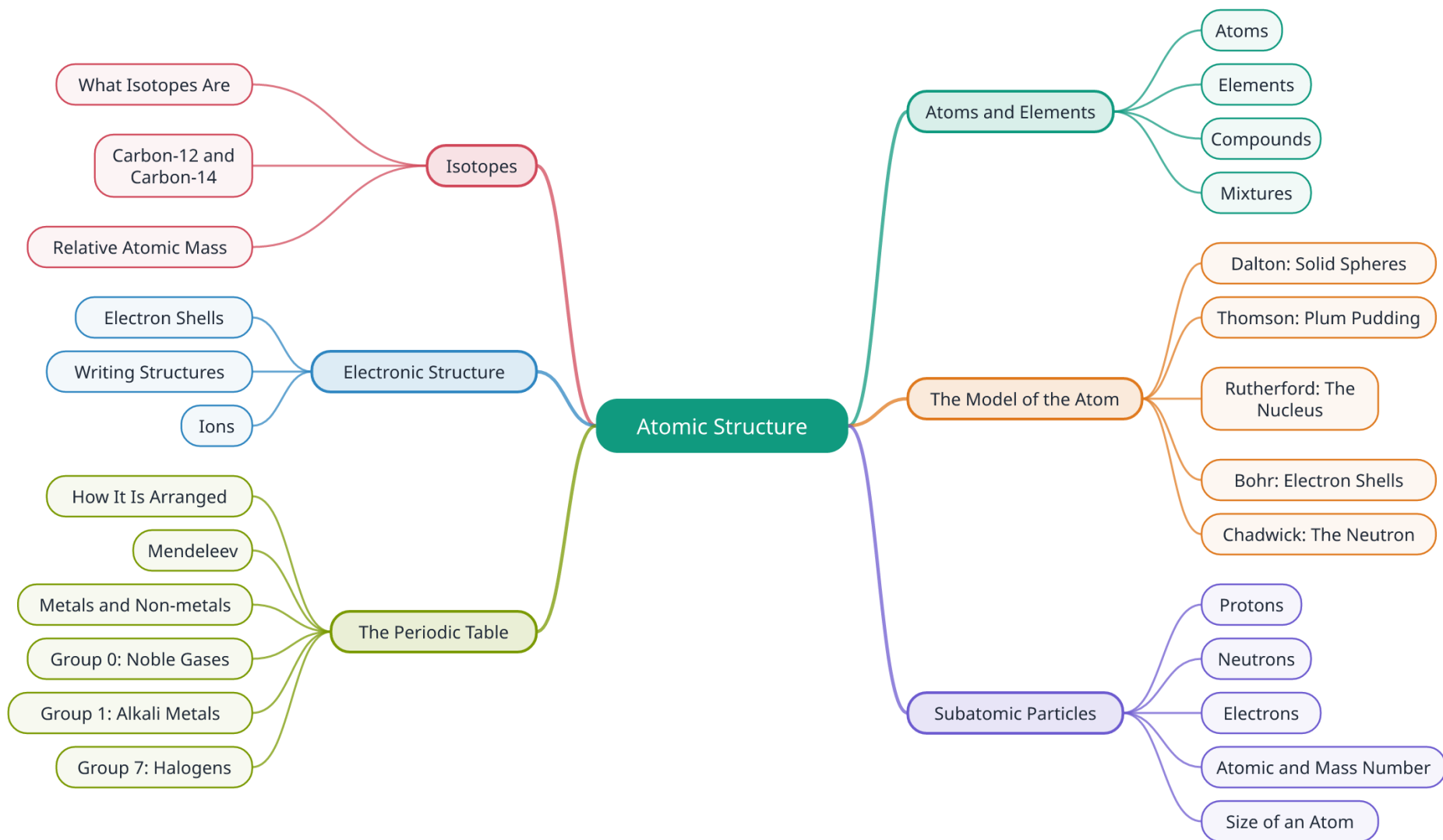


Atomic Structure Mind Map (GCSE)

GCSE · Chemistry · mindmap.ai/mind-maps/atomic-structure



Atomic Structure mind map · mindmap.ai/mind-maps/atomic-structure

Atomic Structure mind map explained

Atoms and Elements

The basic building blocks, and the difference between substances that are chemically combined and those that are only mixed.

Atoms

The smallest part of an element that can exist. Atoms have no overall charge, because they contain equal numbers of protons and electrons.

Elements

A substance made of only one type of atom. There are about 100 elements, shown in the periodic table, and every atom of an element has the same number of protons.

Compounds

Two or more elements chemically combined in fixed proportions. Compounds can only be separated into their elements by chemical reactions.

Mixtures

Two or more substances not chemically combined. Mixtures can be separated by physical processes:

- Filtration
- Crystallisation
- Simple distillation
- Fractional distillation
- Chromatography

The Model of the Atom

The model changed whenever a new experiment produced evidence the old model could not explain. Exam questions often ask what evidence led to each change.

