Al-Mustaqbal University
College of Science
Department of Medical Physics
The Fourth Stage
First Course

Radiation Protection

LECTURE TWO

Types of Radiation

Assist. Prof. Dr Forat Alsultany
Pof. Dr Anees Al-jubouri

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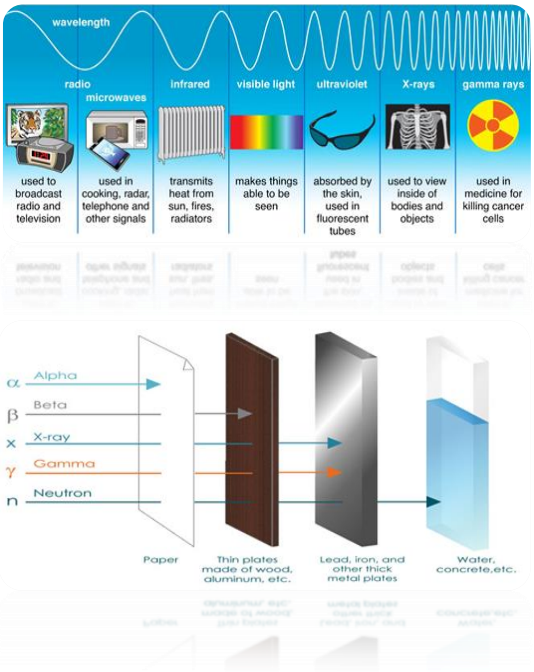


LECTURE TWO: Types of Radiation

- Radiation
- Classification of Radiation
- Ionizing Radiation
- Non-ionizing Radiation
- Spectrum of Electromagnetic Radiation
- Electromagnetic Radiation
- Particles Radiation

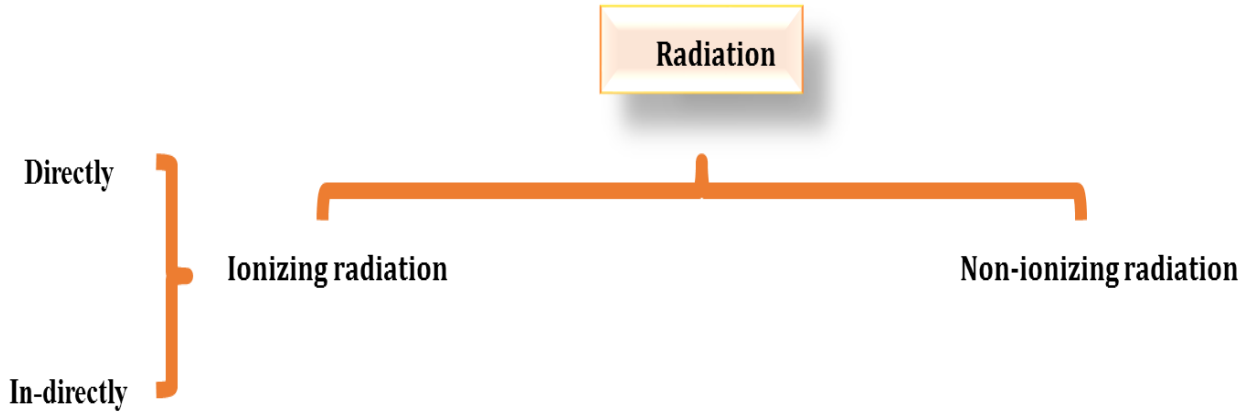
LECTURE TWO: Types of Radiation

❖ Radiation & Classification : First classification

Radiation is energy that moves through space or matter at a very high speed. This energy can be in the form of particles or waves.

Radiation can be classified into two categories;

- The first classification is **depends on the ability to ionize**, which can be divided into two types; (i) Ionizing radiation & (ii) Non-ionizing radiation



❖ Radiation & Classification : First Classification

Ionization process: It is the process of gaining or losing an electron from an atom or a molecule, which will turn into a negative or positive charge

1- Ionizing radiation: It is the radiation that is carry enough energy to produce ions, that can divided into two types

- **Directly ionizing radiation:** are charged particles that have enough kinetic energy to produce ionization by collision.

  These include electrons, protons, alpha particles (helium nucleus) and beta particles high energy electrons).

- **In-directly ionizing radiation:** are uncharged particles that can release ionizing particles.

