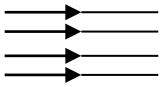
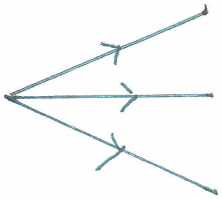
LIGHT

Light is a form of energy. It stimulates the retina of the eye and produces the sensation of sight. We see an object when light leaves it and enters the eye. Objects such as flames, the sum and stars produce their own light and are called luminous objects. Objects that do not give their own light are called non-luminous objects. Light travelling in some medium travels in a straight lines. A ray is a line with an arrow on it. The arrow shows the direction the ray of light is travelling.

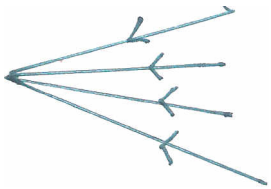
A beam is made up of several rays. It maybe parallel, diverging (spreading out) or converging (getting narrower).



Parallel



Diverging



Converging

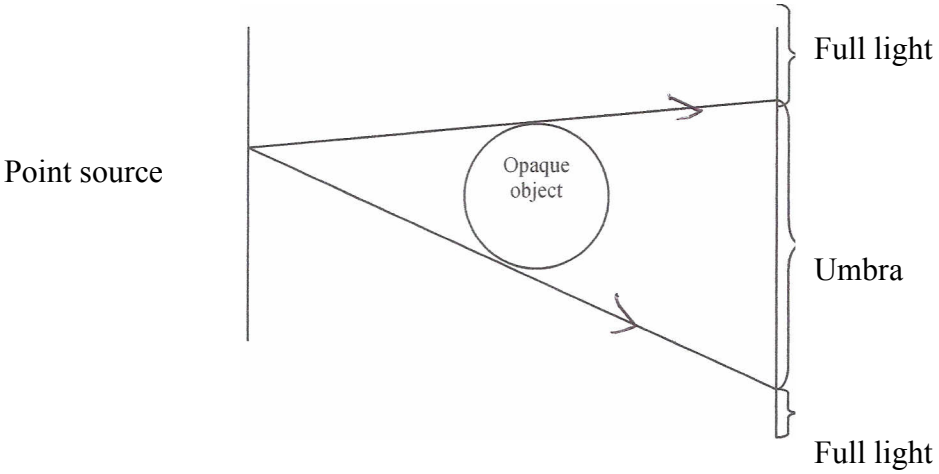
Task: The following terms are associated with light. Define and give 2 examples of each.

Luminous, non-luminous, opaque, transparent and translucent

Shadows

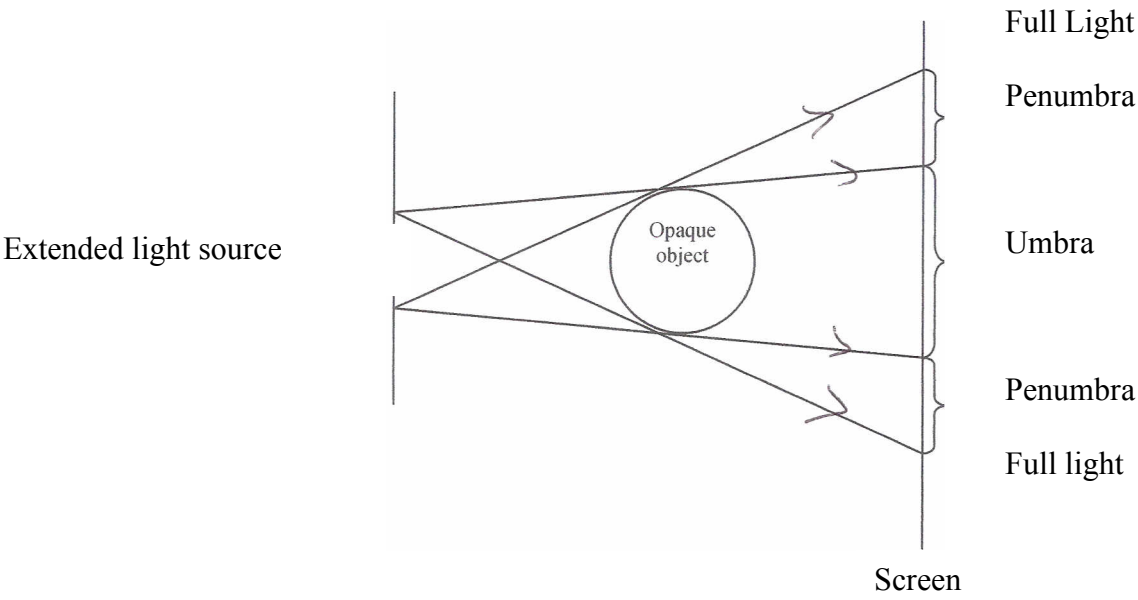
Shadows are formed when an opaque object blocks a light source. There are two types of light sources, **point source** and **extended source**.

