Medical physics Department

diagnostic radiology physics lab.

Third stage

By

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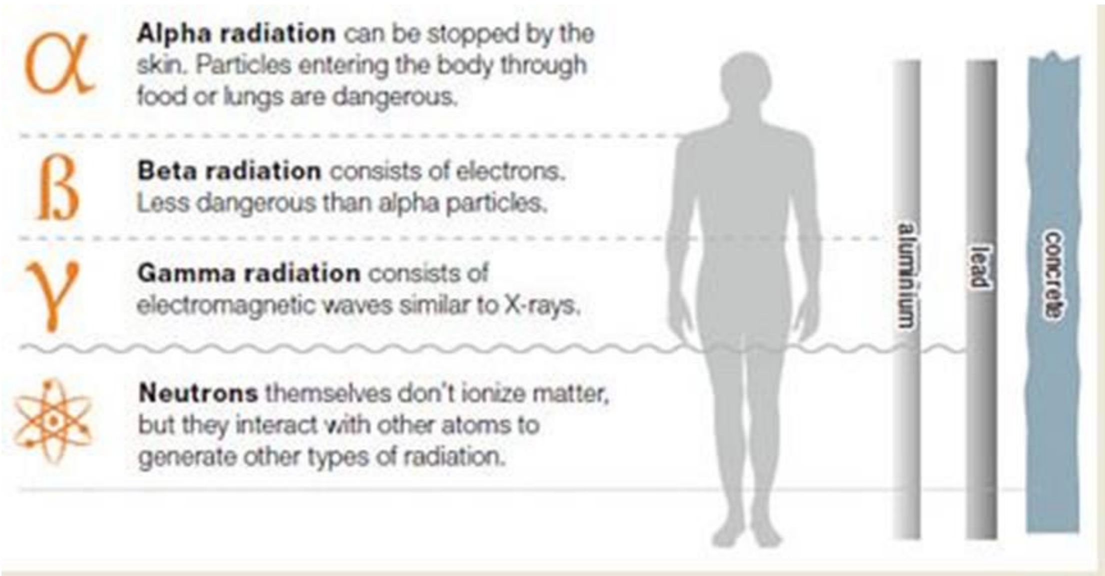


Experiment (2)

Absorption of Beta particles in materials

The Aim:

Study the absorption of beta particles in materials.

Theory:

n physics, absorption of radiation is how matter (typically electrons bound in atoms) takes up a photon's energy and so transforms electromagnetic energy into internal energy of the absorber (for example, thermal energy).

A notable effect of the absorption of electromagnetic radiation is attenuation of the radiation; attenuation is the gradual reduction of the intensity of light waves as they propagate through the medium.

Precise measurements of the absorbance at many wavelengths allow the identification of a substance via absorption spectroscopy, where a sample is illuminated from one side, and the intensity of the light that exits from the sample in every direction is measured. A few examples of absorption are ultraviolet–visible spectroscopy, infrared spectroscopy, and X-ray absorption spectroscopy.

When beta particles pass through an Aluminum fraction of them is removed from the primary beam. If I_0: is the intensity of beta particles which enter a medium, the intensity of beta particles that emerge through thickness d is:

$$I = I_o e^{-\mu d} \qquad (1)$$

I: is the intensity of beta particles that emerges from material.

I_o: is the intensity of beta particles in air.

μ: is the attenuation coefficient of materiald; is the thickness of material.

