s  
 A)  $3 \times 10^5$  km/s B)  $3 \times 10^8$  km/s C)  $3 \times 10^{10}$  km/s D)  $3 \times 10^7$  km/s
2. Burning candle is an example of \_\_\_\_\_  
 A) Non-luminous bodies B) luminous bodies C) Both A&B D) None
3. An invisible energy, which causes us the sensation of vision is  
 A) sound B) heat C) light D) none of these
4. Which is the primary source of light  
 A) moon B) sun C) earth D) Jupiter
5. The bodies which give out light energy by them selves are called  
 A) luminous B) non-luminous C) transparent D) opaque
6. Example of non-luminous body



7. Example of translucent substance  
 A) sun                                      B) star                                      C) burning candle                      D) moon  
 A) butter paper                              B) brick                                      C) wood                                      D) clear air
8. Sun rays entering into a room through a ventilator constitute ..... beam of light  
 A) convergent                              B) divergent                              C) parallel                                      D) all of these
9. The path of light ray is  
 A) Straight                                      B) zigzag                                      C) curve                                      D) parabola
10. The rays originating from a point source of light constitute ..... beam of light  
 A) parallel                                      B) convergent                              C) divergent                                      D) none
11. Light  
 A) requires a material medium to travel from one place to another place  
 B) does not require material medium  
 C) light has mass but it is negligible                                      D) all the above
12. Rectilinear propagation is  
 A) mode of travelling in curved lines                                      B) mode of travelling in straight lines  
 C) ability to bend around the obstacles                                      D) none of these
13. Nothing can travel faster than  
 A) The speed of light                                      B) The speed of sound  
 C) The speed of an electron                                      D) The speed of a rocket
14. The speed of light is  
 A) the same in all media                                      B) the greatest in vacuum  
 C) greater in air than vacuum                                      D) does not change from medium to medium
15. A source of light is  
 A) an object that can absorb light                                      B) an object that can reflect light  
 C) an object that can give light                                      D) none of these
16. A narrow stream of light is called  
 A) ray                                      B) beam                                      C) sunlight                                      D) none of these
17. A broad beam of light is called  
 A) ray                                      B) beam                                      C) twilight                                      D) sunlight
18. The light emanating from a torch light is  
 A) convergent                                      B) divergent                                      C) parallel                                      D) irregular
19. Characteristics of image formed in pin hole camera is  
 A) inverted                                      B) real                                      C) Smaller than original                      D) all
20. Extended source of light  
 A) Bricks                                      B) Butter paper                                      C) Bulb                                      D) none
21. Homogeneous medium is  
 A) Vacuum                                      B) air                                      C) pure alcohol                                      D) none
22. Optical medium is  
 A) Vacuum                                      B) air                                      C) water                                      D) all
23. Transparent medium is  
 A) Vacuum                                      B) clean air                                      C) thin layer of water                      D) all
24. Opaque bodies are  
 A) wood                                      B) stone                                      C) bricks                                      D) all
25. Penumbra is seen  
 A) inside the umbra                      B) outside the umbra                      C) away from the umbra                      D) none
26. The umbra is seen  
 A) inside the penumbra                                      B) outside the penumbra  
 C) away from the penumbra                                      D) none of these
27. The light circular portion of the shadow is called  
 A) umbra                                      B) object                                      C) source of light                                      D) penumbra

28. Shadow of an object falls in  
 A) the direction of the source of light  
 B) the direction opposite to that of the source of light  
 C) a direction perpendicular to the source of light      D) none of these
29. Penumbra is formed only by a  
 A) point source of light      B) extended source of light  
 C) both the above      D) none of these
30. A solar eclipse occurs on  
 A) all new moon days      B) all full moon days  
 C) a particular new moon day      D) a particular full moon day

◆ ◆ ◆ **ACHIEVERS ( Level - II )** ◆ ◆ ◆

**ANSWER THE FOLLOWING:**

- Classify the following as transparent, translucent and opaque objects:  
 a) Stone      b) Wax paper      c) Reading glasses      d) Common salt  
 e) Skin of a drum      f) Wood      g) Smoke      h) Leather      i) Blood      j) Dense fog
- What type of shadows are formed by transparent, translucent and opaque objects?
- Why do we not see the shadow of aeroplanes and birds flying in the sky?
- State the principle behind the working of a pinhole camera. Describe in detail how you will make a simple pinhole camera at home

