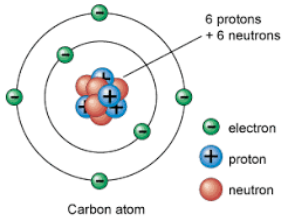
science physics

Topic 4 – Atomic Structure

Atomic Structure



Mass Number = Protons and Neutrons
Atomic Number = Protons

Electrons are usually the same as Protons so that they balance each other out and the atom is neutral.

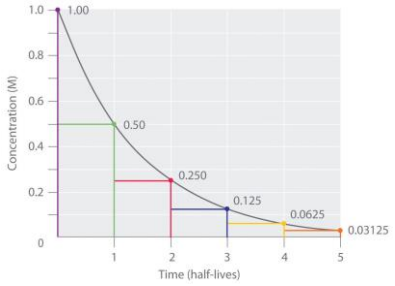
More electrons = Negative Ion
Less electrons = Positive Ion

	Charge	Mass
Proton	+1	1
Neutron	0	1
Electron	-1	0

Isotopes

Atoms of the same element with the same number of Protons but a different number of neutrons.

Half Life "The time taken for half the radioactive nuclei now present to decay"



Fraction remaining

After 1 half life = ½

After 2 half lives = ¼

After 3 half lives = 1/8

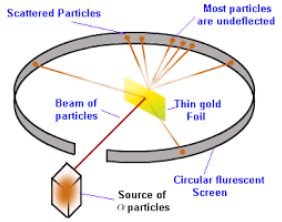
After 4 half lives = 1/16

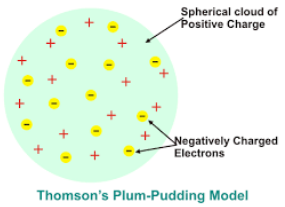
After 5 half lives = 1/32

After 6 half lives = 1/64

Development of the Nuclear Model

1. Scientists thought it was just a sphere
2. Scientists discovered the electron
3. The Plum pudding Model was proposed (cloud of positive charge with randomly placed electrons)
4. Rutherford carried out his experiment and found evidence of the nucleus





Observation	*Explanation*
Most of the alpha particles went straight through	The atom is mostly empty space (mass in one place – nucleus)
Some of the alpha deflected	Went near something positive (protons in the nucleus)
A few bounced back	Hit something heavy – concentrated mass – nucleus - neutrons

Plum Pudding	*Nuclear Model*
Positive Charge spread out	Positive charge concentrated in the nucleus
Electrons randomly arranged	Electrons in energy shells (Niels Bohr)
No neutrons	Neutrons (James Chadwick)
Mass spread out	Mass concentrated in nucleus
Nucleus	No nucleus

Irradiation is the exposure of an object to nuclear radiation the object is not radioactive
Contamination is the unwanted presence of materials containing radioactive atoms

	Structure	Mass/Charge	Penetration	Ionisation	Uses and Dangers
Alpha	A helium Nucleus 2 protons and 2 neutrons	Mass = 4 Charge = +2	Stopped by skin/paper	Heavily ionising	Used in smoke alarms Harmful if ingested
Beta	An electron - Released from the nucleus when a neutron decays to form a proton and electron	Mass = 0 Charge = -1	Stopped by thin aluminium	Moderately ionising	Used in paper thickness machines/sterilising equipment
Gamma	An electromagnetic wave of energy	No Mass No Charge	Stopped by thick lead	Weakly ionising	Used for radiotherapy Very dangerous
Neutron	A neutron	Mass = 1 No charge	Stopped by thick concrete		

Alpha Decay

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

In alpha decay, you lose 2 protons and 2 neutrons
The mass number decreases by 4
The Atomic (proton) number decreases by 2

Beta Decay

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

In beta decay, a neutron splits to form a proton and an electron (this is emitted)
The mass number stays the same (swap a neutron for a proton
The Atomic (proton) number increases by 1

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Topic 5a – Atomic structure Triple and Triple

