Lesson 1

LIGHT

İs a form of energy that enables us to see.

Sources of light

Natural sources include sun, star, glowing insects

Artificialluminous bodiesinclude bulb, candle, kerosene lamp e.t.c.

An object is seen only when light from the object enters the eyes.

Most of the things like moon seen do not make their own light but reflect light from other sources to our eyes, such things are called nonluminous.

Some objects like sun, star, lamp e.t.c make their own light, these are calledluminous.

Transmission of light

Light travels from its source to another place through vacuum or amedium.

The media of light include:

(i) **Transparent Medium** is a substance that allows almost all the light to pass through it and objects are clearly seen through it. E.g. colourless water, paraffin,colourless glass.

(ii) **Translucent medium** is one which allows some light to pass through it but objects are not clearly seen through it. E.g. cloudy liquid,frosted glass and oily paper.

(iii) **Opaque medium**is one which does not allow light to pass through it at all.

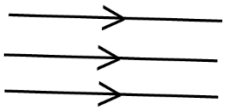
Rays and beams

A ray is the direction of the path in which light travels. It is represented by a straight line with an arrow on it.

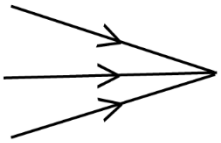
A beam is a collection of rays.

There are three kinds of beams:

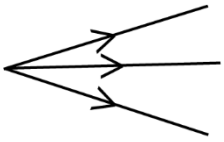
(i) Parallel beam. is a collection of rays which do not meet at all.



(a) Parallel beam



(b) Converging beam



(c) Diverging beam

(ii) Convergent beam.

Convergent beamis a collection of rays originating from different directions and ending up at the same point.

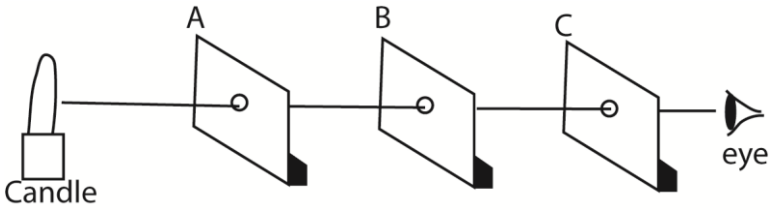
(iii)Divergent beam isa collection of rays which originate from one point and are spread out in different directions.

Rectilinear propagation of light

This is the property of light travelling in a straight-line when produced from a source. It is propagated (sent outward) and it travels in straight lines

Experiment to show that light travels in a straight line

Experiement I



(i) Equal square cards A,B and D are cut from piece of thick paper board each with a hole in the middle.

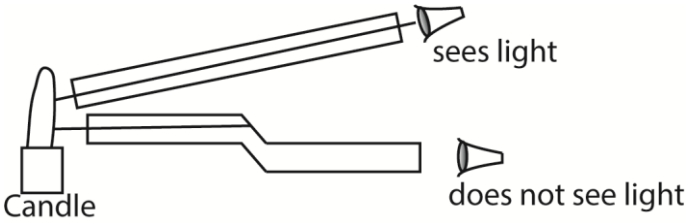
(ii) When the card are arranged as shown above with their holes in a straight line light passes through and seen on the other end.

(iii) İf the middle card is displaced such that its hole is removed from the line, light is cut of from the other end

Conclusion: This shows that light travels in a straight line.

Experiment II

A candle light can be observed through a straight pipe but when the pipe is bent no light is seen

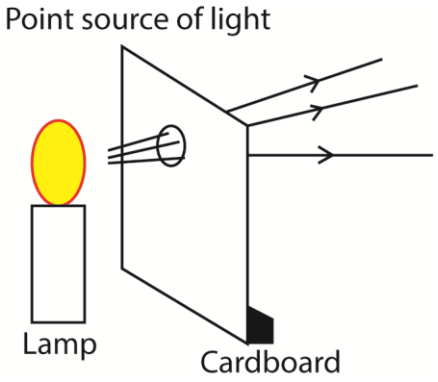


Experiment II
Formation of shadows and eclipses indicates that light travels in straight line.

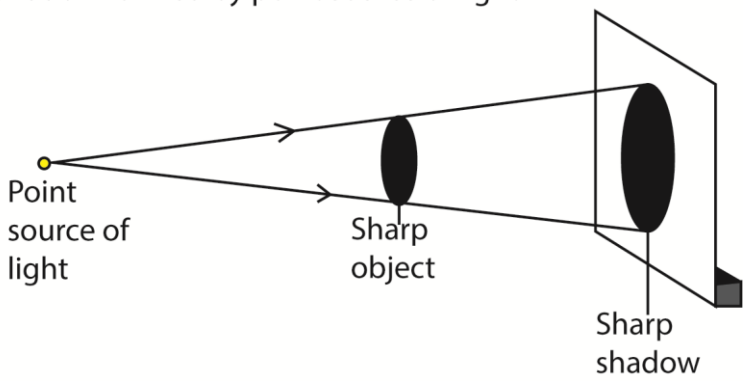
Shadow
A shadow is formed when an object obstructs light. Shadows are formed because light travels in a straight line.

(i) A Shadow is formed by a point source is equally sharp as shown below

A point source is a very small source of light. İt can obtained by placing a cardboard with a small hole in front of a lamp as shown.

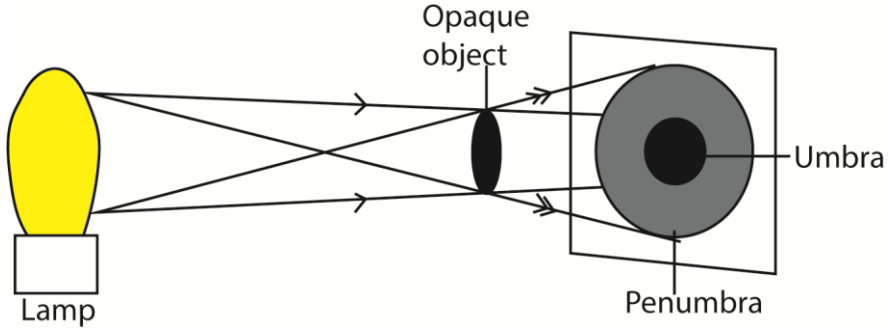


Shadow formed by point source of light



Note: For a point source
When the opaque object is moved near the source, the size of the shadow increases. But when the object is moved near the screen, the size of the shadow decreases.