◆ ◆ ◆ **EXPLORERS ( Level - III )** ◆ ◆ ◆

**State whether the given statements are true (or) false and write the correct statements:**

- Moon and the planets are luminous bodies.
- When a large number of rays travel parallel to each other, then collection of such rays is called parallel beam of light.
- Pinhole camera is used to take photographs of moving objects.
- The birds flying high in the sky do not cast their shadows.
- Glass is a transparent body.
- A region of total darkness is called umbra.
- When the earth comes in between the sun and the moon, solar eclipse is formed.
- The characteristics of a shadow depends upon the size of the source of light.
- Umbra and penumbra are clearly formed when source of light is big and the obstructing opaque body is small.
- The shadow cast by heavenly bodies is called umbra
- Tube-light is a natural luminous body.
- Stars reflect the sunlight.
- During solar eclipse moon comes between earth and sun.
- Rainbow is formed due to shadow formation.
- Jugnoo (glow worm) is a luminous body.

**Find the odd one out. Give a reason for your choice:**

- oiled paper, stones, wood, cotton.
- glass, air, butter paper, alcohol.
- butter paper, air, bricks, dust filled air.

**Match the following:**

◆ This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column-I** have to be matched with statements (p, q, r, s) in **Column-II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct matches are A-p, A-s, B-r, B-r, C-p, C-q and D-s, then the correct bubbled 4\*4 matrix



should be as follows:

- 19.**
- |   |   |
|---|---|
| <p><b>Column A</b></p> <p>a. A luminous body<br/>b. A transparent object<br/>c. A translucent object<br/>d. An opaque object</p> <p>A) a - 1, b - 2, c - 3, d - 4<br/>C) a - 3, b - 4, c - 1, d - 2</p> | <p><b>Column B</b></p> <p>1. Thick windows glass pan<br/>2. Brick<br/>3. Star<br/>4. Clear water</p> <p>B) a - 4, b - 1, c - 2, d - 3<br/>D) a - 2, b - 1, c - 4, d - 3</p> |
|---|---|
- 20.**
- |   |   |
|---|---|
| <p><b>Column A</b></p> <p>a. Solar eclipse<br/>b. Lunar eclipse<br/>c. Sun<br/>d. Bouncing back of light</p> <p>A) a - 1, b - 2, c - 3, d - 4<br/>C) a - 3, b - 4, c - 1, d - 2</p> | <p><b>Column B</b></p> <p>1. . Ultimate source of light.<br/>2. New moon day.<br/>3. Full moon night.<br/>4. Plane mirror.</p> <p>B) a - 4, b - 1, c - 2, d - 3<br/>D) a - 2, b - 3, c - 1, d - 4</p> |
|---|---|
- 21.**
- |  |   |
|--|---|
| <p><b>Column A</b></p> <p>a. Luminous object<br/>b. Eclipse<br/>c. Transparent object<br/>d. Translucent object</p> <p>A) a - 1, b - 2, c - 3, d - 4<br/>C) a - 3, b - 4, c - 1, d - 2</p> | <p><b>Column B</b></p> <p>1. Water.<br/>2. shadow.<br/>3. ground glass.<br/>4. Fluorescent tube.</p> <p>B) a - 4, b - 2, c - 1, d - 3<br/>D) a - 2, b - 3, c - 1, d - 4</p> |
|--|---|

**Comprehension type**

- ◆ This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Choose the correct option.

A medium which allows most of the light energy to pass through it is called transparent medium. medium which partially allows the light energy to pass through it is called translucent medium

- 22)** Ground glass is a ..... medium  
 A) transparent                      B) translucent                      C) opaque                      D) all
- 23)** Medium which allows light partially through it ..... is called  
 A) transparent                      B) translucent                      C) opaque                      D) none
- 24)** clean air is ..... type of medium  
 A) translucent                      B) transparent                      C) opaque                      D) all

**Fill in the blanks:**

- 25.** ..... is an invisible energy which causes the sensation of vision
- 26.** A source of light which is of the size of pin head is called .....
- 27.** Ground glass is an example for ..... substances
- 28.** The speed of light in vacuum is ..... km/s
- 29** Burning candle is an example for ..... source of light
- 30.** ..... is the principle of working of pin hole camera
- 31.** The image formed in a pinhole camera ....., ..... and .....
- 32.** Umbra is formed due to the ..... source of light
- 33.** Shadow cast by heavenly bodies is called .....
- 34.** Solar eclipse is formed on ..... day
- 35.** Lunar eclipse is formed on .....
- 36.** Sun light on earth is ..... beam of light
- 37.** Any medium through which light energy can pass is called ..... medium.


