OCR A Physics A-Level

PAG 7.3

Determine half-life using an ionisation chamber

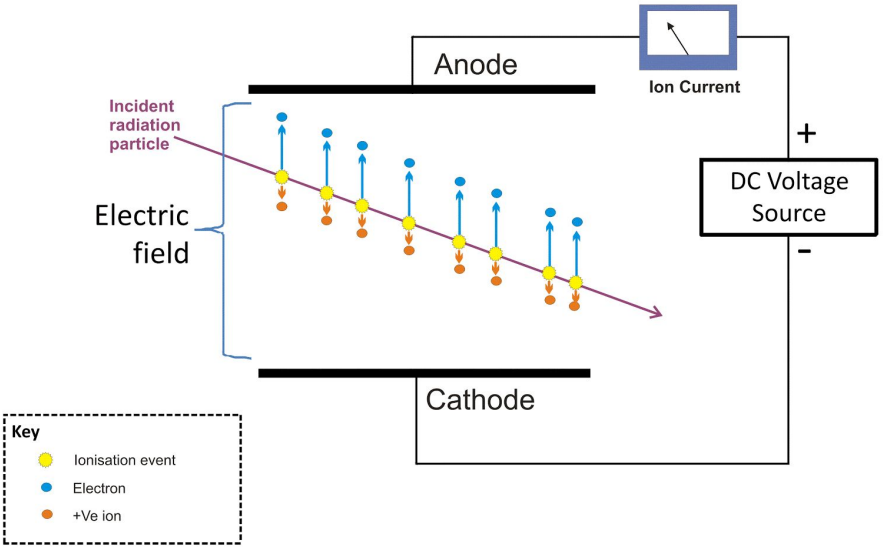
An ionisation chamber is a gas-filled chamber with a cathode and an anode. The ionisation chamber can be connected to a DC voltage source so that a uniform electric field is formed across the electrodes. When ionising radiation is incident on gas particles in the chamber, they will become ionised and the positive ions will move to the cathode, while the free electrons will move to the anode forming a current (ionisation current). The ionisation current is proportional to the number of ion pairs formed, therefore it is proportional to the intensity of the radiation.

Equipment

- Radioactive source
- Source holder
- Ionisation chamber
- DC voltage source
- High precision ammeter
- Stopwatch

Method

1. Set up the ionisation chamber, connecting it to the DC voltage source and ammeter as shown in the diagram below:



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2. Remove the radioactive source from its storage box and place it in its holder in front of the ionisation chamber. Immediately start the stopwatch.
3. Record the ionisation current every 10 seconds for 3 minutes.
4. Repeat this procedure twice more with a new source after waiting for at least 5 minutes between repeats, and find the average current for each reading.

Calculations

- Draw a graph of ionisation current against time and draw a line of best fit, which in this case will be a curve.
- You will be able to see that the decay is exponential. The time taken for the ionisation current to halve is constant and the name for this value is the half-life ($T_{1/2}$) of the sample.

- Using your curve you can measure the half-life of the radioactive substance by measuring the time taken for the ionisation current to halve, across several half-lives (if possible) and finding a mean.

Safety

- Ionising radiation can be incredibly dangerous, to reduce your exposure:
  - Never directly handle the source, use long-handled tongs.
  - Store the source in a lead-lined container when not in use.
  - Never point the source at others.
  - Keep the source as far away as possible from yourself and others.

Notes

- Even though the decay of the radioactive substance can be seen to follow an exponential decay, the process of nuclear decay is completely random. This can be seen from your measured values of ionisation current and the fact that your graph (probably) won't follow a perfect exponential decay curve.