(ii) A shadow produced by extended source of light has a dark patch (umbra) and a lighter outer patch (penumbra) as shown below



Umbra is a region of the shadow where no light reaches at all.
Penumbra is a region of the shadow where some light reaches.

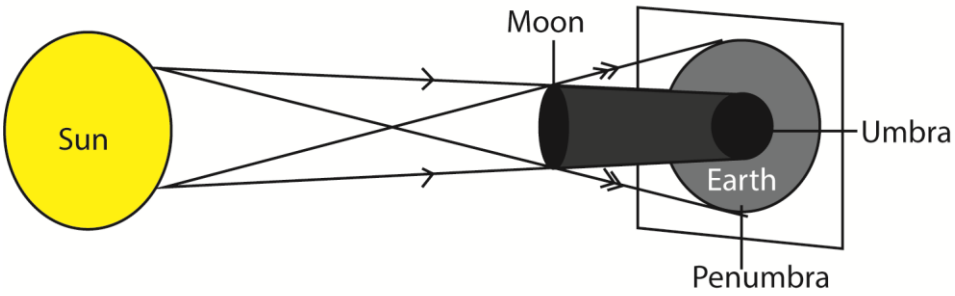
Note that for an extended source
When the opaque object is moved near the source, then the size of the umbra decreases but the size of the penumbra increases. When the object is moved near the screen, the size of the umbra increases but the size of the penumbra decreases.

Eclipse
An eclipse occurs when the sun, moon and earth are in a straight line. There are three types of eclipses namely: solar, annular and lunar.

Solar eclipse
Solar eclipse also called eclipse of the sun occurs when the moon is between the sun and earth such that both umbra and penumbra reaches the earth.

The area on earth covered by the umbra has total eclipse and the sun cannot be seen at all.
The area covered by penumbra has partial eclipse and only part of the sun is seen.

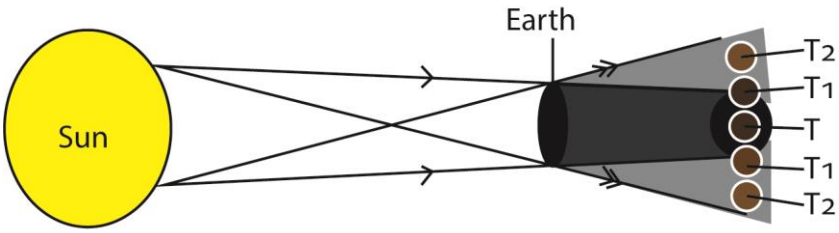
Eclipse of the sun



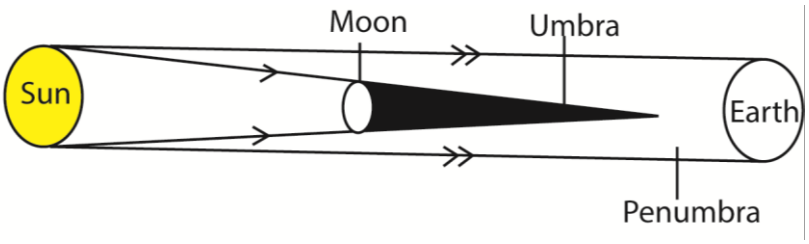
Lunar eclipse
Lunar eclipse is also called eclipse of the moon. Lunar occurs when the earth is between the sun and the moon.

During the eclipse of the moon the earth's shadow is cast on the moon such that when the moon is at position "T," total eclipse occurs, in position "T_1" partial eclipse occurs and when the moon is in position "T_2' no eclipse occurs but the moon is less brighter than usual.

Eclipse of the moon



Annular eclipse
Annular eclipse of the sun occurs when the sun is very far from earth and the moon is between the earth and the sun such that umbra does not reach the earth but only penumbra reaches earth.



Note: Total eclipse of the moon lasts longer than total eclipse of the sun because for total eclipse of moon, the earth which is in the middle is larger than moon in the eclipse of the sun.

FLOURESCENCE AND PHOSPHORESCENCE

Fluorescence is a substance, which absorbs energy and immediately releases the energy in the form of light.

Example of such a substance is Zinc sulphide. The screen of a T.V and C.R.O are made of a fluorescent substance.

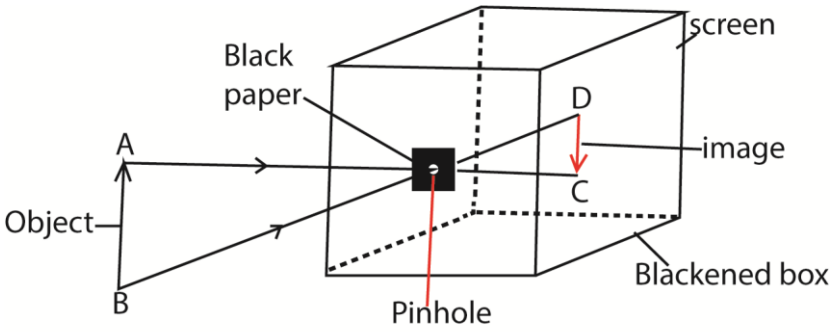
Phosphorescence is a substance which absorbs the energy falling on it, stores it, and when energy stops falling on it, it releases it in the form of light.

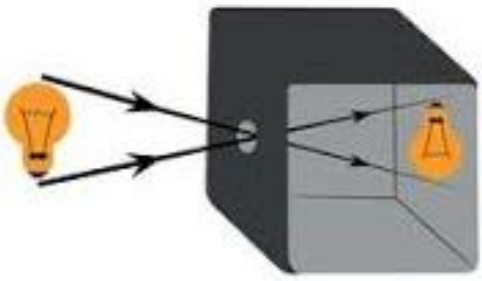
An example of such a substance is calcium sulphide.

Pinhole camera

A pinhole camera works on the property of light travelling in a straight line.

A pinhole camera consists of a closed blackened box with a small hole on one face and a screen of tracing paper on the opposite face.The box of pinhole camera is blackened inside to prevent reflections inside the box.





Properties of images formed by pinhole camers

(i) İt is real i.e. it can be produced on the screen. İt is formed by real rays of light reaching the screen.