**KEY**
**ΦΦ TEACHING TASK :**

- 1.A    2.C    3.B    4.C    5.B    6.C    7.C    8.D    9.B    10.B    11.C    12.C  
 13. transparent    14. non luminous    15. shape    16. shadows    17. Mirror  
 18)C    19)A    20)F    21)T    22)T    23)F    24)T    25)T    26)Moon    27)Expansion  
 28)Image    29)Mirror    30)Glass    32)A    33)C    34)A    35)A

**ΦΦ LEARNER'S TASK :****□ BEGINNERS :**

- 1)A    2)C    3) C    4)B    5)A    6) D    7)A    8) C    9)A    10)C    11)B    12)B  
 13)A    14)B    15)C    16)A    17) B    18)C    19) D    20)C    21)C    22)D    23)C    24)D  
 25)B    26)A    27)D    28)A    29)B    30)C

**□ EXPLORERS :**

- 1) F    2) T    3) F    4) T    5) T    6) T    7) F    8) F    9) T    10) F    11) F    12) F  
 13) T    14) F    15) T    16) Oiled paper    17) Butter paper    18) Bricks    19)C  
 20)D    21)C    22)B    23)B    24)B    25) light,    26) point source of light,  
 27) transparent,    28)  $3 \times 10^5 \text{ km/s}$ ,    29) point    30) rectilinear propagation  
 31) real, inverted, smaller size than object    32) point    33) Eclipse  
 34) new moon day    35) full moon night    36) parallel    37) transparent

**§§ Basic laws:****1. Law of rectilinear propagation of light:**

It states that light propagates in straight lines in homogeneous media.

**2. Law of independence of light rays:**

It states that light rays do not disturb each other upon intersection.

**3. Law of reversibility of light rays:**

It states that light rays retrace their path when their direction is reversed.

**§§ Mirror :** A polished surface from which regular reflection can take place is called mirror.

**§§ Reflection of light:**

When a beam of light travelling through a medium, is incident on any other surface, three situations can arise.

- i) A part of light, on striking the surface is sent back in the original medium. It is called Reflection of light.
- ii) A part of light on striking the surface passes through it is called Refraction of light.
- iii) A part of light gets absorbed by the medium

**§§ Reflection:** The phenomenon of returning of incident light into the same medium is known as reflection.

**§§ Reflection is of two types:**

- (i) Regular reflection                      (ii) Irregular reflection

**i) Regular Reflection:**

The reflection in which all rays of light return in a particular direction in the same media after reflection, obeying the laws of reflection is known as regular reflection.

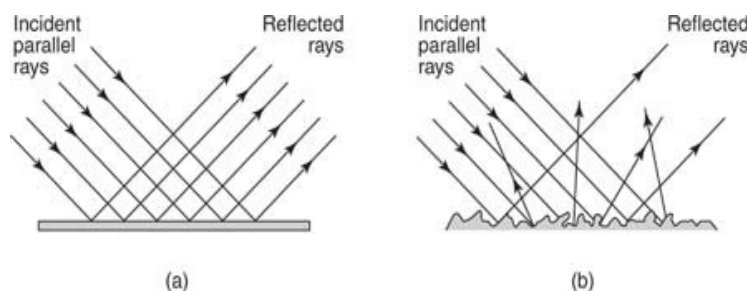
Regular reflection takes place from the objects like looking glass, smooth glass, still water, oil, highly polished metals etc.

Regular reflection is useful in the formation of images

**ii) Irregular reflection (or) diffused reflection:**

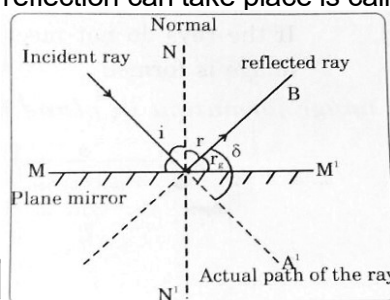
The reflection in which all rays of light return not in a particular direction in the same media after reflection, is known as irregular reflection.

