

## The correlation between light intensity and distance

Medical Physics

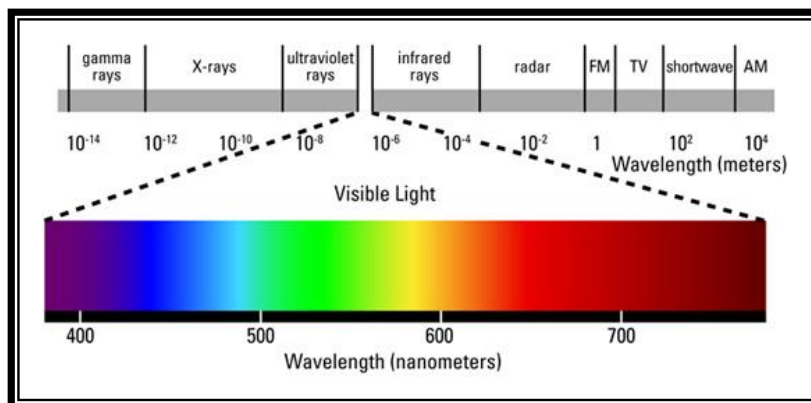
Lab -9-

### The Nature of the Light

The nature of the light it's much more difficult to understand than that of sound. **Newton** in the 17<sup>th</sup> century was convinced that light was comprised of tiny mass-less particles, whereas **Huygens**, working at the same time, argued that it must be a wave of some sort.

**Maxwell** derived the mathematical theories of electromagnetic wave, and demonstrated that light exhibited the properties expected of electromagnetic radiation.

In the early **twentieth** century, light was discovered to have both **particle** properties and **electromagnetic wave** properties. The wavelength of electromagnetic radiation with the range from about  $10^{-4}\text{m}$  to about  $10^8\text{m}$ . We use electromagnetic radiation over this whole spectrum in various application of medical physics, **visible light** occupies only a narrow band from about **400-700 nm**.



### Light as a Ray

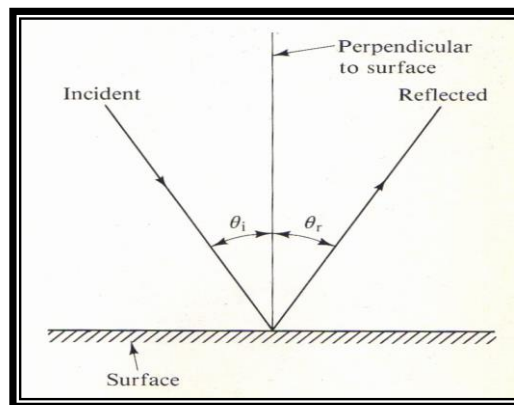
Light comes to an observer's eyes either **directly** or **indirectly** from some source.

## The Characteristics of Light

- The Reflection.
- The Refraction.
- The Interference.
- The Diffraction.

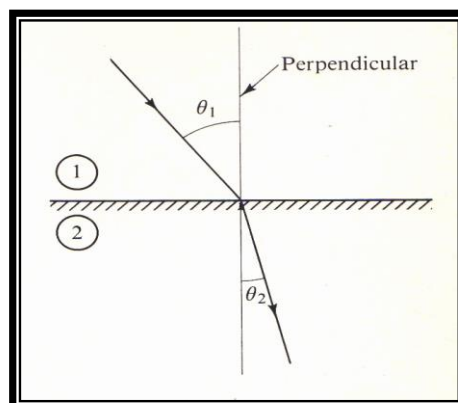
### Reflection

Light waves reflect when they strike the surface that separate between two medium, the law of reflection says very simply that when light is reflected the angle of incidence **equals** the angle of reflection.



### Refraction

Light waves usually changes directions when it goes from one medium to another **because** of changes there velocity in the different medium. There is most easily observed for objects partially submerged in water.



**Interference**

Light waves interact and interfere with each other in just the same way as do sound waves. The relative phase of the waves determines whether the interference is **constructive**, increasing the intensity, or **destructive**, reducing the intensity.

**Diffraction**

All light waves undergo diffraction as they pass through a **small opening**.

**Speed of the Light**

The speed at which light travels in a vacuum is an approximately ( $c=3 \times 10^8 \text{m.s}^{-1}$ ).

Its speed in a transparent medium is always less than this, and is given by ( $V=c/n$ ).

Where ( $n$ ) is the **index of refraction** of the substance. The value of the **index of refraction** depends on both the **composition** of the substance and the **color** of the light.

**Intensity of the Light**

Intensity of the light is defined in terms of an energy flux, or power, per unit area and has dimensions of ( $\text{W/m}^2$ ).

$$(I=P/A)$$

**Where: -**

**P** = is the power (**Watt**).

**A** = is the area (**m**).

**The relation between light intensity and distance can be given by: -**

$$(I \propto 1/d^2)$$

## **The Medical Applications of Light**

### **\* In Medicine: -**

The light in medicine is beneficial in diagnostic purposes and therapeutic purposes.

#### **A. Diagnostic use of light**

There are a number of medical instruments used the visible light in the diagnosis; which are: -

##### **1. Ophthalmoscope.**

Used for examining the eyes.

##### **2. Otoscope.**

Used for examining the ears, nose, and throat.

##### **3. Transillumination**

Is the transmission of the light through the tissues of the body. **Transillumination** is used clinically in the detection of hydrocephalus (**water-head**) in infants and also used to detect pneumothorax (**collapsed lungs**) in infants.

##### **4. Endoscope.**

Used for examining the internal body cavities. Special purposes endoscopes are often given names indicating their purposes, which are: -

- **Cyctoscope:** - is used to examine the bladder.
- **Proctoscope:** - is used to examine the rectum.
- **Bronchoscope:** - is used to examine the air passage into lungs.

**B. Therapeutic use of light**

Many premature infants have **jaundice**, a condition in which an excess of bilirubin is excreted by the liver into the blood. The most premature infants recover from jaundice if their bodies are exposed to the visible light (**phototherapy**).

**\* In Dentistry: -**

1. Fluorescence is used in medicine is in the detection of **porphyria**, a condition in which the teeth fluoresce red when irradiated with **UV light**.
2. In dental chair.
3. Subgingival calculus detection system: the detector features is a light that reflects off the calculus and is then sensed by an optical fiber and converted into an electrical signal to be analyzed.



4. In light cure: - curing the composite resin.