(ii) İt is inverted

Factors affecting the proprties of image formed by pinhole camera

(i) When the distance between the object and the pin hole is reduced the image becomes bigger but less bright because the image is spread over a larger area and vice versa

(ii) When the distance between the pin hole and screen is increase the image becomes bigger but becomes less bright because an image is spread over a bigger area. And vice versa

(iii) When the pin hole is enlarged, the image becomes blurred but brighter because of too much light entering

Linear magnification

Linear magnification is the ratio of image size to object size.

Or: **Linear magnification** is the ratio of image distance to object distance.

$$\textbf{Magnification} = \frac{\textbf{magnification}}{\textbf{height of objects}} = \frac{\textbf{CD}}{\textbf{AB}}$$

$$\textbf{Magnification} = \frac{\textbf{distance of image from pinhole}}{\textbf{distance of object from pinhole}}$$

So larger magnification is obtained when the object is nearer the pin-hole and smaller magnification is produced when the object is farther away.

Example 1.

Calculate the height of a building 150m away from a pinhole camera which produces an image 5cm high if the distance between pin hole and screen is 10cm.

Object distance = 150m

Image height = 5cm = 0.05m

Image distance = 10cm = 0.1m

$$\textbf{Linear magnification} = \frac{\textbf{image height}}{\textbf{object height}} = \frac{\textbf{image distance}}{\textbf{object distance}}$$

$$= \frac{0.05}{\text{h}} = \frac{0.1}{150}$$

h=75m

Example 2.

The length of a pin-hole camera is 25cm. An object 2m high is placed 10m from the pin-hole. Calculate the height of the image produced and its magnification.

Solution

Image distance = 25cm = 0.25m

Object height = 2m

Object distance = 10m

$$\textbf{Linear magnification} = \frac{\textbf{image height}}{\textbf{object height}} = \frac{\textbf{image distance}}{\textbf{object distance}}$$

$= \frac{\text{image height}}{2} = \frac{0.25}{10}$

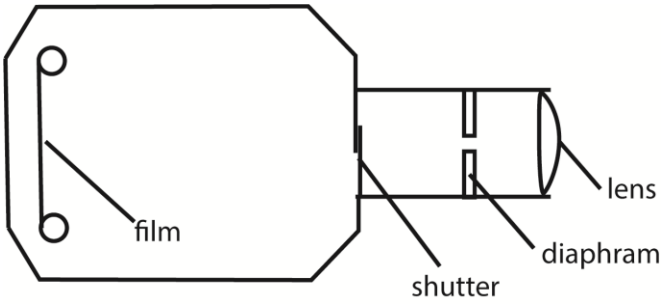
Image height = $\frac{0.25}{10}$ x 2

= 0.05m = 5cm

Linear magnification= $\frac{\text{image distance}}{\text{object distance}} = \frac{0.25}{10}$

= 0.025

Lens camera



- The lens focused light from the object on to film
- The diapragm controls the amount of light reaching the film
- The shutter controls the exposure time of ligh reaching the film

Differences between a pinhole camera and a lens commera

- in a pinhole camera the image is always focused while in a lens camera the image is brought to focus by adjusting the position of the lens.
- İn pinhole camera the intensity of light entring is fixed while in a lens camera the intensity of light entering is controlled by a shutter or diaphram.
- İn a pinhole camera the image distance is fixed while in a lens camera the image distanc is not fixed.

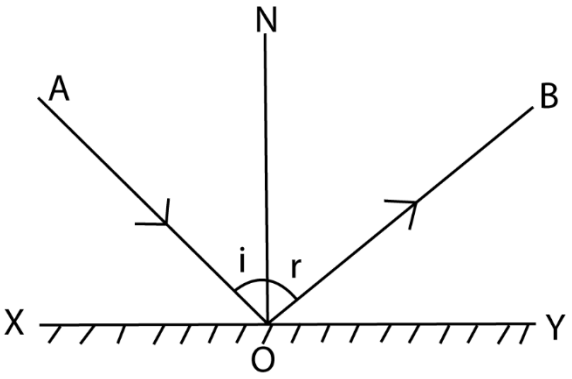
Differences between the lens of a camera and eye

- The between the lens and retina is fixed while that between the lens and film in camera is variable
- The focal length of the eyes lens is variable while thatof a comera is fixed
- Eye lens is living while the camera lens is artificial

Lesson 2

Reflection of light
Reflection is the process by which light energy falling on a body or surface bounces off. The surface from which reflection occurs is called the reflecting surface.

Types of rays



Incident ray (AO) is a ray of light from source of light falling on to the reflecting surface.
Reflected ray (OB) is a ray of light which has been bounced off from the reflecting surface.
Normal (ON) is one which at 90^0 with the reflecting surface. So this is incident and reflected along the same path

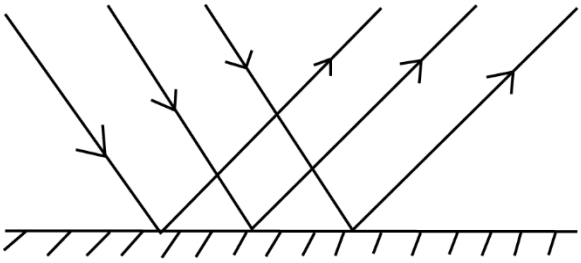
Angle of reflection (r) is the angle made by the reflected ray with the normal at the point of incidenceon the reflecting surface.
Angle of Incidence (i) is the angle made by the incident ray with the normal at of incidence on the reflecting surface.

The laws of reflection
First of lawof reflection states that the incident ray, the reflected ray and the normal at the point of incidence all lie in the same plane.

Second law of reflection state that the angle of incidence is equal to angle of reflection.

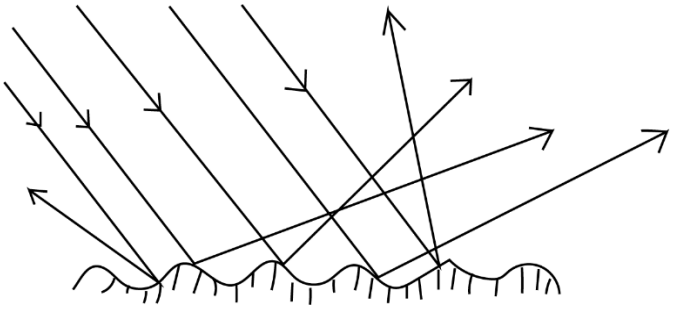
Types of reflection
There are two types of reflection namely:
-Regular reflection.
-Irregular reflection.

