Experiment 2A

Radioactive Decay of Radon-220

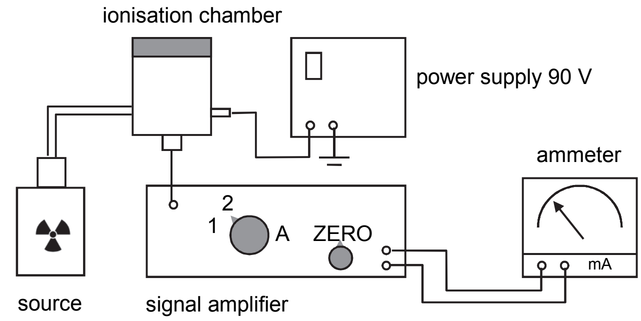
Name:
……………………………………………...

Aim

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 a 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.



Read the introduction on page 4 of the booklet *ISP Experiments* about the decay of radioactive substances.

Measurements

1 Set switch A of the signal amplifier to position 1. Check if the indicator of the ammeter is set on zero. If not, use the "set zero" button to put the indicator on zero. Now set switch A in position 2.

2 Open the tube clip, gently squeeze the small plastic bottle until the reading of the ammeter exceeds the value of 6 mA, and close the tube clip.

3 The ammeter reading will now slowly decrease. As it passes the value of 6 mA, start the clock. This is t = 0 s. Take readings of the time t (in s) as the indicator passes the values of 5, 4, 3, 2 and 1 mA, respectively. Record your measurements in the table below.

current I (mA)	6	5	4	3	2	1
time t (s)	0					

Assignments

1 Plot your measurements (current I as a function of time t) in the graph on the other side of this worksheet (left).

2 Determine the half-life $t_{1/2}$ of ^{220}Rn by choosing a value of the current and measuring in the graph after how much time this value is halved. Do this three times for three different values of the current. Record your measurements below (A, B and C), and calculate the average value of the half-life of ^{220}Rn.

The current I decreased

A from …… to …… mA in …… s

B from …… to …… mA in …… s

C from …… to …… mA in …… s

Average half-life $t_{1/2}$ of ^{220}Rn:

$t_{1/2}$ = …… s

3 Draw another graph of the same data, but this time on the single logarithmic graph paper below (right). What is special about this graph?

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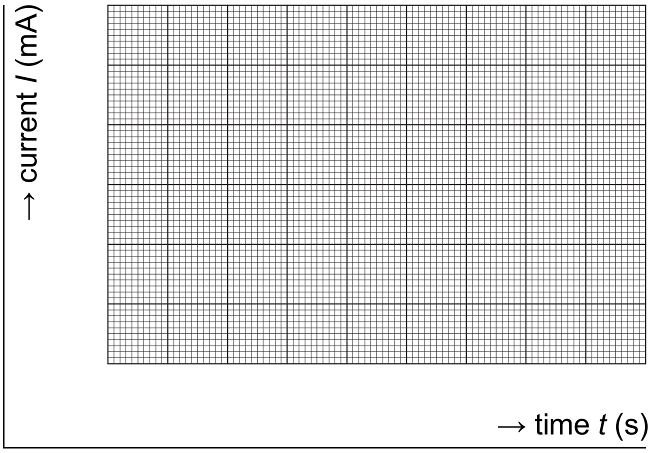

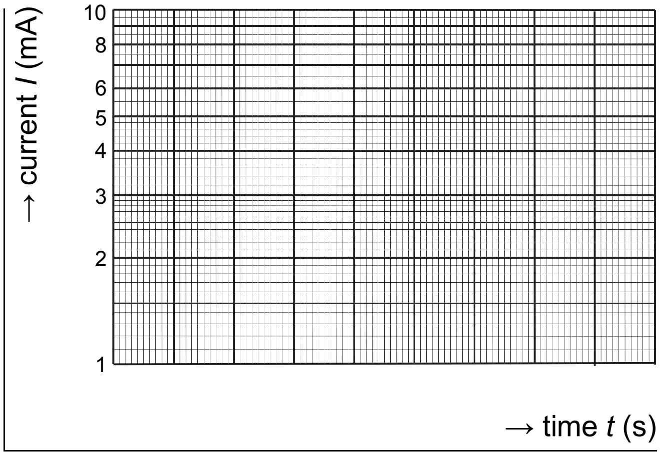

4 Determine from this new graph the half-life $t_{1/2}$ of ^{220}Rn:

$t_{1/2}$ = ……. s

5 In assignments 2 and 4 you used two different ways to determine the half-life of ^{220}Rn. Which of these is the most accurate, and why?

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6 What is the literature value of the half-life of ^{220}Rn according to the table of isotopes in the booklet *ISP Experiments* (page 30)? What is the difference between this and your own value?

Literature value: …… s. Deviation: …… %

7 Calculate the time in which the activity of ^{220}Rn will decay to 6.25% of the original activity (100%).

Time: …… s

8 ^{220}Rn is a so-called daughter product of ^{232}Th, which decays into the stable ^{208}Pb according the decay series below.

$^{232}_{90}\mathrm{Th} \xrightarrow[1.4\cdot10^{10}\ \mathrm{a}]{\alpha} {}^{228}_{88}\mathrm{Ra} \xrightarrow[\dots\dots]{\dots} {}^{228}_{89}\mathrm{Ac} \xrightarrow[\dots\dots]{\dots} {}^{228}_{90}\mathrm{Th} \xrightarrow[\dots\dots]{\dots} {}^{224}_{88}\mathrm{Ra} \xrightarrow[\dots\dots]{\dots} {}^{220}_{86}\mathrm{Rn} \xrightarrow[\dots\dots]{\dots}$

$^{216}_{84}\mathrm{Po} \xrightarrow[\dots\dots]{\dots} {}^{212}_{82}\mathrm{Pb} \xrightarrow[\dots\dots]{\dots} {}^{212}_{83}\mathrm{Bi} \xrightarrow[\dots\dots]{\dots} {}^{212}_{84}\mathrm{Po} \xrightarrow[\dots\dots]{\dots} {}^{208}_{82}\mathrm{Pb}$ (stable)

Complete the decay series of ^{232}Th above. In this decay series you put the particle (α or β) above the arrow and the half-life below the arrow, as already done for the first decay step. You can find the necessary half-life values on page 30 of the booklet *ISP Experiments*.

9 What can you say about the danger of inhalation of ^{220}Rn? Motivate your answer.

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Note

See the booklet *ISP Experiments* (page 31-32) for the reasons of using single logarithmic graph paper in determining the half-life of a radioactive isotope.