Tishk International University
Faculty of Applied Science

Medical Technical Radiology
General Physics

Optics

First Grade- 2025-2026

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Learning outcomes
At the end of the session, you should be able to:-

I. Optics
II. Neutral of light
III. Light interaction with matter, wave theorem, particle theorem

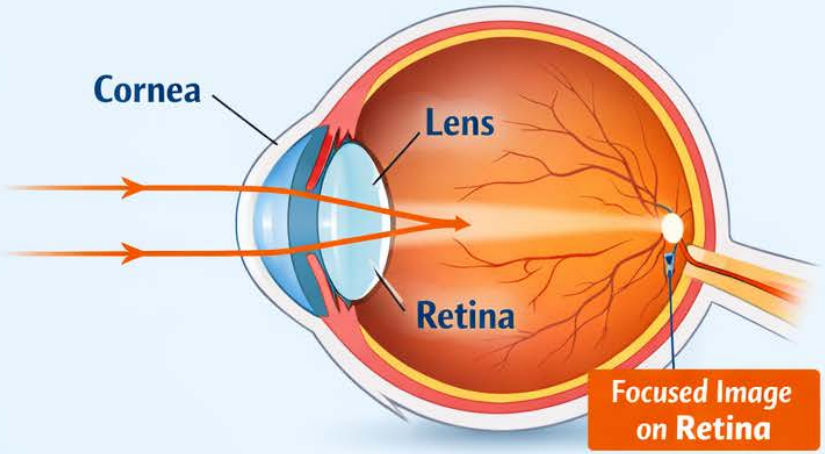
- **Optics**

Optics is the branch of physics that involves the behavior and properties of light, including its interactions with matter and the instruments that use or detect it.

So Light can travel through:

- space,
- air, glass, water,
- cornea, eye lens, etc.
    - Each one is referred to as a medium
-

How Light Bends in the Eye



- Light bends when it passes from *air* to the *eye lens*.
- This bending helps *focus images* clearly.
- We see because light is *focused* on the *retina*.

Refractive Index: $n = \frac{c}{v}$

n = Refractive Index
c = *Speed of Light in Vacuum*
v = *Speed of Light in Medium*

- **The Particle Nature of Light**

  - "Particles" of light are called *photons.* **Each photon has a particular energy** E = h ƒ
  - **h** is *Planck's constant* = 6.63 x 10^{-34} J s

