

Atomic Structure Notes

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What actually is an atom, and what is an atom made of? Let's start with that first question. **What is an atom?**

An atom: the simplest particle of an element that is neutral.

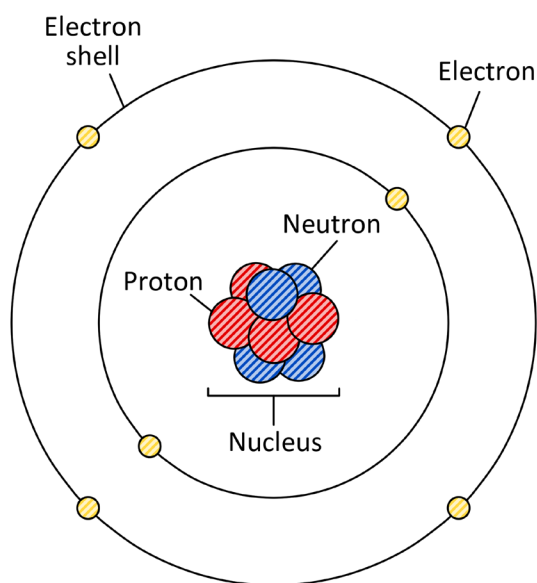
What is an atom made of? Atoms are made of three different particles.

1. Protons.
2. Neutrons.
3. Electrons.

Where do we find each particle?

- Protons and neutrons are located in the nucleus of the atom.
- Electrons are located in the orbits also known as electron shells surrounding the nucleus.

The figure below shows the structure of an atom.



The radius of an atom is approximately 1×10^{-10} metres or 0.1 nm

The radius of a nucleus is about 10,000 times smaller, at approximately 1×10^{-14} metres

Each particle has its own electrical charge and mass:

Particle	Charge	Mass
Proton	+1	1
Neutron	0	1
Electron	-1	$\frac{1}{2000}$

How can we tell how many of each of these particles are present in each atom?

In the periodic table the numbers of each of these particles is given to us. Take the example of helium below.

He

4
2

Mass number

Tells us the number of protons and neutrons in an atom.

Atomic number

Tells us the number of protons in an atom.

What other things can we work out from this information?

- In a neutral atom the number of electrons is equal to number of protons.
- The number of neutrons can be found by subtracting the atomic number from the mass number.

Electronic Configurations

As mentioned, electrons are arranged in orbits or shells around the nucleus of an atom.
For GCSE, we only have to know how many electrons can be held in the first three shells 😊

The first shell can hold a maximum of 2 electrons.

The second shell can hold a maximum of 8 electrons.

The third shell can hold a maximum of 8 electrons.

There are two ways to represent the atomic structure of an element or compound;

1. Electronic Configurations.

2. Dot & Cross Diagrams.

How to write electronic configurations

With electronic configurations elements are represented numerically by the number of electrons in their shells and number of shells. Take the example of N^{14}_7 below.

Step 1: we take note of the atomic number of the element. Which in this case, nitrogen is 7. This means that there are 7 protons in an atom of nitrogen. As an atom is neutral this means that we have 7 electrons 😊

Step 2: now that we know how many electrons we are working with (7) we start filling the electron shells. Fill from the inside shell to the outside shell. 2 electrons go in the 1st shell. This leaves 5 electrons remaining go in the 2nd shell.

The electronic configuration for nitrogen is 2, 5

Presentation note: when writing out an electronic configuration the numbers are usually separated by commas. But, they can also be separated by dots (full stops) so the electronic configuration for nitrogen could look like **2. 5**

A few more examples of electronic configurations of atoms 😊

H = 1

He = 2

Li = 2, 1

Be = 2, 2

B = 2, 3

C = 2, 4

How to write electronic configurations of ions

Exam note: exam boards really like to ask questions for the electronic configuration of ions. Ions are not atoms. So, their electronic configuration will be different.

What is an ion? An ion is an electrically charged particle. It can be charged if it loses or gains electrons.

An atom becomes positively charged when it loses electrons. An atom becomes negatively charged when it gains electrons.

