Experiment 2A

Radioactive Decay of Radon-220

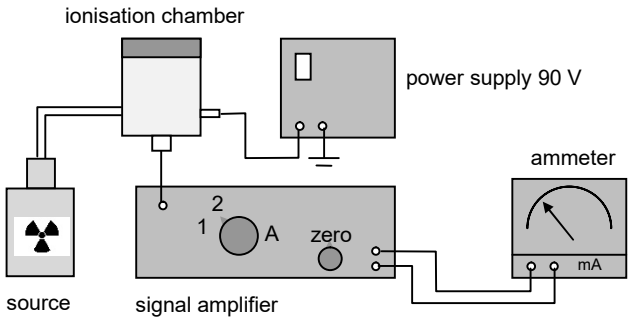
First read the introduction at experiment 2 in the booklet *ISP Experiments* about the decay of radioactive isotopes.

Aim

- To determine the relation between ionisation current (or: activity of the source) and time.
- To measure the half-life of radon-220.

Set-up

The set-up consists of an ionisation chamber that is filled with radon gas from a small plastic bottle containing a source of thorium-232 (^{232}Th). The α particles emitted by the radon-220 (^{220}Rn), which is itself a decay product of ^{232}Th, ionise the air in the ionisation chamber. The charge produced is displayed as a current on the ammeter after amplification by the signal amplifier. The value of the current I at time t is a measure of the number of radioactive radon nuclei N_t at that moment. Because: the larger the number of radioactive radon nuclei is, the larger is the ionisation of the air and so the larger is the current measured.
Depending on the available equipment, you might have to adjust the amplifier settings: turn switch A of the signal amplifier to position 1, and check whether the indicator of the ammeter points at zero. If not, use the button 'zero' to put the indicator in the right position, and turn switch A to position 2. The measuring range of the ammeter is 6 mA.
Insert the radon gas into the ionisation chamber in the following way: open the tube clip, gently squeeze the small plastic bottle until the indicator of the ammeter gives a maximum deflection, and close the tube clip.
For measuring time, use a stopwatch.



With the equipment set-up, the half-life $t_{1/2}$ of ^{220}Rn can be determined by measuring the ionisation current I 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 ionisation current I 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 ^{220}Rn.

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.
- 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 ^{220}Rn.

- 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 ^{220}Rn from your measurements when using normal graph paper and single logarithmic graph paper.

Extra question
In 2013, the RIVM (Institute for Public Health and the Environment) showed that in a typical residence in the Netherlands the activity is about 15,6 Bq per m^3 air, because of Radon. Assuming that your lungs (6,0 L) are constantly filled with this air, how many alpha-particles do you process each year?

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.