Light and Its Optical Properties

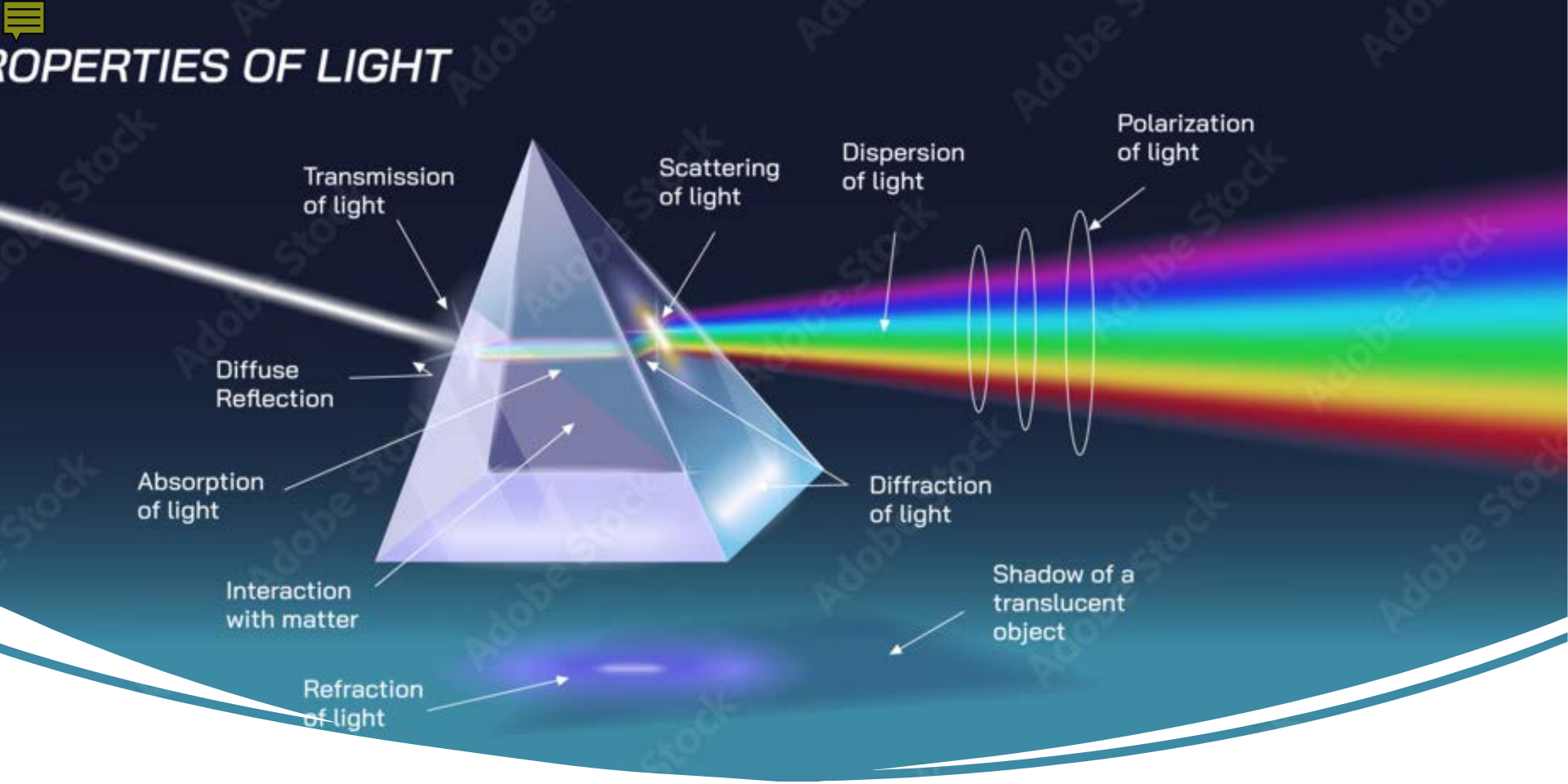
Light is a form of **energy** that travels as an **electromagnetic wave**.
It does **not need a medium** to travel and can move through a **vacuum** at a very high speed

