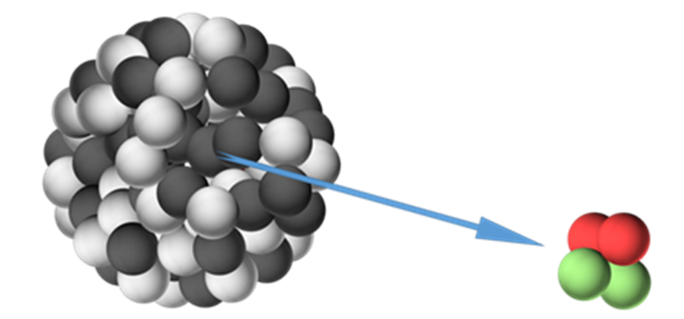
**Explaining alpha decay**

A large, proton rich and unstable nucleus often decays by emitting an alpha particle.

**

***To do:***

Match each statement about what happens in a large, proton rich and unstable nucleus to a reason, to explain how alpha decay can happen.

A proton is attracted to nearby protons and neutrons.

A proton is repelled from all other protons.

An alpha particle can form.

An alpha particle behaves as a single particle.

An alpha particle is repelled by protons.

This combination of protons and neutrons are held very strongly together.

By the electrostatic force.

It has a charge of +2.

By the strong nuclear force.

It has a positive charge.

An alpha particle is repelled more strongly than a proton.

Protons and neutrons jiggle about at high speeds.

**What happens in a nucleus.**

**Why it happens.**

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***In your own words:***

Explain how alpha decay can happen.

*Physics > Big idea PMA: Matter > Topic PMA5: Nuclear physics > Key concept PMA5.2: Radioactive decay*

|  |
| --- |
| **Response activity** |
| **Explaining alpha decay** |

**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: | Describe what happens to an atom and its nucleus during an alpha decay. |
| Activity type: | Linking ideas |
| Key words: | Radioactive decay, nucleus, proton, neutron, alpha particle, alpha decay, unstable |

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

* Diagnostic question: Alpha decay story
* Diagnostic question: Why alpha?

**What does the research say?**

At ages 14-16, students are rarely taught about the cause of alpha radiation and why some unstable nuclei emit alpha particles rather than single protons. Thinking about the mechanisms behind alpha decay can support the development of a useful mental model for students, which can help challenge misunderstandings about radioactive decay and clarify gaps in understanding that could otherwise lead to some confusion or uncertainty.

Key to understanding the reasons for alpha decay, is an understanding of the repulsive electrostatic forces between protons in a nucleus. However, amongst students age 13-18, the level of awareness is low that an electrostatic force attracts electrons to a nucleus and causes electrons around a nucleus, or protons within a nucleus, to repel each other (Harrison and Treagust, 1996; Tabor, 2013). In his study, Taber (2013) found that it was more common for students aged 15-18 (N=105) to think instead, that gravity or magnetism attracts electrons towards a nucleus. These findings suggest it is likely that many students think about atomic structure in isolation from their thinking about electrostatic forces and need support to defragment their understanding of each concept.

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It is best done as a pencil and paper exercise.

Students should read the statements and follow the instructions on the worksheet. 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.

* Following the matching activity, in order to consolidate learning, it might be helpful to give each pair or small group the opportunity to explain in their own words why an alpha particle is almost always emitted from a large, proton rich and unstable nucleus, and not a proton. This could be completed either with or without reference to the original exercise.

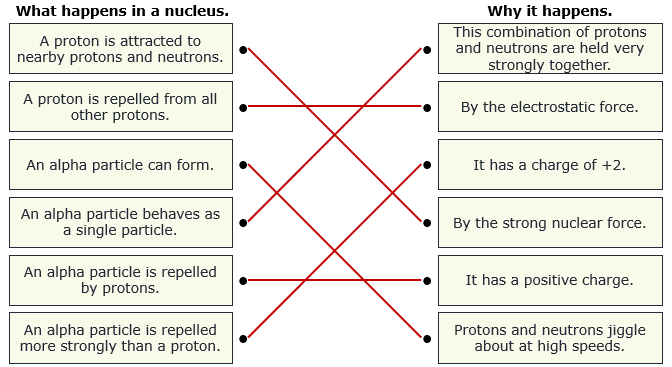
Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*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**

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**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Harrison, A. G. and Treagust, D. F. (1996). Secondary students' mental models of atoms and moelcules: Implications for teaching chemistry. *Science Education,* 80(5)**,** 509-534.

Tabor, K. S. (2013). Upper secondary students' understanding of the basic physical interactions in analogous atomic and solar system models. *Research in Science Education,* 43**,** 1377-1406.