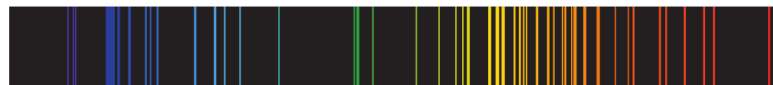




- 1 The atoms are small. The radius of an atom 1×10^{-10} m the nucleus is 100,000 times smaller with a radius about 1×10^{-15} m
- 2 The **nucleus** of atom contains the **nucleons**—**protons** and **neutrons**
- 3 **Rutherford's** fired alpha particles at **gold leaf** as most as went through and some deflected it proved that **nucleus** was positively charged and that atoms are mostly empty space.
- 4 **Isotopes** are atoms with the same proton number but different number of neutrons
- 5 Electrons can only exist at specific **energy levels** known as shells (**Bohr Model**)
- 6 Electrons can absorb and emit energy when they move between energy shells. This results in absorption and emission spectra. This can be used to identify elements in distant stars.
- 7 Too much energy given to atom can lead to the loss of electrons creating an **ion**. This process is called **ionisation**.
- 8 We are constantly exposed to a low levels of ionising radiation called **background radiation** . Sources can **natural** such as radioactive minerals in **rocks, food, cosmic rays** from the Sun to **man-made** e.g. **X rays, gamma scans** and past **nuclear weapon tests**.
- 9 Radioactivity can be measured by a **Geiger- Muller (GM) tube** Radiation passing through the tube **ionises** the gas inside giving a reading. The amount of radiation a person has been exposed to (**dose**) can be measured by a **dosimeter** which contains a photographic film that gets darker.
- 10 The types of radiation that can be emitted when a nucleus **decays** include **alpha** and **beta** particles, **positrons**, **gamma rays** and **neutrons**.

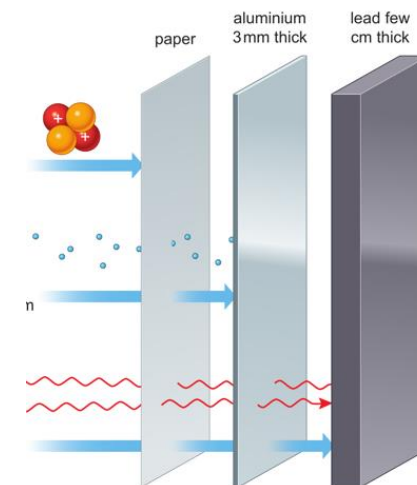
emission



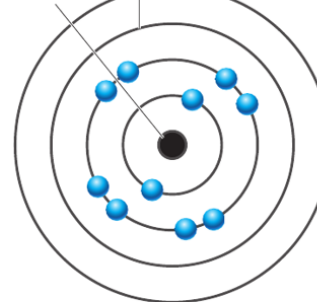
absorption



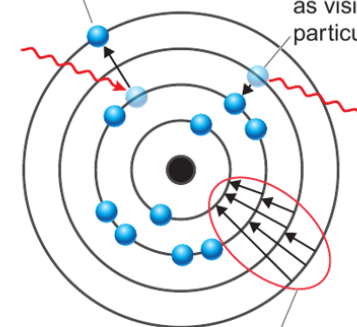
Particle	Symbol	
alpha	α	${}^4_2\text{He}$
beta	β^-	${}^0_{-1}\text{e}$
positron	β^+	${}^0_{+1}\text{e}$
neutron		n



These orbits (electron shells) are normally empty in neon atoms.



If an atom absorbs energy, an electron can move to a 'higher' orbit.



When an electron returns to a lower orbit the atom emits energy as visible light of a particular wavelength.

Electrons can make all of these different orbit changes. Each different change produces a different wavelength of light.



1 **Alpha** particles are like **helium nuclei** (relative mass 4, charge of 2+), they are **most ionising** but **least penetrating**. **Beta minus** particles are fast moving electrons are **moderately ionising** and have **medium penetration**. **Gamma rays** are electromagnetic waves-highly penetrating but low ionisation.

