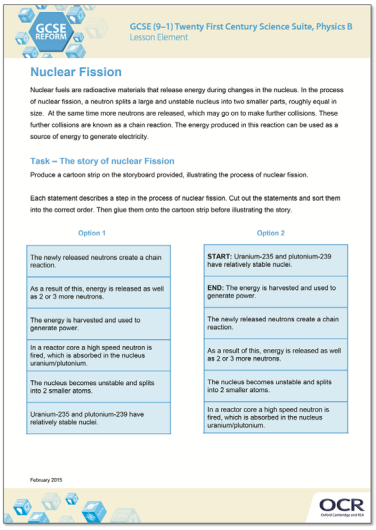
Nuclear Fission

PROVISIONAL

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Nuclear Fission' activity
which supports OCR GCSE (9–1) Twenty First Century Science Suite, Physics B.



GCSE (9–1) Twenty First Century Science Suite, Physics B
Lesson Element

Nuclear Fission

Nuclear fuels are radioactive materials that release energy during changes in the nucleus. In the process of nuclear fission, a neutron splits a large and unstable nucleus into two smaller parts, roughly equal in size. At the same time more neutrons are released, which may go on to make further collisions. These further collisions are known as a chain reaction. The energy produced in this reaction can be used as a source of energy to generate electricity.

Task – The story of nuclear Fission

Produce a cartoon strip on the storyboard provided, illustrating the process of nuclear fission.

Each statement describes a step in the process of nuclear fission. Cut out the statements and sort them into the correct order. Then glue them onto the cartoon strip before illustrating the story.

Option 1	Option 2
The newly released neutrons create a chain reaction.	**START:** Uranium-235 and plutonium-239 have relatively stable nuclei.
As a result of this, energy is released as well as 2 or 3 more neutrons.	**END:** The energy is harvested and used to generate power.
The energy is harvested and used to generate power.	The newly released neutrons create a chain reaction.
In a reactor core a high speed neutron is fired, which is absorbed in the nucleus uranium/plutonium.	As a result of this, energy is released as well as 2 or 3 more neutrons.
The nucleus becomes unstable and splits into 2 smaller atoms.	The nucleus becomes unstable and splits into 2 smaller atoms.
Uranium-235 and plutonium-239 have relatively stable nuclei.	In a reactor core a high speed neutron is fired, which is absorbed in the nucleus uranium/plutonium.

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Summary of key information

Nuclear fuels are radioactive materials that release energy during changes in the nucleus. In the process of nuclear fission, a neutron splits a large and unstable nucleus into two smaller parts, roughly equal in size. At the same time more neutrons are released, which may go on to make further collisions. These further collisions are known as a chain reaction. The energy produced in this reaction can be used as a source of energy to generate electricity.

Objectives

1. Recall that some nuclei are unstable and may split into two nuclei this is called nuclear fission.
2. Explain how energy is released during nuclear fission in ionising radiation and in the kinetic energy of the resulting particles.
3. Explain how nuclear fission can lead to further fission events in a chain reaction.

Common learner misconceptions:

1. *Atoms cannot be changed from one element to another.*
   Atoms can be changed to new elements with the addition or subtraction of a proton. Atoms change in nuclear fission reactions.
2. *Nuclear fission produces electricity.*
   Nuclear fission is a source of energy used to generate electricity.

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This resource is an exemplar of the types of materials that will be provided to assist in the teaching of the new qualifications being developed for first teaching in 2016. It can be used to teach existing qualifications but may be updated in the future to reflect changes in the new qualifications. Please check the OCR website for updates and additional resources being released. We would welcome your feedback so please get in touch.

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Task Instructions

Task 1: To illustrate that heavy nuclei can become unstable and can be split into smaller parts

In small groups, give learners a deck of cards *(half a deck will work if supplies are limited).* Learners should build a house of cards from 7 of the cards. Learners should then attempt to build a second house of cards from the remaining cards.

The cards represent neutrons, the house itself a nucleus. Discussion should arise, that the larger house is more likely to fall down, because it is unstable. In the same way a large atom is more likely to split as it is 'unstable'.

Extension: Higher ability learners should identify the flaws with this model.

Task 2: To illustrate the chain reaction

Learners model the chain reaction. Learners represent atoms and softballs are used as neutrons. The teacher throws in the initial neutron at the first learner/atom. The learner/atom releases two soft balls at two more learners/atoms and this continues. In this model the learners/atoms illustrate the release of neutrons but do not illustrate the splitting. Learners should work together to adapt the model to illustrate the splitting of atoms in the chain reaction as the release of neutrons. As an alternative to soft balls, learners could be 'fired'.

Extension: Analogies/models for chain reactions that could be discussed are breaking at the start of a pool game, or domino chains. Both models illustrate that as neutrons are released, they hit other atoms. However, they do not illustrate the 'splitting' or that the reaction in a reactor is controlled. Learners should come up with their own model that illustrates the elements not shown by the snooker break or dominoes chain.

Task 3: To consolidate the process of nuclear fission

Produce a cartoon strip on the storyboard provided, illustrating the process of nuclear fission. For lower ability students, provide statements that have been jumbled up. Learners should cut these out, sort and glue them onto their storyboard.

Answers for jumbled sentences;

1. Uranium-235 and plutonium-239 have relatively stable nuclei.
2. In a reactor core a high speed neutron is fired, which is absorbed in the nucleus uranium/plutonium.
3. The nucleus becomes unstable and splits into two smaller atoms.
4. The newly released neutrons create a chain reaction.
5. As a result of this, energy is released as well as 2 or 3 more neutrons.
6. The energy is harvested and used to generate power.

Questions that may arise and suggested answers

Where does Uranium come from and what is it?

Uranium is a metal, but it looks a bit like lead. Like most metals, it is found everywhere in the earth's surface.

Can a nuclear plant blow up?

It can, but only if it is not designed or operated sufficiently. Same goes for any type of Power Station such as coal or gas. Chernobyl's plant reached 150 times its normal power level before its water turned to high pressure steam and blew the plant apart.

Could a nuclear Power Station be used as a bomb?
Could the reaction be used in a bomb?

A nuclear Power Station could not be used as a bomb. The reaction used in a nuclear Power Station could not be used as a bomb. In a Power Station, the Uranium is assembled in a way that allows stable and steady reaction. Heat is produced, which is then used to boil water to produce steam, and that steam then produces electricity through turbines, same as any other electrical Power Station. A bomb carries the reaction in a much more compact space, allowing for a greater less, controlled reaction resulting in an explosion releasing harmful gases.

Other useful resources

Video: An introduction to nuclear fission - BBC learning clips

http://www.bbc.co.uk/learningzone/clips/an-introduction-to-nuclear-fission/6020.html

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