Half Life Decay Experiment

In this experiment you will first estimate the efficiency of the Geiger Counter and the dead time. Then, we will record data of a short lived isotope to verify and measure the exponential decay of the isotopes activity.

A. Efficiency of the Geiger Counter

In this part, you will estimate the efficiency of the Geiger-Mueller tube for a particular source. The efficiency of the Geiger counter will depend on the sample, so be sure to record the activity and date for the sample used. From the activity written on the source, use the half-life formula to determine the activity in decays/sec of your source today. We will define the efficiency ϵ as:

$$\epsilon \equiv \frac{particles\ detected}{particles\ emitted} \tag{1}$$

This is not a measure of the efficiency of the tube itself, but also includes the distance the source is from the detector (geometry factor). We will investigate the effect of the distance in our experiment.

a) Place your source as close to the tube as you can, and count for 2 minutes. Measure the distance the source is away from the tube. Determine the efficiency of the Geiger-Mueller tube for this positioning of the source.

b) Move the source away from the tube and repeat part a) for three or four different source-detector distances.

How does the count rate vary with distance? Does the count rate decrease as the inverse square of the distance? Discuss.

B. Half-life of Ba^{137m}

The half-life of Ba^{137m} is on the order of minutes. In this experiment, we will record the counts for the Ba^{137m} source for a 10 second counting time. We take these readings every 30 seconds. Before you start the experiments make a data table similiar to the form below:

time (sec)	Counts in 10 seconds
0	...
30	...
60	...
90	...
...	...

a) After the instructor places the sample under your Geiger Counter tube, start recording data. Collect data for around 15 minutes. When you are done, keep the sample under the tube.

b) To determine the background counts, wait another 15 minutes with the sample still under the tube. Once you think the count rate is fairly constant, take data for around 10 minutes (for good statistics) to estimate the background.

b) To correctly analyze the data, you will have to correct for dead time and background. Enter the raw data into excel. Construct a column in Excel that corrects for dead time. Construct another column that corrects for background. Then make a graph of the number of counts/sec as a function of time. Fit the graph with an exponential function. Determine the decay constant (and half-life) from the slope of the graph.

Report for Experiment 2

1. (8 points) Show your data and calculations for determining the efficiency of your Geiger counter for the different source-detector distances of your experiment.

2. (12 points) For the Ba^{137m} decay, show your data and how you corrected for dead time and background. Show graph of your data with trendline fit.
a) Is the decay exponential? i.e. does it obey the half-life formula?
b) If it does follow an exponential decay, what is the half-life of the decay? Show all your calculations.