$$c = 3 \times 10^8 \ m/s$$

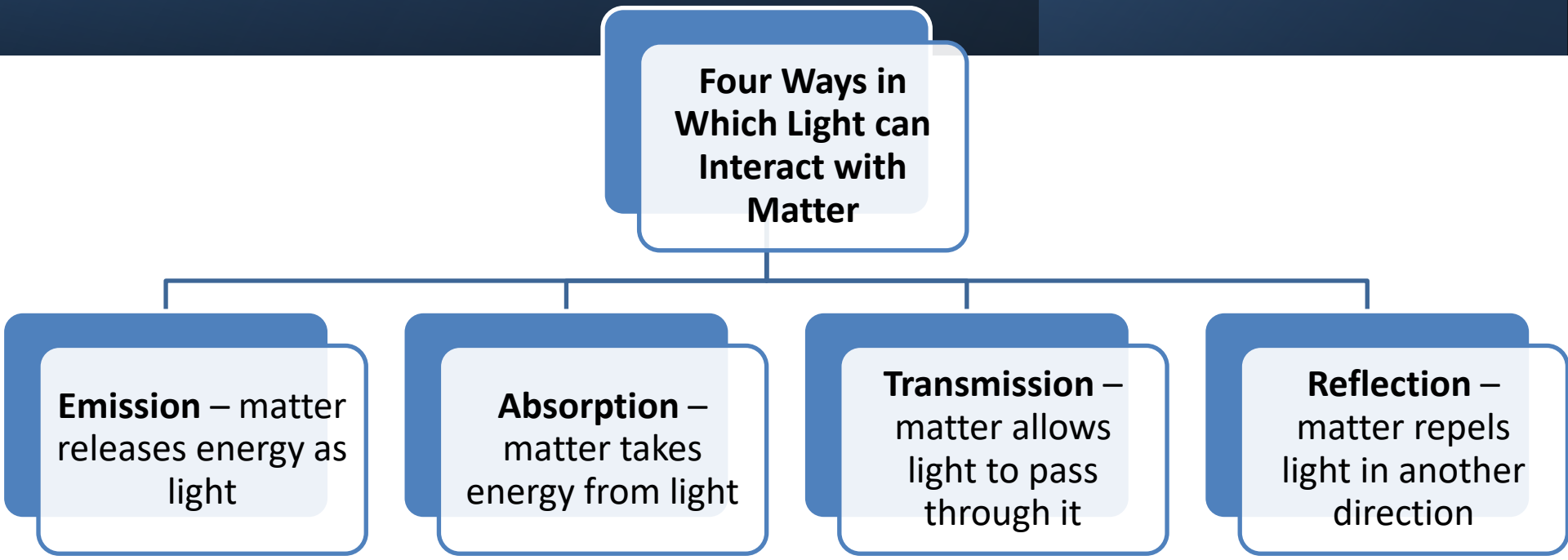
Light is everywhere around us and allows us to **see objects**, **transmit information**, and **support life on Earth**.

Importance of Light in Real Life

- **Vision**: Human eyes depend on light
- **Communication**: Optical fibers, internet
- **Medicine**: X-rays, lasers, endoscopy
- **Technology**: Screens, cameras, sensors
- **Nature**: Photosynthesis, climate balance



- **Properties of Light**
- Waves, particles and EM spectrum
- Interaction with matter
- Absorption
- Reflection, refraction and scattering
- Polarization and diffraction


Four Ways in Which Light can Interact with Matter
Emission – matter releases energy as light
Absorption – matter takes energy from light
Transmission – matter allows light to pass through it
Reflection – matter repels light in another direction

Four Ways Light Interacts with Matter

Emission

Matter **releases energy** as light.

Absorption

Matter **takes energy** from light.

