Experiment 1
Information sheet

Range of Alpha Particles in Air
Ionisation Curve

Because α particles are charged helium nuclei, they ionise the atoms of the matter they move through. This offers a method of detecting α particles: measuring the ionisation current in an ionisation chamber. This ionisation current depends on the distance between the α source and the ionisation chamber. With increasing distance, the ionisation current first increases. After reaching a maximum the ionisation current quickly decreases with a further increase of the distance. The distance at which the ionisation current becomes zero is called the range *R* of the α particles.

Ionisation Curve
After leaving the source, the speed (or energy) of the α particles decreases as a result of energy transfer when ionising the molecules in air (on average 32 eV per ionisation). It appears that the ionising capacity of an α particle depends on its speed: at a lower speed more molecules in air are ionised as compared to higher speeds. Or, in other words: at a lower speed the interaction between α particles and nitrogen and oxygen molecules in the ionisation chamber is stronger. The larger the distance between the source and the ionisation chamber is, the lower is the speed of the α particles entering the ionisation chamber and, thus, the larger is their ionising capacity. The α particles then cause more ionisations in the ionisation chamber, and thus a larger ionisation current. This relation between distance and ionisation current holds as long as the α particles still have sufficient speed (or energy) for being able to ionise the molecules of air in the ionisation chamber. With increasing distance between source and ionisation chamber the speed (or energy) of the α particles will, at a certain point, become too small to ionise the molecules of air in the ionisation chamber. Therefore, at a certain distance between source and ionisation chamber, the ionisation current will quickly decrease till zero.
In summary: if the distance between source and ionisation chamber increases, the ionisation current first gradually increases, and after reaching a maximum quickly falls back to zero. This *ionisation curve* is displayed in the diagram of Figure 1.

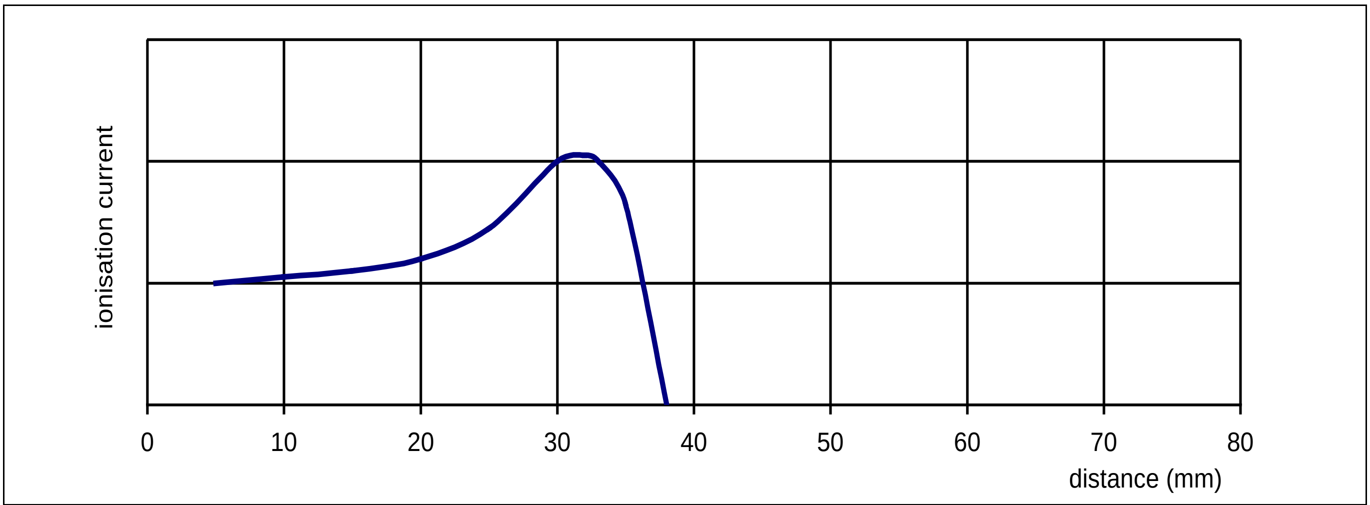

Figure 1 – Ionisation curve for α particles in air, emitted by the isotope ^{210}Po.

The ionisation curve of Figure 1 relates to α particles in air, emitted by the isotope ^{210}Po. From the graph it appears that the range *R* of these α particles in air is about 38 mm.
The ionisation curve has roughly the same shape for all α emitters. The exact shape of this ionisation curve depends on the energy of the α particles. This energy differs for each isotope, and therefore the range *R* of the α particles in air differs for each isotope.

Mixture of Isotopes

The ionisation curve your measured in Experiment 1 belongs to a ^{226}Ra source. Such a source contains all decay products of ^{226}Ra. Part of these decay products are α emitters. The table below shows the different α emitters in the ^{226}Ra source, including the energy and the range of their α particles in air.

