Physics Knowledge Organiser
Atomic Structure(Triple Science)

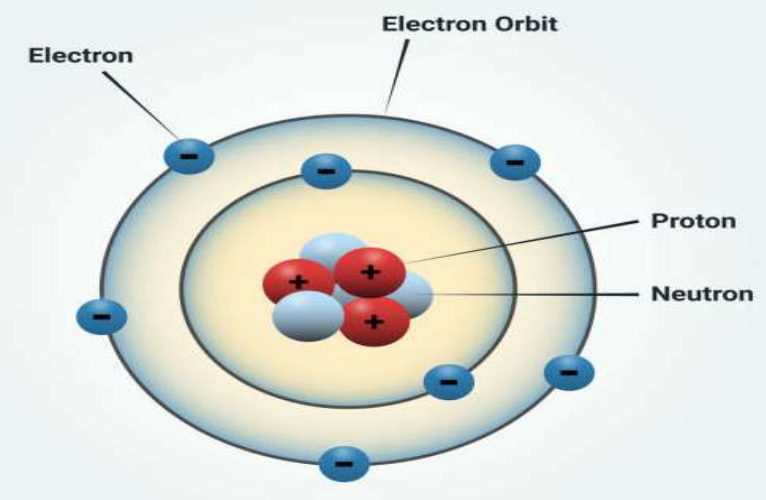
Size of atoms

All matter consists of atoms.
The radius of the atom is $\mathbf{1 \times 10^{-10} m}$.
The radius of a nucleus is 10,000 smaller than an atom.

Charge of atoms

In an atom, it has equal amount of protons and electrons.

Therefore, an atom should always be neutrally charge as they have equal numbers of positive and negative charges.



Structure of Atoms

An atom is made from three sub atomic (smaller than an atom) particles.

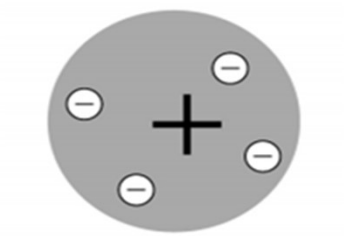
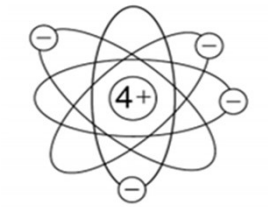
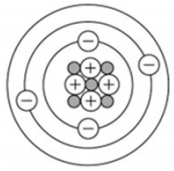
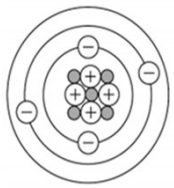
Name	Relative Charge	Relative Mass
Electron	-1	Negligible
Proton	+1	1
Neutron	0	1

Location of subatomic particles in the atom. protons, neutrons and electrons

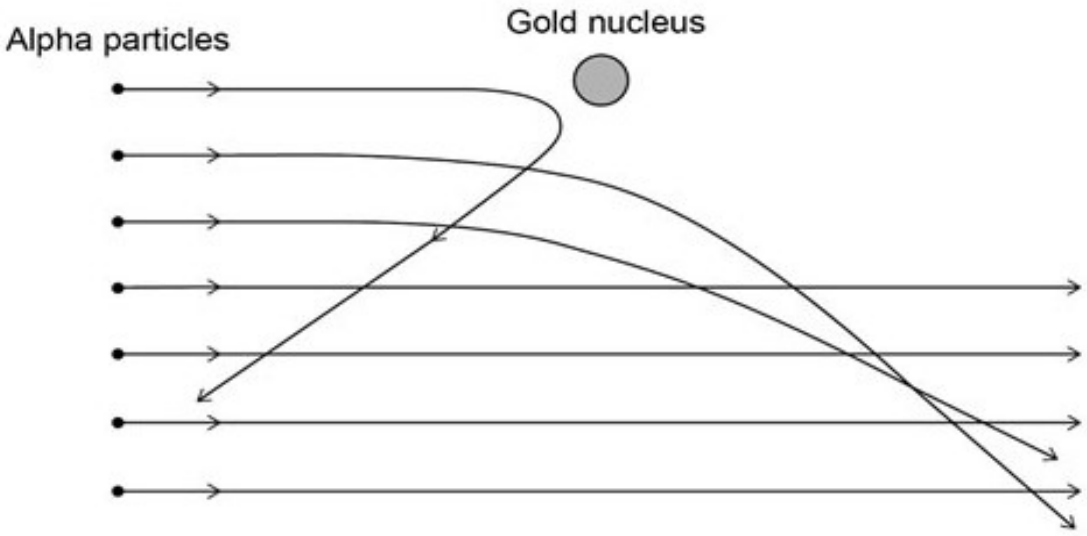
The protons and neutrons are in the centre of the atom in the nucleus.

