Geometric Optics

[اكتب العنوان الفرعي للمستند]

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Optics I

Introduction

Light is a transverse, electromagnetic wave that can be seen by the typical human. The wave nature of light was first illustrated through experiments on diffraction and interference. Like all electromagnetic waves, light can travel through a vacuum. The transverse nature of light can be demonstrated through polarization.

Nature of Light

First: Newton's Corpuscular Theory:

According to **Newton**, light travels in space with a great speed as a stream of very small particles called corpuscles. This theory was failed to explain interference of light and diffraction of light. So wave theory of light was discovered.

Second: Wave Nature of Light:

Light waves are electromagnetic waves so there is no need of medium for the propagation of these waves. They can travel in vacuum also. The speed of these waves in air or in vacuum is maximum i.e., $(3 \times 10^8\ \mathrm{m/s})$. Photoelectric effect was not explained with the help of wave theory, so **Planck** gave a new theory which was known as quantum theory of light.

Third: Quantum Theory of Light:

When light falls on the surface of metals like caesium, potassium etc., electrons are given out. These electrons are called 'photo-electrons' and phenomenon is called 'photo-electric effect'.

Interaction of light with matter

Light and Matter relate to each other in numerous ways. The interaction of light and matter determines the appearance of everything around us. Light interacts with matter in ways such as emission and absorption. The photoelectric effect is an example of how matter absorbs light. What matter does with the energy from light depends on what kind of light it is and there is a whole spectrum of light called the electromagnetic spectrum.

Electromagnetic Spectrum

The electromagnetic spectrum shows the different ranges of light. Many people think that the only form of light that exist is the light that we can see but this is not true. The visible light that people see only accounts for a small fraction of all wavelengths of light. The entire range of light, or electromagnetic radiation, is known as the electromagnetic spectrum shown in the picture below:

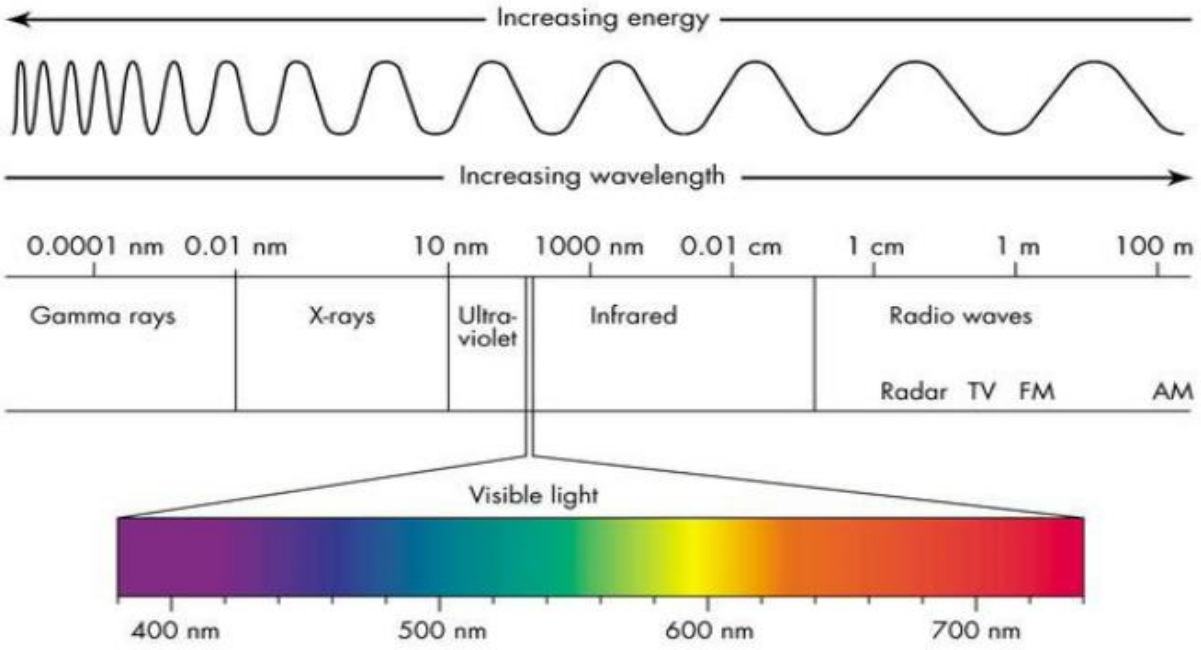

Fig.(1): the electromagnetic spectrum.

The visible region on the electromagnetic spectrum (400-700 nm) only accounts for a small portion of the electromagnetic spectrum. The regions with long wavelengths have low energy and the regions with short wavelengths have high energy. Along with wavelengths determining the energy, wavelengths also determine what color the light is. The electromagnetic spectrum represents a lot of information about the different forms of light.

Reflection of Light

The process due to which the light rays fall on the surface, and get bounced back is known as a reflection of light.