Dalton: Solid Spheres

In the early 1800s, John Dalton described atoms as tiny solid spheres that could not be divided.

Thomson: Plum Pudding

In 1897, J.J. Thomson discovered the electron. His plum pudding model pictured the atom as a ball of positive charge with negative electrons embedded in it.

Rutherford: The Nucleus

In the alpha particle scattering experiment (1909), alpha particles were fired at thin gold foil. Most passed straight through, but a few were deflected. This showed that an atom's mass is concentrated in a tiny, positively charged nucleus and that most of the atom is empty space. Rutherford proposed this nuclear model in 1911.

Bohr: Electron Shells

In 1913, Niels Bohr suggested that electrons orbit the nucleus in shells at fixed distances. His calculations agreed with experimental observations.

Chadwick: The Neutron

In 1932, James Chadwick showed that the nucleus also contains neutrons, which have no charge.

Subatomic Particles

Learn the charge, mass and position of each particle. They often come up as a table to complete.

Protons

Relative charge +1, relative mass 1, found in the nucleus. The number of protons is the atomic number, and it defines the element.

Neutrons

Relative charge 0, relative mass 1, found in the nucleus. Neutrons add to the mass but not the charge, and their number varies between isotopes.

Electrons

Relative charge -1, very small mass (Edexcel gives it as $1/1836$), found in shells around the nucleus. Electrons decide how an atom reacts.

Atomic and Mass Number

- Atomic number: the number of protons
- Mass number: the number of protons plus neutrons

So the number of neutrons = mass number - atomic number.

Size of an Atom

Atoms have a radius of about 0.1 nanometres (1×10^{-10} m). The radius of the nucleus is less than $1/10,000$ of the radius of the atom.

Isotopes

Isotopes explain why relative atomic masses in the periodic table are not always whole numbers.

What Isotopes Are

Atoms of the same element with the same number of protons but a different number of neutrons, so a different mass number.

Carbon-12 and Carbon-14

Both have 6 protons. Carbon-12 has 6 neutrons and carbon-14 has 8.

Relative Atomic Mass

The average mass of an element's atoms, taking account of how common each isotope is:

relative atomic mass = (mass of isotope 1 x % abundance + mass of isotope 2 x % abundance) / 100

For example, chlorine is 75% chlorine-35 and 25% chlorine-37: $(35 \times 75 + 37 \times 25) / 100 = 35.5$.

Electronic Structure

Electrons are arranged in shells, and the outer shell controls how an element reacts.

Electron Shells

Electrons occupy shells, also called energy levels, filling the shell closest to the nucleus first. For the first 20 elements, the first shell holds up to 2 electrons, the second up to 8, and the third up to 8.

Writing Structures

Write the number of electrons in each shell, separated by commas:

- Sodium (11 electrons): 2,8,1
- Chlorine (17 electrons): 2,8,7

Ions

Atoms gain or lose electrons to get a full outer shell. Metals lose electrons to form positive ions; non-metals gain electrons to form negative ions.

The Periodic Table

The table's layout follows from electronic structure, which is why elements in the same group behave alike.

How It Is Arranged

Elements are in order of atomic number. Elements in the same group have the same number of outer electrons, so they have similar chemical properties. The period number is the number of electron shells.

Mendeleev

In 1869, Dmitri Mendeleev ordered the elements mainly by atomic weight, but swapped some to fit their

properties and left gaps for elements not yet discovered, correctly predicting their properties.

Metals and Non-metals

Most elements are metals, found on the left and in the middle of the table. Metals form positive ions; non-metals are on the right.

Group 0: Noble Gases

Full outer shells, so they are unreactive. Boiling points increase down the group.

Group 1: Alkali Metals

One outer electron. They react with water to form a metal hydroxide and hydrogen. Reactivity increases down the group, because the outer electron is further from the nucleus and is lost more easily.

Group 7: Halogens

Seven outer electrons, and they exist as molecules made of pairs of atoms. Reactivity decreases down the group, because it is harder to gain an electron further from the nucleus, while melting and boiling points increase. A more reactive halogen displaces a less reactive one from a solution of its salt.

How to revise with this mind map

1. Learn the particle table. Be able to fill in the relative charge, relative mass and position of protons, neutrons and electrons from memory.
2. Tell the story of the atom with evidence. For each model, from Dalton to Chadwick, know what the scientist proposed and what evidence made the old model change. The alpha particle scattering experiment comes up often.
3. Practise the calculations. Work out numbers of protons, neutrons and electrons from atomic and mass numbers, write electronic structures for the first 20 elements, and calculate relative atomic mass from isotope abundances.
4. Explain the group trends. Don't just state that Group 1 gets more reactive down the group: explain it using how far the outer electron is from the nucleus. Higher marks need the reason.
5. Make it yours. Build your own atomic structure map in Mindmapi from your class notes, and ask the AI about any branch you are unsure of. The answer is saved into that branch's notes for next time.