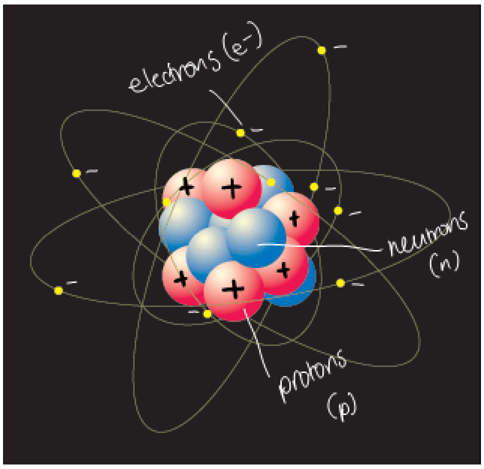
2.1 – The Atom

2.1.1 - State the position of protons, neutrons and electrons in the atom

Atoms are made up of a **nucleus** containing positively charged <u>protons</u> and neutral <u>neutrons</u>, with negatively charged <u>electrons moving around the nucleus</u> in shells.



2.1.2 - State the relative masses and relative charges of protons, neutrons and electrons

	Relative Mass	Relative Charge
Proton	1	1
Neutron	1	0
Electron	5×10^{-4}	-1

2.1.3 - Define the terms *mass number (A)*, *atomic number (Z)* and *isotopes an element*

Mass Number – **A** – Sum of the number of protons and neutrons in the nucleus

mass number = number of protons + number of neutrons

Atomic Number – **Z** – the number of protons in the nucleus. Since atoms are electrically neutral, the number of protons is also <u>equal to the number of electrons</u>.

Isotopes of an Element – Atoms of the same element with the same number of protons, but with a different number of neutrons

2.1.4 - Deduce the symbol for an isotope given its mass number and atomic number

$^{A}_{Z}X$ This is **nuclide notation**, which shows the mass number, atomic number and symbol to represent a particular isotope.

2.1.5 - Calculate the number of protons, neutrons and electrons in atoms and ions from the mass number, atomic number and charge

Protons

Find the atomic number. This is the number of protons

Neutrons

The difference between the mass number and the atomic number

$$\boldsymbol{number\ of\ neutrons = mass\ number - atomic\ number}$$

Electrons

If the atom is electrically neutral, then the number of electrons is equal to the number of protons.

In an ion, we take the number of protons, and then subtract the charge. For example:

$$(Al^{3+}) \quad n(e^-) = 13 - (+3) = 10$$

$$(Cl^-) \quad n(e^-) = 17 - (-1) = 18$$

2.1.6 - Compare the properties of the isotopes of an element

Chemical properties depend on their outer shell of electrons. Since they still have the same number of electrons, these properties will remain the same.

Physical properties depend on their nuclei. Since the number of neutrons changes, properties such as density, rate of diffusion, melting and boiling change.

The **mass** will also change.

2.1.7 - Discuss the uses of radioisotopes

Many isotopes are **radioactive** because the nuclei are more prone to breaking down spontaneously. Radiation is emitted when this happens. Radioisotopes can occur naturally or be man-made.

^{14}C *Carbon-14*

<u>Radiocarbon dating</u>

In living things, the isotope carbon-14 exists in a set ratio to carbon-12. When the organism dies, the carbon-14 decays, altering the ratio. This is used to estimate the age of the organism, called radiocarbon dating.

These isotopes are very penetrating and can be used to treat cancerous cells.

^{60}Co *Cobalt-60*

<u>Radiotherapy</u>

Cobalt-60, is a powerful **gamma** emitter, making it useful for the treatment of cancer. It has also been used in recent times to stop the immune response to transplanted organs in the body. It is also used in levelling devices and to sterilize foods and spices.

^{131}I *Iodine-131*

<u>Medical tracer</u>

Iodine-131 releases both **gamma** and **beta** radiation. It can treat thyroid cancer, and detect if the thyroid is functioning correctly. The thyroid will take up the iodine and then the radiation will kill part of it.

^{125}I

Iodine-125

<u>Medical tracer</u>

Iodine-125 is a gamma emitter, can treat prostate cancer and brain tumours. It is also taken up by the thyroid gland.

Radioactive cobalt and iodine are dangerous and there is some concern as to whether they could be used to do considerable damage with bombs.

^{241}Am *Americium-241*

This is artificially produced radioisotope used in smoke detectors and detects the presence of smoke or heat sources. These smoke detectors have ionisation chambers and are more effective than ones which detect change in light

Americium has a half-life of 432 years. It is also used as a thickness gauge in the glass industry. It is insoluble and so would simply pass through the body if swallowed. In a soluble form, the radiation of alpha and gamma rays would concentrate in the skeleton.

^{99}Tc *Technetium-99*

It is used in radiotherapy for cancer and studying metabolic processes. It emits low energy radiation, so can be administered in small doses.