Reflection of Light

i. What is Reflection of Light?

Reflection is the process where light hits a surface and bounces back into the same medium (like air).

- **Simple Analogy:** Think of throwing a rubber ball against a wall. The ball hits the wall and bounces back. Light behaves in a very similar way.

- **Why is it important?** We see most objects around us (like your book, a chair, or the moon) because light from a source (like the Sun or a light bulb) hits these objects and reflects into our eyes. Objects that don't produce their own light are called non-luminous objects.

A simple diagram showing a light source, light hitting a book, and then reflecting to an eye.

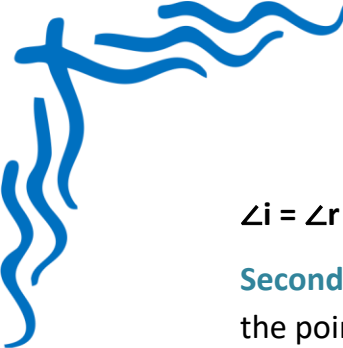## ii. Key Points and Important Terms

To understand reflection, we need to know some important terms. These are best understood with a diagram.

- **Mirror/Reflecting Surface:** A smooth, polished surface that reflects light. We usually draw it as a straight line with dashes on one side to show the non-reflecting part.

- **Incident Ray:** The ray of light that falls on the surface. (The incoming ray).

- **Reflected Ray:** The ray of light that is sent back by the surface after reflection. (The bouncing ray).

- **Point of Incidence:** The point on the surface where the incident ray strikes.

- **Normal:** An imaginary straight line drawn at a right angle (90°) to the surface at the point of incidence. This is a very important line! We use it to measure our angles.

- **Angle of Incidence (∠i):** The angle between the incident ray and the normal.

- **Angle of Reflection (∠r):** The angle between the reflected ray and the normal.

iii. The Laws of Reflection

Reflection of light from a smooth surface follows two simple laws:

First Law of Reflection: The angle of incidence is always equal to the angle of reflection.

∠i = ∠r

Second Law of Reflection: The incident ray, the reflected ray, and the normal at the point of incidence, all lie in the same plane.

Simple Explanation: Imagine the diagram of reflection is drawn on a flat sheet of paper. All three lines (incident ray, reflected ray, normal) will lie flat on that paper. The reflected ray won't suddenly pop out of the page or go into it.

Types of Reflection

Not all surfaces reflect light in the same way.

a) Regular Reflection (or Specular Reflection)

- **Surface:** Occurs on smooth and polished surfaces like a plane mirror, still water, or shiny steel.

- **How it works:** When parallel rays of light hit the surface, they are all reflected in the same direction, remaining parallel to each other.

- **Result:** It forms a clear and sharp image. This is why you can see your face in a mirror.
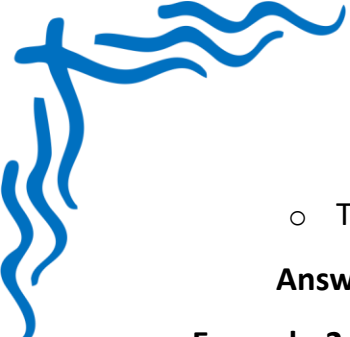
b) Irregular Reflection (or Diffuse Reflection)

- **Surface:** Occurs on rough or uneven surfaces like a wall, wood, paper, or a road.

- **How it works:** When parallel rays of light hit the surface, they are reflected in many different directions. This is because each point on the rough surface is angled differently, so the "normal" is different for each ray.

- **Result:** It does not form an image. Instead, it makes the object itself visible from all directions. This is why you can read a book from any angle, but you can't see your reflection in its pages.

iv. Detailed Examples with Solutions

Example 1: A ray of light strikes a plane mirror such that the angle of incidence is 40°. What is the angle of reflection?

- **Given:** Angle of Incidence (∠i) = 40°

- **To Find:** Angle of Reflection (∠r)

- **Solution:**

    o According to the First Law of Reflection, the angle of incidence is equal to the angle of reflection (∠i = ∠r).

- o Therefore, if ∠i = 40°, then ∠r = 40°.

