Experiment 19

Range of Alpha Particles and Air Pressure

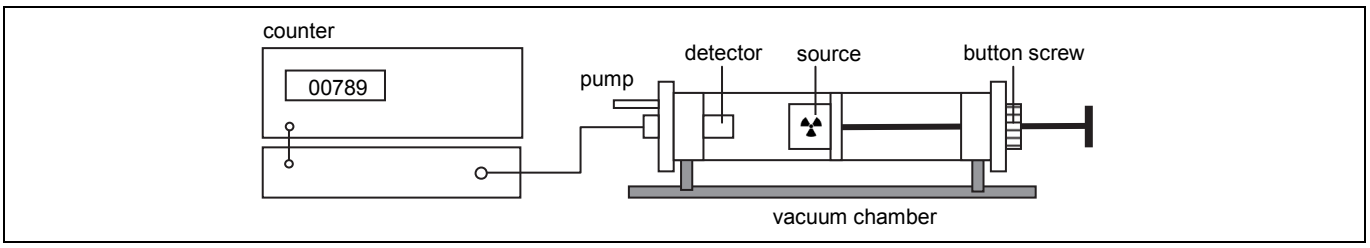
Name: ……..

Aim

To determine the relation between range of α particles in air and air pressure.

Set-up

The set-up consists of a detector, a pulse counter, a vacuum chamber and a source of americium-241 (^{241}Am). The vacuum chamber can be closed with a button screw. The air pressure in the vacuum chamber can be adjusted with a hand-operated vacuum pump, and can be read on a pressure meter.



Read the introduction on page 23 of the booklet *ISP Experiments* about the expected relation between range of α particles in air and air pressure.

Measurements

1 Position the holder with the source at a distance of 3.0 cm to the detector. Close the vacuum chamber by turning the button screw. Note: do not turn this button too tight. Start the counter. Reduce the air pressure in the vacuum chamber by pumping slowly. Stop pumping when the counter just starts counting. At this value of the air pressure, only the α particles emitted with the highest energy reach the detector. Read the air pressure *p* in the vacuum chamber, and record the result in the table below. So, at this value of the air pressure, the range *R* of the α particles is 3.0 cm.

2 Repeat this for the other values of the range (or: the distance between source and detector) as indicated in the table below.

range *R* (cm)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
air pressure *p* (hPa)									
$1/p$ (hPa)$^{-1}\cdot 10^{-3}$									

Assignments

1 Plot your measurements (air pressure *p* as a function of range *R*) in the graph at the other side of this worksheet (left).

2 In the graph of Assignment 1, choose a value of the range *R* (for example, 3.0 cm) and read the air pressure at that range *R* and at a range that is twice as large (so, 2·R). How many times as low is the air pressure when the range is twice as large? What will then probably be the relation between range of α particles in air and air pressure?

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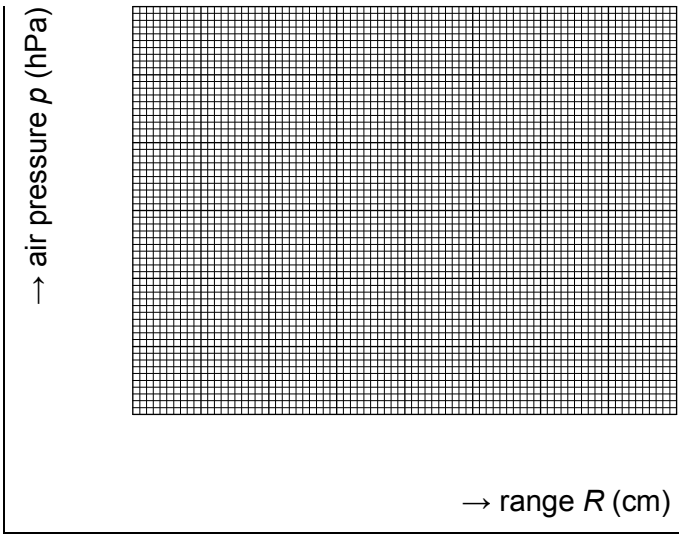
From Assignment 2 it appears that the relation between range *R* of α particles in air and air pressure *p* is probably inversely proportional. In a formula:

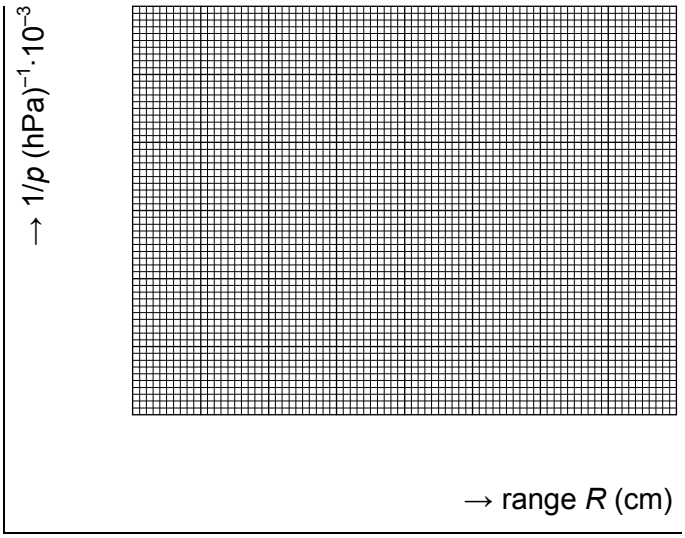
$$R = \frac{c}{p} = c \cdot \frac{1}{p}$$

In this formula, *c* is a proportionality constant. To check whether this relation is indeed valid, we plot the

range R versus $1/p$. The graph then has to be a straight line that also goes through the origin, as the above formula indicates that the range R is proportional to $1/p$.

3 Calculate the value of $1/p$ for each measured value of the air pressure p, and record the results in the table on the other side of this worksheet. Now plot the range R versus $1/p$ in the graph on the right.





4 Which conclusion about the relation between range of α particles in air and air pressure can be drawn from the graph of Assignment 3?

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5 From the graph, determine the proportionality constant c in the formula for the relation between range R and air pressure p.

c = …… cm·hPa

6 Use the value of the proportionality constant c to calculate the range of α particles in air at an air pressure of 100 hPa.

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7 Use the value of the proportionality constant c to calculate the air pressure at which the range of α particles in air is 10 m.

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8 The source contains the radioactive nuclide ^{241}Am. The decay of this nuclide is described by the equation below.

$$^{241}_{95}\text{Am} \xrightarrow{\cdots} {}^{237}_{93}\text{Np}\,(\text{unstable})$$

Write the kind of radiation emitted in this decay above the arrow.