

Experiment 10 Mini Generator: The Barium Cow

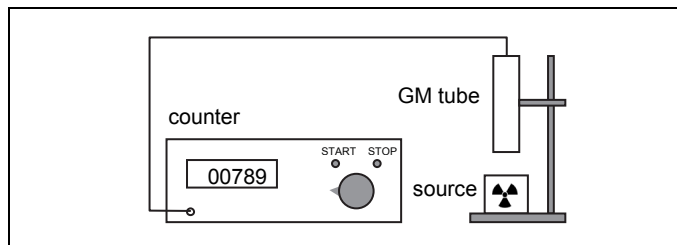
Name:

Aim

- To measure the half-life of barium-137m from the decreasing activity of the 'milk'.
- To measure the recovery time of the mini generator from the increasing activity of the 'cow' after having been milked.

Set-up

The set-up consists of a Geiger-Müller tube, a pulse counter, a mini generator with caesium-137 (¹³⁷Cs) (the 'cow'), a bottle with a solution of hydrochloric acid for 'milking' the 'cow', and a dish for collecting the solution of hydrochloric acid with barium-137m (^{137m}Ba) (the 'milk').



Read the introduction on page 12 of the booklet *ISP Experiments* about the operation of the mini generator.

Measurements

- 1 Measure the intensity I_b of the background radiation (in pulses per 30 s) three times and record your measurements in the table below. Make sure that the mini generator is at approximately 1 m distance from the GM tube. Calculate the average intensity $I_{b,avr}$ of the background radiation (in pulses per 30 s). Record the result in the table below.

| | | | | | |
|--------------------|--|--|--|--------------------------|--|
| I_b (pulses/30s) | | | | $I_{b,avr}$ (pulses/30s) | |
|--------------------|--|--|--|--------------------------|--|

- 2 Take the mini generator out of the lead container, and position the tip of the bottle with the solution of hydrochloric acid in the wide opening of the mini generator. Gently squeeze the bottle, so that roughly 25 drops of liquid go through the mini generator into the dish. Put the mini generator back in its container, and store it at 1 m distance from the GM tube.
- 3 You will first measure the activity of the 'milk' as follows. Position the dish underneath the GM tube. Start simultaneously both stopwatch and counter. Allow the stopwatch to run for 7.5 minutes. Measure according to the table below in consecutive time intervals the radiation intensity I (in pulses per 30 s) of the 'milk', and record these in the table. After each measurement, reset the counter. Finally, correct for the background radiation: $I_{cor} = I - I_{b,avr}$.

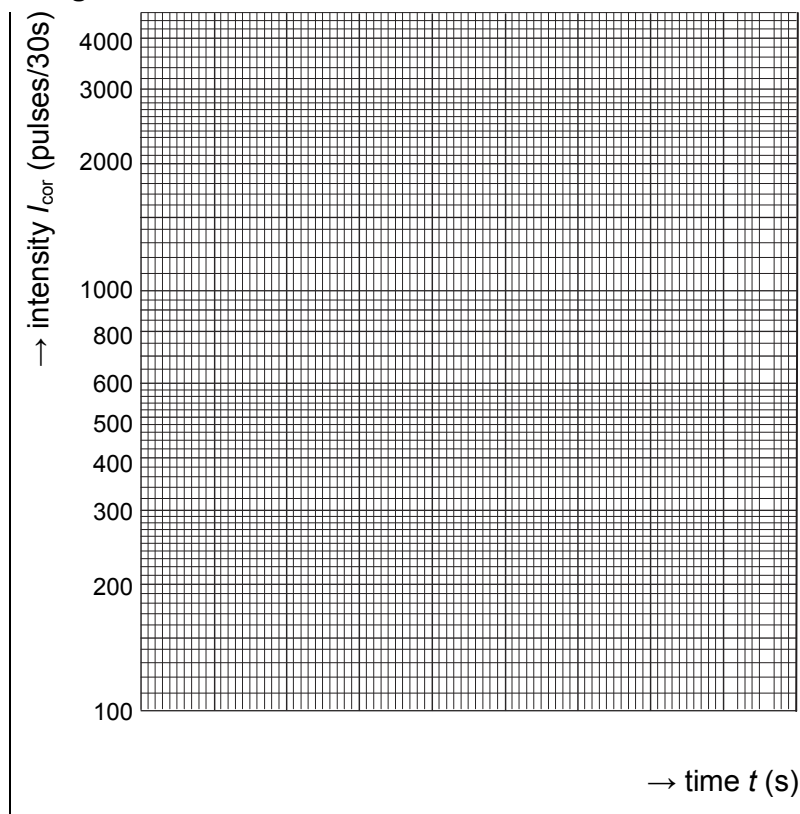
| | | | | | | | | |
|------------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| time t (minutes) | 0 – 0.5 | 1 – 1.5 | 2 – 2.5 | 3 – 3.5 | 4 – 4.5 | 5 – 5.5 | 6 – 6.5 | 7 – 7.5 |
| I (pulses/30s) | | | | | | | | |
| I_{cor} (pulses/30s) | | | | | | | | |

