**Radioactive material**

Americium-241 is a radioactive isotope.

In smoke detectors americium oxide is used as a radioactive source.



Smoke detector

*A tiny amount of radioactive material is glued into a radioactive source.*

*Inside the smoke detector this is shielded with stainless steel.*

The statements are about the atoms in radioactive materials.

For each statement, tick (✓) **one** column to show what you think*.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | All radioactive material contains radioactive atoms. |  |  |  |  |
| **B** | Most radioactive materials contain atoms that are not radioactive. |  |  |  |  |
| **C** | Radioactive atoms disappear when they decay. |  |  |  |  |
| **D** | The types of atoms in a radioactive source change over time. |  |  |  |  |

*Physics > Big idea PMA: Matter > Topic PMA5: Nuclear physics > Key concept PMA5.4: Radioactive half-life*

|  |
| --- |
| **Diagnostic question** |
| **Radioactive material** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Radioactive half-life is the predicted time it takes for half of a large sample of radioactive nuclei to decay randomly. |
| Observable learning outcome: | Describe the decay of a radioactive material. |
| Question type: | Confidence grid |
| Key words: | Radioactive material, radioactive source, radioactive isotope, radioactive atom |

**What does the research say?**

A common misunderstanding students have is that atoms disappear during radioactive decay (Prather, 2005). Prather (2005) found that the majority (59%) of (n=258) undergraduate students believed that the mass or volume of a radioactive substance would reduce by half during one half-life. Expressed differently, this means that a radioactive object disappears as it decays. This misunderstanding is likely to stem from the fact that is not clear to a lot of students that radioactive materials contain both stable and unstable atoms.

**Ways to use this question**

Students should complete the confidence grid individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations, it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

Statements A, B and D are right; and statement C is wrong.

**How to respond - what next?**

Radioactive materials comprise of radioactive atoms in a compound or mixture with other elements. The radioactive atoms decay, independently of the structure they form a part of, releasing radiation as their nuclei transform, often into nuclei of different elements. Almost all of the mass of the radioactive material is retained throughout this process, with just alpha, beta and/or gamma radiation being lost.

A Most students should recognise that a radioactive material contains radioactive atoms.

B It is common for students to think that radioactive materials contain only atoms that are radioactive, rather than a combination of both stable and unstable atoms.

C It is common for students to think that mass or volume of a radioactive material is halved after one half-life. This implies that radioactive atoms disappear when they decay, yet it is likely that most students do not believe this to be true. This statement is intended to prompt discussion about perceived volume and mass changes.

D Some students may recognise that radioactive atoms do not disappear when they decay, and also think that this statement is wrong. These students are not correctly accounting for what happens to radioactive atoms when they decay.

In Prather’s study (2005) the majority of undergraduate students thought mass and/or volume of a radioactive source halved after one half-life. It is likely that many of these students applied a fragmented understanding of radioactivity, and that if their attention had been focused, they could have explained how a radioactive atom can change into a different type of atom during a radioactive decay.

If students have misunderstandings about the decay of a radioactive material, it can help to model what happens to a radioactive material as it decays. The following BEST ‘response activities’ could be used to do this, in follow-up to this diagnostic question:

* Response activity: Half-life of clay dice
* Response activity: Half-life of pizza

**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.