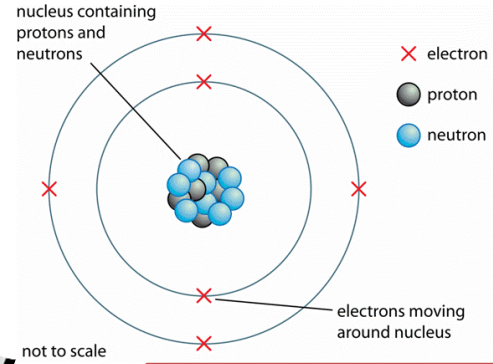
GCSE Science – Atomic Structure – Higher

START

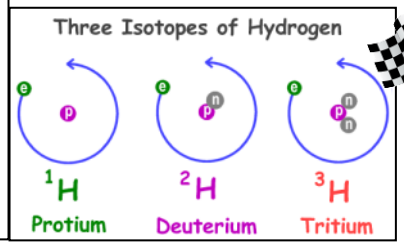
Atomic Structure



Particle	Mass	Charge
proton	1	+1
neutron	1	0
electron	almost 0	-1

Isotopes;

- Atoms that have the same number of protons (element), but different numbers of neutrons



Key words:

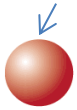
1. **Atoms - an atom has no overall charge**
2. **Mass number = protons + neutrons**
3. **Atomic number = protons (also = electrons)**
4. **Isotopes – atoms of the same element with the same numbers of protons and electrons but different numbers of neutrons.**
5. **Background radiation – low level radiation present at all times.**
6. **Irradiation – exposing an object to a radioactive source.**
7. **Contamination – unwanted radioactive atoms on an object.**
8. **Half-life – the time taken for the number of radioactive nuclei in a sample to halve.**

Development of the model of the atom;

New experimental evidence may lead to the model being changed or replaced.

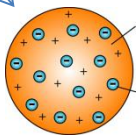
Early ideas;

Before the discovery of the electron atoms were tiny spheres, they couldn't be divided



Plum pudding;

After the electron was discovered the atom became a ball of positive charge with negative electrons scattered in it



Alpha particle scattering;

Showed that the mass of an atom was concentrated in the centre, it was charged too

Niels Bohr;

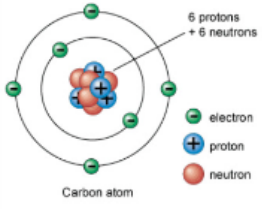
Adapted the nuclear model suggesting electrons in orbitals at set distance

Nucleus development;

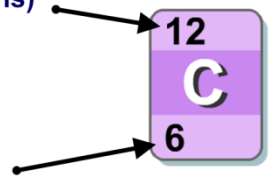
Experiments now show nucleus is made of smaller particles of positive charge

James Chadwick;

Evidence to show the existence of neutrons in the nucleus



Mass number
(= protons + neutrons)



Atomic number
(= number of protons = number of electrons).

So in carbon:
Protons = 6
Electrons = 6 (same as protons)
Neutrons = 12 – 6 = 6

GCSE Science – Atomic Structure – Higher (page 2)

START

Alpha (α) radiation

Description	2 neutrons, 2 protons Note:– An alpha particle is the same as a helium nucleus
Electric charge	+2
Relative atomic mass	4
Penetrating power	Stopped by paper or a few centimetres of air
Ionizing effect	Strongly ionizing
Effect of magnetic/ electric field	Weakly deflected

Beta (β) radiation

Description	High energy electron
Electric charge	-1
Relative atomic mass	1/1860
Penetrating power	Stopped by a few millimetres of aluminium
Ionizing effect	Weakly ionizing
Effect of magnetic/ electric field	Strongly deflected

Gamma (γ) radiation

Description	High energy electromagnetic radiation
Electric charge	0
Relative atomic mass	0
Penetrating power	Stopped by several centimetres of lead or several metres of concrete
Ionizing effect	Very weakly ionizing
Effect of magnetic/ electric field	Not deflected

Nuclear Equations

Uranium-238 can decay into thorium-234 by emitting an alpha particle. Uranium has 92 protons and thorium has 90 protons.

