Experiment No. 6

Absorption of Beta Particles and Gamma Rays

I. OBJECTIVES

- To investigate the absorption of alpha particles, beta particles and gamma rays

II. BACKGROUND

Many nuclides of atoms are unstable and spontaneously alter themselves through radioactive decay to attain a stable configuration despite the strong nuclear forces that bind the nucleons together. Unlike the case of atomic radiation, there is no external excitation needed for the decay process to occur. The energy liberated during the radioactive decay comes from within individual nuclei. And this could be explained by the equivalence of mass and energy, a concept contained in Einstein's famous equation, $E = mc^2$.

Experimental measurements on the activity (decay per unit time) of radioactive nuclides indicate that the phenomena is a statistical process that obeys the laws of chance. No cause-effect relationship is involved in the decay of a particular nucleus, only probability per unit time. And the decay process is found to follow a very orderly exponential mode, that is, the number of nuclei decreases exponentially with time.

There are basically three kinds of radioactive decay that a nucleus may undergo. These are the alpha (α) , beta (β), or gamma (γ) decay.

Alpha radiation occurs when the nucleus emits an alpha particle, a particle that is similar to a Helium nucleus – that is, it consists of two protons and neutrons. Alpha decay occurs whenever the nucleus is too large.

Beta decay, on the other hand, is the emission of high energy electrons or positrons. β^+ decay occurs when there are plenty of protons compared to the number of neutrons in a nuclei. In a β^+ decay, a proton in the nucleus of an atom transforms into a neutron and in the process emits a positron and a neutrino. A β^- decay occurs when the nucleus has too many neutrons relative to the number of protons. During a β^- decay, a neutron in the nucleus of an atom turns into a proton and in the process emits an electron and a neutrino.

The last kind of decay does not involve emission of matter particle but electromagnetic radiation. This is called gamma decay. Here a nucleus has excess energy and therefore to attain a more stable (lower energy) configuration, an intense radiation in the form of gamma rays is emitted. Gamma decay, unlike the two previous decays, leaves the nucleus intact.

The three kinds of particle/radiation emitted vary in their penetrating strength in matter, with the gamma ray being the most penetrating, followed by beta particle, the alpha particle being the least penetrating.

III. PROCEDURES

1. Set up the Geiger-Müller (G-M) counter. Adjust the operating voltage to 400 V and set the count rate at 60 s. Also press the memory button to store the counts made by the counter.
2. Place the beta source (^{204}Tl) in the sample holder, and insert in the second or third shelf of the tube stand. Place the empty absorber slide in the shelf immediately above the sample.
3. Get 3 readings and determine the activity of the sample with no absorber by getting the average of the 3 readings. Note: The reading in the G-M counter includes the background activity (without radioactive source) which is negligible compared to the activity of the sample.
4. Insert the thinnest absorber slide and determine the activity again. Record. The radioactive material should not be removed throughout these measurements.
5. Repeat with the other absorbers, going from thinnest to the heaviest. Again get 3 readings and determine the activity of the sample with no absorber by getting the average of the 3 readings. Remember to record all data. Use the table below.
6. Replace the beta source with a gamma source and follow steps 3 to 5. Do this also for the alpha source.
7. Make three graphs one for each radioactive source with the natural logarithm of activity on the y-axis against absorber thickness on the x-axis. Draw a trendline for each graph. Which line has a steeper slope? Compare the penetrating ability of each source.

DATA

Sample =	**Alpha Source Activity (cpm)**			
Absorber Thickness (mg/cm^2)	**1st**	**2nd**	**3rd**	**Average**
0				
4.5				
6.5				
14.1				
28.1				
59.1				
102				
129				

Sample =	**Beta Source Activity (cpm)**			
Absorber Thickness (mg/cm^2)	**1st**	**2nd**	**3rd**	**Average**
0				
4.5				
6.5				
14.1				
28.1				
59.1				
102				
129				

Sample =	**Gamma Source Activity (cpm)**			
Absorber Thickness (mg/cm^2)	**1st**	**2nd**	**3rd**	**Average**
0				
4.5				
6.5				
14.1				
28.1				
59.1				
102				
129				

IV. EVALUATION

1. Account for the differences of alpha, beta and gamma absorption.
2. What are some ways in which alpha rays react with matter? Beta? Gamma?
3. Recommend a type of shielding for alpha, beta and gamma.