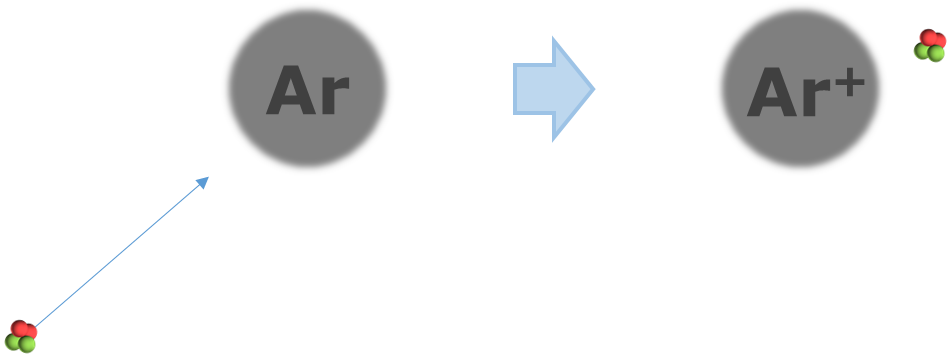
**Alpha ionisation**

Alpha particles are emitted by some radioactive isotopes.

They move at high speed and can ionise atoms or groups of atoms.



What happens when an alpha particle ionises an atom?

*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** | It can force off an outer electron. |  |  |  |  |
| **B** | It can force an electron out of the nucleus. |  |  |  |  |
| **C** | Its electric charge can pull electrons off. |  |  |  |  |
| **D** | A direct hit is not needed. |  |  |  |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Alpha ionisation** |

**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: | Describe what happens when radiation causes ionisation. |
| Question type: | Confidence grid |
| Key words: | Ionisation, radiation, alpha particle |

**What does the research say?**

Radioactive materials contain radioactive particles that are unstable and may undergo radioactive decay, and emit radiation. Alpha and beta particles are types of radiation, but it is common for students to describe them as ‘radioactive particles’ (Millar and Gill, 1996). This is wrong because they are both stable particles and do not undergo radioactive decay. Similarly, gamma radiation, which comprises of high energy photons, (which, at this stage, can be thought of as short bursts of electromagnetic wave) does not undergo radioactive decay.

Radiation can be harmful if it causes ionisation. Ionising radiation can cause outer electrons to be forced out of atoms, in turn affecting bonds and interactions between atoms. Often, discussion about ionising radiation is limited to a description of the relative likelihood of alpha, beta or gamma radiation to cause ionisation and to be ‘absorbed’. Alpha particles are typically described as the most likely to ‘collide’ with and ‘knock out’ an atom’s outer electrons, because they are the biggest radiation particle with the most electrical charge. This description is also used to explain that alpha particles are the most easily absorbed, because they are slowed down or stopped by each collision. However, this description can lead to a misunderstanding that direct collisions with electrons are necessary to dislodge them. In fact, it is the attraction or repulsion between the electric field of an electron and that of alpha, beta or gamma radiation that is responsible.

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

**How to respond - what next?**

An alpha particle is highly ionising because it has an electric charge of +2 that attracts electrons, and because it has a relatively large momentum, sufficient for it to pull electrons off atoms or groups of atoms that is moves past.

In the statements, the word ‘force’ has been used deliberately because it does not imply that a direct collision is necessary, between an alpha particle and an electron.

A, B Students with a good understanding of atomic structure are likely to correctly decide that statement A is correct and statement B is wrong.

C Although most students will be aware that beta particles have an electric charge, they do not necessarily make use of their understanding of electric fields in situations that are new to them. This separation of understanding may allow some students to think this statement is wrong.

D Often the language used to describe ionisation leads to the misunderstanding that electrons are knocked off atoms or groups of atoms when electrons are directly hit by alpha or beta particles.

If students have misunderstandings about describing what happens when radiation causes ionisation, it may be necessary to review their understanding of atomic structure and electrostatic forces between charged particles, in order to make students aware that these concepts can be applied to explain the process of ionisation.

A helpful analogy might be that of a magnet moving past a group of iron balls.

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

* Response activity: Beta ionisation

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Millar, R. and Gill, J. S. (1996). School students' understanding of processes involving radioactive substances and ionizing radiation. *Physics Education,* 31**,** 27-33.