WJEC (Eduqas) Physics GCSE

9.4: Nuclear Fission and Fusion

Detailed Notes

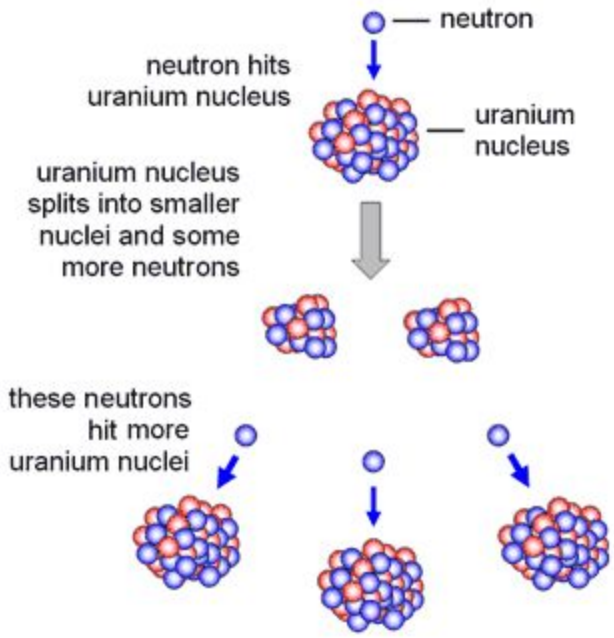
(Content in **bold** is for higher tier **only**)

Nuclear Fission

Nuclei of atoms are not always in a stable state depending on the **ratio of protons and neutrons**. Unstable nuclei emit **ionising radiation** through **radioactive decay** to become more stable. In this process, a huge amount of **energy** is also released that can build up, making a **chain reaction** more likely to form.

Nuclear reactors use the process of **nuclear fission** to generate **electricity**. Fission is the process of **splitting** a fissile nucleus after the **absorption** of a **slow neutron**. This makes the nucleus **unstable** so it splits apart into **two smaller nuclei**, releasing two or three more neutrons as well as a lot of **energy**.

A **chain reaction** develops as the released neutrons go on to be absorbed by other nuclei leading to the same processes again.



Chain nuclear reaction of uranium-235 (bbc.co.uk).

Uranium-235 and **Plutonium** are the most commonly used in fission reactors as they are **large** nuclei which are **easier to split** apart into smaller ones. The chain reaction created by these materials has to be **controlled** in nuclear reactors to prevent it becoming dangerous.

Equations for nuclear fission can be written using ${}_{0}^{1}n$ as the symbol for a neutron. These equations need to be **balanced**.

$$ {}_{92}^{235}U + {}_{0}^{1}n \longrightarrow {}_{56}^{144}Ba + {}_{36}^{89}Kr + energy $$

Generating Power

The heat energy released from the nuclear fission reactions is used to **boil water** and **generate steam**. The steam is then used to **drive a turbine** to generate **electricity**. All components are sealed inside a reactor with **steel lined concrete walls**. This prevents the ionising radiation from escaping the reactor and reducing the risks of cancer for workers.

Nuclear Fusion

Lighter elements undergo **nuclear fusion** to produce **heavier** elements. Only elements lighter than iron can fuse, however the main element to undergo fusion is **hydrogen**.

Nuclei are **positively charged** so would ordinarily **repel** each other at close proximities, however if they are **moving very fast**, they can **overcome** this electrostatic repulsion and **collide**. This collision releases a lot of **energy**, and the **hotter** the molecule, the **faster** it will move and the **more likely** a **high energy** collision will occur.

Hydrogen Fusion

Stars, including our sun, use nuclear fusion to **generate energy** and create heavier elements. Most of the fusion taking place in stars is between **hydrogen** nuclei to form **helium** nuclei. The two hydrogen nuclei are **hydrogen** and **deuterium** (*H-2*) and these create a **helium-3** nucleus. This fusion reaction can be written as an equation and balanced.

$$ {}_{1}^{1}H + {}_{2}^{2}H \longrightarrow {}_{2}^{3}He + energy $$

The **energy** released is produced as a result of **mass conversion**. This is where some of the mass involved in the fusion process is converted into energy, known as the **energy of radiation**.