The electrons orbit on the outside of the atoms in energy levels/shells.

Evolution of the atomic model

Diagram	Model Name	Who discovered it	New thing discovered
	Plum pudding	JJ Thomson	Electrons
	Nuclear model	Rutherford	Nucleus
	Bohr model (Shell model)	Bohr	Electron energy levels
	Current model	Chadwick	Neutron

Rutherford Scattering Experiment



Alpha particles consist of 2 protons and two neutrons. They have a positive charge.

A gold nucleus consists of protons and neutrons. Therefore, it has a positive charge.

Observations

1) Most alpha particles passed through with little or no deflection.
2) Some alpha particles were deflected at small angles.
3) A small number are deflected by large angles more that 90°.

Conclusions

1) Most of the atom is empty space.

2) The nucleus is positively charged. This is because the alpha particles and nucleus repel due to their same charges

3) The nucleus is very small and contains most of the mass. There is a stronger repulsive force due to being closer to the nucleus.

Radioactive Decay

The nucleus of the atom in most elements is stable.

However, in some elements, this nucleus is **unstable**. This is a **radioactive nucleus**.

A radioactive nucleus **will decay and release radiation** becoming more stable.

Nuclear Radiation

During decay four types of radiation can be emitted from the nucleus.

Type of Radiation	**What is it?**
Alpha Particle	**Helium nucleus (2 protons and 2 neutrons)**
Beta Particle	**An electron**
Gamma Rays	**An EM (electromagnetic) wave**
A neutron	**A neutron**

Properties of Ionising Radiation

	Alpha	Beta	Gamma
Range in air	About 5cm	About 20cm to 1m	Several meters
Ionising power	Strongly Ionising	Weakly Ionising	Very Weakly Ionising
Penetrating Power	Stopped by paper	Stopped by a few mm of aluminium	Stopped by a few cm of lead or several m of concrete.

Risks of ionising Radiation

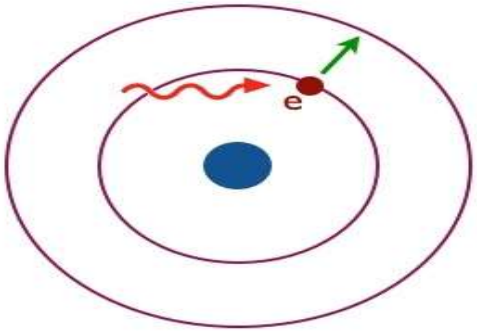
- It can add or remove electrons from atoms turning them into ions.
- This can lead to damage to cells/mutations in DNA.
- Therefore, increasing your risk of cancer.

Applications of Nuclear radiation

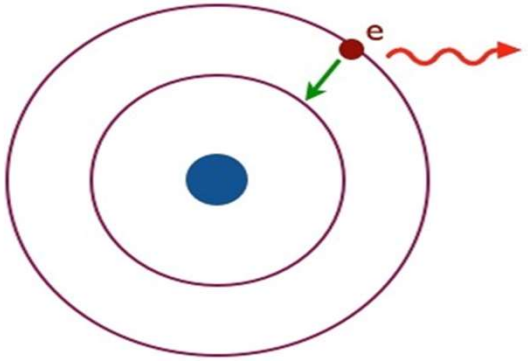
Radiation	Application	Reason
Alpha	Smoke alarms	Least penetrating so can't penetrate through the smoke particles. Additionally, can't penetrate outside of the device reduce irradiation of people near by.
Beta	Manufacturing paper or aluminium sheets	It can penetrate through small thicknesses of aluminium. Therefore, it is sensitive to slight changes in thickness of the material.
Gamma	Radioactive tracers	Most penetrating so it can be detected outside the body. Least ionising so least damage to the healthy cells and tissue in the body.

Electromagnetic (em) Radiation

When electrons absorb electromagnetic (em) energy/ light, they move to higher energy levels. They get further from the nucleus.



When electrons fall to a lower energy levels, they release energy as light (em energy).



Nuclear Decay Equations

Alpha and beta particles have the following symbols in decay equations.

Alpha Particle $^{4}_{2}He$

Beta Particle $^{0}_{-1}e$

Radioactive decay involves the release of alpha and beta particles by these equations:

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

Beta Decay $^{14}_{7}N \rightarrow {}^{14}_{8}O + {}^{0}_{-1}e$

Half Life

Radioactive decay is a random and natural process.

There is no way to predict when a radioactive nucleus will decay

Activity is the number of nuclei that decay and give off radiation every second.

Activity has units of Becquerels (Bq) or counts per second and can be measured by a GM tube.

