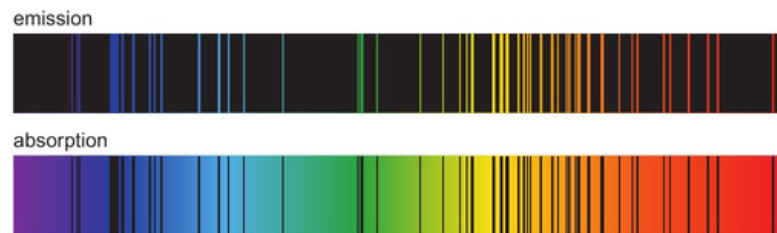
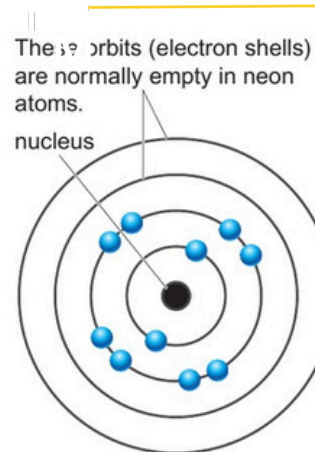
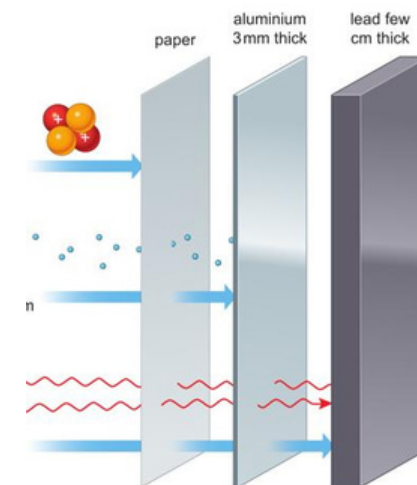


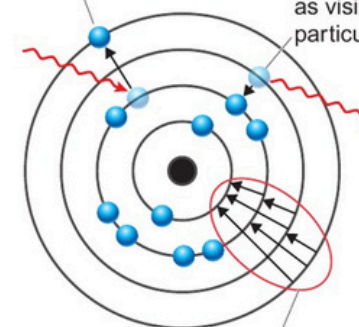
- 1 The atoms are small. The radius of an atom  $1 \times 10^{-10}$  m the nucleus is 100,000 times smaller with a radius about  $1 \times 10^{-15}$  m
- 2 The **nucleus** of atom contains the **nucleons**—**protons** and **neutrons**
- 3 **Rutherford** fired alpha particles at **gold leaf** as most 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**.



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



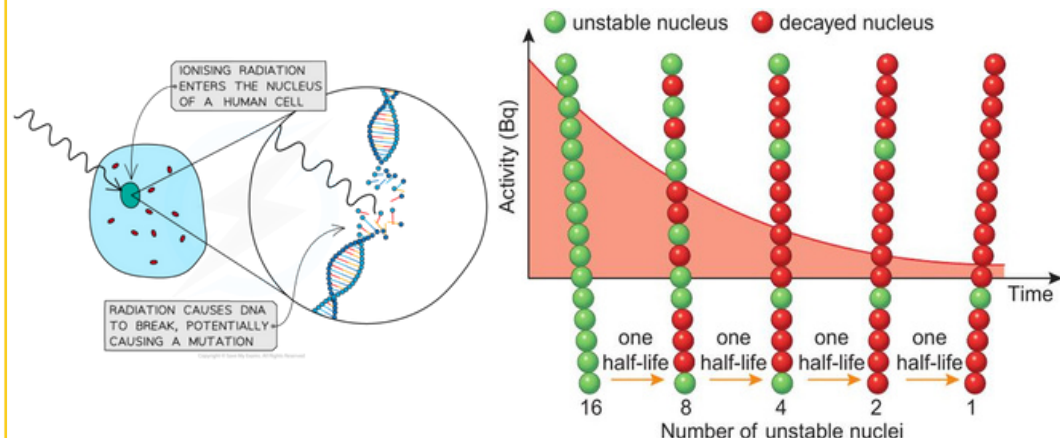
If an atom absorbs energy, an electron can move to a 'higher' orbit.



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 | <b>Alphaparticles</b> are like <b>helium nuclei</b> (relative mass 4, charge of 2+), they are <b>most ionising</b> but <b>least penetrating</b> . <b>Beta minus</b> particles are fast moving electrons are <b>moderately ionising</b> and have <b>medium penetration</b> . <b>Gamma rays</b> are electromagnetic waves-highly penetrating but low ionisation.                                                 |
| 2 | <b>Activity</b> is the number of nuclear <b>decays</b> per second and is measured in <b>Bequerels (Bq)</b>                                                                                                                                                                                                                                                                                                     |
| 3 | <b>Half-life</b> is the time it takes for <b>half the unstable nuclei</b> in a sample to <b>decay</b> . Decay is a <b>random</b> . Half-life predicts the number of undecayed nuclei but not which nuclei. Elements with <b>long lives</b> are used to <b>date very old things e.g. rocks</b> (U-235, 700 million years). Whereas those with a very short half-life (Tc-99M, 6 hrs) are used in medical scans. |
| 4 | <b>Radiocarbon dating</b> 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 <b>penetration</b> and <b>ionisation</b> needed.                                                                                                                                                                                                                 |
| 6 | <b>PET</b> scanners make images from gamma rays produced when a positron and electron <b>annihilate</b> each other.                                                                                                                                                                                                                                                                                            |
| 7 | <b>Internal radiotherapy</b> has the RA source placed inside the body external radiotherapy has gamma rays, x rays or protons fired into the patient. Radioactive materials can damage tissue and can cause <b>mutations</b> that                                                                                                                                                                              |
| 8 | can lead to <b>cancer</b> .                                                                                                                                                                                                                                                                                                                                                                                    |
| 9 | <b>Precautions</b> include using tongs, ( <b>intensity</b> of radiation <b>decreases</b> with <b>distance</b> ), handle for a short period of <b>time</b> (lessens exposure), store in a lead lined box. Wear gloves/ goggles/ suit/ respirator to prevent contamination.                                                                                                                                      |



|    |                                                                                                                                                                                                                                                                                                                                                                                                            |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10 | <b>Irradiation</b> is when we are exposed to a radioactive source this <b>stops when we move away</b> . <b>Contamination</b> is where radioactive substance <b>gets onto our skin or inside us</b> . <b>Nuclear reactors</b> generate electricity by using the heat energy from the <b>fission</b> —splitting of large atoms (Uranium). Control rods are used to determine the rate of the chain reaction. |
| 11 | <b>Uranium</b> is a <b>non renewable</b> fuel and the <b>decommissioning</b> of reactor and management of <b>nuclear waste</b> are expensive. Energy produced is large with <b>no CO2</b> when running.                                                                                                                                                                                                    |
| 12 | <b>Chernobyl</b> and <b>Fukushima</b> are examples of nuclear accidents where radioactive materials have contaminated the environment for thousands of years due to long half-lives.                                                                                                                                                                                                                       |
| 13 | <b>Nuclear fusion</b> is where smaller nuclei combine to form larger ones releasing energy. This happens in stars at <b>high temperature and pressure</b> . Hydrogen is fused to form Helium. Nuclear <b>fusion</b> occurs in <b>atomic (H) bombs</b> . <b>Fusion reactors</b> are being researched but they currently <b>use more energy</b> to create the conditions for fusion than is released.        |
| 14 |                                                                                                                                                                                                                                                                                                                                                                                                            |
| 15 |                                                                                                                                                                                                                                                                                                                                                                                                            |