Nuclear Fission and Fusion Notes

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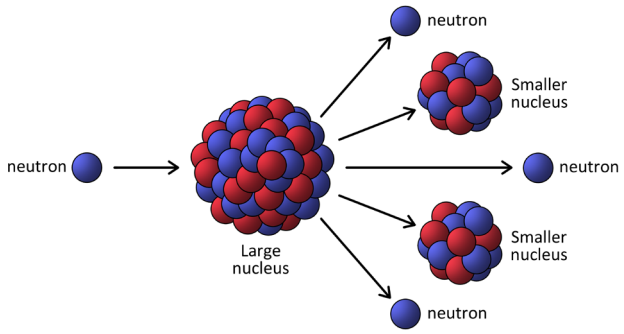
Nuclear fission: the splitting of a large, unstable nucleus to release two smaller nuclei and a lot of energy. This occurs when the nucleus absorbs a **slow-moving** neutron. (If the neutron is moving too fast, it will just bounce off!)

The figure below shows nuclear fission taking place.



Exam hint: definitely be able to draw and label a nuclear fission diagram 😊

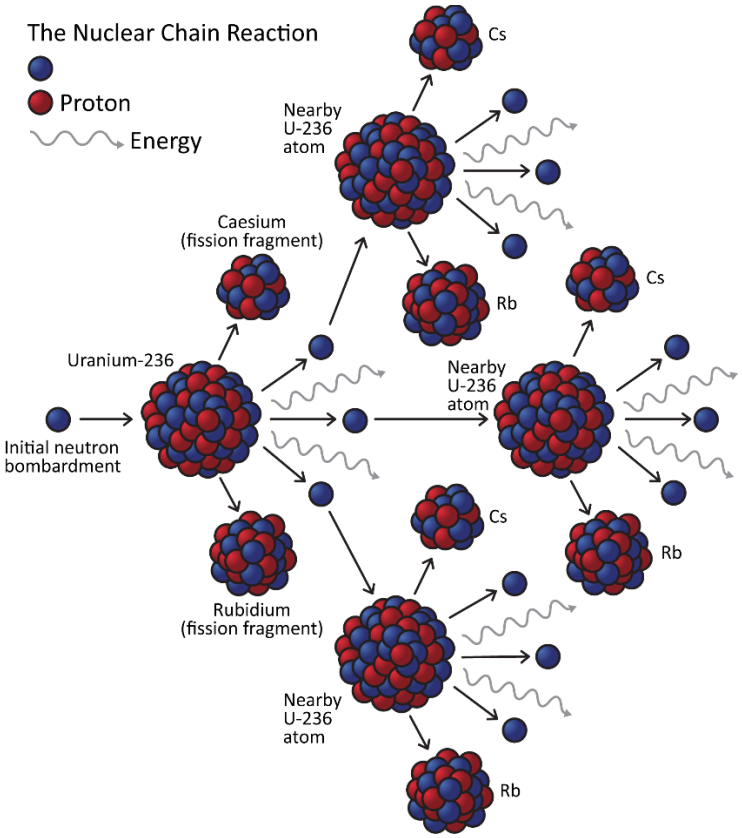
Exam note: When the nucleus splits, the two smaller nuclei produced are roughly the **same size**. The reaction also emits **gamma rays**. It's important to know that all of these products (the new nuclei, neutrons, and gamma rays) are released with **kinetic energy**!

As nuclear fission produces three neutrons from each nucleus these can go on and cause more nuclear fission reactions. A reaction that starts and can then go on itself is called a "chain reaction".

Chain reaction: a reaction where the products of one reaction trigger the next reaction.

So, in a nuclear chain reaction the neutrons from one fission reaction can cause three neutrons to be released. These three neutrons can **each** cause a fission reaction of another atom and on it goes.

