Chapter 18
Ionising Radiation and Risk

Type:	Alpha α	Beta β	Gamma γ
Nature	2p + 2n	e	electromagnetic
Charge	+2e	-1e	0
Typical Speed	0.1c	up to 0.9c	c
Typical Energy	10MeV	0.03 - 3MeV	1MeV
Ionising effect	$\sim 10^5$	$\sim 10^3$	~1
Penetration	Stopped by 0.5mm paper	Stopped by 5mm aluminium	Intensity halved by 100mm lead
Effect of a magnetic field			

The intensity of a gamma source is governed by:

$$I = I_o e^{-\mu x}$$

Fission and Fusion

Fission - a heavy nucleus splits to form two nuclei of roughly the same mass.
Fission chain reactions occur when neutrons from one fission reaction starts another.
Certain properties must be met cause a chain reaction:

- If the fission material is less than a critical size to many neutrons escape without hitting nuclei.
- Slower neutrons are better for causing fission.
- Less then 1% of uranium is uranium - 235. Over 99% is uranium - 238, this absorbs medium speed neutrons without fission occurring.

Thermal Reactor

Nuclear fuel -	uranium - 235 enriched uranium dioxide.
Moderator - speed	slows down the medium neutrons produced by fission. (Contains Boron - a neutron absorber).
Coolant -	Carries heat from the reactor to a heat exchanger.

Fusion - nuclei fuse to form heavier ones
Much more difficult that fission because the nuclei repel one another.

Typical Radioactive Decays

- Alpha Decay

$$^{b}_{b}X \rightarrow {}^{a-4}_{b-2}Y + {}^{4}_{2}\alpha$$

- Beta Decay

$$^{b}_{b}X \rightarrow {}^{a}_{b+1}Y + {}^{0}_{-1}\beta + {}^{0}_{0}\bar{\nu}$$ Beta minus decay

$$^{b}_{b}X \rightarrow {}^{a}_{b-1}Y + {}^{0}_{+1}\beta + {}^{0}_{0}\nu$$ Beta plus decay

Binding Energy

The mass of an actual nucleus is slightly different from the mass when adding together the mass of the number of protons and neutrons. the difference is known as the mass defect and determines the binding energy.

The stability of a nucleus can be estimated by the ratio of neutrons: protons. The most stable nuclei have equal numbers of protons and neutrons.

The concept of risk combines the probability of an event with the consequence of the event occurring: risk = probability x consequence