Irregular reflections occurs on a rough surfaces, It is also known as scattering. This reflection( diffused reflection) takes places from ground, walls, trees etc. Irregular reflection helps us to see things around us.



### §§ General definitions about reflection:

- Mirror:** A smooth polished surface from which regular reflection can take place is called mirror.
- Incident ray:** A ray of light which travels towards the mirror is called incident ray.
- Point of Incidence:** The point on the mirror, where an incident ray strikes is called point of incidence.
- Reflected Ray:** A ray of light which bounces off the surface of a mirror, is called reflected ray.
- Normal:** The perpendicular drawn at the point of incidence, to the surface of mirror is called normal.
- Angle of Incidence:** The angle made by the incident ray with the normal is called angle of incidence.
- Angle of Reflection:** The angle made by the reflected ray with the normal is called angle of reflection.
- Glance angle of Incidence:** The angle which the incident ray makes with the mirror is called Glance angle of incidence.
- Glance angle of Reflection:** The angle which the reflected ray makes with the mirror is called glance angle of reflection.

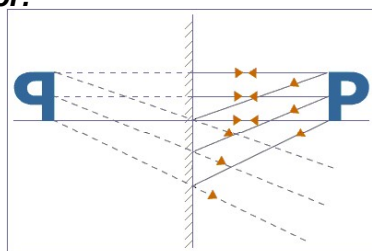


### §§ Laws of reflection:

- The incident ray, the reflected ray and the normal drawn at point of incidence lie in the same plane.
- The angle of incidence is always equal to the angle of reflection i.e.  $\angle i = \angle r$

### ¶¶ Characteristics of image formed in plane mirror:

- The image is formed as far behind the mirror as the object is in front of it.
- The image is formed on the perpendicular drawn, from the object to the mirror produced behind the mirror.
- The image is virtual, cannot be taken on a screen.
- The image formed is same size as the object.
- The image is laterally inverted. If a mirror is rotated through an angle ' $\theta$ ' the reflected ray gets rotated through an angle ' $2\theta$ '.
- Image is erect.
- If ' $\theta$ ' be the angle of inclination between two mirrors and 'n' the number of images



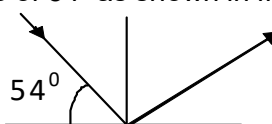
formed then

$$\therefore n = \frac{360}{\theta} - 1$$

### TEACHING TASK

**Choose the correct answer:**

1. A ray of light strikes a plane mirror, at an angle of  $54^\circ$  as shown in figure. What is the angle between the incident and the reflected rays.
 



A)  $72^\circ$                       B)  $54^\circ$   
 C)  $36^\circ$                       D)  $90^\circ$
2. Calculate the number of images formed when two plane mirrors are facing each other.  
 A) 100                      B) 200                      C) 1000                      D) infinite
3. A ray of light strikes a plane mirror, such that angle with the mirror is  $30^\circ$ . What is the angle of reflection? What is the angle between incident and the reflected ray?  
 A)  $60^\circ, 120^\circ$                       B)  $120^\circ, 60^\circ$                       C)  $180^\circ, 60^\circ$                       D)  $120^\circ, 180^\circ$
4. A ray of light strikes a plane mirror, such that angle with the normal is  $30^\circ$ . What is the angle of reflection? What is the angle between incident and the reflected ray?  
 A)  $60^\circ, 30^\circ$                       B)  $30^\circ, 60^\circ$                       C)  $40^\circ, 60^\circ$                       D)  $120^\circ, 40^\circ$
5. A ray of light strikes a plane mirror, such that angle with the mirror is  $40^\circ$ . What is the angle of reflection?  
 A)  $60^\circ$                       B)  $60^\circ$                       C)  $40^\circ$                       D)  $120^\circ$
6. An object is placed at a distance of 15cm from a plane mirror. If the object is moved 8 cm farther away from the mirror, what is the new distance between the object and its image  
 A) 6cm                      B) 46cm                      C) 40cm                      D) 120cm
7. An object is placed at a distance of 8cm from a plane mirror. If the object is moved 4 cm towards the mirror, what is the new distance between the object and its image?  
 A) 8cm                      B) 16cm                      C) 20cm                      D) 12cm
8. An object is placed at a distance of 22cm from a plane mirror. If the object is moved 7 cm towards the mirror, what is the new distance between the mirror and its image?  
 A) 18cm                      B) 15cm                      C) 25cm                      D) 30cm
9. An object is placed at a distance of 15cm from a plane mirror. If the object is moved 7 cm towards the mirror, what is the new distance between the mirror and its image?  
 A) 8cm                      B) 16cm                      C) 4cm                      D) 20cm
10. An image is formed at a distance of 14cm from a plane mirror. If the object is moved 6 cm away from the mirror, what is the new distance between the mirror and its image?  
 A) 18cm                      B) 8cm                      C) 16cm                      D) 4cm