Shadow formed by a point source.



An **umbra** shadow is a region of total darkness.

Shadows formed by an extended light source.



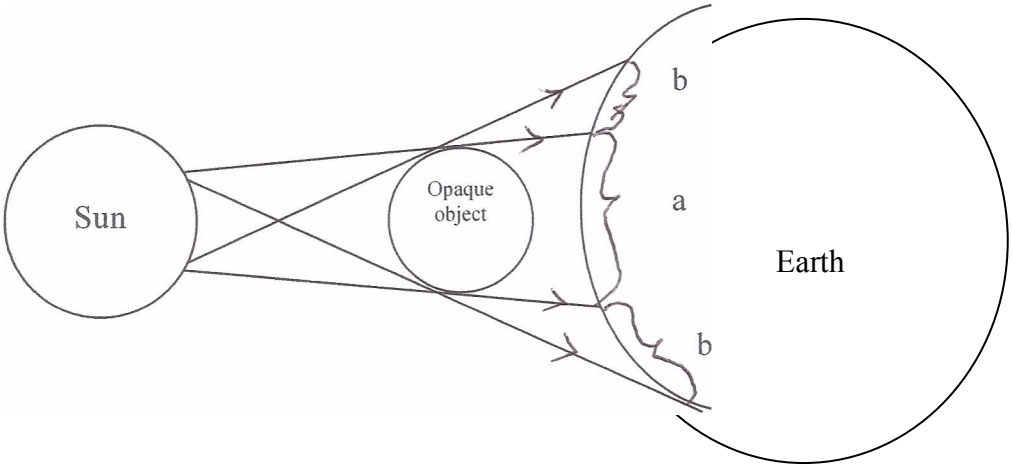
A **penumbra** shadow is a region of partial darkness. (Some light but not full light)

Eclipses

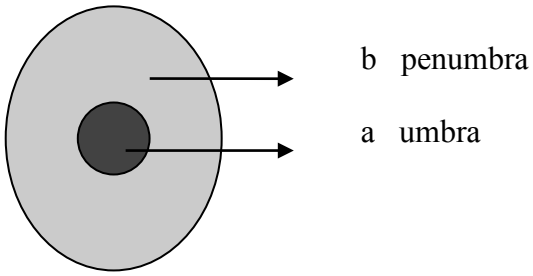
Eclipses are examples of large-scale shadow production.

A **solar eclipse** occurs when the moon is between the earth and sun. When a solar eclipse occurs, the earth falls into darkness. Since the moon travels around the earth every 29 days we might see a solar eclipse once a month. However, the moon and the earth do not orbit in the same plane and do not get in straight lines very often, hence total solar eclipses are very rare.

