



Experiment 20

Radioactive Decay of Protactinium-234

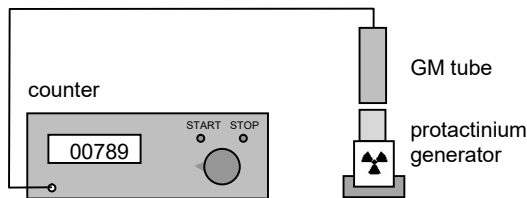
First read the introduction at experiment 20 in the booklet *ISP Experiments* about the operation of the protactinium generator.

Aim

- To determine the relation between radiation intensity (or: activity of the source) and time.
- To measure the half-life of protactinium-234.

Set-up

The set-up consists of a Geiger-Müller tube, a pulse counter and a protactinium generator (^{234}Pa). The counter can be set to an automatic measuring time of 10 s or to 'continuous'. In the latter case, after starting the counter will continue counting until the stop button is pressed. For measuring time, then use a stopwatch. The protactinium generator has no removable lid. So, do not try to open up the generator in one way or another.



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The protactinium generator has to be 'started' by thoroughly shaking it. After shaking, you will have to wait for about one minute before measuring can start. With the equipment set-up, the half-life $t_{1/2}$ of ^{234}Pa can be determined from measuring the intensity I (in pulses per unit of time) of the emitted radiation as a function of time t .

Research Question • Draw up a research question fitting the aim and equipment set-up of this experiment.

Hypothesis

- Draw up an argued hypothesis about the relation between the intensity I of the emitted radiation and time t .
- Give this hypothesis also in the form of a sketch of the relation between these quantities in an I, t -graph.
- Also draw up a hypothesis about the order of magnitude of the half-life $t_{1/2}$ of ^{234}Pa .

Plan of Work

- Draw up a plan of work for the investigation with the given equipment set-up.
- In this plan of work, indicate how you will vary which quantities in order to be able to check your hypothesis.
- Indicate how you will correct your measurements for the background radiation.
- Prepare an (empty) table for recording your measurements.
- Indicate whether the experiment will contribute to the radiation dose you receive during the laboratory session. And, if so: how you can take care that this radiation dose stays as low as possible.
- Discuss your research question, hypothesis and corresponding plan of work with your teacher or the school's laboratory technician.
- If necessary, review your research question, hypothesis and/or plan of work.

Investigation

- Carry out the investigation according to your plan of work. During the laboratory session, take care of an adequate radiation protection.

Data Processing

- Process your measurements in order to check your hypothesis, and to answer your research question. The box below gives some instructions for such data processing.

Instructions

- Plot your measurements in a graph.
- > From this graph, determine the half-life $t_{1/2}$ of ^{234}Pa .
- Information about an accurate way of determining the half-life from a graph on single logarithmic graph paper can be found in the booklet *ISP Experiments*.

> Compare the accuracy of determining the half-life $t_{1/2}$ of ^{234}Pa from your measurements when using normal graph paper and single logarithmic graph paper.

Extra question

Hospitals often do not receive the isotope that is actually necessary for radiation treatment, but a different one. For instance they would receive Mo-99 instead of Tc-99m when Tc-99m is needed. Can you explain why?

Report

- Write a report about this investigation. This report presents your *research question*, *hypothesis*, (processed) *measurements* and *conclusion* about the hypothesis being confirmed or not.