BioMedical Admissions Test (BMAT)

Section 2: Chemistry

Topic C1: Atomic Structure

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The Atom

- The **plum pudding model** was an early model for the atom in which the atom was believed to be a **sphere of positive charge** with **negatively charged electrons dotted around within the sphere at random**; like plums in a pudding!

- The **gold foil** experiment by Rutherford, Geiger and Marsden **disproved** the **plum pudding model**. In this experiment, positively charged **alpha particles** were fired at a very thin gold sheet. If the plum pudding model was true, it was expected the alpha particles would pass straight through the foil. However, while **most of the particles passed straight through, a small number of particles were deflected;** some changed direction slightly and an even smaller proportion were reflected straight back. This suggested there was a **small, concentrated positive charge** in the atom which caused the deflection of a small proportion of the alpha particles.

- This experiment led to the current nuclear model of the atom:

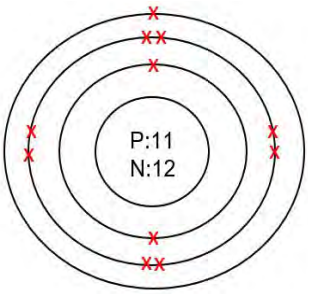
The nucleus	• Contains **protons (positively charged) and neutrons (no charge)** • Found in central nucleus • Overall **positively charged** due to protons • Very small

Electrons	• **Negatively charged (-1)**
	• Arranged in **shells around the nucleus**
	• Each shell of electrons has a **fixed energy level**
	  ○ Lowest energy levels (closest to nucleus) filled first
	  ○ The 1st shell can only fit 2 e^-. The 2nd and 3rd shells will accept 8e^-.
	  ○ Atoms with a full shell of electrons, such as the Group 18 noble gases, are more stable. **Partially filled shells make the atom reactive.**

Protons	• **Positively charged (+1)** • Found in central nucleus • **No. of protons = no. of electrons** → therefore overall atom = neutral

Worked example

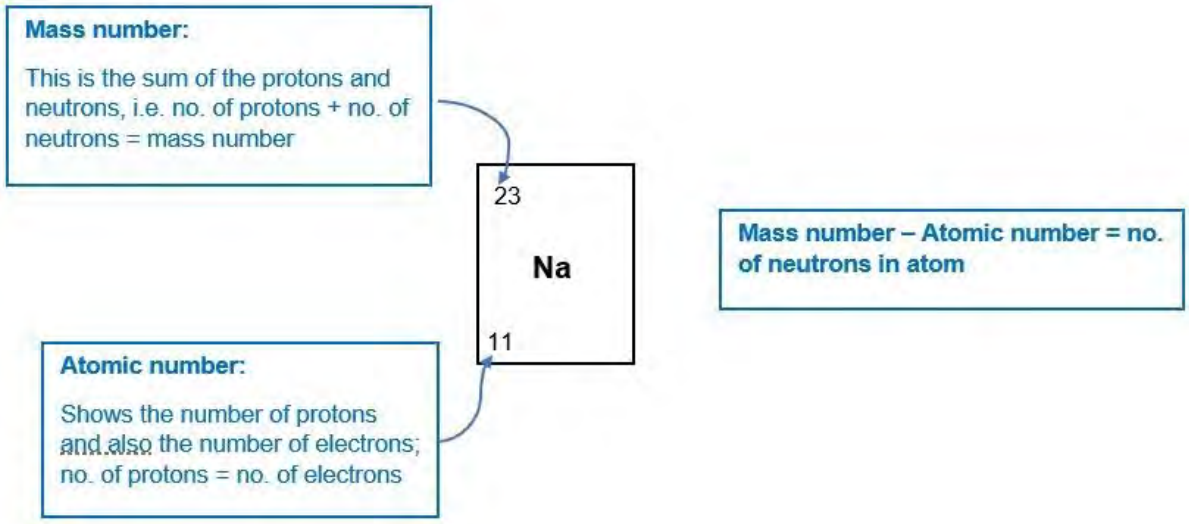
For example, Sodium:



This is a diagram of a Sodium atom.

- ➔ There are 11 positively charged protons and 12 neutrons packed into the nucleus at the centre of the atom.
- ➔ Sodium has 11 electrons in total, arranged into 3 shells.
- ➔ There are 2 electrons in the 1st shell, 8 in the 2nd and 1 in the 3rd shell.

Below is **Sodium** in the form it is found in the periodic table.



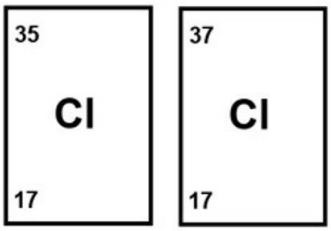
- This gives us information on its **mass number** (the number of protons + the number of neutrons) and its **atomic number** (the number of protons).
- We can calculate the number of **neutrons** by taking the atomic number from the mass number.

Important information to note

- Atoms of the same element always have the same number of protons.
- However, atoms of the same element can have a different number of neutrons. Atoms with the **same number of protons,** but a **different number of neutrons** are called **isotopes.**
- Isotopes have the same chemical properties (since these are defined by the number of protons) but a different relative atomic mass.

Worked example

For example, **chlorine-35** and **chlorine-37**:



Notice they have the same **atomic number** - 17. If they had different atomic numbers, they would be different elements.

The atomic number of 17 means both chlorine-35 and chlorine-37 have 17 protons and 17 electrons each.

Chlorine-35 has 35-17 = 18 neutrons

Mass Spectroscopy

Mass spectroscopy can be used to determine the number of protons, neutrons and electrons in atomic calculations.

This is discussed in much more detail in C4 Quantitative Chemistry - including a worked example.