Eclipse of the sun (not drawn to scale)



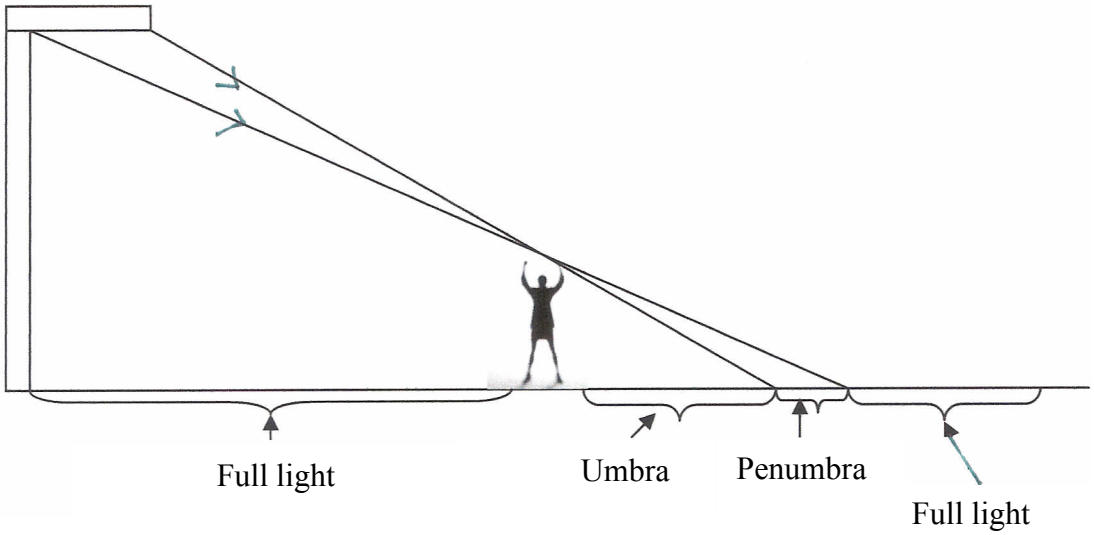
Front view of earth showing shadows.



Lunar eclipse

This is the eclipse of the moon and it occurs when the moon passes into the shadow of the earth. Lunar eclipse can only occur when the moon is on the opposite side of the earth from the sun (at full moon).

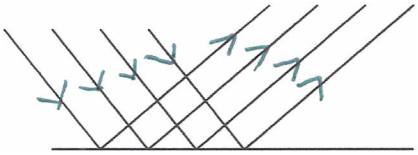
Shadows produced by a light post.



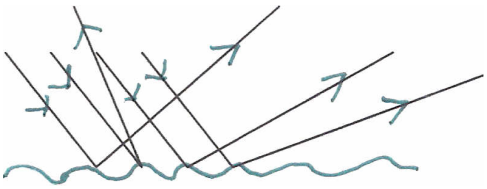
The further away the man walks from the extended light source the longer his shadow gets.

Reflection

When light strikes a surface it is reflected.



Mirror or polished surface



Rough surface

Mirrors

A plane mirror is a flat smooth reflecting surface by which regular reflection is used to form images.
When an object is placed in front of a mirror an image is seen.

Images formed by a plane mirror are

1. the same size as the object
2. the same distance behind the mirror as the image is in front
3. laterally inverted – left becomes right and right becomes left
4. virtual – light appears to come from the image

Mirror terms

CD is the symbol for a mirror.

NO is called the **NORMAL.** The normal is a line drawn at right angles to mirror surface.