**More than one option:**

- ◆ This section contains multiple choice questions. Each question has 4 choices (A), (B), (C), (D), out of which **ONE or MORE** is correct. Choose the correct options

11. Image formed by plane mirror is  
 a) Virtual                      b) Same size                      c) Erect                      d) Laterally inverted  
 A) a and b                      B) b and c                      C) a, b and c                      D) All
12. Regular reflection occurs on  
 a) still water                      b) walls                      c) highly polished metals                      d) trees  
 A) a and c                      B) b and c                      C) a, b and c                      D) All

**State whether the given statements are true or false and write correct statement.**

13. When a ray of light strikes a plane mirror perpendicularly, the angle of incidence is  $90^\circ$ .
14. A plane mirror can focus solar rays to a point.
15. A ray of light which bounces off the surface of mirror is called incident ray.
16. Image formed by plane mirror is always inverted.
17. Regular reflection produced when light falls on the walls.

**Find the odd one out. Give a reason for your choice:**

- 18. Walls, Oil, Trees, Ground
- 19. Plane mirror, Smooth glass, Brick, Polished metals

**Match the following:**

◆ This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column-I** have to be matched with statements (p, q, r, s) in **Column-II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct matches are A-p, A-s, B-r, B-r, C-p, C-q and D-s, then the correct bubbled 4\*4 matrix should be as follows:

20.	Column A	Column B
	a. House	1. Regular refraction
	b. plane mirror	2. Irregular refraction
	c. Angle of Incidence ray	3. virtual
	d. still water	4. Equal to angle of Reflection
	A) a - 1, b - 2, c - 3, d - 4	B) a - 4, b - 1, c - 2, d - 3
	C) a - 3, b - 4, c - 1, d - 2	D) a - 2, b - 3, c - 4, d - 1

**Comprehension:**

◆ This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Choose the correct option.

If 'θ' be the angle of inclination between two mirrors and 'n' the number of images

formed then 
$$\therefore n = \frac{360^\circ}{\theta} - 1$$

- 21. If angle between the two mirror is 30° then number of image formed are  
 A) 12                      B) 11                      C) 15                      D) 20
- 22. If number of images formed by two plane mirror are 5 then angle between the mirrors is  
 A) 40°                      B) 90°                      C) 60°                      D) 50°



◆ ■ ◆ **BEGINNERS ( Level - I )** ◆ ■ ◆

**Choose the correct answer:**

- 1. The surfaces which cannot produce clear images are called  
 A) rough surfaces    B) ideal surfaces    C) smooth surfaces    D) curved surfaces
- 2. An ideal mirror  
 A) absorbs all the amount of light incident on it                      B) reflects all the light  
 C) refracts all the light                      D) none of these
- 3. In order to be used as mirrors, glasses are coated with  
 A) silver                      B) copper                      C) aluminium                      D) platinum
- 4. We are able to see the objects because  
 A) they absorb light                      B) they reflect the light  
 C) neither absorb nor reflect the light                      D) None
- 5. The angle of incidence in plane mirror is ..... to angle of reflection  
 A) equal                      B) greater than                      C) less than                      D) can't say
- 6. The perpendicular drawn at any point on a mirror is called  
 A) incident ray    B) reflected ray    C) normal    D) image