Regular reflection
Regular reflection occurs when a parallel incident beam strikes a smooth reflecting surface and a parallel reflected beam is obtained. Example of smooth plane surface is a plane mirror.



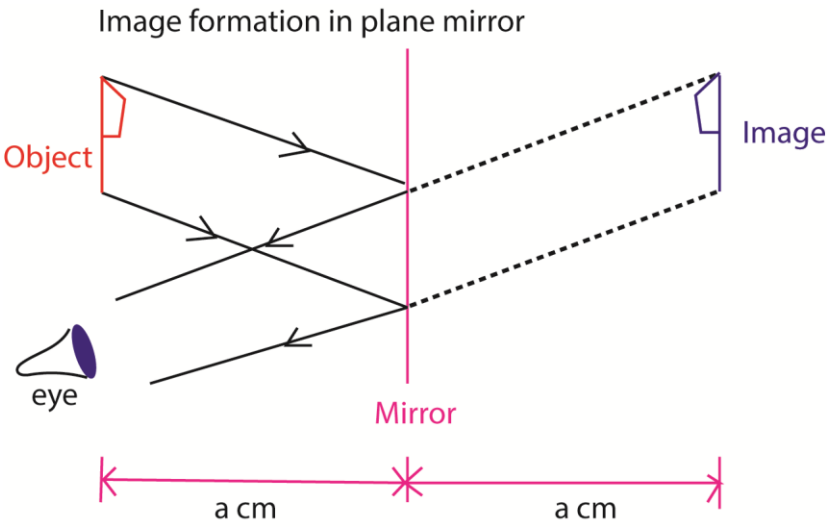
Irregular or diffused reflection

Diffuse reflection occurs when a parallel incident beam strikes a rough surface and a scattered reflected beam is obtained.



The images formed by a plane mirror

An image in a plane mirror is formed by reflection of light as shown below



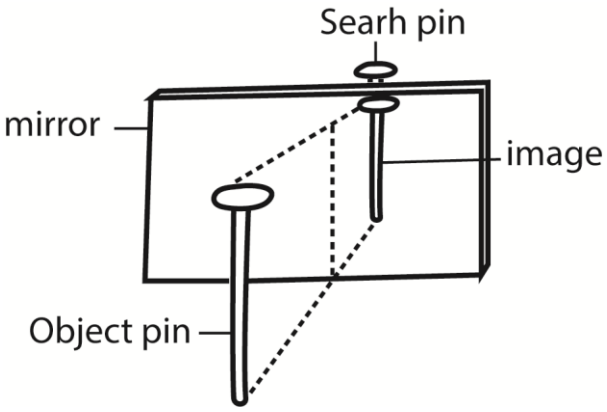
Properties of image formed by a plane mirror

- **(i)** İt is **virtual,** i.e. it cannot be produced on the screen and is formed by imaginary rays.
- **(ii)** İt is **Lateral inverted,** i.e., the right of the object is the left of the image and the left of the object is the right of the image
- **(iii)** Same size as the object
- **(iv)** Same distance from the mirror as the object
- **(v)** İt is erect

Note: The linear magnification produced by a plane mirror is **1** sinceImage distance from the mirror is equal to object distancefrom the mirror. Andthe image size is equal to the objectsize.

Formation of image by no parallax in plane mirror

1. Obtain a sheet of paper and draw a mirror line.
2. Place the mirror on the line as shown.
3. Place the pin at least 5 cm from the mirror and obtain another pin (search pin)
4. Move the serch pin behind the mirror to locate the position of the image where there is **no parallax** and place your second pin.

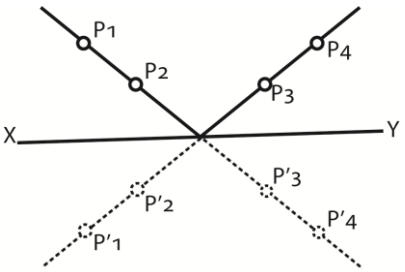


The **principle of reversibility of light**

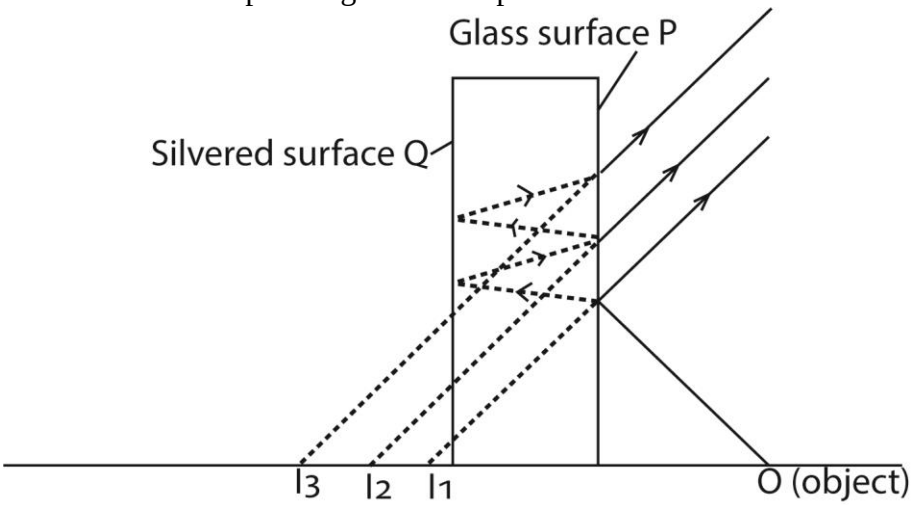
Sstates that **light** follows the same path if the direction of the travel of **light** is reversed

Experiement to demsntrate the principle of reversibility of light

1. A flash of light normal to the plane mirror surface is reflected through the same path
2. By locating the images of two pin after reflection through the plane mirror by no parallax method.
    - Two pins P_1 and P_2 are fixed vertically in front of the plane mirror XY
    - Viewing from the other side Y, pins P_3 and P_4 are placed such that they appear to be in line with the images of of P_1 and P_2 in the mirror.
    - When viewed from side X, the images of P_3 and P_4 will be seen to be in line with pins P_1 and P_2
    - This shows that light through pins P_1 and P_2 to the mirror then through P_3 and P_4 reverses through the same path from P_4 to P_3 to Mirror then to P_2 and P_1.



Formation of multiple images in thick plane mirror



Multiple images are formed due to partial reflection and refraction at the non silvered surface of the mirror.

