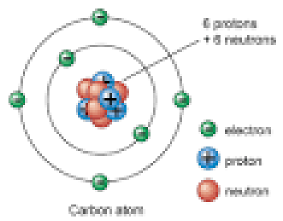
RADIATION SUMMARY NOTES

Structure of the atom



Stable atoms contain positively charge protons and neutral charged neutrons in the nucleus, surrounded by negatively charged electrons.
In an atom the number of protons = number of electrons
Unbalanced no. of p and e = ion
Overall charge on atom = 0

Background Radiation

Sources of background radiation include *radon gas, rocks and buildings (such as granite), food and drink, cosmic rays, medical uses and a very small percentage from nuclear power and weapons.*

Average annual background radiation dose of member of public is **2.2mSv**.

The average annual effective dose limit for radiation workers is **20 mSv** (ie 20 mSv/y)

Average annual effective dose limit for a member of public **1.0mSv**. (ie 1.0 mSv/y)

Ionisation

Ionisation is the loss or gain of electrons from a stable atom

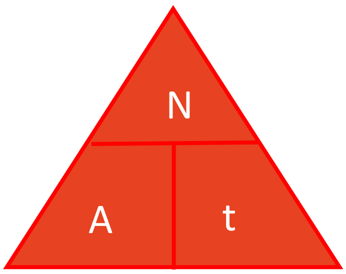
Activity

An activity of 70 kBq means 70 thousand disintegrations occur.

Ionising Radiation kills or changes the nature of living cells.

Activity

Activity is the number of



nuclear disintegrations per second
A = Activity (Bq)
N = Number of disintegrations
t = time (s)

Activity

An activity of 70 kBq means 70 thousand disintegrations occur each second.
Ionising Radiation kills or changes the nature of living cells.

Types of ionising radiation

Type	Made of	speed	Mass	Ionising	Absorbed by
Alpha α	2p, 2n	Slower	Heaviest	Most	Paper/skin
Beta β	Fast moving e from nucleus	Faster	Lighter	Lesser	Few mms aluminium
Gamma γ	High energy em wave	fastest	Negligible	Least	Most absorbed by few cms lead/graphite or metres of lead

Half - life

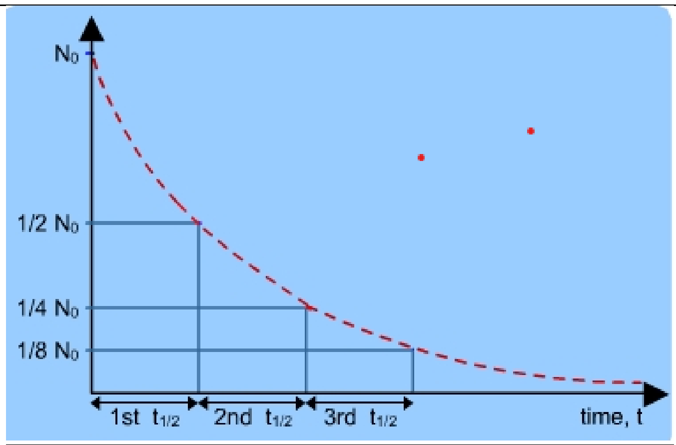
Half life is the time taken for the activity of a source to decrease by half e.g. Calculate the half life of Francium. The initial activity was 20 MBq and after 24 days the activity was 2.5 MBq

A_i: 20 MBq A_f: 2.5 MBq t: 24 days

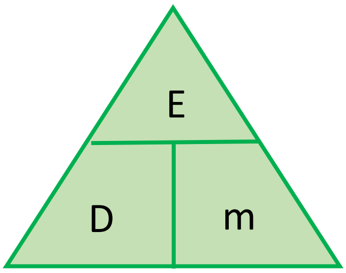
20 → 10→ 5→ 2.5 (count the arrows)

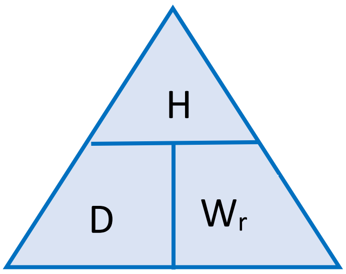
$3t_{1/2}$ = 24 days

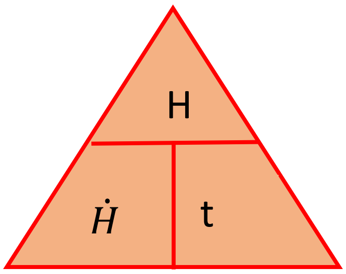
$t_{1/2}$ = 8 days



Dosage







$\dot{H} = equivalent\ dose\ rate\ Svh^{-1}$

The dose a mass of tissue receives can be calculated by
D = Absorbed dose (Gy), E = Energy received (J), m – mass of tissue (kg)
The equivalent dose received depends on the type of radiation, exposure time, biological harm.
H = equivalent dose (Sv), D – absorbed dose (Gy), Wr = radiation weighting factor (given on data sheet).
2.2 mSv Average Annual Background Radiation in UK.
1 mSv average annual effective dose limit for a member of the public in UK
20 mSv average annual effective dose limit for radiation workers in UK

Safety

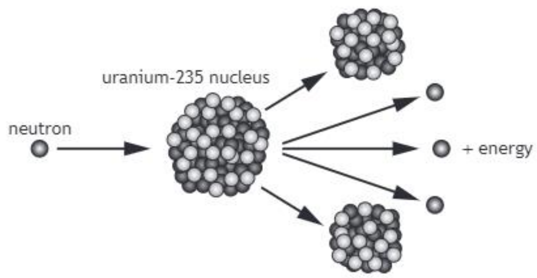
Ionising radiation can cause harm to living cells and exposure should be monitored. Radiation workers often wear film badges/personal dosimeters

Radiation can also be detected by Geiger Müller tubes, spark wires and scintillation counters

Fission and Fusion

Fission: A large nucleus splits into smaller nuclei, usually emitting some neutrons and energy

Fusion: Two small nuclei combine to make a big nucleus and release energy.



Nuclear Reactor
Moderator: slows the neutrons
Control Rods: absorbs the neutrons
Fuel rods: contain the fuel, provide the energy
Containment vessel: prevents neutrons and radioactive material from leaking out
Coolant: Takes the heat energy from the reactions to the heat exchanger.

Chain Reaction:
The neutrons from the fission of one nucleus go on and may split other uranium nuclei if conditions are right. These fissions then produce more neutrons that split more nuclei and so on.

Fission: produces lots of energy, highly radioactive waste. No greenhouse gases, reliable, high build and decommissioning costs.

Fusion Lots of cheap energy once the reaction started. Hard to contain (magnetic fields) have to overcome electrostatic forces pushing ions apart. No harmful waste, large energies produced per reaction. No greenhouse gases.

Applications of Nuclear Radiation

Electricity generation, cancer treatment, gamma cameras (investigation internal organ function), monitoring the thickness of paper and foil production, smoke detectors.