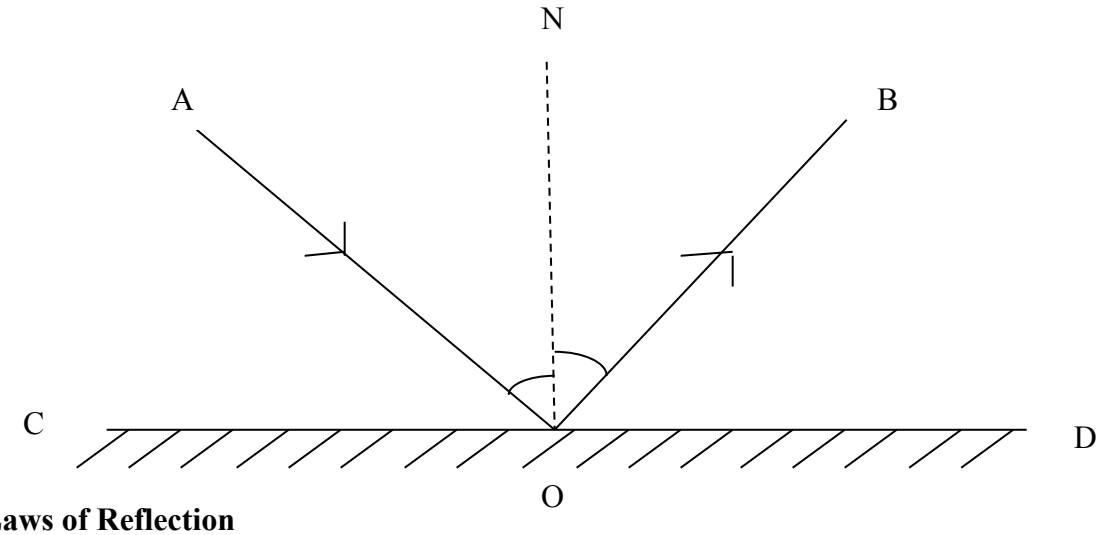
(Note it is dashed line).

AO is the **incident ray.**

Angle AON is called the **angle of incidence,** symbol **i**.

OB is the **reflected ray.**

Angles BON is called the **angle of reflection**, symbol **r**.

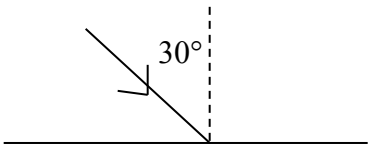


Laws of Reflection

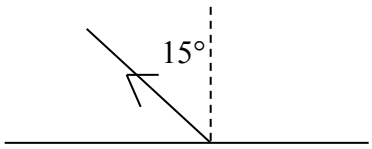
- The normal, the incident ray and the reflected ray all lie in the same plane.
- The angle of incidence is equal to the angle of reflection, **i = r**

Determine the angle of reflection and incidence for each of the following.

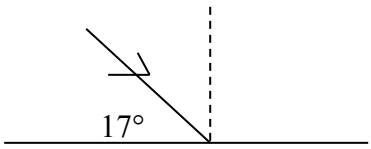
a)



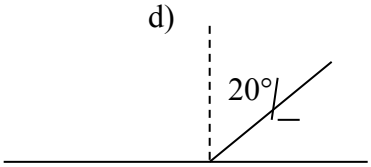
b)



c)



d)



Determine r from both mirrors

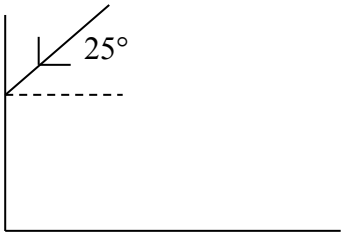
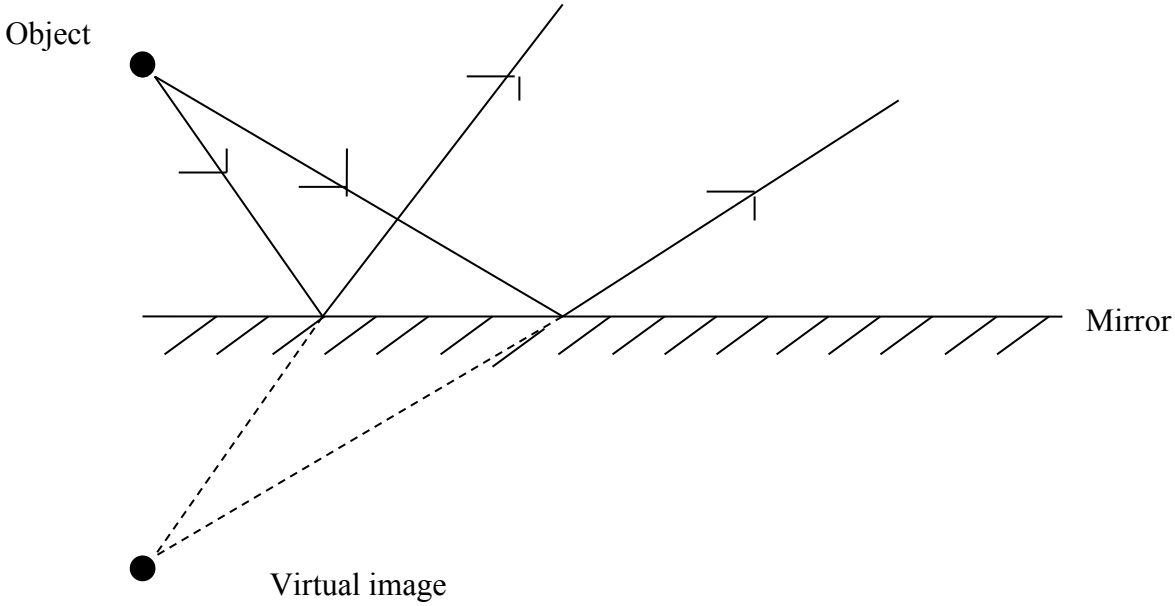