- İmage I_1 is formed by reflection on the glass surface P
- The image I_2 (the brightest is formed by reflection of the most light on the silvered surface Q
- Others by partial refraction

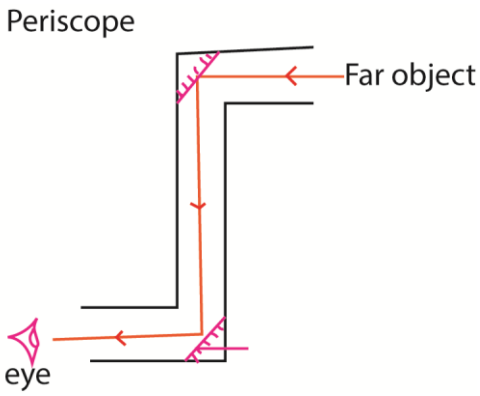
Parallax

Parallax is the apparent relative motion of two objects due to the movement of the observer. As one travels in a car, trees, houses and other fixed objects seem to be in motion relative to one another. Parallax occurs only when the objects are at a distance from one another. For this reason parallax can be used to locate images in a plane mirror.

Uses plane mirrors

(i) Submarine periscope

The arrangement has two plane mirrors, each fixed at 45°. Light from the object is turned through 90° at each reflection.



(ii) Pointer instruments

A plane mirror in the scale of the pointer instruments facilitates the correct reading of the value.

(iii). Optical lever

Plane mirrors are sometime attached to the galvanometer, such that light falling on the mirror as the galvanometer rotates is reflected over the scale.

(iv). Kaleidoscope

Inclined mirrors are used in Kaleidoscopes for producing differentpatterns of objects placed between them.

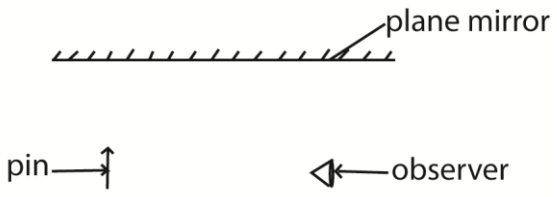
Revision questions

1. The brightness of the image formed by a pin hole camera depends on
   A. the size of the object
   B. The shape of the object
   C. the size of the pinhole
   D. the shape of the pinhole

2. When reflection occurs in a plane mirror
   A. the image is real, erect and magnified
   B. the angle of reflection is equal to the angle of incidence
   C. the incident ray and reflected ray lie in different planes
   D. the object and the real image are at the same distance from the mirror

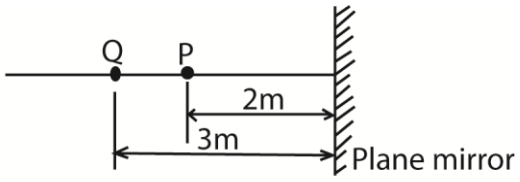
3. A pun-hole camera, sharper and taller images are obtained by
   A. widening the hole and moving the object farther
   B. narrowing the hole and moving the object nearer
   C. using a longer camera with a wider hole
   D. using a shorter camera with a narrower hole

4.



A person observes the image of a pin placed infront of a plane mirror as shown in the figure above. The reflected beam from the pin reaching the observer is a
   A. virtual beam
   B. divergent beam
   C. parallel beam
   D. convergent beam

5.



Objects P and Q are placed at distances of 2 m and 3 m respectively from a plane mirror as shown in figure 7. find how far the image of P is from Q.
   A. 1m. B. 4m. C. 5m. D. 7m.

6. When a pin hole camera is moved nearer an object, the size of the image
   A. remains the same
   B. becomes smaller
   C. becomes larger
   D. becomes diminished

7. Ligtht; energy is reflected when,
   A. angle of incidence is greater than angle of reflection.
   B. angle of incidence is equal to ancle of refraction,
   C. angle of incidence is equal to angle of reflection.
   D. the normal at the point of incidence iviakey the same angle us the incident ray.
8. When does the eclipse of the moon occur?
   A. When the moon is between the sun and the earth
   B. When the earth is between the sun and the moon
   C. When the sun is totally eclipsed by the moon
   D. When a bright ring of sun light shows round the age of the moon

9. The image formed in a plane mirror is
   (i) the same distance behind as the object is infront.
   (ii) laterally inverted.
   (iii) magnified and virtual.
   A. (i) and (ii) only. B. (i) and (iii) only.
   C. (ii) and (iii) only. D. (i), (ii) and (iii).

10. Which one of the following is true about a periscope? It
   A. gives a laterally inverted image.
   B. is used to observe an obscured object.
   C. is used for viewing distant objects.
   D. gives a magnified image of the object.

11. Two plane mirrors M_1 and M_2 are inclined to each other at an angle of 70°.

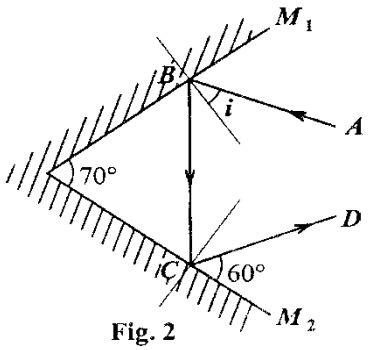


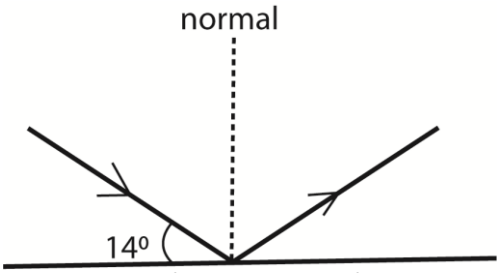
Fig. 2

If the ray AB incident on M\ is reflected as shown in figure 2, find the angle of incidence, *i*.
   A. 40°. B. 50°. C. 60°. D. 70°.

