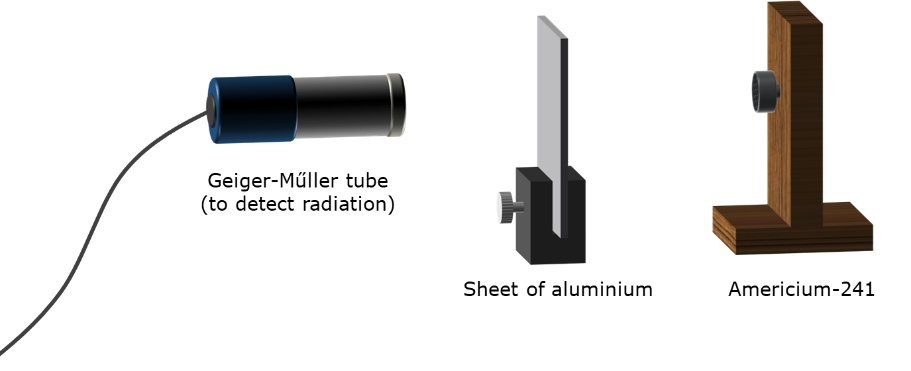
**Alpha and gamma**

Americium-241 is a radioactive isotope.

It is used in schools to make **alpha radiation**.

Alpha radiation can be blocked with a piece of aluminium.



Some students are discussing why the Geiger-Műller tube is still detecting radiation from the americium-241.

**Hafsah:** Gamma radiation can pass through the aluminium**.**

**Gethin:** Some alpha radiation can pass through the aluminium.

**Isha:** Americium-241 can decay to make either alpha radiation or gamma radiation.

**Kacey:** Gamma radiation is made after every alpha decay of americium-241.

**Joel:** Americium-241 is slowly changing into a different element.

**To answer**

1. Who is right about why the G-M tube is detecting radiation?

*Explain your answer*

2. Who is wrong about why the G-M tube is detecting radiation?

*What would you say to help them understand?*

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| --- | --- |
| Cards for  **Alpha and gamma** | **Gethin:** Some alpha radiation can pass through the aluminium. |
| **Hafsah:** Gamma radiation can pass through the aluminium**.** | **Isha:** Americium-241 can decay to make either alpha radiation or gamma radiation. |
| **Joel:** Americium-241 is slowly changing into a different element. | **Kacey:** Gamma radiation is made after every alpha decay of americium-241. |

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| Cards for  **Alpha and gamma** | **Gethin:** Some alpha radiation can pass through the aluminium. |
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*Physics > Big idea PMA: Matter > Topic PMA5: Nuclear physics > Key concept PMA5.2: Radioactive decay*

|  |
| --- |
| **Response activity** |
| **Alpha and gamma** |

**Overview**

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| Learning focus: | Some large nuclei, which are unstable because they contain too many protons, decay spontaneously by alpha radiation because of repulsive forces between protons. |
| Observable learning outcome: | Explain why a nucleus usually emits gamma radiation after an alpha decay. |
| Activity type: | Talking heads |
| Key words: | Radioactive decay, nucleus, proton, neutron, alpha particle, alpha decay, unstable, excited |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic question:

* Diagnostic question: After alpha

**What does the research say?**

At ages 14-16, students are rarely taught that the causes of alpha, beta and gamma radiation are each different. By thinking about a connection between alpha and gamma decay, this response activity is designed to support the development of a useful mental model for students, that can help challenge their misunderstandings about radioactive decay and clarify gaps in understanding that could otherwise lead to some confusion or uncertainty.

Prather (2005) found that, even after tuition, 59% of the undergraduates believed that the mass or volume of a radioactive substance reduced by half after one half-life, when half the substance had decayed. This outcome is suggestive that the language used to describe what is happening: ‘half of it has decayed’ and ‘half-life’ is taken literally by students; which in turn suggests that many students do not have a clear mental model of radioactive decay that they can draw on.

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It can be done as a pencil and paper exercise or projected onto a screen.

Students should read the statements and follow the instructions on either the worksheet or the PowerPoint. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in each group. For example, you may choose to select a student with strong prior knowledge as the scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

Hafsah, Joel and Kacey are right; and Gethin and Isha are wrong.

Gamma radiation can pass through a sheet of aluminium, but alpha radiation cannot (and the thickness of aluminium shown, will also stop beta radiation). Therefore, the G-M tube is detecting gamma radiation\*.

During alpha decay, the nucleus of an americium-241 atom loses two protons and two neutrons and therefore becomes an atom of a different element (neptunium). The emission of an alpha particle from americium-241 leaves behind an excited nucleus that then emits a gamma photon (gamma radiation) in order to transfer excess energy away from the nucleus. It is this gamma radiation that is being detected.

Gethin is wrong because alpha radiation is extremely unlikely to penetrate the aluminium sheet.

Isha is wrong because each americium-241 decay emits *both* alpha and gamma radiation.

An alpha decay leaves an excited (neptunium) nucleus, which then emits gamma radiation in order to transfer excess energy away, and one cannot happen without the other.

\* *Background radiation has not been mentioned in this question, but it was stated that the G-M tube was detecting radiation from the americium-241, so it can be assumed that the count rate is significantly higher than it would be for a purely background count.*

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Prather, E. (2005). Students' beliefs about the role of atoms in radioactive decay and half-life. *Journal of Geoscience Education,* 53(4)**,** 345-354.