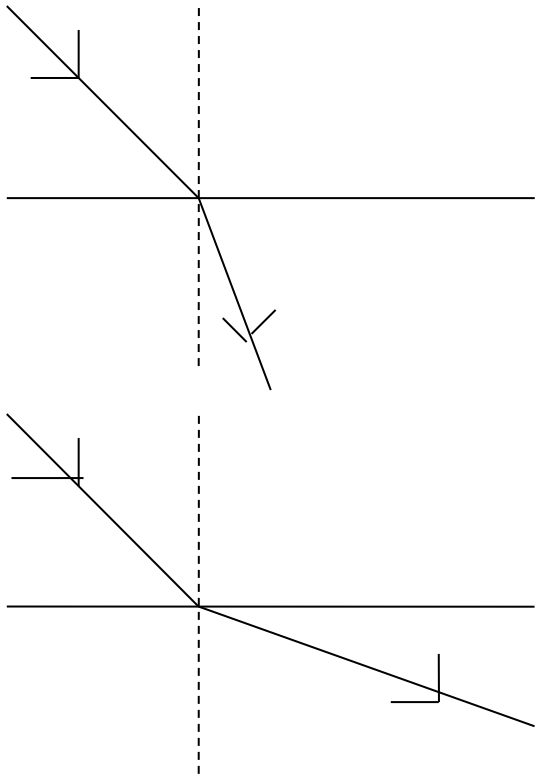
Image formed by a plane mirror



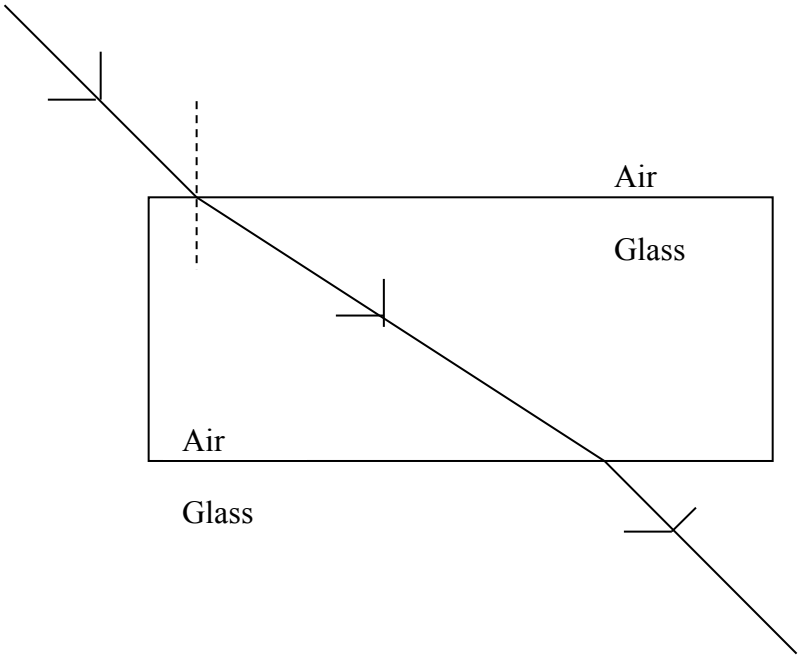
Refraction

Refraction is the bending of light. It occurs when light travels from one medium into another. Example when light travels from glass to water or water to glass. Glass and water are mediums.

Rules



Path of ray through a glass block.



Note the incident ray and the emergent ray is parallel.

Laws of Refraction

1. The incidence ray, the normal and the reflected ray all lie in the same plane.
2. ***Snell's Law***
   The ratio of the sine of the angle of the incidence to the sine of the angle of refraction is called the refractive index, ***n***.

$$\textit{refractive index (n)} = \frac{\sin i}{\sin r}$$

Example
Determine the refractive index when a) i = 12° r = 10°
b) i = 60° r = 35°

Refractive index
Ice 1.31; water 1.33; Perspex 1.49; glass 1.65

(1) If the angle of incidence is 30° determine the angle of refraction for each material