Two classes of ionizing radiation

1. Electromagnetic waves:

X- Rays

Gamma Rays

2. Particles:

Alphas

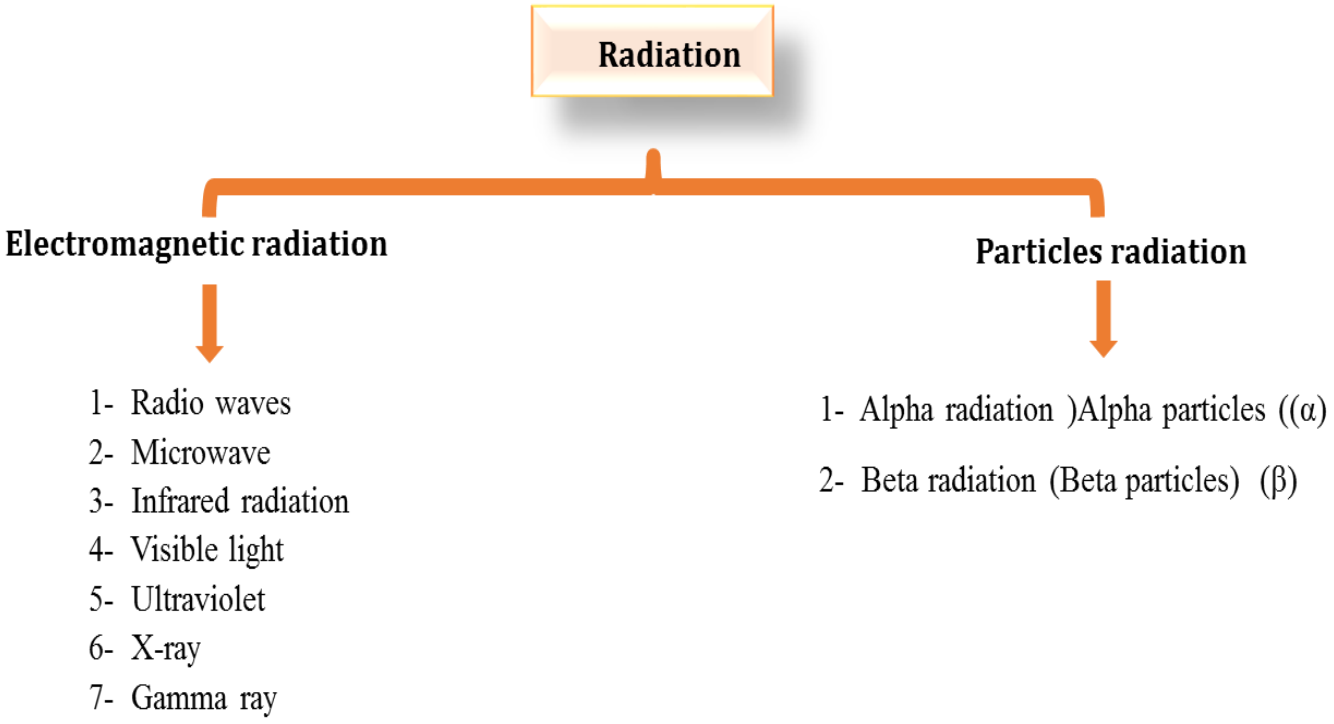
Beta

Protons

Neutrons

2- Non-ionizing radiation: It is the radiation that is cannot carry enough energy to produce ions

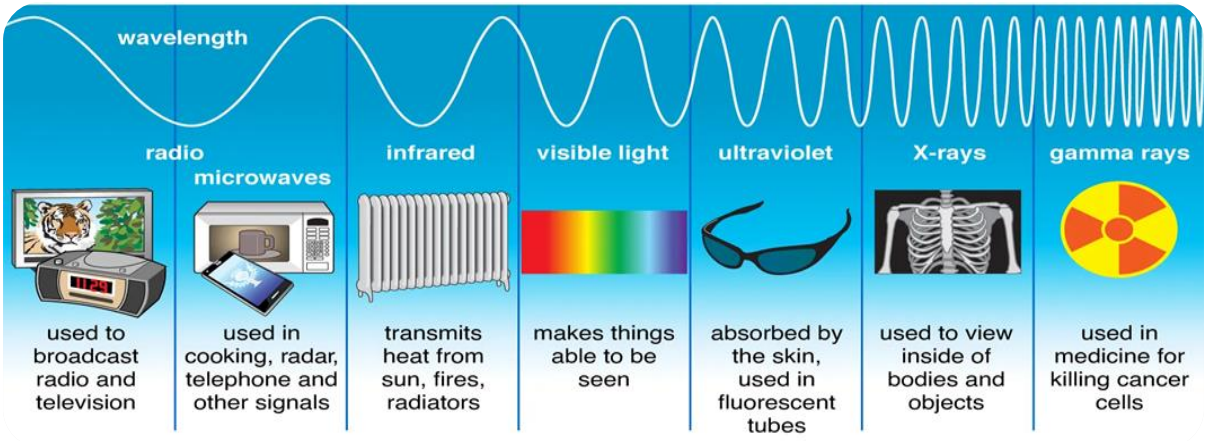
- The second classification is based on the **components of the radiation,** which can be divided into **waves** and **partials** , as follows;



