College Physics I
Lab 10: Nuclear Radiation

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Introduction

You will learn how to use a Geiger tube and a Geiger counter, and you will observe some of the properties of ionizing radiation.

Note: Throughout this lab, you will measure activity as a number of counts per unit time. The problem is that, if the sample is not very active, you will have to wait a long time to get, say 100 counts. On the other hand, if the sample is very active, you can get plenty of counts in just a few seconds. Radioactive decay is a random process, so don't expect your results to be consistent or repeatable unless you've gathered plenty of counts (about 100 to 1000 or more). As a rule, try to gather at least 100 counts for each test, and then divide that by the time it took. If things are so slow that it seems it will take forever to get 100 counts, then maybe you'll have to settle for only 50, or 10. On the other hand, if it is a very active sample and you can quickly get around 1000 or more counts, do so. The more counts the better. The suggestions given here for how many seconds or how many counts for each activity are just suggestions; they may not be the best way to proceed. Pay attention to what is going on, and change how you gather data if you think that would be best.

Part 1: Setting the voltage in the Geiger tube

I will explain to you how the Geiger tube and counter work. You can adjust the voltage on the tube from 0 to 1200 V, and you will need to find the optimum voltage. To do this, place the β source in the top position, and take a reading for, say, 5 s, with the voltage set at 500 V, 600 V, ... all the way up to 1200 V. Then make a careful graph of activity (in counts/second) versus voltage. The place where your graph just begins to flatten (usually around 800 V) is the voltage you should use for the rest of the experiment. This point is sometimes hard to recognize—ask me if you are not sure how to interpret your graph.

To hand in for Part 1

- Graph of activity versus voltage, showing where you think the optimum voltage is,
- Data used to generate the graph mentioned above.

Part 2: Estimating background radiation

With nothing in or near the counter, and your radioactive samples placed at least 1 m away from the detector, estimate the background radiation. Find the number of counts in 10 seconds 5 different times, and see if your 5 different results agree. Then find the number of counts in 1 minute 5 different times. Your five results will probably be more in agreement in this second case. At any rate, make some estimate of what you think the background radiation is in counts/second. You should keep your result for background radiation in mind when looking at data for the other parts of the lab.

To hand in for Part 2

- Result for background activity, and how you arrived at that result.

Part 3: Activity graph

You have a box of various plates. Though they are made of different materials, each plate is marked in kg/m^2 (or something with units of mass per unit area). This is called areal density. Basically, this tells you how much stuff there is per unit area that the radiation beam must penetrate—it measures how thick the plate is. Set up a sample with the plate between the sample and the Geiger tube. Get a reading of activity for each plate, and make a graph of activity versus areal density for that sample. Start by taking a data point with no plate. Then continue with the thinnest plate; if you are sure, after a few plates, that no radiation is getting through, then there is no need to check the activity for the thicker plates. Draw a line on your graphs showing the background activity from activity 2.

Do all this for the β and γ emitters.

To hand in for Part 3

- 2 graphs of activity versus areal density—for the β and γ emitters,
- Data used to generate the above graphs,
- Compare, based on your observations, the ability to penetrate of β and γ radiation.