The Properties of Radioactivity

Objective: To determine net count (in cpm) of a beta-emitting source and the net count for four other shielding materials (Poly 8 mil, and Poly 0.030, Al 0.090, and Lead 0.032)

Theory: Radioactive elements have unstable nuclei that disintegrate (crumble) instantaneously (rapidly), resulting in emitting various kinds of radiation. There are three types of radioactivity emitted by naturally occurring radioactive elements; they are called α (alpha) particles, β (beta) particles, and γ (gamma) rays. Radioactivity cannot be detected using our six senses, but sensitive instruments are made to detect and measure the nature and intensity of various types of radiation. One common instrument used is the Geiger-Muller counter, which measures β (energetic electrons) and γ radiation (electromagnetic energy) very well. α particles, however, has a mass of He (helium) atoms which results in slow atom movements resulting in the inability to penetrate more than a few centimeters of air. Throughout our lives, we theorized that the farther we are away from a source of light or sound, the less intensity of the source will have in us; using the same idea, the strength of radiation is identical to a radioactive source. The strength of the radioactivity (R; in units of rads or rems) at a position that is meters (d) away is directed by the inverse square law

R ∞

When the value of d increases, the R value rapidly decreases. In a graph with the R values on the y-axis and the d values on the x-axis, the plots will yield a straight line.

Β particles and γ rays go far in air, but these two radioactivity will eventually be stopped rapidly by denser materials. However, the amount of penetration depends on many factors such as the density of the material. Some examples of the material that will result in the radioactivity to travel at a shorter distance are heavy metals and concrete.

In addition, radioactive sources are found everywhere meaning that even if there are no radioactive materials present in the lab room, the Geiger-Muller counter will still record some naturally generated counts in the air (remember, β particles and γ rays are in the air). This naturally present radiation is called the **background count**. Before beginning any experiment involving radiation counting, the background radiation should be defined because the background radiation is fairly constant; the background counts MUST be subtracted from any counting rate measurements made of a radioactive source. An important procedure to prevent background counts errors is to remove all radioactive sources from the counter, such as luminous wristwatches.

Materials/Equipment:

* Geiger-Muller counter
* Beta-emitting source
* Shielding number 7 (Al 0.090), 8 (Lead 0.032), 2 (Poly 8 mil), and 3 (Poly 0.030)

Procedure:

Background Count

After finding the background radiation, the background counts were subtracted from counting rate of measurements that were from radioactive source.

Inverse Square Law

After placing a beta-emitting source on the 50 mm groove (groove 6) of the Geiger-Muller tube housing frame, the net counts were measured. The beta-emitting source was moved every 10 mm intervals from groove 2 to groove 6 and the net count at those distances were measured by taking the reading in the Geiger-Muller counter and subtracting it from the background count found in the beginning of the experiment.

Shielding a Beta Emitter

After placing the beta-emitting source on the 30 mm groove (groove 4) of the Geiger-Muller tube housing, the net counts were measured. Then the shielding #7 (Al 0.090) was placed into groove 1 in the Geiger-Muller tube housing and the net count was measured. Afterwards, shielding #8 (Lead 0.032) was placed in groove 1 and the net count was measured. Next, shielding #2 and #3 were placed in groove 1 individually and the net counts were measured.

Results: The graph for the Inverse Square Law part of the experiment formed a decreasing curve with a negative slope. The graph for the Beta Emitter Shielding part of the experiment formed a decreasing curve with a negative slope.

Conclusion/Discussion:

In the first part of the experiment, the net count/cpm kept decreasing as the beta-emitting source moves down each groove. It resulted in a decrease cpm because the farther away a material is, the less radiation the material will absorb. In the second part of the experiment, the net count/cpm also kept decreasing due to the thickness of the material. The thicker the material, the lesser the material would be exposed to radiation. Therefore, in conclusion, the further and thicker the material is, the less amount of radiation will be absorbed.

Sources of Error:

1. Plotting errors

* The scale on the graph may not be accurate
* The best-fit line may not be drawn accurately (may not hit most of the plots)

1. Miscalculation

* The distance might not be calculated correctly because of the mistyping on the calculator or forgetting to square the distance
* The net count/cpm may be calculated incorrectly because one might have forgotten to subtract the reading on the Geiger-Miller tube with the background count