The electromagnetic (EM) spectrum is the range of frequency, wavelength, and photon energies of electromagnetic (EM) radiation.

❖ Spectrum of Electromagnetic Radiation

Electromagnetic spectrum, the entire distribution of electromagnetic radiation according to **frequency or wavelength.** Although all electromagnetic waves travel at the speed of light in a vacuum, they do so at a **wide range of frequencies, wavelengths, and photon energies**. The various portions bear different names based on differences in behavior in the emission, transmission, and absorption of the corresponding waves and also based on their different practical applications.



Spectrum of Electromagnetic Radiation

The entire electromagnetic spectrum, from the lowest to the highest frequency (longest to shortest wavelength), includes all radio waves (e.g., commercial radio and television, microwaves, radar), infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays. Nearly all frequencies and wavelengths of electromagnetic radiation can be used for spectroscopy.

اسم الموجة	Name of Wave	Wavelength (λ)	Frequency(f)
الموجه الراديوية	Radio wave	> 1 mm	10^4 Hz
موجات الميكروويف	Microwaves	1 mm – 25 µm	10^8 Hz
الأشعة تحت الحمراء	Infrared	25 µm – 2.5 µm	10^{12} Hz
الاشعة القريبه من تحت الحمراء	near-infrared	2.5 µm – 750 nm	10^{14} Hz
موجات الطيف المرئي	Visible light	750 nm – 400 nm	10^{15} Hz
موجات الأشعة فوق البنفسجية	Ultraviolet	400 nm – 10 nm	10^{16} Hz
موجات الأشعة السينية	X-rays	10 nm – 10 pm	10^{18} Hz
موجات أشعة غاما	Gamma rays	< 10 Pm	10^{20} Hz

Wavelength & Frequency of Electromagnetic Radiation

1-Radio waves are a type of electromagnetic radiation with wavelength **above 1mm** and frequency of **10^4 Hz**.

✓ Radio waves are used for transfer signals of sound, radio and television

2-Microwaves are a type of electromagnetic radiation with wavelength of **1mm-25µm** and frequency of **10^8 Hz**.

✓ Microwaves are used in (i) radar, (ii) communications, (iii) cooking in microwave ovens, (v) and microwave energy used in medicine for the thermal ablation of tissue.

3-Infrared radiation is a type of electromagnetic radiation with wavelength of **25–2.5µm** and frequency of **10^{12} Hz**.

✓ uses of infrared radiation in reduce muscle tension

4- Visible light is defined as the wavelengths that are visible to most human eyes, and it is a form of electromagnetic radiation with wavelength of **750nm–400nm** and frequency of **10^{15} Hz**.

- ✓ The sun is a natural source for visible light waves.
- ✓ Light lamp is an industrial source of visible light waves

5- Ultraviolet is a type of electromagnetic radiation with wavelength of **400nm–10nm** and frequency of **10^{16} Hz**

Uses of ultraviolet;

- ✓ Kill microbes.
- ✓ In hospitals use UV lamps to sterilize surgical equipment.
- ✓ It is suitable dose to produce vitamin D in the body

6- X-ray is a type of electromagnetic radiation with wavelength of **10 nm–10 pm** and frequency of **10^{18} Hz**, which is able to pass through many materials.

Uses of X-ray;

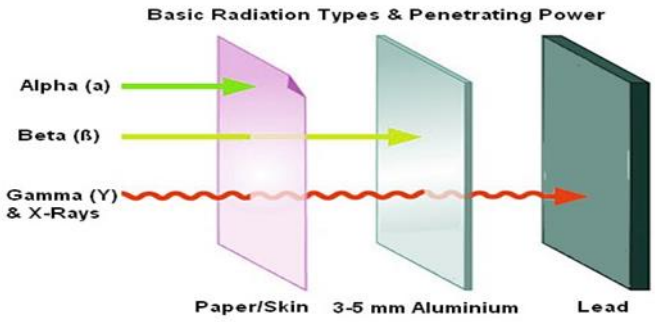
- ✓ Medical imaging: used in medical imaging
- ✓ Radiation therapy: used to kill cancer cells
- ✓ Airport security: used in airports to check for dangerous items

7- Gamma rays are photons or a light wave in the same electromagnetic family as light and x- rays, but much more energetic with wavelength of **less than 10 Pm** and frequency of **10^{20} Hz**.

