



Islamic University / Najaf  
College of Medical Technology  
Department of Radiology Techniques



Second Stage /Radiation PhysicsLab.

# **Absorption of x-ray in the materials. and the Half value thickness**

## **Lecture 1**

**By**

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## **The aim of this experiment:**

- 1-Absorption of x-ray in the materials.
- 2-Find the Half value thickness.

## **The device used in this experiment:**

X-ray device

A layer of absorbing material (aluminium or lead)

## **Introduction:**

When a beam of X-Rays passes through matter, its intensity is reduced as the energy is absorbed or scattered, and **The degree of attenuation depends on the atomic number and physical density of the tissue, and the energy of the X-rays.**the absorption of X-Rays by the various tissues of the patient allows a radiographic image to be made.

Recall that photons are individual units of energy. As an x-ray beam passes through an object, three possible fates await each photon, as shown in the figure below:

1. It can penetrate the section of matter without interacting.
2. It can interact with the matter and be completely absorbed by depositing its energy.
3. It can interact and be scattered or deflected from its original direction and deposit part of its energy.

## Theory:

When a beam of rays falls on any material, the intensity of the transmitted rays is less than the intensity of the incident rays.

Suppose that a beam of incident rays ( $I$ ) passes a thickness of ( $dx$ ), then the decrease in the rays (intensity) ( $dI$ ) depends on the thickness ( $dx$ ) and also on the rays ( $I$ ):

$$dI = -\mu I dx \quad (1)$$

$$dI/I = -\mu dx \quad (2)$$

When the Negative sign means decrease in intensity. and By take the integration for eq. (2):

$$\ln I = -\mu x + C \quad (3)$$

Where :  $C = \text{constant}$

Let  $I=I_0$  , When  $X=0$  (X-ray enter the material medium)

$$\ln I_0 = C \quad (4)$$

After Sub Eq. (4) in eq. (3) we get:

$$\ln I = -\mu x + \ln I_0 \quad (5)$$

$$\ln I - \ln I_0 = -\mu x \quad (6)$$

$$\ln I/I_0 = -\mu x \quad (7)$$

Now, we take exp. function For both sides in eq. (7):

$$I/I_0 = e^{-\mu x} \quad (8)$$

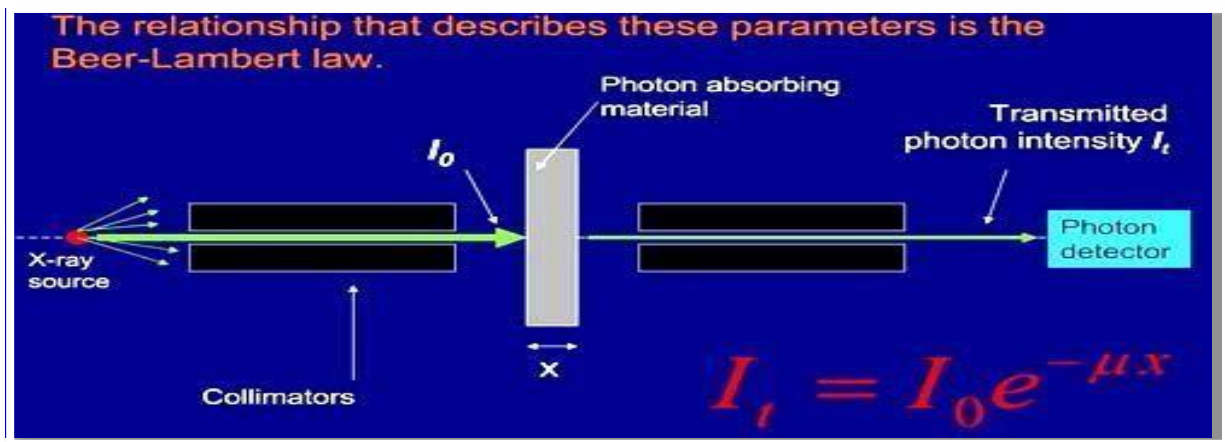
$$I = I_0 e^{-\mu x} \quad (9)$$

Where :eq (9) it calls Beer-lambert law.