12. Which of the following statements are true?
   (i) surfaces which reflect all colours of light appear white
   (ii) Red surfaces absorb all colors and reflect only red light
   (iii) Black surface appear black because they reflect all colours.
   A. (i) only
   B. (i) and (ii) only
   C. (i) and (iii) only
   D. (iii) only

13. Light energy is reflected when.
    A. angle of incidence is greater than angle of reflection
    B. angle of incidence is equal to angle of reflection
    C. angle of reflection is greater than angle of incidence
    D. the normal at the point of incidence makes an angle less than 90^0

14. The figure below shows an incident ray of light at an angle 140 to the reflecting surface, find the angle between the incident ray and the reflected ray



A. 28^0 B 76^0 C. 152^0 D. 166^0

Marking guide for objective

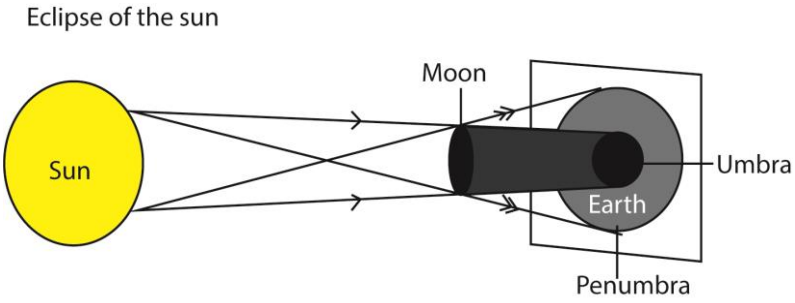
1	C	4	C	7	C	10	C	13	B
2	B	5	C	8	B	11	A	14	C
3	B	6	C	9	A	12	B	15	

Section B question

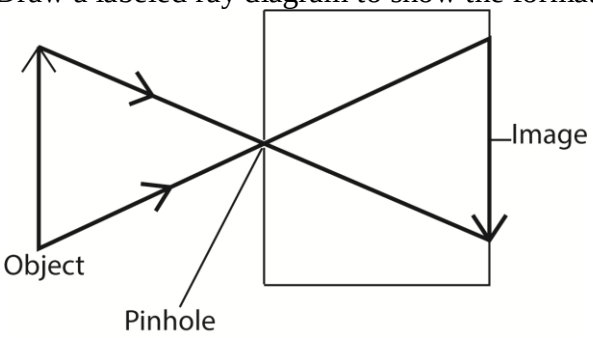
1. A person stands 3.0m in front of a plane mirror. If the mirror is moved away from the parson by 0.5cm. What is the distance between the person and the person's image in the mirror?

Solution
Object distance = 3 + 0.5 = 3.5m
Image distance = 3.5m
Total dist

1. Sketch a diagram to show the formation of a solar eclipse.



2. (a) Draw a labeled ray diagram to show the formation of an image in a pin-hole camera.



(b) State the effect on the image on a pin-hole camera of

(i) enlarging the pin-hole

Image become bright and blurred

(ii) decreasing the distance between the pin-hole and the film

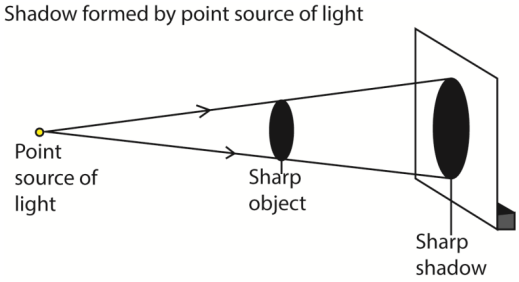
İmage become dinished and brighter

3. (a) What is meant by rectilinear propagation of light?

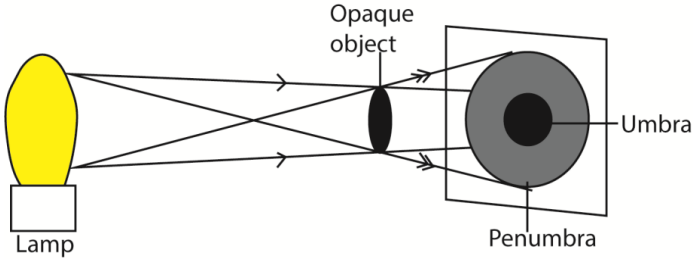
Light travels in straight line

(b) An opaque object is placed in front of a source of light. Draw ray diagrams to show the formation of shadows when part

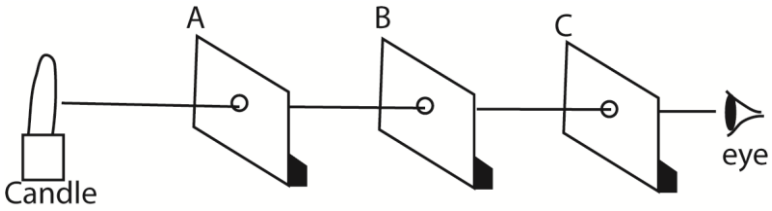
(i) A point source is used



(ii) an extended source is used



4. (a) Describe an experiment to show that light travels in straight line



(i) Equal square cards A,B and D are cut from piece of thick paper board each with a hole in the middle.

(ii) When the card are arranged as shown above with their holes in a straight line light passes through and seen on the other end.

(iii) İf the middle card is displaced such that its hole is removed from the line, light is cut of from the other end

(b) (i) What is the nature of the image

- İnverted
- real

(ii) Explain what happens to the image if the pinehole is made larger, incresing the image distance, and increasing the object distance

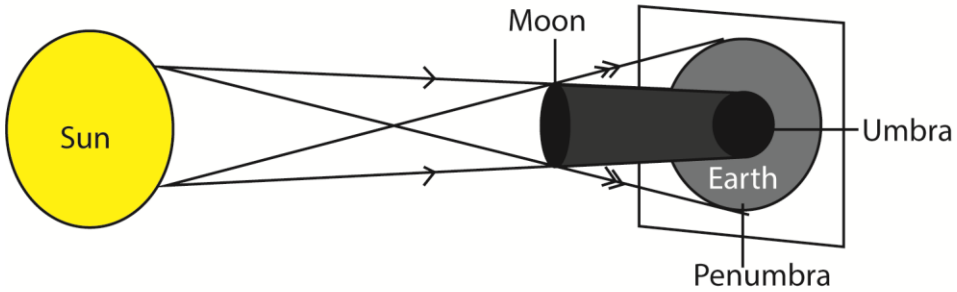
İmage be blurred but bright due to much light entering the camera

(iii) give two differences between a pinhole camera and a lens commera

- in a pinhole camera the image is always focused while in a lens camera the image is brought to focus by adjusting the position of the lens.
- İn pinhole camera the intensity of light entring is fixed while in a lens camera the intensity of light entering is controlled by a shutter or diaphram.
- İn a pinhole camera the image distance is fixed while in a lens camera the image distanc is not fixed.

