Experiment 1

Range of Alpha Particles in Air

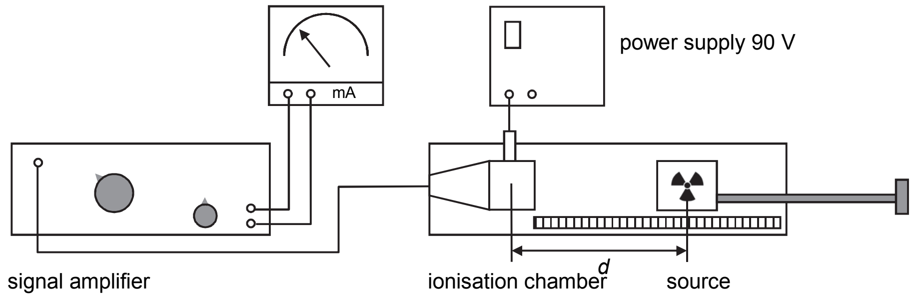
Name: ……………………………………………..

Aim

To measure the range in air of α particles emitted by a source of radium-226.

Set-up

The set-up consists of a radium-226 (^{226}Ra) source and an ionisation chamber. In such an ionisation chamber the α particles cause an ionisation of the air in the chamber, which induces an ionisation current. The distance *d* between the source and the ionisation chamber is adjustable and can be read on a scale. The ionisation current can be read on an ammeter after amplification by a signal amplifier.



Read the introduction on page 3 of the booklet *ISP Experiments* about the range of α particles in air. See also the background information on the information sheet for this experiment.

Measurements

1 Move the holder with the source so that it touches the ionisation chamber. Read the distance *d* (in mm) between the source and the ionisation chamber on the scale. The scale is made in such a way as to take into account the average radiation depth into the chamber in the reading of *d*. Read the ionisation current *I* (in 10^{-11} A) and record your measurement in the table below.

2 Move the source 5 mm backwards, again measure the ionisation current and record your measurement in the table.

You will see that the ionisation current – probably contrary to your expectation – has gained. This is to explained by the following. The ionising ability of an α particle depends on its energy. At the second measurement the distance between the source and the chamber was larger. The α particles that now enter the ionisation chamber have travelled longer distances in which they have lost some energy. With this lower energy the interaction between the α particle and the nitrogen and oxygen molecules in the ionisation chamber becomes larger. This will result in a higher ionisation current.

3 Move the source another 5 mm backwards, measure the ionisation current and record your measurement in the table. Repeat this until the ionisation current has become zero.

d (mm)	25	30	35	40	45	50	55	60	65	70	75	80
I (10^{-11} A)												

Assignments

1 Plot your measurements (ionisation current *I* as a function of distance *d*) in the graph on the other side of this worksheet.

In order to explain the shape of the graph, it is important to first fill in the decay series of ^{226}Ra below. The ^{226}Ra in the source decays through a large number of steps to finally ^{206}Pb. The source also contains the other decay products (daughter products). Each of these daughters decays and emits its own particle with its own energy value.

2 Complete the decay series of ^{226}Ra below. In this decay series you put the particle (α or β) above the arrow and the energy of the particle below the arrow, as already done for the first decay step. You can find the necessary energy values on page 30 of the booklet *ISP Experiments*.

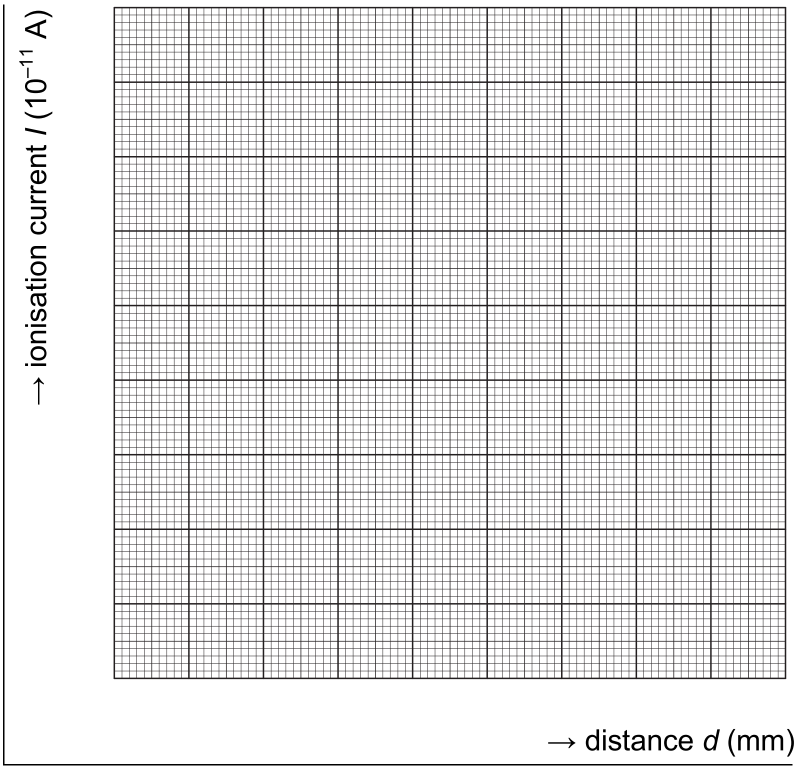
$$^{226}_{88}\text{Ra} \xrightarrow[4.8\text{ MeV}]{\alpha} {}^{222}_{86}\text{Rn} \xrightarrow[\dots\dots]{\dots} {}^{218}_{84}\text{Po} \xrightarrow[\dots\dots]{\dots} {}^{214}_{82}\text{Pb} \xrightarrow[\dots\dots]{\dots} {}^{214}_{83}\text{Bi} \xrightarrow[\dots\dots]{\dots} {}^{214}_{84}\text{Po} \xrightarrow[\dots\dots]{\dots}$$

$$^{210}_{82}\text{Pb} \xrightarrow[\dots\dots]{\dots} {}^{210}_{83}\text{Bi} \xrightarrow[\dots\dots]{\dots} {}^{210}_{84}\text{Po} \xrightarrow[\dots\dots]{\dots} {}^{206}_{82}\text{Pb}\text{ (stable)}$$

3 The range *R* of an α particle is the maximum distance the particle travels in matter. The α particles emitted by the source have different energies, each with their own specific range. Find from the graph the maximum range *R* of these α particles in air.

Maximum range: *R* = ……… mm

4 Explain the shape of the graph now that you know what kind of radiation and energy are released within the decay series of ^{226}Ra.



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5 What can you say about the danger of α particles for both inside and outside radiation of the human body? Motivate your answer.

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Note

In the Wilson chamber of Experiment 9 the range of α particles in air is directly visible.