(2) If the angle of refraction is 15° determine the angle of incidence for each material

Answer No1 ice = 22.3° water = 22.3° Perspex = 19.9° glass = 18°
Answer No 2 ice = 19.8° water = 19.9° Perspex = 23° glass = 25.5°

Lenses
A lens is any glass, plastic or transparent refractive medium with two opposite faces, and at least one of the faces must be curved.

Types of Lenses

There are two types of basic lenses.

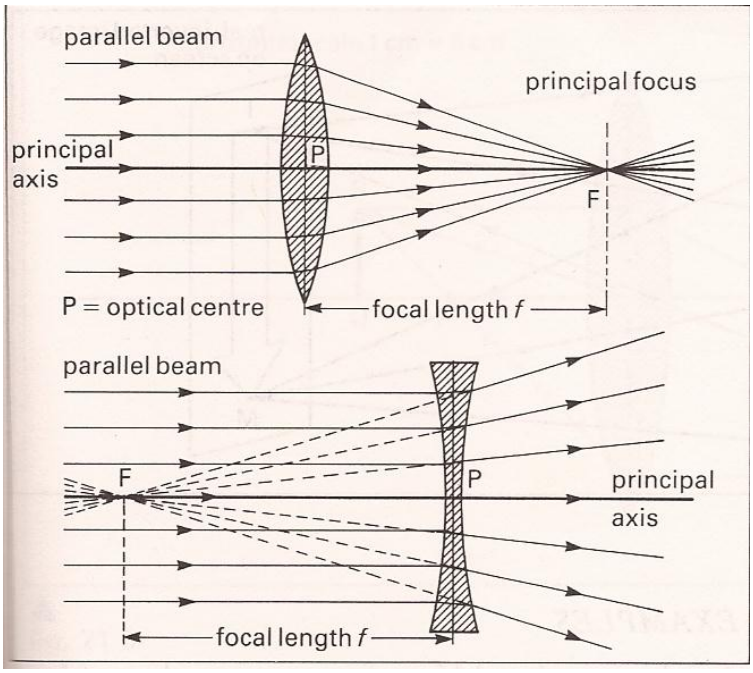
(1.) Converging/ Convex Lenses – These lenses are thicker in the middle than at the edge, and cause parallel beams of light to converge.

(2.) Diverging/ Concave Lenses – These lenses are thinner in the middle, than at the edge and cause parallel beams of light to diverge.

Terms used for lenses

Optical Centre – This is the point in the lenses, through which all rays will pass without any deviation. The centre of the lens is called the *pole* or *optical centre* **P**

Principal Axis – This is an imaginary line perpendicular which passes through the optical centre.



