Guidelines for Radioactivity iLab

Introduction

The purpose of this experiment is to examine one of the basic aspects of radioactive processes, which is the intensity of radiation from radioactive decay as a function of distance.

A Geiger counter is used to measure the radioactivity of a radioactive source. A table holding the radioactive source is rotated until the source is aligned with a hole in a thick lead plate. For the first part of the experiment the head holding the Geiger-Müller tube is set at a fixed distance from the source and many samples of the decay of the source is recorded. In the second part of the experiment the head holding the Geiger-Muller is moved to various distances from the radioactive source in order to examine the inverse-square law of radioactive decay.

Background on the iLab Network

The iLab Network has a lofty goal, which is to form *a scalable and sustainable online network that is recognized as the premier site where students and scientists around the world come together to access and share remote labs*.

You will have a chance to see this for yourself, using an experiment housed at the University of Queensland in Australia.

The Experiment

We will have control over the following parameters in the experiment:

- the number of trials
- the distance between the radioactive sample and the detector
- the period of time the detector is active and counting the 'hits'

You should have **registered for an account** in order to run the experiment. It is set up for you to run through, as demonstrated in class as well as in the 'how to' video on the iLab experiment web site. This is also on our class blog, **http://docvphysics.blogspot.com/2009/08/how-to-access-radioactivity-ilab.html**

You will want to **complete the Pre-Assessment first**. You can access this from the student curriculum page: http://ilabcentral.org/radioactivity/advanced

Then run the experiment. Check out the background information to the experiment and type up a background section addressing each of the topics for your lab report.

In order to run the experiment you will need to answer some questions, which will be recorded for you as a lab journal. Answer the questions thoughtfully and in detail, and answer in complete sentences, for the lab journal can be your lab report in the end.

Select your parameter values as you design your own experiment. Remember, we want to investigate intensity as a function of distance from the strontium source.

The experiment will provide a data table with results, and you can graph it and fit it all within the iLab. You can save (as a pdf file) and print out the lab journal in the end.

In addition to this and your background section, give your thoughts to the following question:

If you round off the exponent in your power law fit to the data, it will be close to an inverse-square law. Because this is real data and not a simulation, we would never expect to get a perfect fit due to statistical fluctuations. Think of a reason connecting the intensity of radiation from a point source as a function of distance to the intensity of gravity and electric fields as functions of distance.

What is a fundamental reason for these completely different phenomena having the same mathematical relationship?

Post-lab

Print out the report, the background section, and your response to the above question.

Then complete the Post-Assessment on the iLab page.

iLab Access Instructions

There will be many times when you will need to figure things out on your own and follow instructions provided. This is one of those times, as I am going to try to be of limited help as you try to do a unique type of lab that pertains to radioactivity.

This is a lab where we will use equipment at another location. Through the Internet, we can access strong radioactive sources and a detector at the University of Queensland in Australia! We can get real data from real equipment in a relatively short period of time, and then use those data in Excel to get some analysis and results completed.

Let's try it! ☺

Keep in mind the following question about radiation and the relevancy of what we have been studying the last few days – how does the intensity depend on distance from the source?

- Go to **http://ilabcentral.org/radioactivity/advanced**
- As you begin the following process, you will likely get complaints about 'Pop up windows' being required; allow pop ups if this occurs in order to get the next screen of the iLab.

Pre-Assessment

- Click on the first activity, which is a pre-assessment. This is a preliminary test of what you know about the topics involved in the iLab BEFORE you do the lab. This can help measure your growth after having done the lab and activities.

When done with the pre-assessment:

- If you need to, repeat the steps prior to the pre-assessment above, and get back to the curriculum page. On the page, scroll down to the Lab Activities and click on the orange button that says 'Launch Lab'.
- You now will need to register for a username and password. A window will pop up for you to log into the experiment, and the first time you do this you will need to select the Register just below the log in section. For Requested Group, scroll down the pull-down menu and choose 'Open Experiment Group.' You will have access information sent to you in an email. Once you have confirmation of the account, you will be able to move on to the experiment, and follow the directions below.

When registered:

- Click the yellow button "Launch Lab".
- Now is the time you want to begin journaling what you are doing. Begin by clicking on the Research button and beginning to read through the questions about the iLab that come up. Write down everything that you do, as this is a completely new investigation for you and, if needed, you have clear notes you can use if you ever need to go back and repeat your experiment…this is essential practice for scientists, engineers, doctors, and so on. This includes answers to the questions you type in and the values of the parameters you select before submitting your experiments.
- The iLab will essentially walk you through the process of the experiment! The experiment should take just a few minutes before you have your data.

- When you get your data, you will want to figure out the average number of counts for each distance you chose. In Excel, you will want Distance (in millimeters) on the x-axis and Average Counts on the y–axis. Then do your thing with Excel to figure out what sort of relationship exists between these two quantities by trying the various fits allowed by Excel and looking at R^2 values. Print out the graph with best-fit function.
- Write up what your results are for the fits and your conclusions about how the intensity of radiation depends on distance.
- You will need your journal page(s) that include your responses to the questions that were asked within the iLab, graph and data table, and conclusions to turn in. Also, write a few sentences about what you think of this experiment, and the fact that this allows us to do experiments that normally would not be able to be done. Was the experiment laid out clearly? Are the instructions understandable as you did the iLab?

Post-Assessment

- Do the online Post-Assessment, which is also on the curriculum page under Post-Lab Activities (http://ilabcentral.org/radioactivity/advanced).

Define in your own words:

- Radiation

- Radioactivity

- Alpha particle

- Beta particle

- Gamma ray

- Half-life

Look up **Geiger counter**…what is it, what does it do, and how does it do it?

Suggested Activity Rubric

Total Possible Score: 30 points

Score	Reflection	Analysis
30	○ All answers are complete and clearly demonstrate reflection. ○ The research question is thoughtful and complete. ○ All experimental variables defined in the design phase (Distances, Measurement Time, and Number of Trials) are clearly justified.	○ Data is clearly labeled and organized. ○ All trials and average of trials are clearly graphed with the linear and power best-fit functions, equations and R^2 values for each fit functions, and labels for axes with correct units.
25	○ Some answers are complete and moderately demonstrate reflection. ○ The research question is somewhat thoughtful and complete. ○ Some experimental variables defined in the design phase (Distances, Measurement Time, and Number of Trials) are clearly justified.	○ Data is moderately labeled and organized. ○ Some data is graphed with best-fit functions, equations, R^2 values, and labels are somewhat clear.
20	○ Most answers are incomplete and demonstrate poor reflection. ○ The research question is incomplete and not thoughtful. ○ Most experimental variables defined in the design phase (Distances, Measurement Time, and Number of Trials) are poorly justified.	○ Data is poorly labeled and organized. ○ Data and best-fit functions are not properly graphed or labeled.
15	○ All answers are incomplete and demonstrate no reflection. ○ The research question is incomplete and not thoughtful. ○ None of the experimental variables defined in the design phase (Distances, Measurement Time, and Number of Trials) are justified.	○ Data and graphs are incomplete.