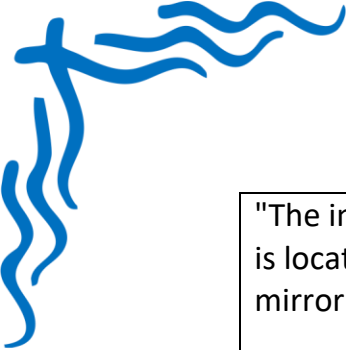**Answer:** The angle of reflection is 40°.

Example 2: A ray of light strikes a plane mirror at an angle of 30° with the mirror's **surface.** What is the angle of reflection?

- **Given:** Angle between the incident ray and the mirror surface = 30°.

- **To Find:** Angle of Reflection (∠r).

- **Solution:**

  - o **Step 1:** Find the angle of incidence (∠i).

    1. Remember, the normal is at 90° to the mirror surface.

    2. The angle of incidence (∠i) is the angle between the incident ray and the normal.

    3. So, ∠i = 90° - (angle with the mirror surface)

    4. ∠i = 90° - 30° = 60°.

  - o **Step 2:** Find the angle of reflection (∠r).

    1. According to the First Law of Reflection, ∠i = ∠r.

    2. Since ∠i = 60°, then ∠r = 60°.

  Answer: The angle of reflection is 60°.

v. Common Misconceptions and Clarifications

Misconception	Clarification
"We see things because light travels from our eyes to the object".	False. Light travels from a source (like the sun), reflects off an object, and then enters our eyes. Our eyes are detectors, not sources.
"The angle of incidence is the angle between the light ray and the mirror".	False. The angle of incidence (and reflection) is always measured from the Normal, not the surface of the mirror.
"Rough surfaces like paper or wood do not reflect light at all".	False. They reflect light, but they do it in a diffuse (scattered) way. This is precisely why we can see them. If they didn't reflect light, they would be invisible.

"The image formed by a mirror is located on the surface of the mirror".	False. For a plane mirror, the image appears to be located behind the mirror, at the same distance behind it as the object is in front of it.

vi. Practice Problems with Step-by-Step Solutions

Problem 1: If the angle of reflection for a light ray is 55°, what is its angle of incidence?

- **Solution:**
  - **Step 1:** Recall the First Law of Reflection: $\angle i = \angle r$.
  - **Step 2:** The problem gives $\angle r = 55°$.
  - **Step 3:** Therefore, the angle of incidence, $\angle i$, must also be 55°.
  - **Answer:** 55°.

Problem 2: A light ray hits a mirror. The angle between the incident ray and the reflected ray is 100°. What is the angle of incidence?

- **Solution:**
  - **Step 1:** The total angle between the incident and reflected ray is $\angle i + \angle r$. So, $\angle i + \angle r = 100°$.
  - **Step 2:** We know from the Law of Reflection that $\angle i = \angle r$.
  - **Step 3:** We can substitute $\angle i$ for $\angle r$ in our equation: $\angle i + \angle i = 100°$, which means $2 \times \angle i = 100°$.
  - **Step 4:** Solve for $\angle i$: $\angle i = 100° / 2 = 50°$.
  - **Answer:** The angle of incidence is 50°.

Problem 3: Why can you see your reflection clearly in a calm lake, but not when the water is disturbed by wind?

- **Solution:**
  - **Step 1:** Identify the type of surface. A calm lake has a very smooth surface.
  - **Step 2:** A smooth surface causes regular reflection, where all light rays from your face bounce off in a uniform direction, forming a clear image.
  - **Step 3:** When the wind disturbs the water, the surface becomes rough and uneven.
  - **Step 4:** A rough surface causes diffuse reflection, where light rays are scattered in all directions. This prevents a clear image from forming.

o **Answer:** A calm lake causes regular reflection (forming an image), while disturbed water causes diffuse reflection (scattering the light).

vii. Summary of Main Concepts

- Reflection: Light bouncing off a surface.

- Laws of Reflection:

- Angle of incidence equals angle of reflection ($\angle i = \angle r$).

- The incident ray, reflected ray, and normal are all in the same plane.

- Key Terms: Always measure angles from the Normal, which is 90° to the surface.

- Regular Reflection: Happens on smooth surfaces and forms a clear image (e.g., mirror).

- Diffuse Reflection: Happens on rough surfaces and scatters light, allowing us to see the object itself (e.g., a book).

- Seeing Objects: We see non-luminous objects because they reflect light into our eyes.