

E267: Participation in the CLEAPSS/ University of Liverpool investigation of school americium sources

Introduction

If you have a standard 'cup-style' 185 kBq (5 μ Ci) americium-241 source and a ZP1481 or equivalent Geiger-Muller (GM) tube, you can participate in this investigation. If you have more than one americium source, we would welcome data from all of them. Individual schools won't be identified in anything we publish.

Some school sources behave oddly and we are looking into the extent of this. We came across this when several schools told us that when detecting alpha emissions, their americium source appeared to have become less radioactive than when it was new. Strangely, the source worked as expected with a spark counter and an open ionisation chamber. But using a sheet of paper to block alpha particles in front of a GM tube did not make much difference to the detected radiation. Half-life can't be a factor because it is 433 years for americium-241.

CLEAPSS has been researching this with physicists at the Nuclear Physics Department, University of Liverpool, and we've found that in these oddly-behaving sources, the americium has diffused deeper into the metal disc¹. Consequently, the average energy of the alpha particles is reduced and fewer particles penetrate the GM mica window - hence the reduced detection rate. Conversely, we have also seen a few cases where the americium seems to have diffused closer to the source surface.

We're asking for your help in ascertaining how widespread these effects are and whether there are any general patterns that could help us understand what is going on in more detail. We can get a fair idea if the americium has diffused significantly, and in which direction, by how the ratio of count rate without and with a paper block varies with distance of the source from the GM tube.

What equipment is needed

- Cup style americium source, 185 kBq (5 μ Ci), e.g. the type supplied in lead-pot wooden boxes such as those from, for example, Griffin, Philip Harris, Nicolson, Timstar and Edulab. But not Panax (their americium sources are 4.6 kBq), or Isotrak.
- 'Radioactive bench' or similar for mounting and adjusting the position of the source and GM tube.
- A sheet of plain thick card and a sheet of 1 mm ruled graph paper*.
- A roughly 100 mm square piece of paper, cut from a sheet of 80 gsm white paper. 80 gsm is the normal 'thickness' (area density) of printer and photocopier paper.
- ZP1481 (or MX168, or LND72233) GM tube with a removable protective end cap. If you are not sure what your GM tube is, see the appendix.
- Counter (scaler) unit with 100 s gate (or manually stop it by hand and stop clock).

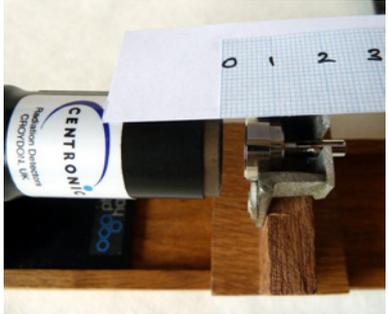
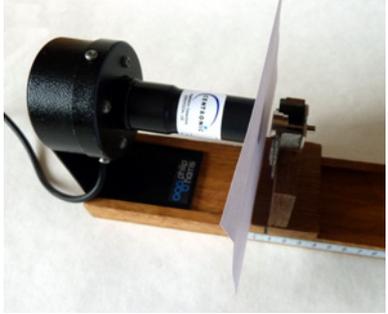
*The distance between the cup source and GM tube is measured with a card rule. If your radioactivity bench has a scale that allows you to set the distance between the front of the source and the metal end of the GM tube accurately, then use that. You can use a plastic rule to set the distance, but if you accidentally clip the mica window with it, you are more likely to break the window.

¹ You can find the full report in "Evidence for age-related performance degradation of ²⁴¹Am foil sources commonly used in UK schools" Whitcher, Page, Cole. J. Rad. Prot. Vol 34, No 2, June 2014, pp. 347-361.

What to do

We would like you to place a 185 kBq ($5\mu\text{Ci}$) cup-style americium-241 source at various distances from a ZP1481 (or equivalent) GM tube and record the detected counts. Set a distance and record the counts over 100 seconds, first without, then with, a piece of paper placed between the GM tube and source.