(c) Draw a diagram to show formation of solar and lunar eclipse

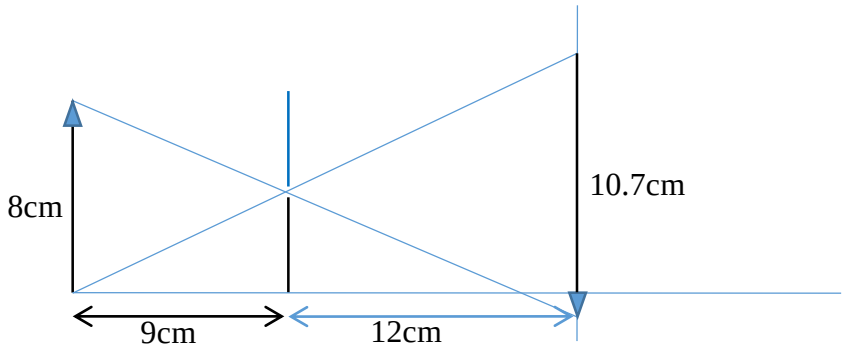
Eclipse of the sun



6. (a) Describe an experiment to show that light travels in a straight line.

(b) An object of height 8cm is placed 9cm away from a pin hole camera. The screen is 12 cm from the pinhole

(i) Draw to scale a raydiagram to show the formation of the image by pinhole camera.



(ii) What is the nature of the image?

İnverted

Real

Magnified

(iii) Find the magnification.

Magnification = $\frac{Image\ height}{object\ height} = \frac{10.7}{8} = 1.3$

(iv) Explain what happenes to the image if

- the pinhole is made larger,
- İncreasing the image distance
- İncreasing object distance

(c) Draw diagrams to show the formation of

- a solar eclipse
- lunar eclipse

7. (a) What do you understand by the terms

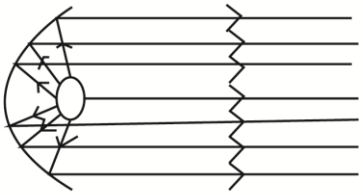
(i) deffuse reflection

Diffuse reflection occurs on a rough surface, a parallel beam is reflected in different directions

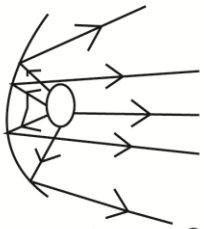
(ii) regular reflection in reference to light

Regular reflection occurs on a smooth surface; a parallel beam is reflected as a parallel beam.

(b) Using diagrams, why is a parabolic mirror most suitable for use in car headlight?

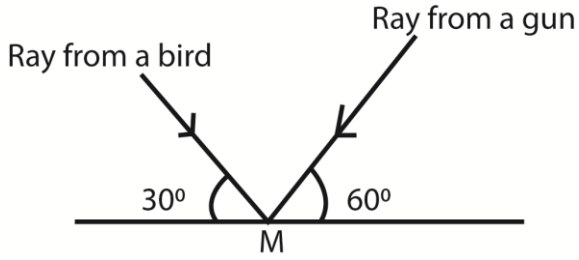


parabolic mirror reflect
strong beam of light



Concave mirror reflect
dull beam of light

(c) A ray from a bird makes an nagle of 30^0 with a plane reflector and a ray from from the barrel of a gun B makes an angle of 60^0 to the same reflector at the same point, M, as shown in the figure below



Find the angle through which the reflector must be rotated about M such that the ray from the barrel of the gun makes the same angle as the ray from the bird.

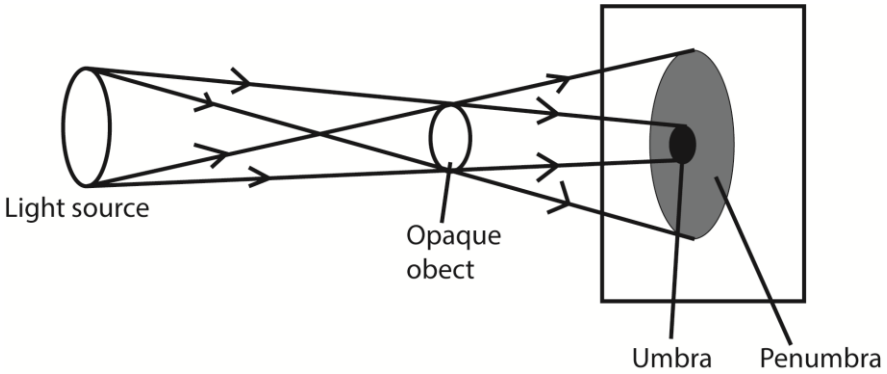
$30 + \theta = 60 - \theta$

$2\theta = 30$

$\theta = 15^0$

8.(a) Explain with aid of ray diagram, the formation of umbra and penumbra

Umbra and penumbra are formed when an opaque object is placed between light from extendd source and the screen.

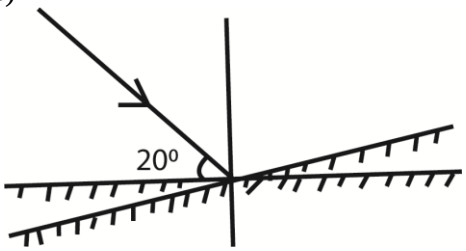


The shadow in the center umbra does not receive any light; the partal shadow penumbra receives some light.

(b) define the term leteral inversion as applied to mirrors.

İs the formation of the image in the plane mirror where the light hand side of the object appears to be the left hand side of the image.

(c)



An incident ray makes an angle of 20^0 with theplane mirrorin position M_1 as shown in the diagram above . What will be the angle of reflection, if the mirror is rotated through 6^0 to position m_2 while the direction of incidence remain the same?

After rotation of the mirror, the glancing angle becomes 20 + 6 = 26
The angle of incidence becomes 90 = 26 = 64^0
From the second law of reflection; angle of incidence = angle of reflection
Therefore, angle of reflection = 64^0.

9. (a) state the laws of reflection.

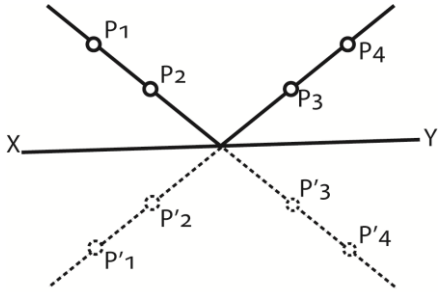
1st Law states that the incidence ray, the rflected ray and the normal at the point of incidence all lie in the same plane.

