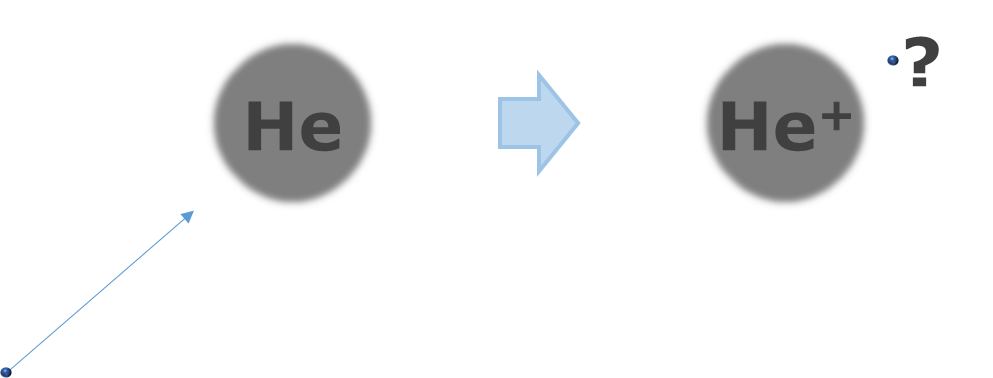
**Radiation remains**

Beta particles are emitted by some radioactive isotopes.

A beta particle can ionise a helium atom.



**a.** What answer best describes what happens to a beta particle after it has ionised an atom?

*Put a tick (✓) in the box next to the best answer.*

|  |  |  |
| --- | --- | --- |
| **A** | It bounces off an electron. |  |
|  |  |  |
| **B** | It moves less quickly. |  |
|  |  |  |
| **C** | It loses its radioactivity. |  |
|  |  |  |
| **D** | It disappears. |  |

**b.** Which reason best explains your last answer?

*Put a tick (✓) in the box next to the best answer.*

|  |  |  |
| --- | --- | --- |
| **A** | The atom gains an electric charge. |  |
|  |  |  |
| **B** | The atom gains radiation. |  |
|  |  |  |
| **C** | Energy is transferred to a moving electron. |  |
|  |  |  |
| **D** | It decays. |  |

*Physics > Big idea PMA: Matter > Topic PMA5: Nuclear physics > Key concept PMA5.3: Ionising radiation*

|  |
| --- |
| **Diagnostic question** |
| **Radiation remains** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Some forms of radiation can ionise atoms or groups of atoms. Several properties of each form of ionising radiation are determined by its ionising power. |
| Observable learning outcome: | Explain why ionising radiation does not make objects radioactive. |
| Question type: | Two-tier multiple choice |
| Key words: | Ionisation, radiation, beta particle, decay |

**What does the research say?**

Classroom discussions about ionisation often do not include opportunity for students to consider what happens to radiation particles after they have caused an ionisation (Eijkelhof, 1990). It is common for students to think that an object exposed to radiation becomes radioactive as a consequence\* (Prather, 2005) , perhaps because they think that radiation is conserved (Morales Lopez and Tuzon Marco, 2021) and can transfer from one material to another.

In a series of lesson observations of a class of 14 students, age 16-17, Eijkelhof (1990) found that although the teacher consistently referred to the ‘absorption of radiation’, students typically described it as being stopped by a material. This suggests some students may have a mental model of radiation bouncing off of a material.

When an alpha or beta particle causes ionisation, some of the energy it has because of its motion is transferred to the electrons it forces away from atoms or groups of atoms, reducing its speed.

*\*An exception to this rule is the example of high-energy gamma photons that may excite atomic nuclei.*

**Ways to use this question**

Students should complete the questions 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. The follow-on question will give you insights into how they are thinking and highlight specific misconceptions that some may hold.

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**

a. B b. C

**How to respond - what next?**

The electric field of a fast-moving beta particle can interact with the electric field of an electron that is found in an atom. If sufficient energy is transferred to the electron from a beta particle, it may be able to escape from the atom. With each interaction, the beta particle is left with less energy and moves more slowly. Eventually the energy of the beta particle reduces towards the mean energy of other particles in the substance and it is therefore absorbed.

a. Each of the distractors in *part a* are relatively common misunderstandings and it likely that in a class all four options will be chosen.

*b. Part b* prompts students to think more deeply about the reasons for their first answer.

A A common misunderstanding is that beta particles are absorbed into the atom they collide with, and some students may imagine the addition of the charge from the beta particle causes the atom to become an ion. If this were the case, the ion would have a negative charge.

B. It is also common for students to think that radiation is conserved and is passed from one particle (or substance) to another, making each particle radioactive in turn. The beta particle was created by an unstable nucleus decaying, it is not unstable, and is therefore not radioactive.

D. In everyday language, when something decays we often mean that it wears away or rots away and there becomes less of it. Some students are happy to imagine that particles can simply disappear, and do not realise that in everyday decay, the particles that are ‘worn away’ are just moved elsewhere.

If students have misunderstandings about explaining what happens to beta particles and therefore why ionising radiation does not make objects radioactive, it can help to guide them through the mechanism of what happens step by step. Giving them opportunity to work in pairs or small groups to work out their own descriptions of what happens can help to develop and consolidate understanding.

The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: Irradiated strawberries.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Eijkelhof, H. M. C. (1990). *Radiation and risk in physics education.* Rijksuniversiteit Utrecht.

Morales Lopez, A. I. and Tuzon Marco, P. (2021). Misconceptions, Knowledge, and Attitudes Towards the Phenomenon of Radioactivity. *Science & Education*.

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