7. The light from the sun takes 500 sec to reach the earth. Assuming that the speed of light is  $3 \times 10^5$  km/s. Calculate the distance between the sun and the earth  
A) 100 million km      B) 150 million km      C) 200 million km      D) 300 million km.
8. If the angle of incidence is  $80^\circ$ , What will be the angle of reflecting w.r.t the normal drawn perpendicular at the point of reflection ?  
A)  $80^\circ$       B)  $100^\circ$       C)  $160^\circ$       D)  $20^\circ$
9. The image formed by a plane mirror is  
A) at the same distance behind the mirror as the object is in front of is  
B) laterally inverted      C) of the same size as that of the object      D) all the above
10. Plane mirrors are arranged parallel to each other to get  
A) a single image      B) two images  
C) a large number of reflected images      D) no image
11. A real image  
A) cannot be captured on a screen      B) can be captured on a screen  
C) can be captured only on a celluloid screen      D) none of the above
12. A virtual image is  
A) always real      B) always erect  
C) always caught on a screen      D) always uncapturable on a screen.

◆ H ◆ **ACHIEVERS ( Level - II )** ◆ H ◆

**Solve the following:**

1. A ray of light strikes the plane mirror at angle of  $60^\circ$ . Find  
A) angle of incidence      B) angle of reflection.
2. A ray of light strikes the plane polished surface. If the angle of incidence is  $45^\circ$ , then find the angle of reflection ?
3. A ray of light strikes the plane mirror at an angle of  $90^\circ$ . Then find  
a) Glancing angle of incidence      b) Glancing angle of reflection
4. Calculate the number of images formed in two plane mirrors, when they are held at an angle of  
i)  $72^\circ$       ii)  $30^\circ$       iii)  $60^\circ$       iv)  $90^\circ$       v)  $18^\circ$
5. Find the angle of between two plane mirrors, when the number of images formed between them is  
i) 9      ii) 8      iii) 11      iv) 12      v) 2
6. A ray of light strikes a plane mirror, such that angle with the mirror is  $20^\circ$ . What is the angle of reflection ? What is the angle between incident and the reflected ray ?
7. What must be written on a vehicle so that a driver may read 'EMERGENCY' in his driving mirror?
8. How would the image of a letter 'P' appear in a plane mirror ?
9. An object is placed at a distance of 10cm from a plane mirror. If the object is moved 4 cm farther away from the mirror, what is the new distance between the object and its image ?
10. An object is placed at a distance of 7.5cm from a plane mirror. If the object is moved 2cm towards the mirror. What is the new distance between the object and its image ?
11. A ray of light strikes a plane mirror, such that angle with the mirror is  $60^\circ$ . What is the angle of reflection ? What is the angle between incident and the reflected ray ?
12. A ray of light strikes a plane mirror, such that angle with the mirror is  $70^\circ$ . What is the angle of reflection ? What is the angle between incident and the reflected ray ?
13. An image of car is formed at a distance of 29cm from a plane mirror. If the car is moved 11cm towards the mirror, what is the new distance between the mirror and its car ?

◆ H ◆ **EXPLORERS ( Level - III )** ◆ H ◆

**State whether the given statements are true or false and write correct statement.**

1. Real image formed by plane mirror
2. The angle of incidence is twice of the angle of reflection.

**Find the odd one out. Give a reason for your choice:**

3. looking glass, still water, highly polished metals, walls.
4. Virtual, Same size, Erect, Laterally inverted
5. still water, walls, highly polished metal, trees

**Match the following**

◆ This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column-I** have to be matched with statements (p, q, r, s) in **Column-II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct matches are A-p, A-s, B-r, B-r, C-p, C-q and D-s, then the correct bubbled 4\*4 matrix should be as follows:

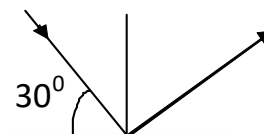
6. Angle	Number of Images
a. 60°	1. 11
b. 30°	2. 3
c. 90°	3. 17
d. 20°	4. 5
A) a - 1, b - 4, c - 2, d - 3	B) a - 4, b - 1, c - 2, d - 3
C) a - 3, b - 4, c - 1, d - 2	D) a - 2, b - 3, c - 1, d - 4

**Comprehensive**

◆ This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Choose the correct option.

The angle of incidence is always equal to the angle of reflection i.e.  $\angle i = \angle r$ .

