Geometric Optics

Physics – Leaving Cert

Quick Notes

Geometric Optics

Properties of light

Light is a form of energy. As such it can be converted into other forms of energy.

We can demonstrate this using a Solar cell – this is a device which converts light energy into electrical energy.

Light travels in straight lines – this is why shadows have straight edges.

Reflection of Light

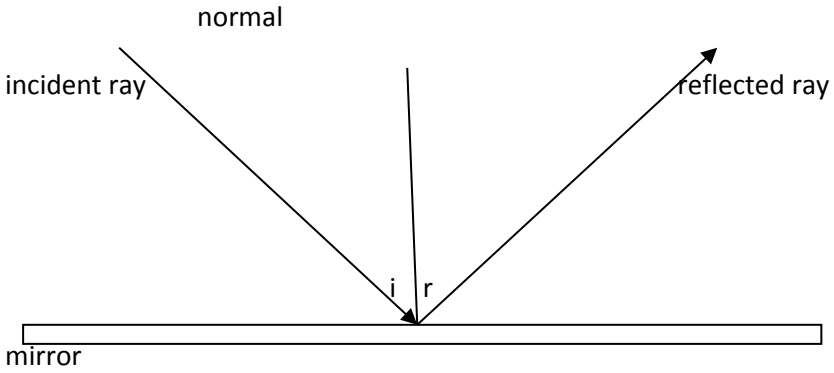
Reflection of light is the bouncing of light off an object

Plane Mirrors

There are two types of reflection

Diffuse reflection – when light shines onto a rough surface and is scattered in all directions (this is the case for most objects we see)

Regular reflection – when light shines onto a highly polished smooth surface – the light reflects in a regular way.



Laws of Reflection:

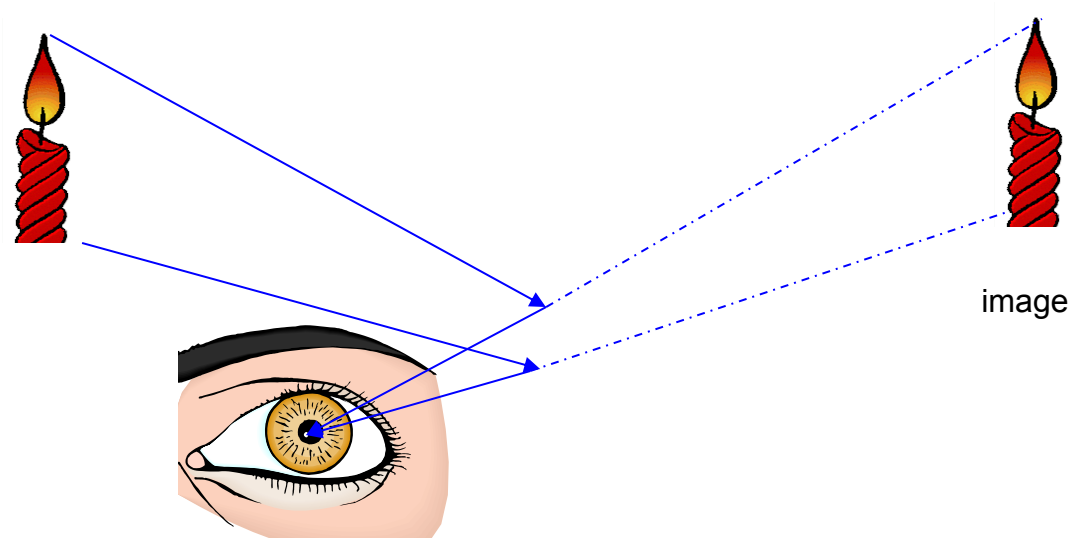
The incident ray, normal at the point of incidence and reflected ray all lie in the same plane

The angle of incidence = angle of reflection i = r

Note: The angles of incidence and reflection are always measured from the normal (imaginary line perpendicular to the surface.

Image formation in a plane mirror:

Each ray reflects off the mirror obeying the laws of reflection (i = r). To the observer looking at these reflected rays, the rays seem to have travelled in straight lines, so seem to have come from a point behind the mirror.



Note: the light rays are not actually passing through the mirror – the simply appear to have come from there. Such an image is called a virtual image

A real image is formed by the actual intersection of light rays. It can be formed on a screen.

A virtual image is formed by the apparent intersection of light rays. It cannot be formed on a screen

Properties of image formed in plane mirror

Image is

Laterally inverted(left to right)

Same size as object

Same distance behind mirror as the object is in front

Virtual

No Parallax: When locating an image we use the method if no parallax. This means lining up the image with a search pin such that when you move your head from side to side they stay lined up (no relative motion)

Spherical mirrors

There are two basic types of curved mirror

Concave mirror – curves inwards

Convex mirror- curves outwards

Rules for image formation in a plane mirror

Angle of incidence = angle of reflection

Ray of light coming in parallel to principal axis is reflected out through the focus

Ray of light coming in through the focus is reflected out parallel to principal axis

Ray of light which comes in through the centre of curvature is reflected back along its own path

The image is formed where these rays meet

(These rules assume that the curvature of the mirror is small)

For a curved mirror the size, nature and location of the image depends on the size and location of the object.

For a concave mirror

Object outside C	Image is real, inverted , diminished , located between F and C
Object at C	Image is real, inverted, same size as object, located at C
Object between C and F	Image is real, inverted, magnified, located outside C
Object at F	Image at infinity
Object inside F	Image is virtual, erect, magnified, located behind the mirror

Rays of light coming from a distant object all arrive at the mirror as a parallel beam and hence are reflected through the focus – the image of a distant object is always at the focus.

Calculation of image position and size

In performing these calculations the ‘real is positive’convention is used. Real distances are given by positive numbers; virtual distances are given by negative numbers.

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

Where f = focal length, u = distance from object to mirror, v = distance from image to mirror.

$$magnification\ (m) = \frac{image\ height}{object\ height} = \frac{image\ distance}{object\ distance} = \frac{v}{u}$$

Uses of concave mirrors: reflector in headlights, make-up mirror, dentist mirror.

For a convex mirror:

The same rules for image formation apply, the difference being that the centre of curvature and the focus are now both behind the mirror, hence

Ray of light coming in parallel is reflected **as if it came from the focus**

Ray of light **heading for the focus** comes out parallel to the axis

The image formed in a convex mirror is always virtual, diminished and located behind the mirror.

The same formulae can be used for a convex mirror remembering that v and f will always be negative in these calculations.

Uses of convex mirrors:

As the image is always diminished, a convex mirror gives a wide field of view – hence used at concealed entrances, rearview mirror in car.