**I:** The intensity is represented after it has passed the thickness of  $x$ .

**$I_0$ :** The intensity of the primary rays .

**$\mu$ :** Absorption coefficient of materials.



Figure(1): Beer-lambert law relates the attenuation of light

### Half value thickness:

This is the thickness of the material which is needed to reduce the intensity ( $I$ ) of the X-ray beam to one half the intensity of the incident radiation ( $I_0$ ).

Where the half value thickness of the material is always the same no matter how much the original intensity has been reduced. If the beam has a spread of energies then the further through the material the X-ray beam passes the longer the half value thickness becomes.

Since :  $I = I_0 e^{-\mu x}$

if  $I/I_0 = 1/2$  then  $e^{-\mu x} = 1/2$  and so:

$$\text{Half value thickness } (x_{1/2}) = \ln 2 / \mu = 0.693 / \mu$$

### The method of work:

1-Prepare the device for a laboratory. Place a radioactive source in front of the counter. Place a copper plate in front of it and record the readings for one minute.

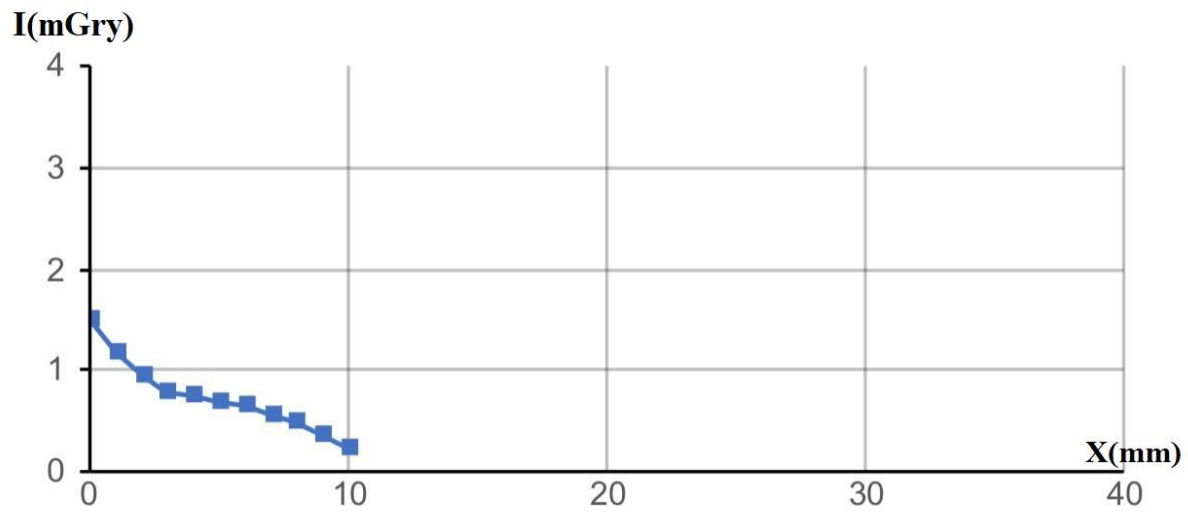
2 -Keep increasing the number of platelets required, recording the readings in each case, then subtract (B.G) from each reading you get.

3- Draw the relationship between distance and the reading of the intensity.

4- From the drawing, calculate the value of  $N_0$ , then  $(I_{0/2})$  and then  $(X_{1/2})$  and find the value.

D(cm)	I (M Gry)
0	1.491
1	1.17
2	0.944
3	0.797
4	0.748

5	0.699
6	0.645
7	0.645
8	0.555
9	0.355



**Fig(2)** The relationship between intensity(I) and thickness(X)