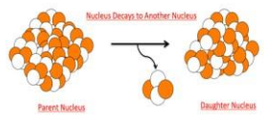
AQA ATOMIC STRUCTURE

Atoms and Isotopes

Radius of an atom 1 X 10^{-10}m

Electrons gained → Negative ion

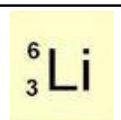
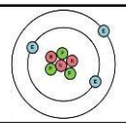
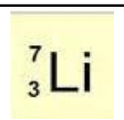
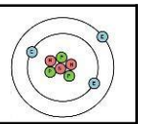
Electrons lost → Positive ion



Atom	*Same number of protons and electrons*
Ion	*Unequal number of electrons to protons*
Mass number	*Number of protons and neutrons*
Atomic number	*Number of protons*

Particle	Charge	Size	Found
Neutron	None	1	In the nucleus
Proton	+	1	
Electron	-	Tiny	Orbits the nucleus

Atom structure

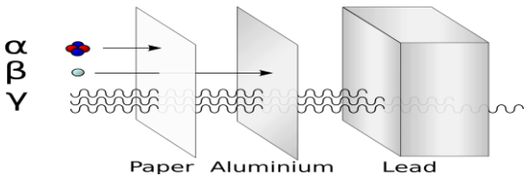
Isotope				
Different forms of an element with the same number of protons but different number of neutrons				

Discovery of the nucleus

Democritus	Suggested idea of atoms as small spheres that cannot be cut.
J J Thomson (1897)	Discovered electrons– emitted from surface of hot metal. Showed electrons are negatively charged and that they are much less massive than atoms.
Thomson (1904)	Proposed *'plum pudding'* model – atoms are a ball of positive charge with negative electrons embedded in it.
Geiger and Marsden (1909)	Directed beam of alpha particles (He^{2+}) at a thin sheet of gold foil. Found some travelled through, some were deflected, some bounced back.
Rutherford (1911)	Used evidence from gold foil experiment to suggest atoms were mostly empty space, with a solid nucleus in the center. Alpha particles deflected due to electrostatic repulsion between the charged nucleus and the alpha particle. Proposed mass and positive charge contained in nucleus, electrons found outside the nucleus.
Bohr (1913)	Suggested modern model of atom – electrons in circular orbits around nucleus, electrons can change orbits by emitting or absorbing electromagnetic radiation. His research led to the idea of some particles within the nucleus having positive charge; these were named protons.
Chadwick (1932)	Discovered neutrons in nucleus – enabling other scientists to account for mass of atom.

Atoms and Nuclear Radiation

Decay	Range in air	Ionising power	Penetration power
Alpha	Few cm	Very strong	Stopped by paper
Beta	Few m	Medium	Stopped by Aluminium
Gamma	Great distances	Weak	Stopped by thick lead



Radioactive decay	*Unstable atoms randomly emit radiation to become stable*
Detecting	*Use Geiger Muller tube*
Unit	*Becquerel*
Ionisation	*All radiation ionises*

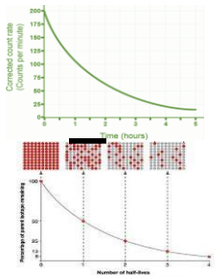
Decay	Emitted from nucleus	Changes in mass number	Changes in atomic number
Alpha (α)	*Helium nuclei (^4_2He)*	-4	-2
Beta (β)	*Electron ($^0_{-1}e$)*	0	+1
Gamma (γ)	*Electromagnetic wave*	0	0
Neutron	*Neutron*	-1	0

$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$

$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$

$^{99}_{43}Tc \rightarrow {}^{99}_{43}Tc + \gamma$

Contamination	*Unwanted presence of radioactive atoms*
Irradiation	*Person is in exposed to radioactive source*



Half life – *The time taken to lose half of its initial radioactivity*

number nuclei = initial number / 2^n
Remaining (n is the number of half lives)

https://www.bbc.co.uk/bitesize/topics/zshssrd
bbcbitesize-ks4 science-physics – atomic structure
https://app.senecalearning.com/classroom/course/fe56ca00-05aa-11e8-9a61-01927559cfd5
Seneca – aqa physics – atoms and radiation

Separates ONLY:

Sievert	*Unit measuring dose of radiation*
Background	*Constant low level environmental radiation, e.g. from nuclear testing, nuclear power, waste*

Uses	*Different isotopes have different half lives*	Short half-lives used in high doses, long half lives used in low doses.
Tracers	*Used within body*	Isotope with short half life injected, allowed to circulate and collect in damaged areas. PET scanner used to detect emitting radiation. Must be beta or gamma as alpha does not penetrate the body.
Radiation therapy	*Used to treat illnesses e.g. cancer*	Cancer cells killed by gamma rays. High dose used to kill cells. Damage to healthy cells prevented by focussed gamma ray gun.

Fuel rods	Made of U-238, 'enriched' with U-235 (3%). Long and thin to allow neutrons to escape, hitting nuclei.
Control rods	Made of Boron. Controls the rate of reaction. Boron absorbs excess neutrons.
Concrete	Neutrons hazardous to humans – thick concreate shield protects workers.

Separates ONLY: Nuclear energy

Nuclear fission	*One large unstable nucleus splits to make two smaller nuclei*	Neutron hits U-235 nucleus, nucleus absorbs neutron, splits emitting two or three neutrons and two smaller nuclei. Process also releases energy.	Process repeats, chain reaction formed Used in nuclear power stations
Nuclear fusion	*Two small nuclei join to make one larger nucleus*	Difficult to do on Earth – huge amounts of pressure and temperature needed.	Occurs in stars