Reflection: Images produced by Flat Mirrors

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When light strikes a polished surface it is reflected.

A **mirror** is any polished surface that exhibits reflection.
[Most mirrors consist of two parts: the front part is a sheet of glass, and the back part is a thin layer of reflective silver or aluminium. The reflective part of a mirror is the shiny thin film on the back. The glass protects the thin film and helps in the physical appearance of the mirror.

A **plane** mirror is used to demonstrate the path of light when it hits the mirror. A plane mirror is a mirror with a flat, reflective surface.

Reflection is the bouncing back of light from any surface. The symbol that is used to represent a mirror is only the reflective thin film.]

An **image** is a reproduction of an original object that is produced through the use of light.

The **incident ray** is the original incoming ray of light approaching the reflecting surface, while the **reflected ray** is the ray of light bouncing off/ leaving the reflecting surface.

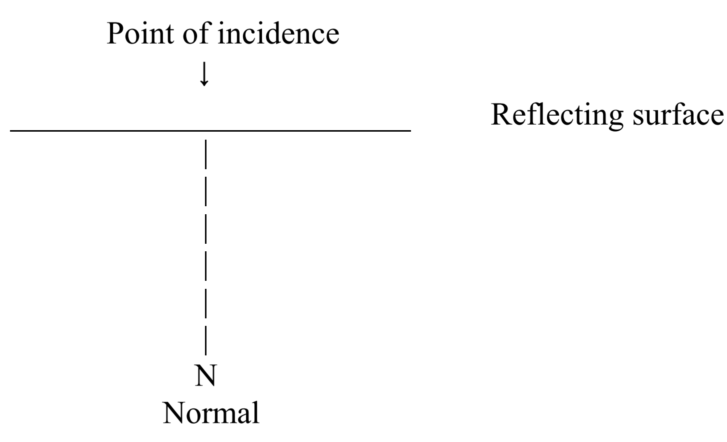
The **point of incidence** is the location where the incident ray strikes the reflecting surface.

The **angle of incidence, i** is the angle between the incident ray and the normal while the **angle of reflection r** is the angle between the reflected ray and the normal.

The **normal, N** is a line drawn perpendicular or right angles to the surface at the point of incidence. [Because angles of incidence and angles of reflection are difficult to measure from curved surfaces, scientists measure them with the help of the normal line.]

A diagram illustrating these features is called a **ray diagram**.

Draw a ray diagram and label the following terms: incident ray, reflected ray, normal, point of incidence, angle of incidence, angle of reflection.



The Laws of Reflection

The light falling on the surface of a mirror is reflected.

If the angle between the mirror and the incident ray is 90^0, then the reflected ray bounces straight back.. Thus the angle of incidence and the angle of reflection are both 90^0.

The two laws of reflection may be summarized as:

1. The angle of reflection, r is always equal to the angle of incidence, i. This may be written using mathematical symbols. (The Greek letter theta, θ , is commonly used as the symbol for an angle.) Thus, if the angle if incidence is θ_i and the angle of reflection is $\theta_{r,}$ then the law of reflection may be written as:

$$\theta_i = \theta_{r,}$$

2. The incident ray, the reflected ray and the normal all lie in the same plane, (i.e. the same level surface). The incident ray, the reflected ray and the normal are coplanar.

The law of reflection, (when light reflects off a surface, the angle of incidence is equal to the angle of reflection), is used to design reflective tail lights for bicycles. A tail light is designed to reflect light from the headlights of the car behind it. This helps to make the bicycle more visible to the driver of the car.

Specular and Diffuse Reflection

When a series of parallel rays are incident on a smooth surface such as a plane mirror, then the angles of incidence for these rays are all the same.

This therefore means that their angles of reflection will also all be identical and hence the rays are reflected as a parallel beam.
The reflection of light off a smooth, shiny surface is called **specular reflection** or **regular reflection**.

Examples specular reflection is the reflection of very still water, or a piece of aluminium foil, or reflection of light from a disco mirror ball in clubs and parties.
(A disco ball consisting of a number of plane mirrors on a spherical surface that produces an eye catching display by reflecting light in all directions.)

When a parallel beam is incident on an irregular/rougher surface, such as a sheet of white paper, a wooden surface, a non-gloss paint, water surface with waves or wrinkled aluminum foil, then the reflected light is scattered in many directions.

This is because the incident rays all have different angles of incidence, thus their angles of reflection would also be different; hence the emergent reflected beam would not be parallel but would be scattered in many different directions. This behaviour is called **diffuse reflection** or **irregular reflection**.
This is why non-gloss paint gives a softer effect than high-gloss paint!

Assignment

1. Draw a ray diagram in which the angle of incidence is 45^0.

2. Why are normals used in light ray diagrams?

3. State the two laws of reflection, and draw a ray diagram to illustrate the first law of reflection.

4. a. What would be the angle of reflection for an angle of incidence of 32^0 ?

b. What would be the angle of incidence for an angle of reflection of 47^0 ?

c. What would the angle of reflection be if the incident ray was 40^0 from the reflecting mirror surface?

5. Explain the difference between regular/specular and diffuse reflection.

6. If you were painting the walls in your classroom, would you want the walls to exhibit specular or diffuse reflection ? Explain.