Where the intensity of electrons in material equals half value of its in air

$I = \frac{1}{2} I_o$ (2)

By substituting the equation (2) in eq (1) so that:

$$\frac{1}{2} I_o = I_o e^{-\mu d}$$

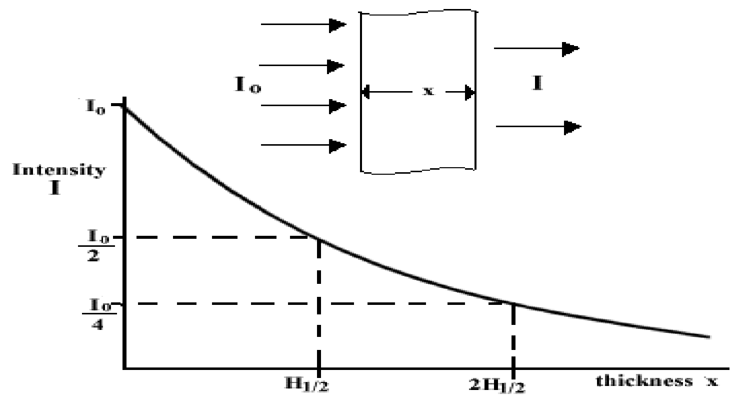
$$\frac{1}{2} = e^{-\mu d}$$

$$\text{Ln}\left(\frac{1}{2}\right) = -\mu d$$

$$\text{Ln}(1) - \text{Ln}(2) = -\mu d$$

$$0 - \text{Ln}(2) = -\mu d$$

$$\mu = \frac{Ln\,(2)}{d} \quad \text{or} \quad d = \frac{Ln\,(2)}{\mu} \qquad (3)$$



Radiation is emitted from a source in all directions. The radiation emitted within the angle subtended by the window of the GM tube is the only radiation counted. Most radiation is emitted away from the tube but it strikes matter.

When it does so, the direction of its path may be deflected. This deflection is known as scattering. Most particles undergo multiple scattering passing through matter. Beta particles especially may be scattered through large angles.

For Geiger counters، the fraction of radiation emitted away from the GM tube that strikes the material supporting the sample. It is deflected toward the tube window and is counted. A beta particle entering matter undergoes a series of collisions with mostly nuclei and sometimes orbital electrons. A collision between particles does not occur in the same manner we picture them in the macroscopic world. There are very little contact collisions, but instead the term، collision, refers to any interaction, columbic or otherwise. (A coulomb interaction is an electrical attraction or repulsion that changes the path of the particle’s motion).

Equipment:

Radioactive source Sr, Geiger-Müller Counter, Counter tube, Screened cable.

Work method

1- Setup the Geiger counter as you have in the previous experiments. Set the Voltage of the GM tube to its optimal operating voltage, which should be around 900 Volts.

2- From the Preset menu, set runs to zero and set Preset Time to 60.

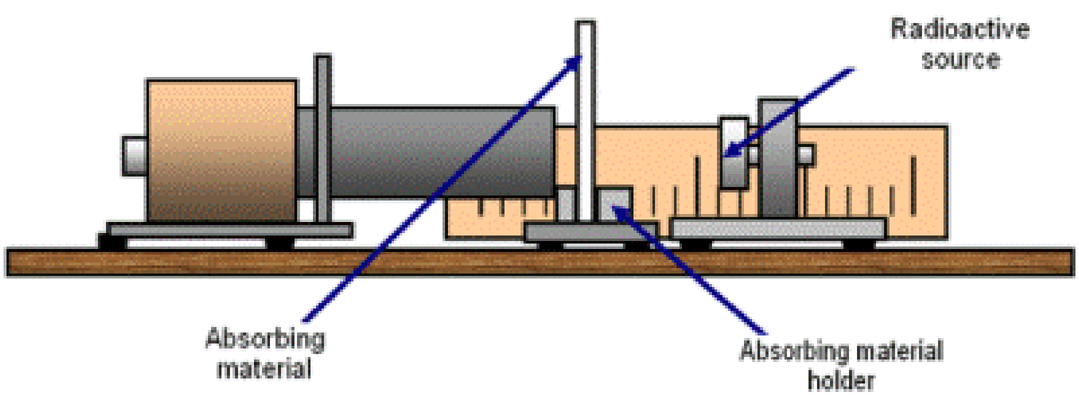
3- First do a run without a radioactive source to determine background radiation level.