7. What is angle of incidence.  
A) 60°                      B) 50°                      C) 40°                      D) 90°
8. What is the angle between incidence ray and reflected ray  
A) 180°                      B) 120°                      C) 140°                      D) 90°



**Fill in the blanks :**

9. In reflection angle of incidence = .....
10. Regular reflection takes place on ..... surfaces
11. Other name for irregular reflection is .....
12. .... images can not be caught on a screen
13. .... images can be caught on a screen
14. A plane mirror always produce ..... image
15. In case of plane mirror, from the mirror distance of the image = distance of the .....

◀ |||| ▶      **RESEARCHERS ( Level - IV )**      ▶ |||| ▶

1. Image formed by a plane mirror is .... [NSO -2009]  
A) virtual, behind the mirror and enlarged  
B) virtual, behind the mirror and of the same size as the object  
C) real, in front of the mirror and enlarged.  
D) real, in front of the mirror and of the same size as the object
2. To cast a bigger shadow on the screen. A man should move... [NSO 2011]  
A) the object closer to the torch                      B) the screen closer to the object  
C) the object away from the torch                      D) the torch away from the object
3. The experiment given below shows that light.. [NSO 2011]  
A) can be reflected    B) is a form of energy  
C) travels in straight line                                      D) can pass through all objects
4. An object placed 2m from a plane mirror shifted by 0.5 m away from the mirror. What is the distance between the object and its image? [NSO 2014]



- A) 2 m                      B) 1.5 m                      C) 5 m                      D) 3 m
5. Casting of shadows by opaque objects gives rise to [NSO 2008]  
 1) day and night    2) eclipse                      3) image in mirror  
 A) 1                      B) 2                      C) 3                      D) 1 and 2
6. When sunlight falls on a red rose, it appears red because [NSO 2008]  
 A) It is a red rose  
 B) Rose absorbs red colour of the light and reflects remaining colours  
 C) Rose reflects red colour and absorbs the remaining colours of the light  
 D) The wavelength of red light increases after being reflected from rose while the wavelengths of remaining colours remain same
7. An image that is not produced by light rays coming from the image but is the result of your brain's interpretations these light rays is called a/an [NSO 2014]  
 A) real image                      B) virtual image                      C) imagined image                      D) none
8. At camp, Raj sees a lighting storm. He sees the lightning before he hears the thunder. What does this show?  
 A) Light moves faster than sound                      B) light moves slower than sound  
 C) light and sound moves at the same speed                      D) cannot be determined
9. When the distance between the object and the plane mirror increase [NSO 2009]  
 A) The image remains at the position  
 B) The size of the image becomes less than the size of the object  
 C) The distance between the image and the plane mirror increases  
 D) The distance between the image and the plane mirror decreases
10. A blurred view is obtained through a paper when a little amount of oil or grease is applied on it because the paper becomes. [NSO 2010]  
 A) clear                      B) transparent                      C) translucent                      D) opaque

KEY

**ΦΦ TEACHING TASK :**

- 1)A    2)D    3)A    4)B    5)C    6)B    7)A    8)B    9)A    10)B    11)D    12)A  
 13) T    14) F    15) F    16) F    17) F    18) Oil    19) Brick    20)D    21)B    22)C

**ΦΦ LEARNER'S TASK :****□ BEGINNERS :**

- 1-A,    2-B,    3-A,    4-B,    5-A,    6-C,    7-B,    8-A,    9-D,    10-C,    11-B,    12-B.

**□ ACHIEVERS :**

1.  $60^\circ$ ,  $60^\circ$                       2.  $45^\circ$                       3.  $90^\circ$ ,  $90^\circ$                       4. 4, 9, 5, 3, 19                      5.  $36^\circ$ ,  $40^\circ$ ,  $30^\circ$ ,  $27.7^\circ$ ,  $120^\circ$   
 6.  $70^\circ$ ,  $140^\circ$                       7. 28 cm                      8.  $60^\circ$ ,  $120^\circ$                       9.  $70^\circ$ ,  $140^\circ$                       10. 18 cm

**□ EXPLORERS :**

- 1) F    2) F    3) Walls                      4) Laterally inverted                      5) walls                      6) B    7)A    8)B  
 9) angle of reflection                      10) smooth                      11) diffused                      12) virtual                      13) real                      14) real  
 15) object

- EXPLORERS :** 1)B,    2)A,    3) C,    4) C,    5) D,    6) C,    7) B,    8)A,    9) C,    10) C