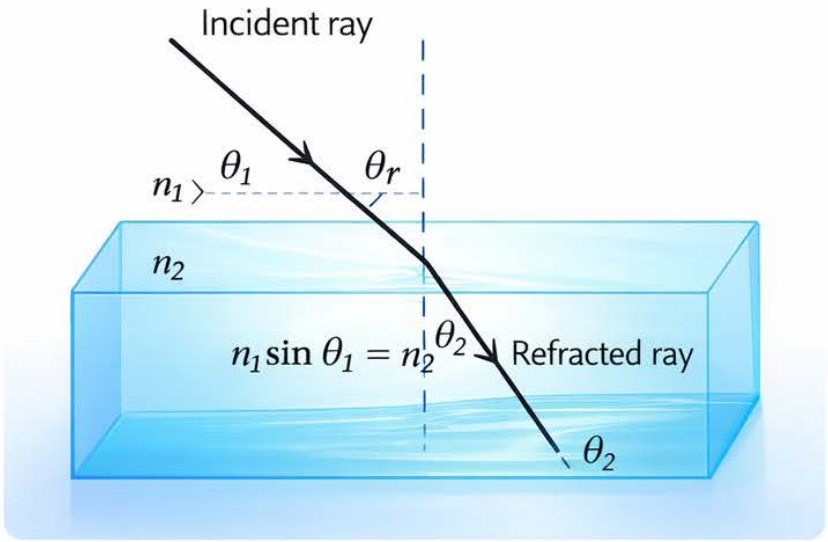
Transmission

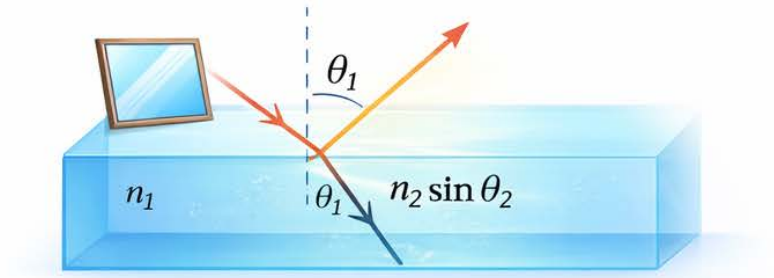
Matter **allows light** to pass through.

Reflection

Matter **repels light** in another direction.

Properties of Light





1 Law of Reflection

- The angle of incidence (θ_1) is equal to angle of reflection (θ_r).
- Reflection occurs when light bounces off a smooth surface.

2 Law of Refraction (Snell's Law)

- Refraction is the bending of light as it passes from one medium to another.
- The relation is given by: $n_1 \sin \theta_1 = n_2 \sin \theta_2$ where n_1 and n_2 are refractive indices of the two media.

3 Inverse Square Law

- Light intensity decreases with the square of the distance from the source:

$$I \propto \frac{1}{r^2}$$

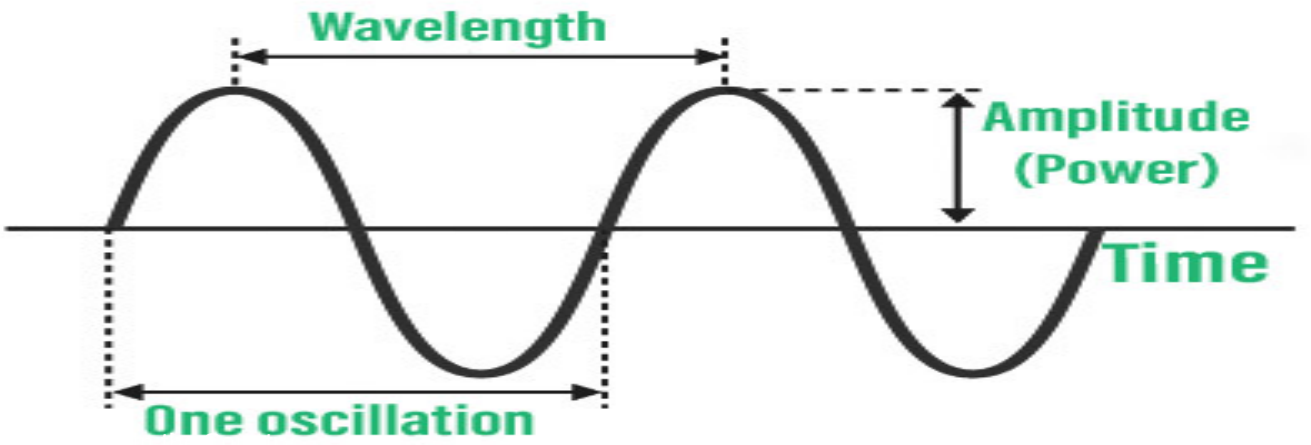
Waves are characterized by **frequency**, **wavelength**, **speed** and **phase**.

Wave : wave is repeating and periodic disturbance that travels through a medium from one location to another location

Frequency is defined as the number of waves (*cycles*) per second that pass a given point in space (symbolized by *f*).

Wavelength is the distance between two consecutive peaks or troughs in a wave

(symbolized by the λ).