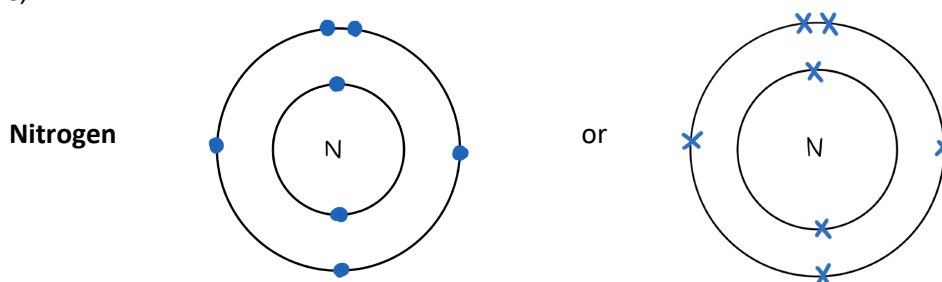
Example: what is the electronic configuration of a Ca^{2+} ion?

Step 1: look at the periodic table to find the atomic number of calcium. We see that this is 20.

Step 2: take the charge into account. As Ca is a 2+ ion this means that 2 electrons have been lost. So there are now 18 electrons not 20. The electronic configuration of $Ca^{2+} = 2, 8, 8$

Dot and Cross Diagrams

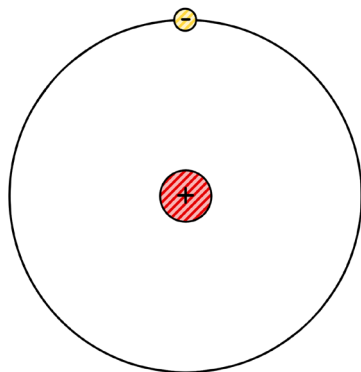
With Dot and Cross diagrams, electrons are represented by Dots or Crosses to show electrons, and circles to show the shells. For example;



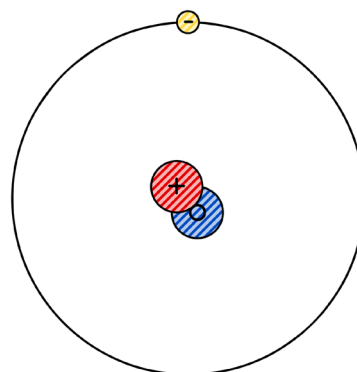
Isotopes

Isotopes: are atoms of elements that have the same number of protons but different numbers of neutrons.

An isotope can still be the same element even though the mass numbers are different. So, again isotopes have the same number of protons but different numbers of neutrons. Take the next figure as an example.



Hydrogen atom



Deuterium atom

We can see here that a deuterium atom is an isotope of hydrogen. Having the same number of protons and a different number of neutrons 😊. We don't have to know about deuterium for the GCSE, it's just a nice example to highlight how having more neutrons makes it an isotope but it's still hydrogen.

Calculating the relative atomic mass of a sample

We can be asked to calculate the relative atomic mass of a sample containing two or more isotopes of an element. "Two isotopes" are the most common style of question. To put it simply we are being asked to find the mean (average) of the two.

Step 1: we multiply the percentage of each atom by its mass number.

Step 2: we then add these multiplied numbers together.

Step 3: we divide this added number by 100.

Take a look at the following examples 😊

Example 1: A sample of copper contains 70% of copper-63 and 30% of copper-65 atoms.
Calculate the relative atomic mass of the sample of copper.

$$\text{Relative Atomic Mass} = \frac{(70 \times 63) + (30 \times 65)}{100}$$

$$\text{Relative Atomic Mass} = \frac{4410 + 1950}{100} = 63.6$$

Example 2: A sample of element X contains the following isotopes:

60% of X-50 (mass = 50)

25% of X-52 (mass = 52)

15% of X-54 (mass = 54)

Calculate the relative atomic mass of element X.

$$\text{Relative Atomic Mass} = \frac{(60 \times 50) + (25 \times 52) + (15 \times 54)}{100}$$

$$\text{Relative Atomic Mass} = \frac{5110}{100} = 51.1$$