**Gamma Rays Attenuation through Absorbers**

**Purpose**

When gamma radiation passes through matter, it undergoes absorption primarily by Compton, photoelectric, and pair-production interactions. The intensity of the radiation is thus decreased as a function of distance in the absorbing medium. The purpose of this experiment is to measure the attenuation of the intensity with absorber thickness, and to derive the half-thickness and the attenuation coefficient.

**Relevant Equations**

The mathematical expression for the surviving intensity, I, is given by the following:



Where

I0 = original intensity of the beam,

I = intensity transmitted through an absorber to a distance, depth, or thickness, x,

μ= linear absorption coefficient for the absorbing medium.

If we rearrange Eq. (13) and take the logarithm of both sides, the expression becomes



The half-value layer (HVL) of the absorbing medium is defined as that thickness, x1/2, which will cut the initial intensity in half. That is, I/I0 = 0.5. If we substitute this into Eq. (14),



Putting in numerical values and rearranging, Eq. (15) becomes



Experimentally, the usual procedure is to measure x1/2 and then calculate μ from Eq. (16). If the thickness of the absorber is expressed in cm, then the units of μ are cm–1, and it is known as the linear attenuation coefficient. Often, the thickness of the absorber is expressed in g/cm2. In that case, the attenuation coefficient has units of cm2/g, and is identified as the mass attenuation coefficient.

**Procedure**

1. Set the voltage of the detector at its operating value.

2. Place the 60Co source ( any other gamma source) about 3 cm from the detector, and make a 2-minute count. Record the number of counts. Take four more reading and record the data in the Table.

3. Note the various thicknesses of the lead sheets in the absorber kit. Incrementing the absorber thickness will require using the various absorbers in suitable combinations to achieve the desired thickness increments.

4. Place the thinnest sheet of lead from the absorber kit between the source and the detector and record its thickness in the Table. Then take a 2-minute count. Record the count value N in the Table. Take four more readings of Ns and record in the Table.

5. Repeat step number with four more absorber thickness of lead. For each absorber thickness record five times the 2-minutes counting interval counts N in the Table.

6. Make a 2-minute background run with the 60Co source (gamma ray source) removed to a long distance from the counting station for 5 times and record this data in Table 1. Check this background count at the maximum absorber thickness employed and without any absorbers. The result should be the same, or close enough to the same that the average of the two background readings can be used for background subtraction from all the corrected counting rates with the source in the counting position

7. Subtract average background from each of the five absorbers counts and record net count Nnet in **Table 2**.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Serial #** | **Absorber-Thickness(mg/cm2)** | **Absorber-Thickness (cm)** | **N1-counts** | **N2-counts** | **N2-counts** | **N4- counts** | **N5-counts** | **Navg** |
| **1** | **0** |  |  |  |  |  |  |  |
| **2** |  |  |  |  |  |  |  |  |
| **3** |  |  |  |  |  |  |  |  |
| **4** |  |  |  |  |  |  |  |  |
| **5** |  |  |  |  |  |  |  |  |
| **6** |  |  |  |  |  |  |  |  |
| **Background-measurement** | **0** |  |  |  |  |  |  |  |

**Table 1:**

**EXERCISE**

**a**. Record the total density of the lead in g/cm3 . Divide the absorber thickness with density of lead to get absorber thickness in cm. Record this data for each absorber thickness in the Table 1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Serial #** | **Absorber-Thickness (cm)** | **Navg** | **Nnet=Navg-Nbkgd** | **Ln(Nnet)** |
|  |  |  |  |  |
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**Table 2:**

**b**. On linear graph paper, plot the Ln(Nnet) (y axis) as a function of absorber thickness (cm) (x axis).

**c**. Draw the best straight line through the points, and determine x1/2  and μ from the slope of the line. Calculate percentage error in x1/2 ?

**d**. Also calculate intensity I0 from the y-intercept of the graph. Compare it with

Nnet(0) counts corresponding to zero thickness of the absorber. Calculate the percentage error in I0 andNnet(0) counts.