

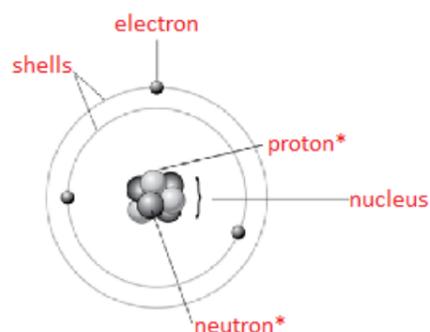
Atomic Structure, Bonding and Types of Substance

1.1 — How has Dalton's model of the atom changed

Dalton said: 1) atoms cannot be **broken down** into something simpler;
 2) atoms of a given element are **identical**; 3) atoms of different elements are **different** from one another; 4) atoms of elements can combine to form **compounds**.

The discovery of the **electron** by JJ Thomson in 1897 disproved point 1. The discovery of the central **nucleus** in the atom by Rutherford around 1911 also disproved point 1. The **proton** was discovered in 1918, and confirms point 3 is correct. The discovery of the **neutron** by Chadwick in 1932 disproved point 2.

1.2 — Describe the structure of the atom



1.3 — Charge & mass of sub-atomic particles

Particle	Relative mass	Relative charge
Proton	1	+1
Electron	1 / 1835 [†]	-1
Neutron	1	0

1.4 — Numbers of protons and electrons

Explain why the overall charge of an **atom** is always zero.

- **Atoms have equal numbers of protons and electrons. Their equal and opposite charges cancel each other out.**

1.5 — Size of the nucleus

Compared to the size of the atom overall, the nucleus is **very small**.

1.6 — Mass of the atom

Most of the mass of the atom is in the **nucleus**. This is because **the protons and neutrons are the particles with most mass, and they are in the nucleus**.

1.7 — Mass number

An atom's mass number tells us the total number of **protons** and **neutrons**.

1.8 — Atomic number

Atoms of an element always contain the same number of **protons**. The number of **protons** in any element is **unique** to that element.

1.9 — Isotopes

Isotopes of an element always contain the same number of **protons**, but a different number of **neutrons** in their nuclei. This means that the **atomic number** is always the same, but different isotopes have different **mass numbers**.

1.10 — Calculate the PEN numbers in atoms*

Atom	Protons	Electrons	Neutrons
${}^1_1\text{H}$	1	1	0
${}^2_1\text{H}$	1	1	1
${}^9_4\text{Be}$	4	4	5
${}^{28}_{14}\text{Si}$	14	14	14
${}^{35}_{17}\text{Cl}$	17	17	18
${}^{37}_{17}\text{Cl}$	17	17	20
${}^{79}_{35}\text{Br}$	35	35	44
${}^{81}_{35}\text{Br}$	35	35	46
${}^{192}_{77}\text{Ir}$	77	77	115
${}^{226}_{88}\text{Ra}$	88	88	138

1.11 — Elements with relative atomic masses (A_r) that aren't whole numbers

Explain why chlorine and copper have A_r values that are not whole numbers.

They have isotopes with different mass numbers. (The weighted mean of these isotopes is not a whole number.)

1.12 — Calculate relative atomic mass values* (HT only)

$$\left((\% \text{ isotope 1} \times \text{mass isotope 1}) + (\% \text{ isotope 2} \times \text{mass isotope 2}) + \dots \right) / 100$$

- Calculate the relative atomic mass of oxygen. Give your answer to 5 significant figures. Isotopic data: ${}^{16}\text{O} = 99.55\%$, ${}^{17}\text{O} = 0.03\%$, ${}^{18}\text{O} = 0.42\%$.

$$\frac{((99.55 \times 16) + (0.03 \times 17) + (0.42 \times 18))}{100}$$

16.009 %

- Calculate the relative atomic mass of silicon. Give your answer to 4 significant figures. Isotopic data: ${}^{28}\text{Si} = 92.23\%$, ${}^{29}\text{Si} = 4.68\%$, ${}^{30}\text{Si} = 3.09\%$.

$$\frac{((92.23 \times 28) + (4.68 \times 29) + (3.09 \times 30))}{100}$$

28.11 %

1.13 — Mendeleev & the organisation of elements

Mendeleev organised the elements into **groups** by using their:

- chemical** properties,
- physical** properties and
- atomic weight (or mass)**.

1.14 — Mendeleev & his table

Mendeleev was unique amongst scientists of his time as he **predicted** the existence of **undiscovered** elements. He also accurately predicted some of their **properties**.

1.15 — Mendeleev & the organisation of the elements

Although he ordered most elements by atomic weight, the (unknown at the time) existence of **isotopes** meant that some elements switched positions, for example **iodine** and **tellurium** were not listed in order of atomic weight.

1.16 — Atomic number

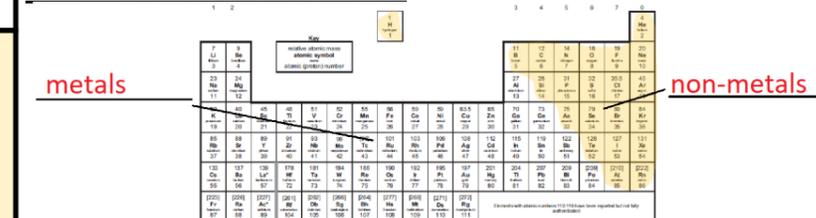
The elements are ordered in the modern periodic table by **increasing** atomic number. This atomic number is **unique** to that particular element.

1.17 — Arrangement of the elements

The elements are arranged in rows called **periods**.

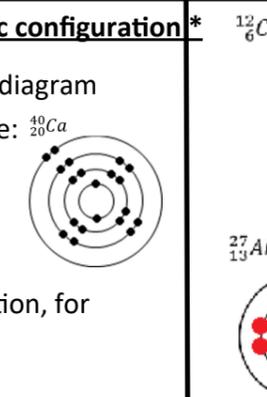
The elements are arranged in columns called **groups**, with elements which have similar **chemical** properties.

1.18 — Metals and non-metals



1.19 — Electronic configuration*

Can be shown in diagram form, for example: ${}^{40}_{20}\text{Ca}$



2.4

Or electron notation, for example: 2.8.8.2

2.8.3

1.20 — Electron configuration & periodic table position

Elements in the same row have the same number of **electron shells**. Elements in the same column have the same number of **electrons** in their **outer shell**.