Principal Focus (F):

(a.) Principal Focus of a Convex Lens – This is the point on the principal axis to which parallel rays converge after reaction by the lens, after refraction.

(b) Principal Focus of a Concave Lens – This is the point on the principal axis from which parallel rays in a beam appear to diverge from after passage through the lens.

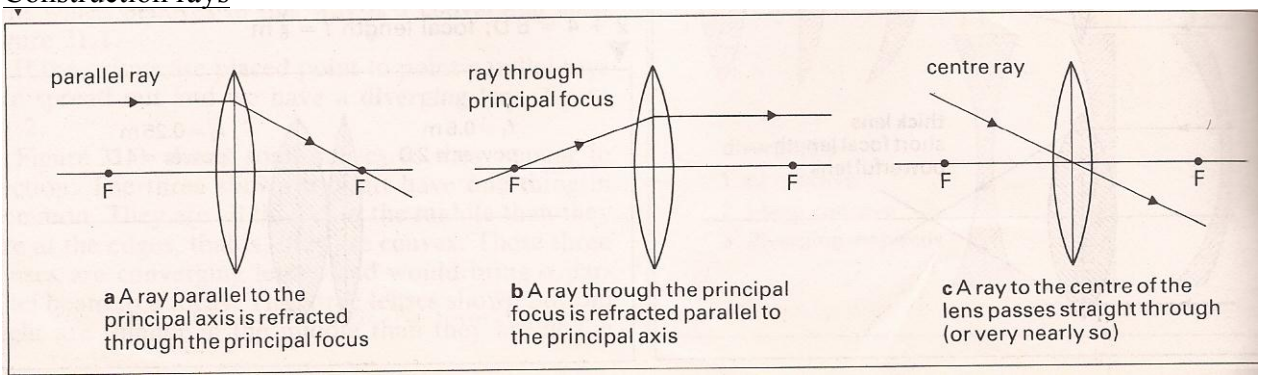
The distance of the principal focus from the optical centre of the lens is called the **focal length f**

Object distance-distance from object (O) to lens.
Image distance-distance from lens to image (I).
Nature of image – is the image real or virtual, erect or inverted.

Ray diagrams to determine location of image

All rays from a point on the object, after passing through the lens come to a focus to form a point on the image.

Construction rays



A B C

Sample question

An object is placed 15 cm from a convex lens of focal length 10 cm. Determine the position, height and nature of the image. Horizontal scale 1 cm = 5 cm.

The position, height and nature of the image are found by scale diagram on graph paper. A sharp pencil and a ruler are required for accurate results.