Isotope	Energy (MeV)	Range in air (mm)	Ionisation Curve
^{226}Ra	4.8	33	1
^{210}Po	5.3	38.4	2
^{222}Rn	5.5	40.5	3
^{218}Po	6.0	46.6	4
^{214}Po	7.7	69.1	5

The separate ionisation curves for each of these isotopes are displayed in Figure 2. The sum of these separate ionisation curves is the aggregated ionisation curve of the ^{226}Ra source you measured in Experiment 1. This aggregated ionisation curve is also displayed in Figure 2. In this aggregated ionisation curve you see – just as in the separate ionisation curves of the different isotopes – a clear maximum in the ionisation current. You also see that the 'delay' in the decrease of the ionisation current to zero is caused by the α particles with the highest energy: those of the isotope ^{214}Po.

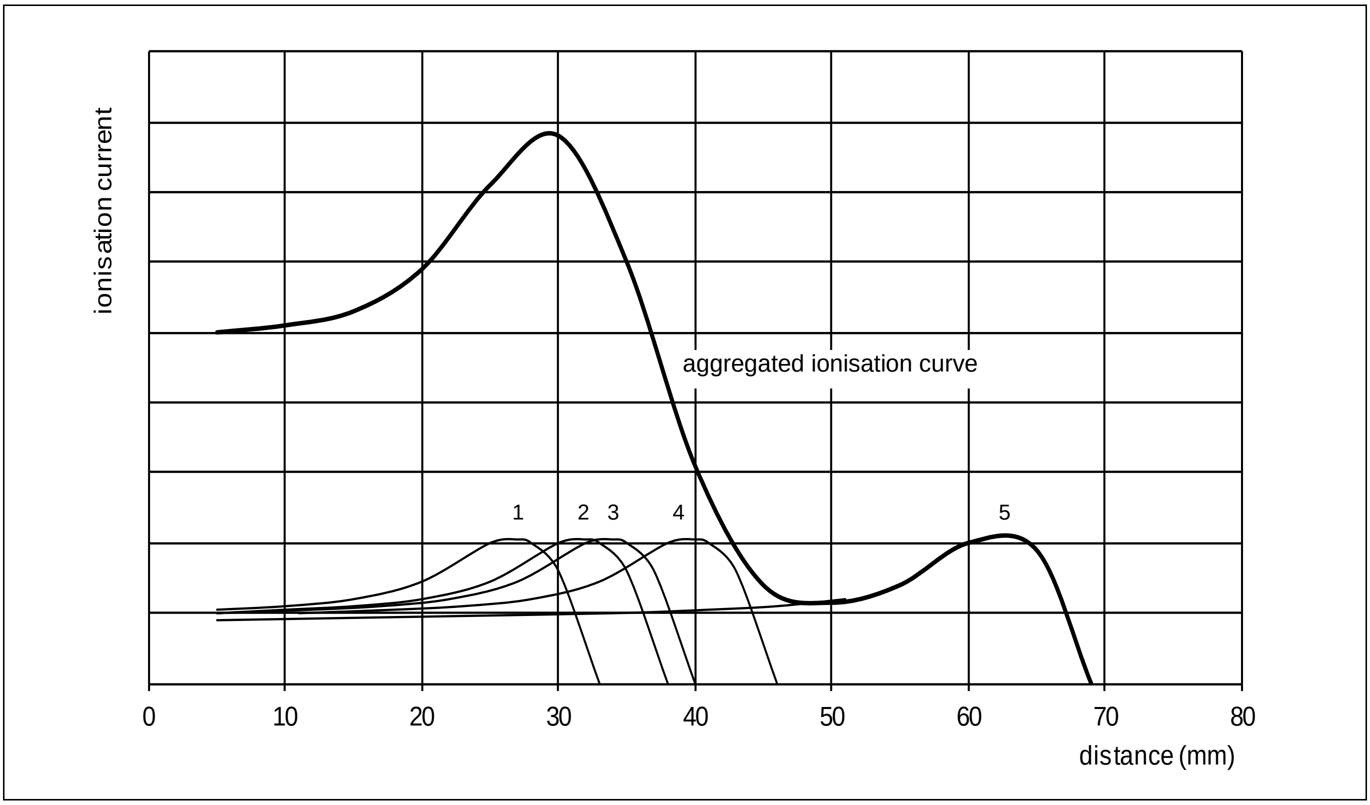

Figure 2 – The ionisation curves 1-5 of the different isotopes, added to the aggregated ionisation curve for all isotopes in the ^{226}Ra source.

Leave this information sheet at the equipment set-up