Key Definitions Trilogy

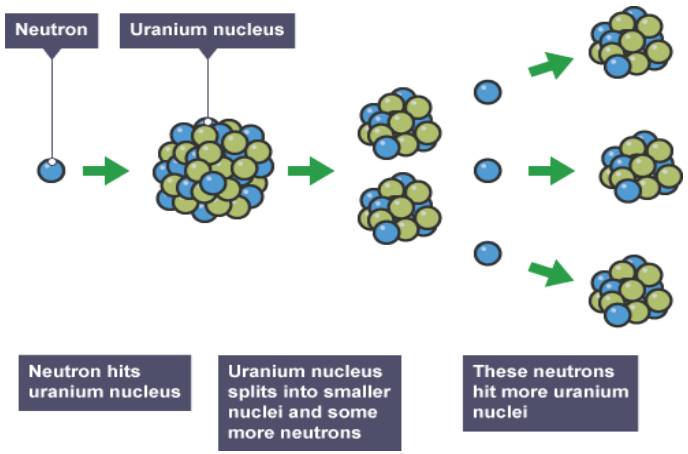
Activity	The rate at which a source of unstable nuclei decays. Measured in becquerel (Bq).
Alpha particle	Made up of two protons and two neutrons (the same as a helium nucleus).
Beta particle	A fast moving electron given out by the nucleus
Contamination	The unwanted presence of radioactive atoms either on or in an object.
Electron	Negatively charged particles which orbit the nucleus.
Gamma ray	Electromagnetic radiation given out by the nucleus.
Half - life	The time it takes for the number of radioactive nuclei in a sample to halve or the time it takes for the count rate/activity of a sample to fall to half its initial value.
Ion	An atom that has gained or lost elctrons.
Irradiation	Process of exposing an object to nuclear radiation. The object itself does not becomeradioactive.
Isotopes	Isotopes of the same element have the same number of protons but different numbers of neutrons.
Mass number	The number of protons and neutrons in the nucleus.
Neutron	Particles found in the nucleus that have no electrical charge (they are neutral).
Proton	Positively charged particles found in the nucleus of an atom.

Key Definitions Triple only

Background radiation	Radiation that is around us all of the time. It comes from both natural sources (e.g. rocks, cosmic rays from space) and man - made sources (e.g. fall out from nu-clear weapons testing and nuclear accidents)
Nuclear fission	The splitting of the **NUCLEUS** to produce lighter nuclei that are more stable. In this process some of the mass may be converted into the energy of radiation.
Nuclear Fusion	The joining of two light **NUCLEI** to form a heavier nucleus. In this process some of the mass may be converted into the energy of radiation.

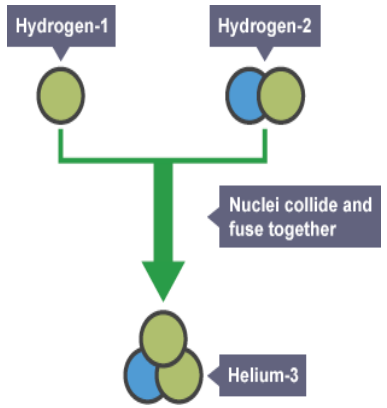
Nuclear Fission and Fusion Triple only

Nuclear fission is when a large unstable **nucleus** into smaller nuclei, releasing energy in the process



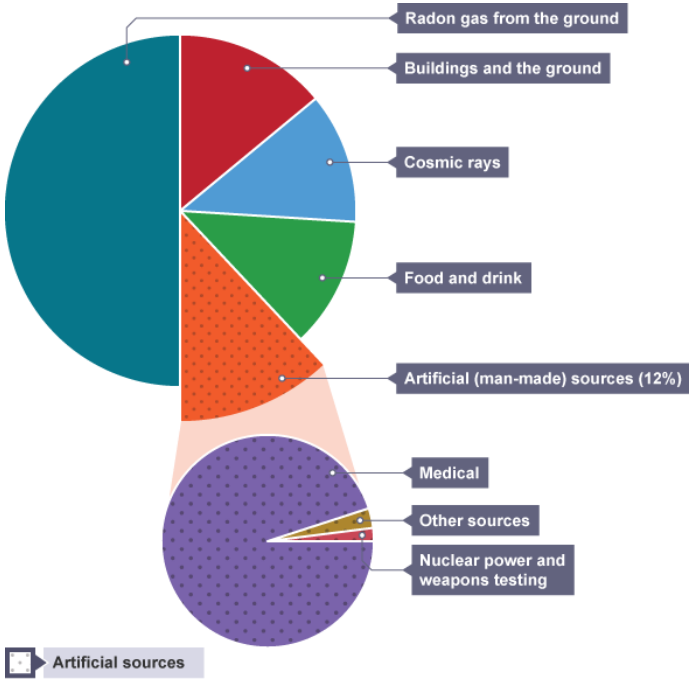
A **chain reaction** is where the neutrons released by fission go on to cause further fissions at an increasing rate.

Nuclear fusion is when two small, light **nuclei** join together to make one heavy nucleus, releasing energy in the process.



Background Radiation Triple only

Background radiation is around us all of the time. It comes from natural and man-made sources.



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