2 **Activity** is the number of nuclear **decays** per second and is measured in **Bequerels (Bq)**

3 **Half-life** is the time it takes for **half the unstable nuclei** in a sample to **decay**. Decay is a **random**. Half-life predicts the number of undecayed nuclei but not which nuclei. Elements with **long lives** are used to **date very old things e.g rocks** (U-235 ,700 million years). Where as those with a very short half-life (Tc-99M, 6 hrs) are used in medical scans.

4 **Radiocarbon dating** used to find the age of items once were alive e.g. skeletons

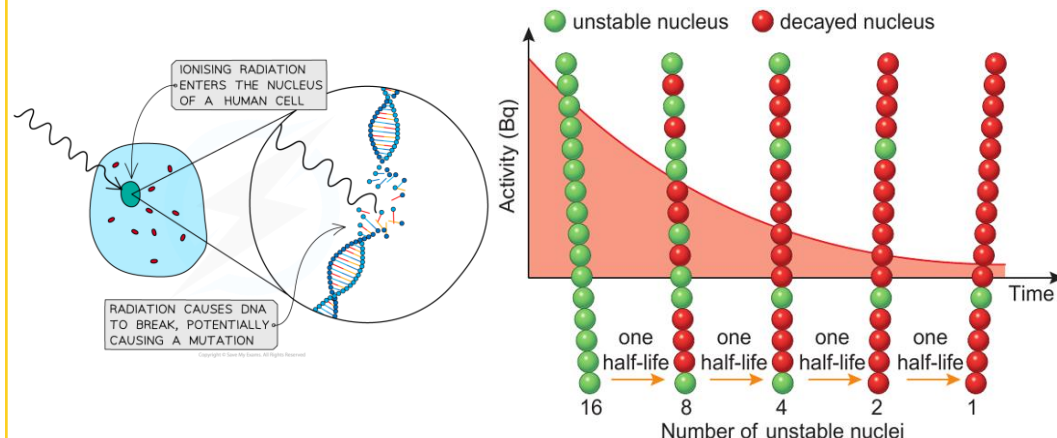
5 Isotopes are used In fire alarms, to determine the thickness of materials, tracers and to kill cancer cells. The role depends on the level of **penetration** and **ionisation** needed.

6 **PET** scanners make images from gamma rays produced when a positron and electron **annihilate** each other.

7 **Internal radiotherapy** has the RA source placed inside the body eternal radiotherapy has gamma rays, x rays or protons fired into the patient .

8 Radioactive materials can damage tissue and can cause **mutations** that can lead to **cancer**.

9 **Precautions** include using tongs, (**intensity** of radiation **decreases** with **distance**), handle for a short period of **time** (lessens exposure), store in a lead lined box. Wear gloves/ googles/ suit/ respirator to prevent contamination.



10 **Irradiation** is when we are exposed to a radioactive source this **stops when we move away**. **Contamination** is where radioactive substance **gets onto our skin or inside us**.

11 **Nuclear reactors** generate electricity by using the heat energy from the **fission** –splitting of large atoms (Uranium). Control rods are used determine rate of the chain reaction.

12 **Uranium** is a **non renewable** fuel and the **decommissioning** of reactor and management of **nuclear waste** are expensive. Energy produced is large with **no CO₂** when running.

13 **Chernobyl** and **Fukushima** are examples of nuclear accidents where radioactive materials have contaminated the environment for thousands of years due to long half lives.

14 **Nuclear fusion** is where smaller nuclei combine to form larger ones releasing energy. This happens in stars at **high temperature and pressure** Hydrogen is fused to form Helium.

15 Nuclear **fusion** occurs in **atomic (H) bombs**. **Fusion reactors** are being researched but they currently **use more energy** to create the conditions for fusion than is released.