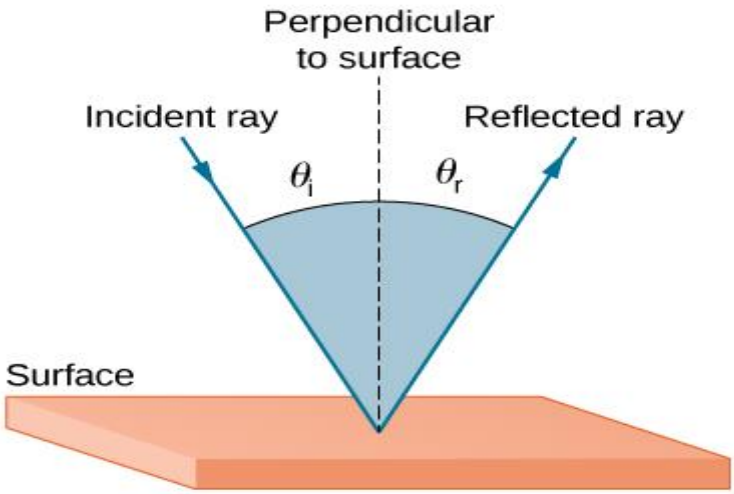

Fig. (2): The process of Reflection of Light.

Incident ray: The ray of light that straightaway falls on the reflecting surface from the object or a source is known as an incident ray.

Reflected ray: The ray of light which is supposed to be reflected back after striking the reflecting surface is known as the reflected ray.

Angle of incidence: The angle that is formed between the incident ray and the general at the point of incidence is known as the angle of incidence, and it is generally represented by (θi).

Angle of reflection: The angle that is formed between the reflected ray and the general at the point of incidence is known as the angle of reflection, and it is generally represented by (θr).

Normal: A straight line perpendicular to the reflecting surface that acts as a separation between the plane of incidence and the plane of reflection is known as the normal.

Types of Reflection

There are two types of Reflection, which are as follows:

1) Regular reflection: This reflection type is created by plane mirrors with smooth surfaces. The image formed is precise and sharp. Such that, all the light rays falling on the surface are reflected equally in a uniform manner. It is also known as specular reflection.
2) Diffused reflection (Irregular reflection): It is referred to as uneven or diffused reflection when light reflects from a rough surface in an erratic manner. As a result,

the brightness and reflection quality is diminished. It is also known as diffused reflection.

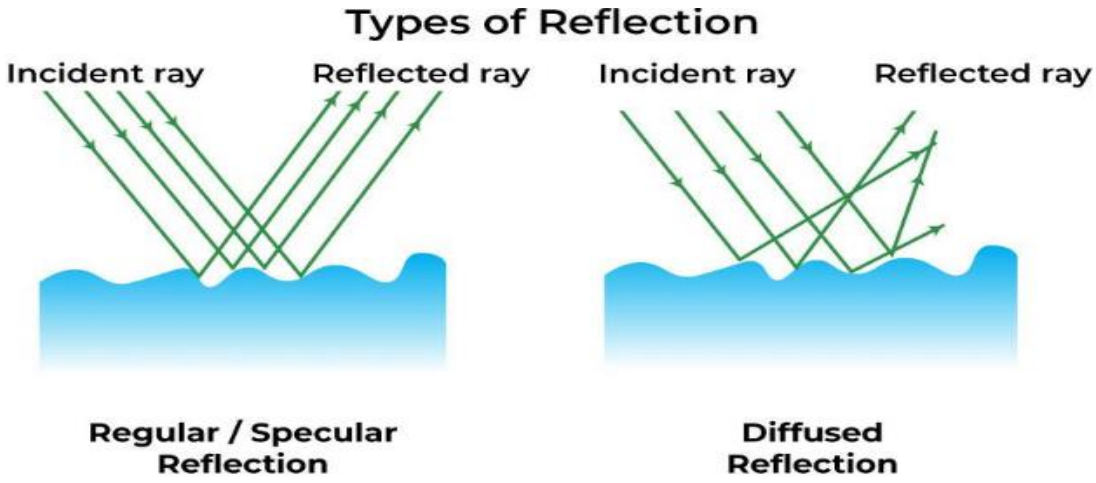

Fig. (3): The image shows the types of reflection.

Laws of reflection

1- The incident ray, the reflected ray, and the normal to the surface of the mirror, all lie in the same plane.
2- The angle of reflection is equal to the angle of incidence. Both angles are measured with respect to the normal to the mirror.

See the diagram below for reference:

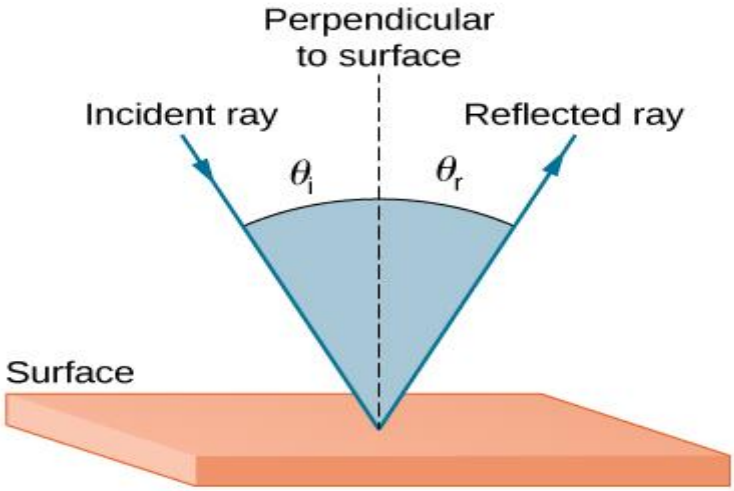

Fig. (4): The law of reflection states that the angle of reflection equals the angle of incidence (θr=θi). The angles are measured relative to the perpendicular to the surface at the point where the ray strikes the surface.