2nd Law states that the angle of incidence is equal to angle of reflection.

(b) Describe a simple experiment to demonstrate the principle or reversibility of light.

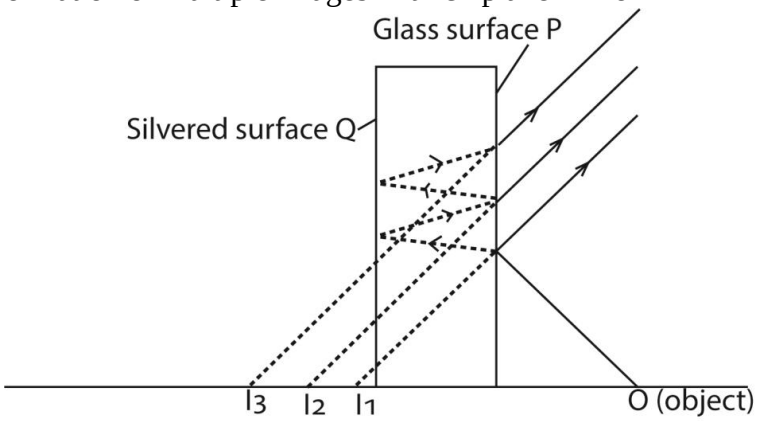
By locating the images of two pin after reflection through the plane mirror by no parallax method.

- Two pins P_1 and P_2 are fixed vertically in front of the plane mirror XY
- Viewing from the other side Y, pins P_3 and P_4 are placed such that they appear to be in line with the images of of P_1 and P_2 in the mirror.
- When viewed from side X, the images of P_3 and P_4 will be seen to be in line with pins P_1 and P_2
- This shows that light through pins P_1 and P_2 to the mirror then through P_3 and P_4 reverses through the same path from P_4 to P_3 to Mirror then to P_2 and P_1.



(c) With the aid of a labelled diagram, explain how a thich plane mirror forms multiple images

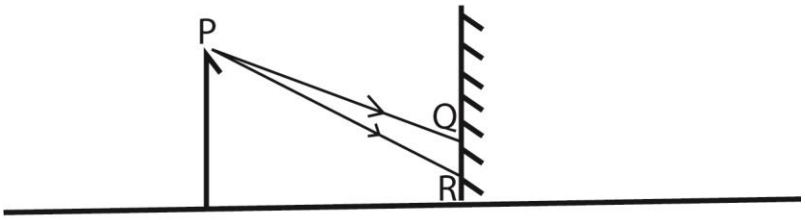
Formation of multiple images in thick plane mirror



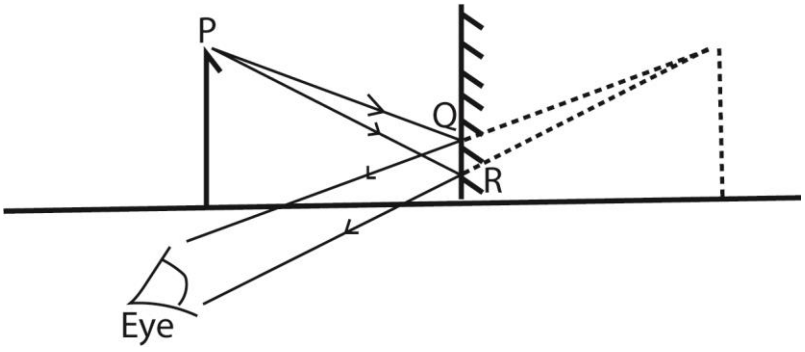
Multiple images are formed due to partial reflection and refraction at the non silvered surface of the mirror.

- İmage I_1 is formed by reflection on the glass surface P
- The image I_2 (the brightest is formed by reflection of the most light on the silvered surface Q
- Others by partial refraction

10. An object OP placed in front of a plane mirror as shown below



(a) Complete the ray diagrm to show the position of the image of OP using incident rays PQ and PR

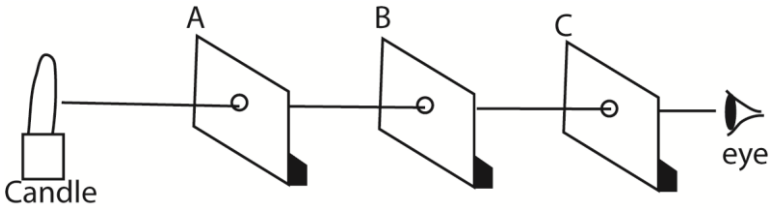


(b) Give two characteristics of images formed by a palne mirror.

- Virtual
- Erect same size as object
- Literally inverted
- Same distance as the object from the mirror

11. (a) What is light?
Light is a form of energy that enables us to seen.

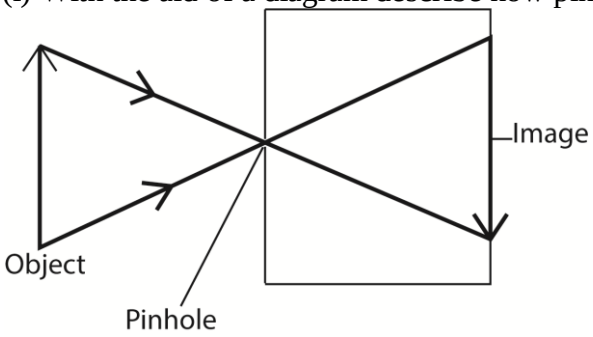
(b) Describe an experienent to show that light travels in straight line (04marks)



(iv) Equal square cards A,B and D are cut from piece of thick paper board each with a hole in the middle.
(v) When the card are arranged as shown above with their holes in a straight line light passes through and seen on the other end.
(vi) İf the middle card is displaced such that its hole is removed from the line, light is cut of from the other end

12. (a) State the laws of reflection (02marks)
- the incident ray, reflected ray and the normal at the point of incidence all lie in the same direction
- Angle of incidence is equal to angle of reflection.

(b) (i) With the aid of a diagram describe how pinhole camera works (03marks)



- Object is placed in front of the pinhole
- Rays from object enter the camera through the pinhole as shown to form an inverted image on the screen.

(c) State characteristics of images formed by pinhole camera
- İnverted
- real