Follow the usual safety guidance in L93 on using cup sources. To ensure reliable comparability of data, please follow this method:

| | | |
|---|---|--|
| 1 | Cut a strip of graph paper, about 20 mm wide and at least 60 mm long, and mount it on a card strip, about 150 mm long, to make a rule. Write numbers on the cm divisions. |  |
| 2 | Plug the GM tube into its holder. Remove the protective 'spider web' cap of the GM tube. This means the fragile mica window is no longer protected so take care not to break it. |  |
| 3 | The GM tube and source need to be reasonably aligned coaxially. Ideally, use a radioactive bench to mount and adjust the GM tube and source. | |
| 4 | Connect the GM tube to the counter unit. If the GM voltage is adjustable, set it to 450 volts. | |
| 5 | With the americium source at least 2 metres away from the GM tube, take the background count over 100 s and record it. | |
| 6 | Put the source into its holder and carefully position it so the front of the cup is 5 mm from the metal end of the GM tube. A stand and clamp may be useful to hold the card rule steady when you adjust the source position. Remember not to lean forward to read the rule. Sit at the normal distance when using sealed sources; use a hands-free magnifying lens if it helps. Be careful: do not knock the source into the GM tube window. |  |
| 7 | Take the count over 100 s. Record it - don't subtract the background count. | |
| 8 | Without disturbing the position of the source , place the roughly 100 mm square piece of paper between the source and GM tube and take the count over 100 s. Record it - don't subtract the background count. |  |
| 9 | Repeat this for 7 mm, 10 mm, 15 mm, 20 mm, 25 mm, 30 mm, 40 mm, 50 mm and 60 mm gaps. | |

It is important that the source-GM distance remains unchanged when taking each pair of count rates, without and then with the paper block. Please don't vary this method, it will invalidate our assumptions.

If you can, take the measurements in one session, not over several sessions. If you have a battery-powered counter, make sure the batteries are in good condition; at high count rates, old batteries can start to fail and give erroneous results.

You may get results that do not make immediate sense. Record them nevertheless. For example, you may find the detected alpha count rate falls considerably when the source is placed very close to the GM tube. This can be caused by the counter/detector dead time increasing at higher count rates. The count-rate ratio of 'without paper' to 'with paper' can also fall as the source becomes very close to the GM tube because of the greater effect of the dead time at high count rates.

At this stage we are not looking into other alpha sealed sources such as plutonium or radium.

Results template

If you are sending us data for more than one source, use a separate result template for each. Fill in this template and email it to science@cleapss.org.uk for the attention of Ralph Whitcher.

| | | |
|---|---|------------------------------------|
| Name and postcode of school (so we can contact you if your source is behaving very oddly). | | |
| Member of staff we can contact. | | |
| Date the measurements were taken. | | |
| Unique source reference or identifier (only if you have more than one americium source). | | |
| Year the source was purchased if known. If you don't know it, leave it blank. If you only know it roughly, give the year and say 'roughly'. | | |
| Supplier of the source if known e.g. Griffin. | | |
| The manufacturer of the counter, and model if known, e.g. Philip Harris, Digicounter. | | |
| Does your counter have 100 second gate (i.e. can it be set to stop counting automatically after 100 s) (Y/N) | | |
| GM type if it is marked on the tube, e.g. ZP1481, MX168. | | |
| Supplier of the GM tube <u>holder</u> if known, e.g. Griffin. | | |
| Results from counting | | |
| Background count over 100 s | | |
| GM tube – source gap / mm | Count over 100 s without paper | Count over 100 s with paper |
| | Remember – please do not subtract the background count | |
| 5 | | |
| 7 | | |
| 10 | | |
| 15 | | |
| 20 | | |
| 25 | | |
| 30 | | |
| 40 | | |
| 50 | | |
| 60 | | |

Appendix

ZP1481 GM tube and holder

The ZP1481 and equivalents all have 2 pins with a central divider (concave on one side) that plug into a B2A socket. The ZP1481 tube is now manufactured by Centronic, older ones were made by Phillips, and even older ones (MX168) by Mullard. The USA manufacturer LND make an equivalent, LND 72233. Holders come in various designs, but they all have the two-pin B2A socket.