The nuclear equation for this decay looks like this:

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

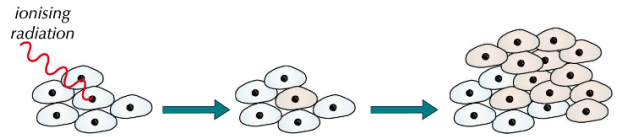
Carbon-14 can decay into nitrogen-14 by emitting a beta particle (when a neutron turns into a proton).

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

Half Life

the time taken for the number of radioactive nuclei in a sample to halve.

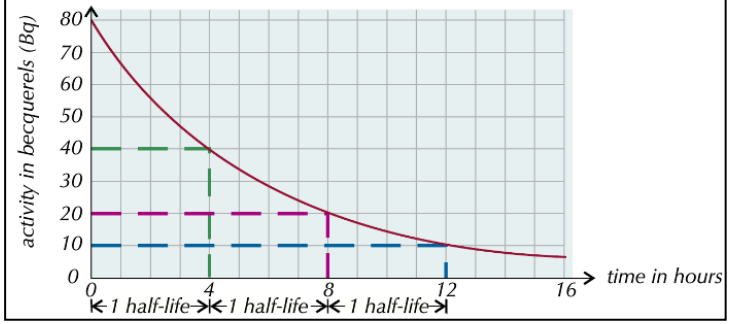
Lower doses tend to cause minor damage without killing the cell. This can give rise to mutant cells which divide uncontrollably — see Figure 1. The cells keep dividing, making more cells and forming a tumour — this uncontrolled cell division is cancer.



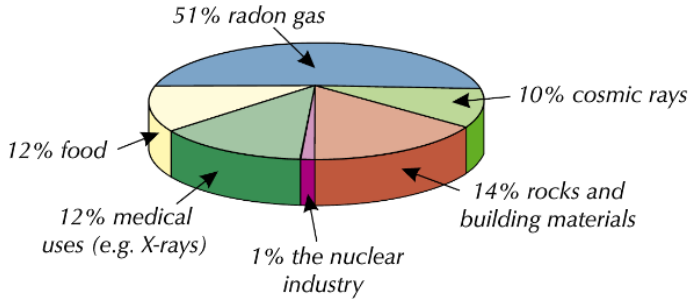
The initial activity is 80, so after one half-life it will be 40 (and after two it will be 20 and after three it will be 10).

To find the half-life of the sample, draw a line from 40 on the activity axis across to the curve and down to the time axis (green dotted line). This tells you that the half-life is 4 hours.

You can check you were right by doing the same for an activity of 20 and checking that you get a time of 8, and so on...



Sources of background radiation



GCSE Science – Atomic Structure Questions

The Atomic Model

- True or false? People used to believe that atoms were tiny spheres that couldn't be broken apart. ☐
- Describe Rutherford and Marsden's experiment which disproved the plum pudding model. ☐
- What happens to an electron in an atom if it releases EM radiation? ☐
- Who provided evidence to suggest the existence of the neutron? ☐
- True or false? Electrons make up most of the mass of an atom. ☐
- What is the overall charge of an atom? ☐
- What happens to an atom if it loses one or more of its electrons? ☐

Nuclear Decay and Half-life

- Which number defines what element an atom is: the atomic number or the mass number? ☐
- What is the atomic number of an atom? What is the mass number of an atom? ☐
- What is an isotope? Are they usually stable? ☐
- For the three types of ionising radiation, give: a) their ionising power, b) their range in air. ☐
- Draw the symbols for both alpha and beta radiation in nuclear equations. ☐
- What is the activity of a source? How does activity relate to count-rate? ☐
- Define half-life and describe how to find a source's half-life, given a graph of its activity over time. ☐

Dangers of Radiation

- Define irradiation and contamination. ☐
- Give two examples of how to protect against: a) contamination, b) irradiation. ☐
- Compare the hazards of being irradiated and contaminated by:
  a) an alpha source, b) a gamma source. ☐