- ✓ **Uses of Gamma rays;** are used to kill cancer cells.

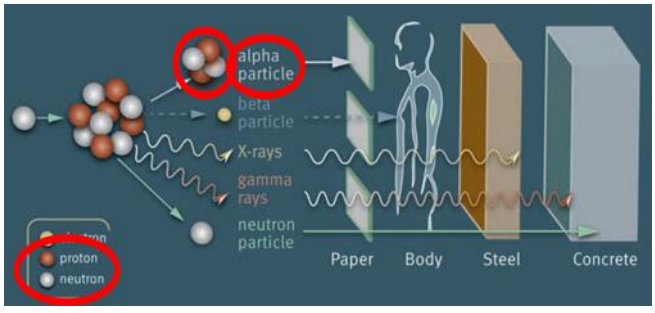
❖ Particles Radiation

Particle radiation is the energy radiation that is formed by a particle beam if all the particles are moving in the same direction. Particle radiation is made up of any subatomic particles, such as protons, neutrons, and high-speed electrons, capable of causing ionization. Alpha and beta particles are two of the more common types of particle radiation.



1- Alpha Particle (Alpha radiation) (α)

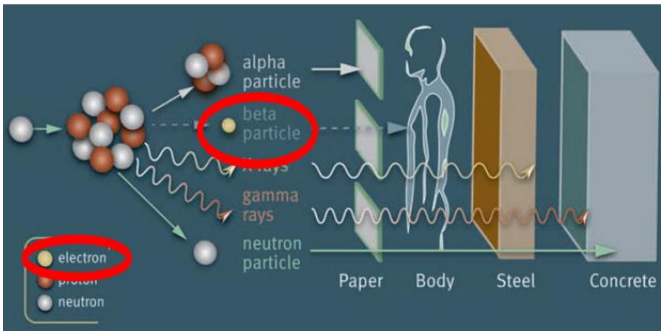
- It is consists of two protons (2p) and two neutrons (2n)
- It is carry a double positive charge.
- It can be stopped by outer dead skin



Alpha Particle (Alpha radiation) (α)

2- Beta Particle (Beta radiation) (β)

- It is charged particles that are ejected from an atom
- It has a negative charge.
- It is can be penetrate the outer dead skin



Beta Particle (Beta radiation) (β)

❖ Calculation the energy of the Radiation

➢ For the waves by using the plank formula

$$E = h f$$

Where *h* is **Planck's constant**, equal to (**6.63×10^{-34} Joule. Sec**)

- The wavelength (λ) is the distance between 2 peaks of the wave.
- Frequency (*f*) is the number of wave/second.
- The relationship between wavelength and frequency is given by:

  Speed of light = wavelength × frequency

  $c = \lambda \times f$..... (2) Where **$c = 3\times10^{8}$ m.s^{-1}**

- 1 eV = 1.6×10^{-19} Coulomb × 1 Volute = 1.6×10^{-19} Joule

➢ For the waves by using the Einstein formula

The mass-energy equivalent ($E=mc^2$) means that the product of the relative mass (m) of an object and the square of the speed of light (c) equals the kinetic energy of that object, and it simply means that matter and energy are one and the same thing.

Bubble sheet questions

Q1- The classification of radiation that depends on the components of the radiation can be divided into two types ----------.

A- directly ionizing & in-directly ionizing B- ionizing & non-ionizing C- waves & partials D- alpha & beta E- frequency & wavelength

Q2- ---------- radiation is suitable dose to produce vitamin D in the body.

A- radio waves B- microwaves C- ultraviolet D- visible light E- x-ray

Q3- Uses of ---------- radiation in reduce muscle tension.

A- radio waves B- microwaves C- infrared D- visible light E- gamma rays

Q4- ---------- are a type of electromagnetic radiation with wavelength of 1mm-25μm and frequency of 10^8 Hz.

A- radio waves B- microwaves C- infrared D- visible light E- gamma rays

Q5- Beta Particle is charged particles that are ejected from an ----------

A- radiation B- electrons C- atom D- vacuum E- molecule