Physics Experiment
Absorption of β-radiation in aluminum

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A. Objective: To study the absorption of β-radiation in aluminum (Al).

B. Safety

Never touch a radioactive source with bare hands. Whenever you need to transfer a radioactive material, always hold it with a lifting tools, like forceps. After the experiment, place the radioactive material back in a properly designed shielding case. Wash your hands thoroughly.

C. Theory

α-radiation can be stopped by a paper sheet, or air around 5 cm thick. β-radiation can be stopped by a Al sheet of around 5 mm thick. γ-radiation is much more difficult to be stopped (Fig. 1). I_o is the intensity of the incident radiation. I is the intensity of radiation after passing through an absorbing material with a thickness *x*. μ is the linear attenuation coefficient (Fig. 2).

$$I(x) = I_o e^{-\mu x} \quad (1)$$

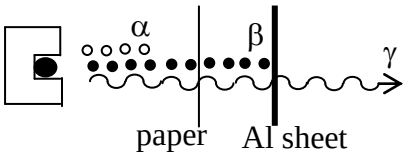

Fig. 1 Penetration power of α, β and γ-radiation.

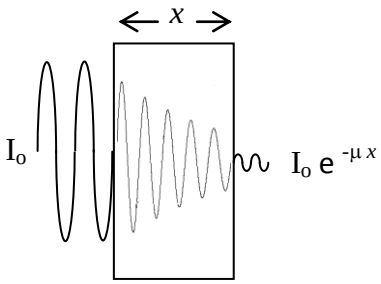

Fig. 2 Attenuation of radiation in a material of thickness *x*.

D. Experiment

D.1 Safety assessment

A survey meter show readings of _____ (mR hr^{-1}) or _____ (mSv hr^{-1}) for a source 30 cm from it. Compare the result with the data given in the document "Radiation units and safety". Hence, assess the risk.

D.2 Radiation absorption

- Place a thin Al foil under the Geiger Muller (GM) tube (Fig. 3). Most of the α-radiation is absorbed. γ-radiation is hardly detected by the GM tube. Therefore, the counts detected by the detector is mainly due to β-radiation.
- Turn on the setup by applying 400 volts to the GM tube.
- The number of counts from the background is collected for 300 s.
- Place a radium (Ra-) 226 isotope at the base plate of the setup. Increase the thickness of the Al sheets successively. Record the corresponding numbers of counts for 300 s for each thickness of Al. Subtract the background counts from the data and complete Table 1.
- Plot the net count rate against the thickness of Al.

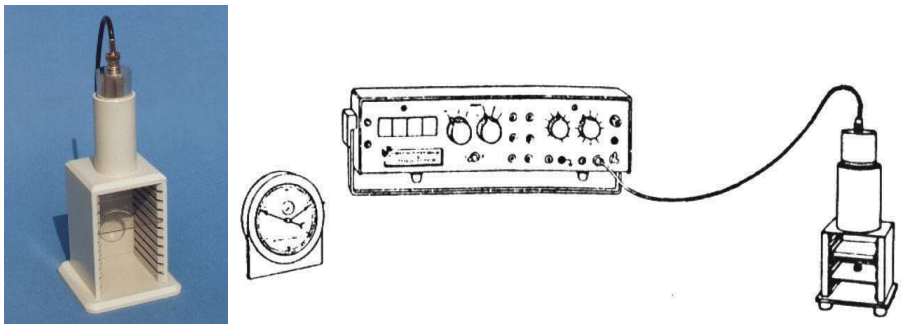

Fig. 3 Setup for the measurements.

Table 1 Counts and count rates. Each measurement lasts for 300 s.

Thickness of absorber (mm)	0.00	0.212	0.371	0.602	1.21	2.12	3.14
Background counts (in 300 s)							
Background count rate (/s)							
Counts (in 300 s)							
Count rate (/s)							
Net count rate = Count rate – Background count rate (/s)							

E. Analysis

- Determine the value of μ for β-radiation absorption in Al from Eq.(1).
- According to the maximum annual effective exposure, discuss whether an Al container can be used to store a radioactive isotope emitting β-radiation.

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