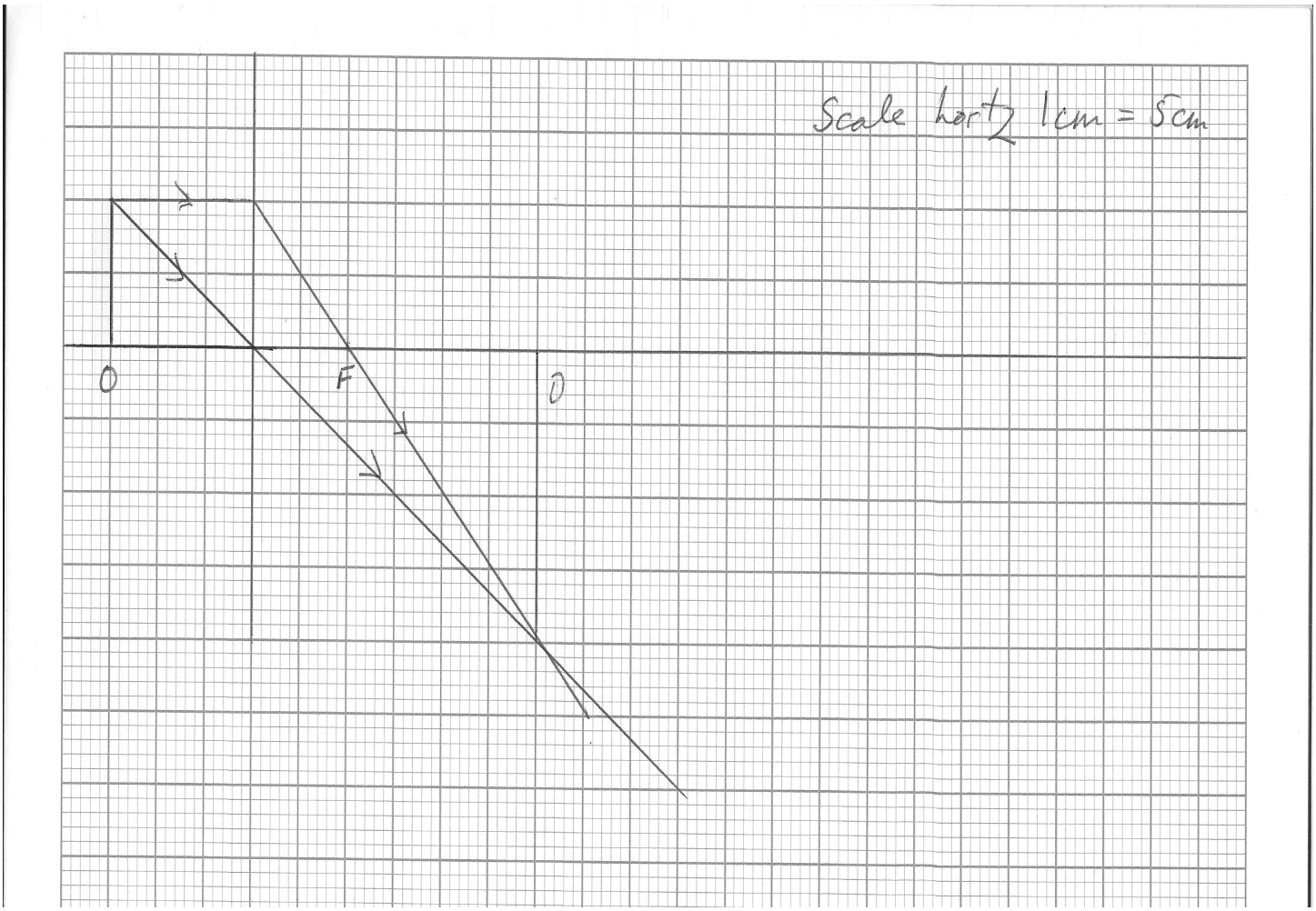
Step 1 Draw a horizontal line 4 squares (4 cm) from the top of the page (landscape). This is the principal axis.
Step 2 Position your rule 4 squares from left edge of graph paper. Draw a vertical line 8 squares (8 cm) long. This is the lens.
Step 3 No height was given for the object. Let us assume it is 2cm tall (2 squares). The object is 15 cm from the lens, using our scale this is 3 cm on our diagram.

3 cm (3 squares) from the lens on the left hand side draw a vertical line 2 squares height. Label line O.

Step 4 The focal length is 10 cm, using our scale this is 2 cm on our diagram. Place a small dot 2 cm (2squares) from the lens on the right hand side. Label this F.
Step 5 Apply construction ray rule A. Starting from the top of the object.
Step 6 Apply construction ray rule C. Starting from the top of the object.
Step 7 Where the two lines from step 5 & 6 intersect is the location of the top of the image.
Step 8 Draw a vertical line from this point to the principal axis.

Solution

Position	Determine the image distance from your diagram 6 cm. Using your scale this is 30 cm (6 X 5)
Height	The image is 4 squares height. Height is 4 cm (no scale was used for object)
Nature	inverted and real
Solution:	the image is 4cm height, located 30 cm from the lens. It is real and inverted.



Magnification

Magnification (M) = $\frac{\text{height of image}}{\text{Height of object}} = \frac{4}{2} = 2$

OR M = $\frac{\text{image distance}}{\text{Object distance}} = \frac{30}{15} = 2$