Relation between λ **and** f **:** $\boldsymbol{f\ \lambda = c}$ *c*: speed of light

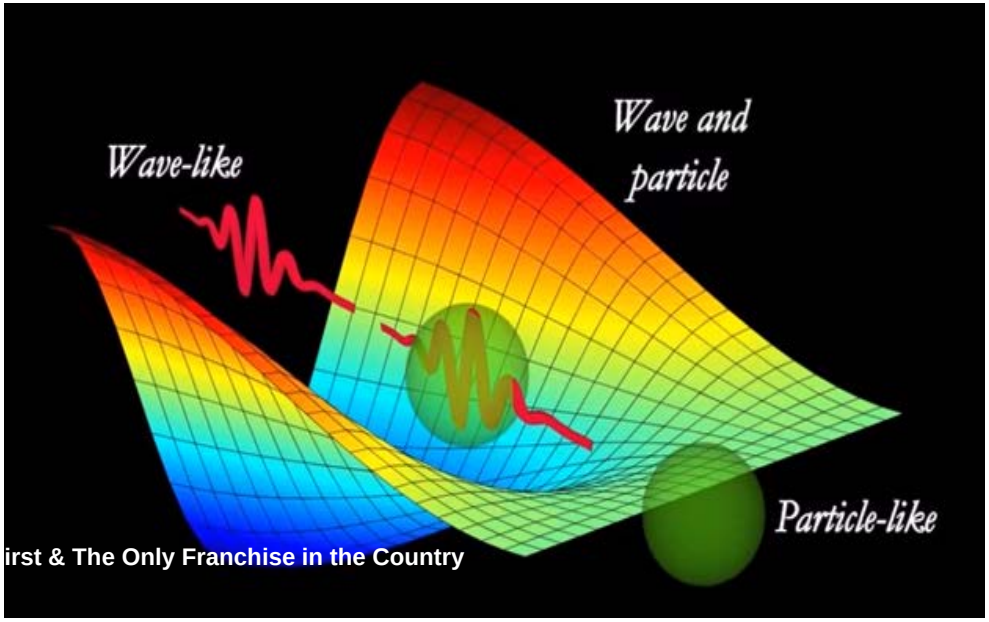
Particles and waves :

Interaction of **X-rays with matter** (human or otherwise)

- the concept of photon energies is used

Interaction of **light with filters**

- the use of wave characteristics may be more useful



$$E=hf$$

E = energy of the photon (J)
h = Planck's constant (6.626×10^{-34})(Js)
f = cycles per second (Hz)

$$c = f\lambda$$

c = speed of light ($3.00X10^{8}$ m/s)
λ = Wavelength (m)
f = frequency (s^{-1} , Hz)

Question

- A radio station is broadcasting a signal with a frequency of 27,000 kHz. What is the **wavelength** of the signal in meters?

- A **"Solution."**
- **Given**
- $f = 27{,}000\ kHz = 2.7 \times 10^7\ Hz$
- $c = 3 \times 10^8\ m/s$
- **Formula**
- $\lambda = \frac{c}{f}$
- **Calculation**
- $\lambda = \frac{3 \times 10^8}{2.7 \times 10^7}$
- **Final Answer**
- λ = 11.1 m

- **Question**
  An electromagnetic wave has a wavelength of **3.0 m** and travels in a vacuum.
  Calculate the **frequency** of the wave.

- **Question**
- Light has a wavelength of **750 nm** in vacuum.
  Find its **frequency**.

- **Question**
- A radio signal has a frequency of **8.5 MHz**.
  Calculate its **wavelength**.

Wave concept, Units of measurement

SI UNITS:

- Wavelength units: length
- Angstrom (A) : 1 A = $1x10^{-10}$ m
- Nanometer (nm): 1 nm=$1x10^{-9}$ m
- Micrometer (μm): 1 μm = $1x10^{-6}$ m

- Energy: joule (J)
- Frequency units: unit cycles per second 1/s (or s^{-1}) is called hertz (abbreviated Hz)

Unit	Frequency, (cycles/sec)
Hertz, Hz	1
Kilohertz, KHz	10^3
Megahertz, MHz	10^6
Gigahertz, GHz	10^9