The figure below shows part of a nuclear chain reaction 😊 They won't ask us to draw one of these in full.
We could see a partly drawn one and we need to complete a specific part of it. We could also be asked to label parts of a pre drawn one. Please do spend a bit of time becoming familiar with this diagram. Drawing it out a few times is not a bad idea at all 😊



If a chain reaction can just keep on getting faster, we would need a way of being able to control it.

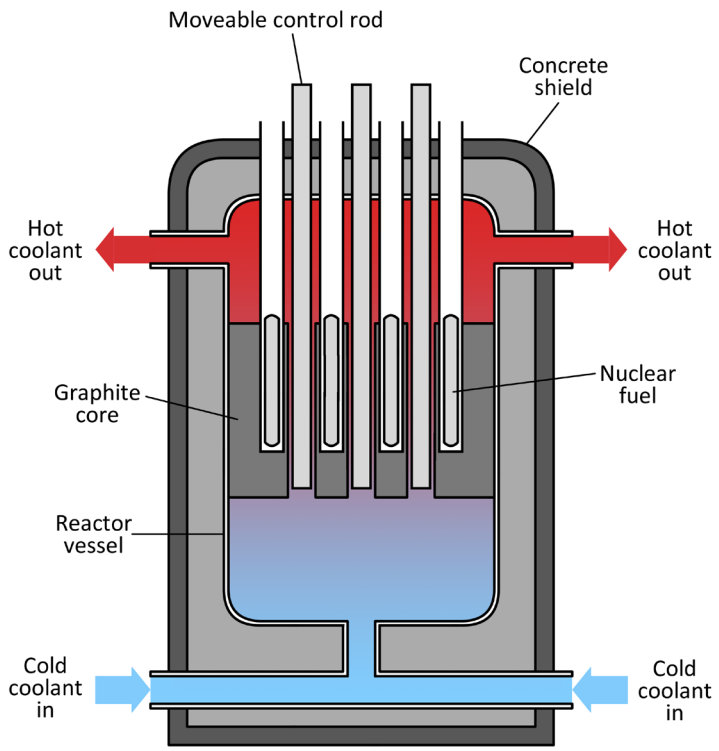
If we can't control a chain reaction the temperature will keep increasing.

If it becomes too hot then the reactor can physically melt. This would expose the nuclear fuel rods to the outside. This would be awful.

That's why it's called a "**meltdown**".

Nuclear Fission Reactors

Nuclear fission reactors are the containers or vessels in which nuclear fission takes place. The figure below shows a typical fission reactor and its component parts.



Component	Function
Nuclear fuel	This material can be either uranium or plutonium. Neutrons from one fuel rod will cause nuclear fission on an opposite rod.
Control rods	These rods are made out of a material that can absorb neutrons and not do nuclear fission. This allows people to control the rate of nuclear fission.
Graphite core	The graphite slows down the neutrons so that they are more likely to be absorbed by a fuel rod and not just bounce off.
Coolant	This liquid water is heated by the nuclear fission (which gives off a vast amount of heat) it is turned into steam and the steam turns a turbine to generate electricity. It is also vitally important to cool the reaction down to prevent a meltdown.
Concrete shield	Is meant to absorb any harmful or ionising radiation that is released during nuclear fission.

Nuclear Fusion

Nuclear fusion: is the joining of two lighter nuclei to form a larger nucleus. This releases huge amount of energy. In nuclear fusion, some of the mass of the lighter nuclei is converted into energy.

At present there are no nuclear fusion reactors that produce electrical energy.

Why is nuclear fusion so much harder to do in a reactor than nuclear fission?

The two atoms that we are trying to fuse together actually repel each other. They repel each other because the nucleus of each atom is positive and like charges repel.

Nuclear fusion requires huge temperatures and pressure to be able to overcome the repulsion between the two atoms and get them to fuse into one nucleus.

An example of nuclear fusion happening in nature is the fusion in stars or the sun. A man-made example of fusion is hydrogen bombs – a more powerful version of nuclear weapons.