



Islamic University / Najaf
College of Medical Technology
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Radiation Protection 1

Stage 2

Lecture 3

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Particle Radiation is a type of energy radiation by particles. Particles are divided into two types: light and heavy particles, when **light particles** interact with matter; they lose their energy in excitation or ionization of the atoms of the matter. As these particles move through the material, they lose part of their energy, which is converted into electromagnetic radiation, the direction of the particles often changes after interaction. **Heavy particles** such as alpha particle, protons and deuterons, When these particles interact with matter, they lose a part of their energy at each collision, the energy loss is small and therefore it will go through a group of collisions, the direction of these particles does not change.

Radiation Units

Radiation can be measured in different ways depending on the amount, energy, and type of radiation. Some quantities are true measurements, but others are calculated quantities that refer to the effect radiation has on matter or biological tissue. It is important to understand the different quantities and units that are used when referring to radiation. It is also important to understand that units have changed over time. Traditional units are still used by regulatory agencies in the United States, but most of the world and most scientific literature now use SI units.

1. Count Rate

The most basic measurement is the count rate, which is the number of radiation interactions that occur in a detector in a certain period of time. This measurement is reported in units such as cps (counts per second) or cpm (counts per minute). It is most useful for measuring particulate radiation, although it can be used for small quantities of x-ray or gamma radiation.

2. Exposure

is a measurement of the amount of electric charge produced by photons in a mass of air. The electric charge comes from the production of ion pairs, which are collected by the detector and measured as a current.

$$\text{Exposure} = X = \frac{Q}{M}$$

Units: (Exposure)

A) Coulomb per kilogram (C/kg) (SI Unit)

B) Roentgen (R) (U.S Unit)

3- Absorbed Dose

Is a measure of the energy deposited in a material by all types of radiation.

$$\text{Absorbed Dose} = D = \frac{\Delta E}{\Delta m}$$

Units: (Absorbed Dose)

A) Gray (Gy) (SI Unit)

B) Rad (U.S Unit)

4- Equivalent Dose

Equivalent dose (H_T) is a quantity calculated from the absorbed dose that takes into account that some types of radiation are more harmful to biological tissue than others. It is equal to the absorbed dose in a tissue from each type of radiation ($D_{R,T}$) multiplied by a radiation weighting factor (W_R) for that type of radiation, summed over all types of radiation present:

$$H_T = \sum W_R \times D_{R,T}$$

Units: (Equivalent dose)

A) Sievert (Sv) (SI Unit)

B) Rem (U.S Unit)

5-Effective Dose / Effective Dose Equivalent

The ED or EDE is a quantity that takes into account that the various organs and tissues of the human body respond to radiation differently. The ED is calculated by multiplying the equivalent dose (H_T) to each organ/tissue by the tissue weighting factor for that organ/tissue (W_T), summed over all the organs/tissues in the body:

$$E = \sum W_T \times H_T$$

Units: (Effective Dose)

A) Sievert (Sv) (SI Unit)

B) Rem (U.S Unit)

6- KERMA

Kerma is an acronym for "kinetic energy released per unit mass", defined as the sum of the initial kinetic energies of all the charged particles liberated by uncharged ionizing radiation (indirectly ionizing radiation such as photons and neutrons) in a sample of matter, divided by the mass of the sample. It is defined by the quotient:

$$\mathbf{K} = \frac{dE}{dm}$$

The SI unit of kerma is the gray (Gy) (or joule per kilogram, the same as the unit of absorbed dose). However, kerma can be different from absorbed dose, depending on the energies involved.