AQA P4 Atomic Structure and Nuclear Radiation
TRIPLE physics

There are no required practicals in this topic

Radius of atom – 1×10^{-10} metres
Nucleus – has a positive charge; it contains protons and neutrons. Radius is 1/10 000th the size of the atom.

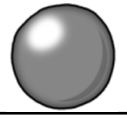
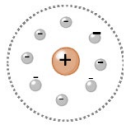
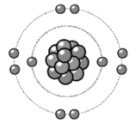
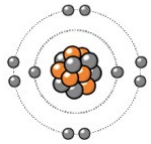
Electron shells – electrons are negative and orbit around the nucleus. If an electron absorbs electromagnetic radiation it will move further from the nucleus. If an electron moves closer to the nucleus it releases electromagnetic radiation.

Atom – has no overall charge because the number of electrons is equal to the number of protons.

Atomic number – tells you the number of protons (and electrons)

Atomic mass – tells you the number of protons plus the number of neutrons

(Mass number) 23
(Atomic number) 11 Na

Development of the model of the atom			
Simple atom		Believed to be tiny solid spheres that could not be divided	Add This was before the discovery of the electron
'plum pudding' model		A ball of positive charge with negative electrons embedded in it	Electron was discovered and it was smaller than an atom
nuclear model		Positively charged nucleus at the centre where the mass is concentrated and surrounded by negative electrons	Discovered by Rutherford's alpha particle scattering experiment where alpha particles were deflected by a tiny nucleus
Nuclear model with electrons in shells		Electrons orbit the nucleus at specific distances	Niels Bohr proposed that electrons orbited in fixed shells; this was supported by experimental observations.
Nuclear model with Neutrons in the nucleus		Realised the nucleus contains neutrons as well as protons	Chadwick discovered the nucleus also contained neutrons 20 years after the nuclear model was accepted.

Type	Made of..	Blocked by…	Range in air	Ionising (damage)
alpha α	2 protons and 2 neutrons (helium nucleus)	Skin, paper etc	~ 5cm	Very
beta β	High speed electron from nucleus (after a neutron turns into a proton)	Thin aluminium etc	~1m	Medium
gamma γ	Electromagnetic wave of energy	Thick lead etc	infinite	weakly
neutron n	A neutron from the nucleus – no other details are needed			

Uses of radioactive isotopes
Alpha – easily blocked but highly ionising e.g. smoke alarms.
Beta – partially blocked by paper e.g. to check paper thickness.
Gamma – passes through and only weakly ionising e.g. medical tracers

Short half life – highly radioactive at start but will not stay dangerously radioactive for long.

Long half life – less radioactive but will stay radioactive for longer.

Nuclear radiation is a random process from unstable nuclei.
Nuclear decay – when radiation is released.
Activity – *total* number of decays per second measured in bequerels, Bq
Count rate - number of decays per second measured by an *instrument* in bequerels, Bq
Half-life – the time for half of the unstable nuclei to be come stable OR the time for count rate (activity) to half

Irradiation - Exposure to radiation. The object does not become radioactive. Used to kill bacteria (sterilisation).

Contamination - Radioactive particles get on or into an object causing them to become radioactive.

Precautions – reduce exposure time. Increase distance. Wear protective equipment.

Nuclear equation with alpha decay

$^{219}_{86}\text{radon} \longrightarrow {}^{215}_{84}\text{polonium} + {}^{4}_{2}\text{He}$

Nuclear equation with beta decay

$^{14}_{6}\text{carbon} \longrightarrow {}^{14}_{7}\text{nitrogen} + {}^{0}_{-1}\text{e}$

net decline ratios after
1 half life is ½
2 half lives is ¼
3 half lives is $^{1}/_{8}$