4- Next, place the radioactive source in the second shelf from the topand take data.

5- Place an absorber piece, or disk, in the source holder and place the source directly on top of it.

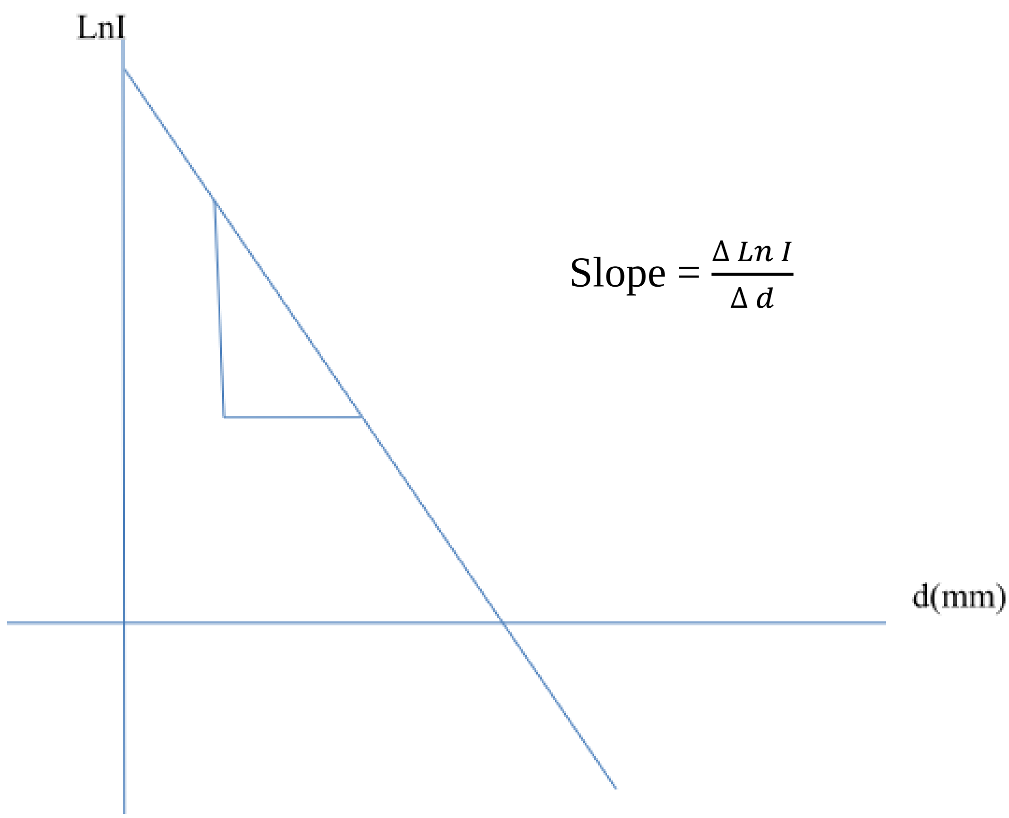
6- Repeat this for Aluminum – Z = 13 at different thickness.

7- Record the data to a file on disk or into a data table.



Calculation:

d (mm)	I	Ln I
0	496.58	
0.5	288.18	
1	157.38	
1.5	79.18	
2	32.39	
2.5	2.29	
3	2.28	
3.5	1.38	
4	0.98	
4.5	0.49	
5	0.3	
5.5	0.29	
6	0.09	



Slope = $\frac{\Delta\, Ln\ I}{\Delta\, d}$

Questions:

1. Define the attenuation of radiation?
2. Discuss the curve in the experiment?
3. Explain about the type of attenuation?
4. Explain the interaction of electrons with matter?
5. Calculate the thickness of the water layer that reduces the number of X-ray photons to 80% of its original number? Where (μ)water = 0.0706 cm^{-1}
6. What are the applications of absorption of electromagnetic radiation?