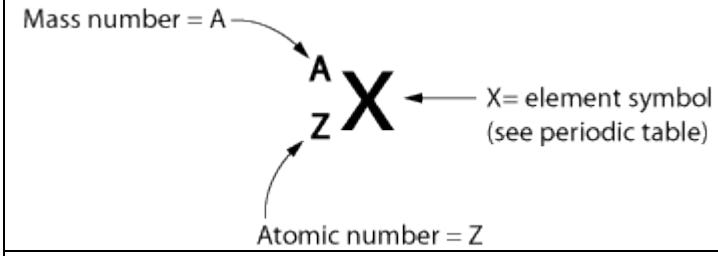
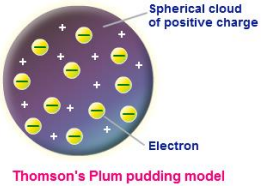
GCSE Physics Key Facts – Atomic Structure

Atoms and isotopes	
Atoms are very small, with a radius of about 1×10^{-10}m. The radius of the nucleus is less than 1/10,000 of the radius of the atom.	Atoms have a positively nucleus (protons and neutrons) surrounded by negatively charged electrons. Most of the mass of the atom is concentrated in the nucleus
Electrons are arranged at different distances from the nucleus (different energy levels). Electrons move further from the nucleus (higher energy level) if electromagnetic radiation is absorbed and move closer to the nucleus if electromagnetic radiation is emitted.	Atoms have no overall electrical charge because the number of electrons is equal to the number of protons
Atomic number = number of protons in an atom **Mass number** = number of protons and neutrons in an atom. Atoms are shown like this: 	Isotopes are atoms of the same element but with different numbers of neutrons
If an atom loses an electron then it forms a positive ion.	If an atom gains an electron then it forms a negative ion.
Before the discovery of the electron, atoms were thought to be tiny spheres that couldn't be divided. Discovery of the electron led to the Plum pudding model of the atom.  Thomson's Plum pudding model	Results from the alpha particle scattering experiment (Rutherford's experiment) led to the nuclear model of the atom (mass of atom is concentrated in positively charged nucleus). Most particles pass through unhindered (most of an atom is empty space). Some particles passed through but were deflected (the positively charged nucleus repels the positive alpha particle) A few bounce back (the nucleus is a small dense mass at the centre of the atom)
Niels Bohr adapted the nuclear model to include electron orbits. Later experiments provided evidence for the proton.	About 20 years after the nucleus became an accepted idea, the experimental work of James Chadwick provided evidence for the neutron.
Nuclear Radiation	
Some atomic nuclei are unstable and give out radiation from the nucleus to become more stable. This process is random process and is called radioactive decay	Activity is the rate at which a source of unstable nuclei decays. It is measured in Becquerels (Bq) Count rate is the number of decays recorded each second by a detector (e.g. Geiger-Muller tube)
There are 4 types of nuclear radiation emitted by an unstable nucleus: Alpha particle (α) two neutrons and two protons, it is the same as a helium nucleus Beta particle (β) – a high speed electron ejected from the nucleus as a neutron turns into a proton	Alpha particles: absorbed by paper, travel about cm in air, highly ionising Beta particles: absorbed by Aluminium (5mm thick) or Lead (2-3mm thick), travel about 1m in air, medium ionising

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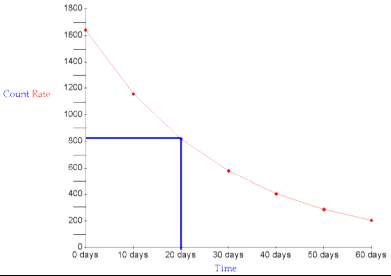
Gamma ray (γ) – electromagnetic radiation from the nucleus Neutron (n).	Gamma waves: absorbed by thick lead (several cm thick) or concrete (more than 1m thick), travels forever in air, low ionising.
The properties of the different types of nuclear radiation make them suited for different applications e.g. beta radiation is used to check the thickness of metal sheets.	Nuclear equations are used to represent radioactive decay. In alpha decay, the mass number decreases by 4 and the atomic number decreases by 2: $^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}\alpha$
In Beta decay, the mass number stays the same and the atomic number increases by 1: $^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$	The emission of a gamma ray does not cause the mass or the charge of the nucleus to change.
The half-life of a radioactive isotope is the time it takes for the number of nuclei in a sample to halve, or the time it takes for the count rate (or activity) to fall to half its starting level.	Half life can be worked out from a graph of count rate against time: 
HIGHER TIER ONLY: The fraction of undecayed nuclei left after n half lives is $1/2^n$ e.g. ½ left after 1 half life $½^2$ = ¼ left after 2 half lives $½^3$ = 1/8 left after 3 half lives	Radioactive contamination is the unwanted presence of radioactive materials in other materials. The hazard is due to the decay of the contaminating atoms.
Irradiation = exposing an object to nuclear radiation. The irradiated object doesn't become radioactive.	
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