

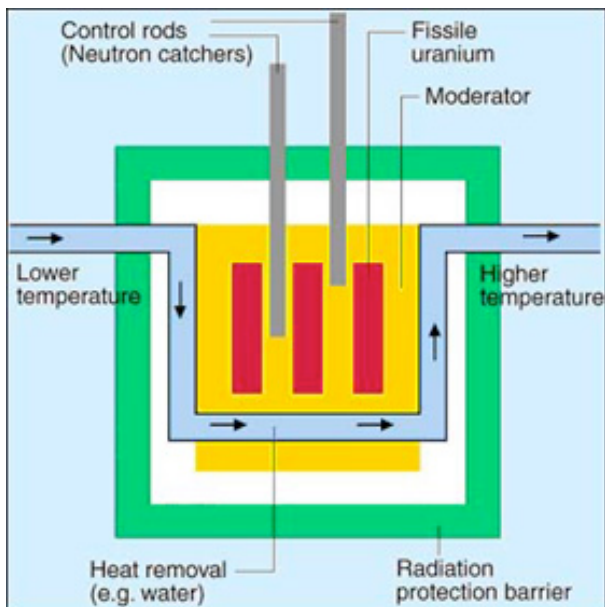
## Radioactivity

### Nuclear fission

- Nuclei of radioactive atoms split releasing very large amounts of energy
- $^{235}_{92}\text{U}$  &  $^{239}_{94}\text{Pu}$  uranium & plutonium will spontaneously split releasing neutrons which hit other nuclei causing them to split
- uranium and plutonium can be made to split when their nuclei are hit by neutrons; more neutrons are released which hit more nuclei; more neutrons are released which go on to hit more nuclei - A CHAIN REACTION ( vast amounts of energy released )
- Chain reactions are used in atom bombs

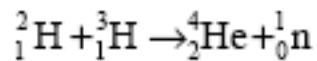
### Nuclear Reactors

- Control the chain reaction - energy released steadily
- Control rods -absorb neutrons to slow reaction
- Control rods lowered - slower reaction, fewer neutrons, less heating
- Control rods raised - faster reaction, more neutrons, more heating
- Moderator - slows neutrons so more likely to hit next atom



## Nuclear Fusion

1. Several prototype reactors are in existence
2. **Technical difficulties in achieving and maintaining** the extreme conditions necessary.
3. The conditions needed are those found in stars ; **very high temperatures and very high pressures.**
4. To produce them on Earth requires the kind of **energy produced by nuclear fission** ie., from a traditional nuclear reactor.
5. The preferred method is the fusion of deuterium and tritium - 2 isotopes of hydrogen - to form helium.



n - neutron

6. This method is chosen because it has a **high reaction rate and is achieved at lower temperatures.**
7. **Very large potential supply of fuel in the oceans.**
8. **Large amounts of energy are created**, neutrons heat water to steam, which can then pass over a turbine to drive a generator.
9. **Energy out needs to be greater than the energy in.** Energy is not only used for starting the fusion process but also for controlling the **plasma** that is formed by these high temperatures ( the Sun is ball of plasma - a gas of nuclei and electrons ).

## Atomic Structure

- Thomson's plum pudding model - negative electrons embedded in positively charged material ( plums in sponge pudding )
- Rutherford - fired alpha particles at thin gold foil
- His findings - Most alpha particles went straight through the foil; Atoms are mostly space.
  - A few were deflected through large angles, a very few were reflected straight back ; the nucleus is very small compared to the size of the atom and it contains most of the mass and all the positive charge.
- Nucleus - contains protons ( +ve charge ) and neutrons ( neutral )
- Electrons ( -ve charge ) orbit the nucleus

- Symbol  $\begin{matrix} A & X \\ & Z \end{matrix}$

$A$  - mass number ( number of protons & neutrons )

$Z$  - atomic number ( number of protons )

- Neutral atom - number of protons = number of electrons
- Alpha -  $\begin{matrix} 4 & \text{He} & \text{or} & 4 & \alpha \\ 2 & & & 2 & \end{matrix}$
- Beta -  $\begin{matrix} 0 & e & & 0 & \beta \\ -1 & & & -1 & \end{matrix}$

### HIGHER ONLY

- Atomic structure
  - Rutherford replaced by Bohr atom
  - electrons orbit in orbitals
  - to go up to next orbital electron needs just the right amount of energy
  - when electron drops back down to the lower orbital it releases this energy as a pulse or photon of light of just one frequency
  - the energy difference between one orbital and the next is different for different atoms
  - this means different atoms give out different frequencies of electro-magnetic radiation eg., different colours
- Decay series
  - Uranium-238 ( U-238 ) decays to become Lead-206 ( Pb-206 ) taking
  - It takes 4 500 million years for half U-238 to decay to Pb-206
  - There are as many U-238 atoms as Pb-206
  - Pb-206 only made from U-238 therefore Earth 4 500 million years old
  - $\begin{matrix} 238 & \text{U} & \longrightarrow & 234 & \text{Th} & + & 4 & \alpha \\ 92 & & & 90 & & & 2 & \end{matrix}$  numbers on left of arrow = numbers on right
  - $\begin{matrix} 234 & \text{Th} & \longrightarrow & 234 & \text{Pa} & + & 0 & \beta \\ 90 & & & 91 & & & -1 & \end{matrix}$  top/bottom row only