Half-life of Ba-137m Prelab

by

Dr. Christine P. Cheney, Department of Physics and Astronomy, 401 Nielsen Physics Building, The University of Tennessee, Knoxville, Tennessee 37996-1200

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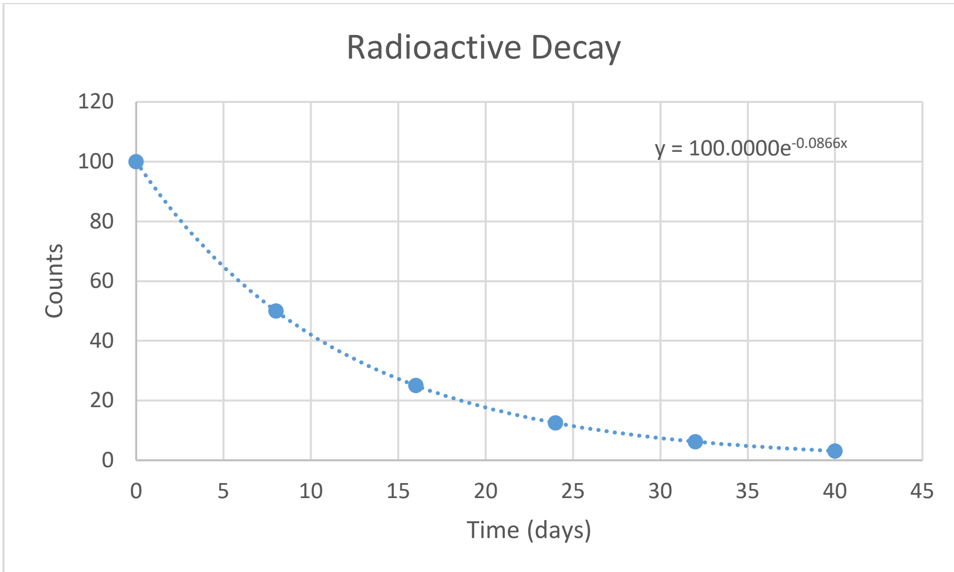
Read the introduction to Half-life of Ba-137m in your lab manual.[1] In the Poisson Statistics lab, you saw that radioactive decay is a random process and that each decay has some probability of occurring. In this week's lab you will measure the half-life of Ba-137m, the metastable state that is a product of Cs-137 radioactive decay. The half-life is the amount of time it takes *N* radioactive nuclei to decay to half of the original radioactive nuclei. The isotope generators that we are using contain up to 10 μCi (370 kBq) of Cs-137 (± 20%) bound on a special ion exchange medium and can produce the short lived isotope, Ba-137m (half-life: 2.6 minutes). Using an eluting solution (which is forced through the isotope exchange column using a syringe) the Ba-137 is selectively extracted from the ion exchange medium leaving only the Cs-137. This process is called "milking the generator." The elution solution contains 0.9% NaCl in 0.04 M HCl.

Certain radioactive materials with short half-lives are useful in the medical field since they do not stay in body for an extensive time before decaying to trace amounts. Radioactive iodine 131 has a half-life of 8.02 days and is commonly used to treat hyperthyroidism caused by Grave's disease and thyroid cancer. It is absorbed by the follicular cells of the thyroid gland via the sodium/iodine symporter.[3] Iodine 131 predominantly decays into xenon 131m (metastable) with a release of high energy electrons (beta particles) and then into xenon 131 with a release of gamma rays. The beta particles can penetrate a few millimeters of tissue.

Other radioactive materials are used as tracers or markers in medical imaging. For example, fluordeoxyglucose (FDG), which uses fluorine 18 combined with deoxyglucose, is used in Positron Emission Tomography (PET) scans. Cancer cells have a faster growth rate than normal tissue and absorb more FDG. The radioactive tracer will be seen in the detection system and point to cancerous material.[4] The half-life of FDG is about 110 minutes and decays by emitting low energy positrons.[5]

Questions:

1. Calculate the half-life of the radioactive material shown below:



2. If you forgot to subtract the background radiation from your counts, how would this affect your measurement for the half-life?

Things to remember for lab:

1. You will need to properly set up the counter as described in the lab manual.
2. You will take a background measurement with the tray and empty planchet.
3. Your GTA will handle the planchets containing the Ba-137 solution. Please do not touch the tray with the planchet. Your GTA will dispose of the planchet at the end of the lab.
4. You will take a measurement with the Ba-137 solution where your counts should be at least 8000 for the first time interval.

References

[1] Parks, James E. *Contemporary Introductory Physics Experiments, 2nd Edition*, Hayden-McNeil Publishing: Plymouth 2014.

[2] http://www.spectrumtechniques.com/products/sources/isotope-generator-kit/

[3] www.khanacademy.org/test-prep/mcat/physical-sciences-practice/physical-sciences-practice-tut/e/the-radioactivity-of-iodine-131

[4] https://www.acrin.org/patients/aboutimagingexamsandagents/aboutpetscans.aspx

[5] Evelina Miele, *et al*. "*Positron Emission Tomography (PET) radiotracers in oncology – utility of 18F-Fluoro-deoxy-glucose (FDG)-PET in the management of patients with non-small-cell lung cancer (NSCLC)*." Journal of Experimental and Clinical Cancer Research, **27**:52, 2008.