- 4 You will now measure the activity of the 'cow'. Follow the steps of measurement 2. Then position the mini generator (and *not* the dish) underneath the GM tube. Measure the radiation intensity I of the mini generator (the 'cow') in the same way as you did in measurement 3, and record the results in the table below.

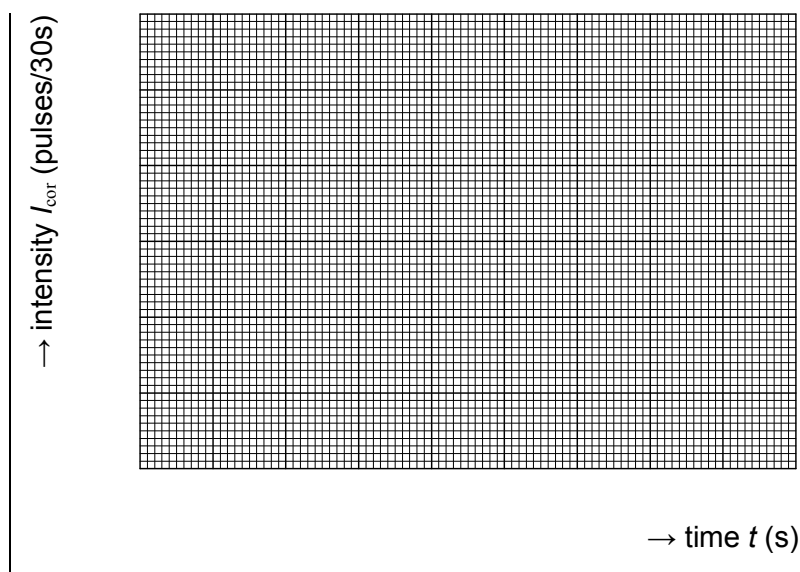
| | | | | | | | | |
|------------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| time t (minutes) | 0 – 0.5 | 1 – 1.5 | 2 – 2.5 | 3 – 3.5 | 4 – 4.5 | 5 – 5.5 | 6 – 6.5 | 7 – 7.5 |
| I (pulses/30s) | | | | | | | | |
| I_{cor} (pulses/30s) | | | | | | | | |

- 5 Put the mini generator back in its container and store it at 1 m distance from the GM tube. Flush the liquid from the dish through the sink. **Don't forget to wash your hands.**

Assignments



- 1 Plot your measurements (intensity I_{cor} as a function of time t) from the table of measurement task 3 on single logarithmic graph paper (left). See the booklet *ISP Experiments* (page 31-32) for the reasons of using single logarithmic graph paper.
- 2 From the graph, determine the half-life $t_{1/2}$ of $^{137\text{m}}\text{Ba}$:
 $t_{1/2} = \dots\dots$ minutes
- 3 In the same graph, draw the decay curve of ^{137}Cs .
Note: Use the information about the decay of ^{137}Cs on page 12 of the booklet *ISP Experiments*.



- 4 Plot your measurements (intensity I_{cor} as a function of time t) from the table of measurement task 4 in the graph (left).
- 5 From the graph, determine the recovery time of the mini generator (the 'cow').
recovery time: $\dots\dots$ minutes

6 Explain why you have to put the mini generator at a distance of 1 m from the GM tube when measuring the activity of the 'milk' in the dish.

.....

7 Explain why it is allowed to flush the 'milk' in the dish through the sink after finishing the experiment.

.....