Half life is the time it takes for half the nuclei in a radioactive substance to decay and become more stable.

Alternatively, it is the time for the original activity to drop to **half**.

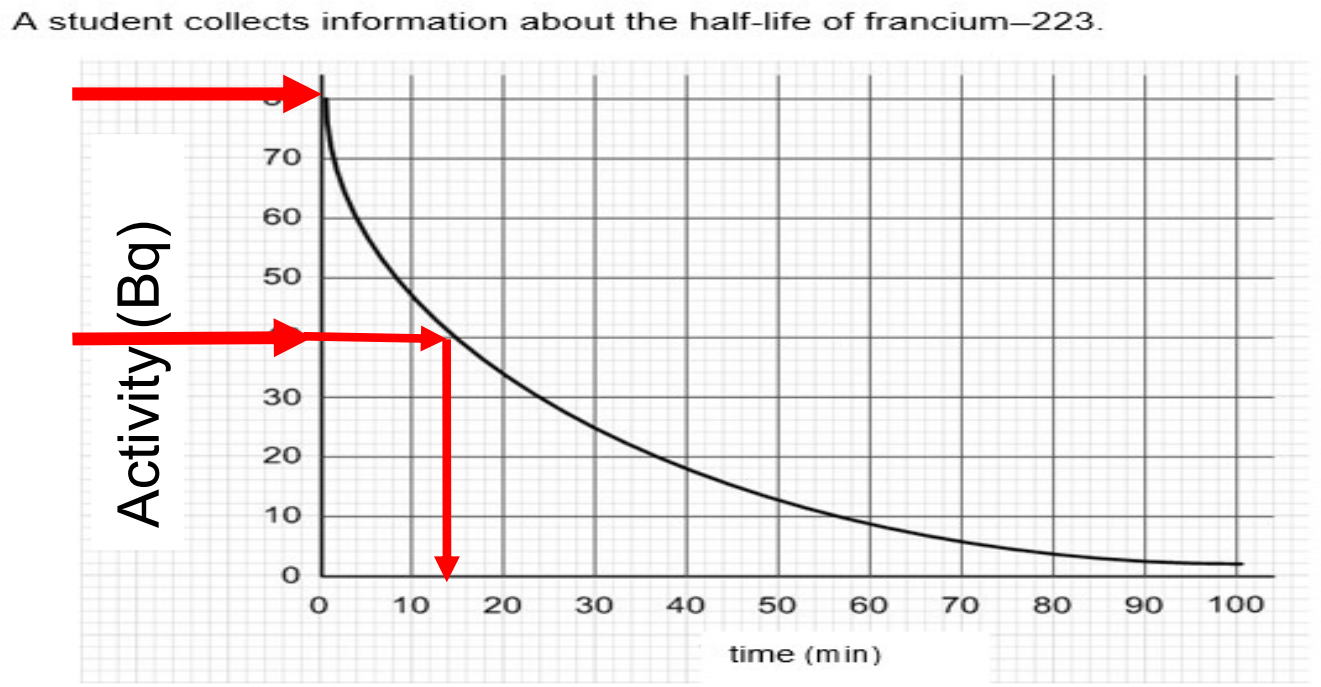
Calculating half life from a graph

1) The starting activity of the sample is 80Bq.

2) After 1 half life, the activity will be 40Bq.

3) Draw a line from 40 to the curve and then draw a second line down to the bottom axis.

4) The time will be the half life of the sample. (14 minutes)



Using half lives answering questions

The activity of a radioactive material is 2000Bq. The half life of the material is 5 days. What will be the activity after 15 days?

Number of half lives = $\frac{Total\ time}{Time\ for\ 1\ half\ life} = \frac{15}{5} = 3\ half\ lives$

After each half life, the activity of the sample will halve. Therefore $\left(\frac{1}{2}\right)^3 = \frac{1}{8}$

The final activity after 15 days = 2000 x $\frac{1}{8}$ = 250 Bq

Irradiation and contamination

Contamination is the unwanted presence of a radioactive substance on a person or object. (When radioactive particles get onto objects by touching)

Irradiation is When objects are exposed to radiation (alpha, beta and gamma).The objects will not become radioactive.

Effects of long term irradiation or contaminiation

Radiation poisoning
Radiation sickness

Increased risk of cancer

Increased risk of tumours

Increased risk of cell damage

Handling radioactive sources safely

Safety Precaution	Reason
Using tweezers or tongs	To prevent contamination and reduce irradiation
Storing radioactive sources in lead lined boxes	To reduce irradiation
Keep exposure time as short as possible.	To reduce irradiation

Peer Review

Scientists can compare (peer review) the results with other scientists for scientific findings before they are published.

This increases the validity of the results.