SOME PROPERTIES OF NUCLEAR RADIATION - USING A Th-232 DAUGHTER (#9.2)

Tools for Research - Tools for Learning

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Overview:

Radioactive materials played an important role in the discovery of the atom and in the ending of a world war, and may yet play an important role in providing energy for mankind. Because the unresolved problem of storage of nuclear waste is limiting the use of nuclear power, environmental and health concerns may soon directly collide with the world's desire for more energy. To make intelligent decisions about this problem requires, in part, some knowledge about the properties of alpha, beta, and gamma radiation, and about the concept of "half life".

Objectives:

After completing this experiment, you should be able to ...

- Define the term "standard deviation", and use the standard deviation to bracket experimental data points to show their uncertainty.
- Differentiate between beta and gamma radiation, and estimate the range of beta radiation in common materials.
- Define the term "half life", and determine the half life of an electron-storage device and a radioactive isotope by examination of experimental data.

Detection of Nuclear Radiation:

The students are led through a discussion of the construction and operation, with schematic diagrams, for a Geiger-Muller (G-M) tube

Experiment 1: Statistics

Random factors in a measurement show up as a scattering of data points, even when one makes the same measurement over and over. One of the best examples of this is the decay of naturally radioactive nuclei. The students will collect twenty separate thirty-second counts from a sample of a radioactive compound, and are guided through the analysis to understand the statistical nature of radioactive decay.

Experiment II: Comparing the penetration of beta and gamma radiation through cards.

Students will determine the range of beta and gamma radiation through paper index cards by stacking the cards between the radioactive source and the Geiger tube, graph the data, and determine the number of cards required to stop the penetration of Beta particles using 30 second counting times.

Experiment III: Determination of the half life of an electron-storage device.

Many natural phenomena exhibit a characteristic known as "half life". In these phenomena, something leaves the system at a rate that is proportional to the number of the items present at that time. Examples of half life are discussed, along with the necessary equations, and a half life is measured using a resistor-capacitory system charged from the ***MicroLAB***.

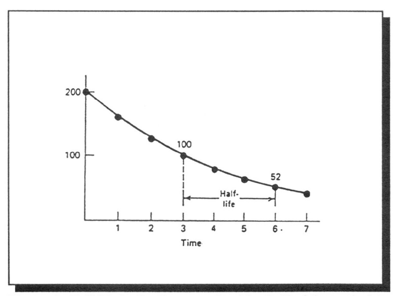

Figure 4. Half life is the time required for half of the material (electrons, in this case) to leave the system.

Experiment IV: Radioactive Half Life:

Radioactive decay is measured using Tl-208* extracted from Th-232, with specific instructions to accomplish the separation in the Instructor Resources. Guidance is given in both experiments for analyzing the data, along with a series of questions to help the students think through the experiment..

Instructor Resources Provided

- Sample Report Sheets providing the format to organize the data collection with sample data.
- Questions to consider, answer and turn-in with suggested answers.
- Tips and Traps section to assist the instructor with potential problems and solutions.
- Sample ***MicroLAB*** screen shots and graphs.
- Laboratory preparation per student station.

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