Atoms, elements and compounds

Teacher review edition. Ask your teacher if anything is unclear.

What is the difference between an element, a compound and a mixture?

What you will learn

- Describe the three particles found in atoms.
- Calculate atomic number, mass number and electron number.
- Tell an element, compound and mixture apart.
- Compare metals and non-metals.

Atoms: the building blocks of matter

> **Atom**
> The smallest unit of an element.

An atom is the smallest unit of an element. All substances are made of atoms.

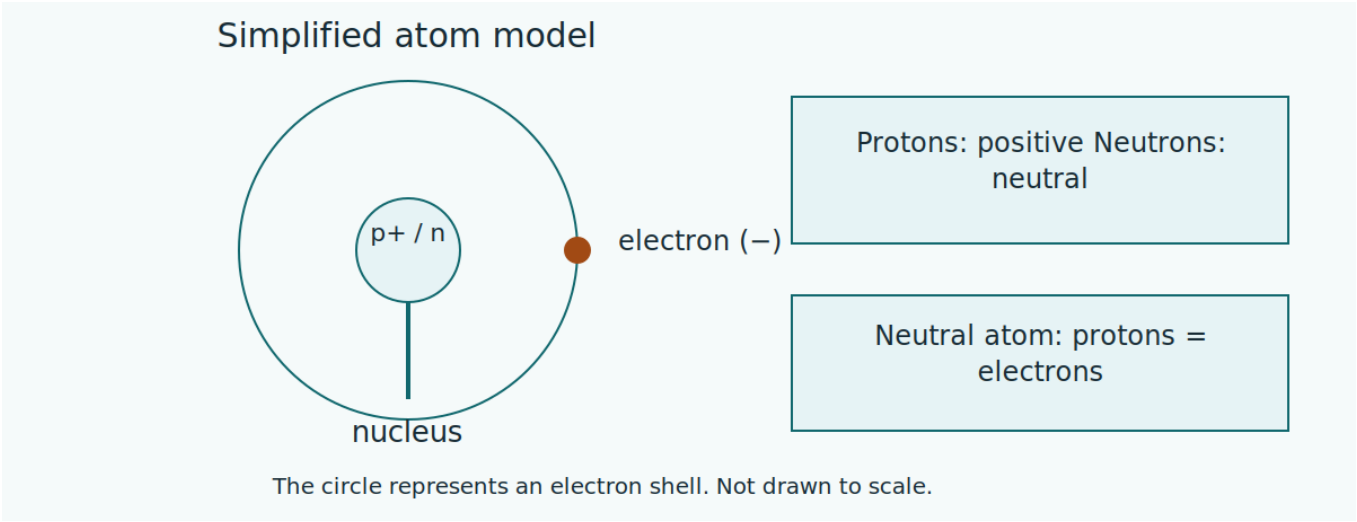
- The tiny nucleus is at the centre. It contains protons and usually neutrons.
- Electrons are found around the nucleus.
- Almost all the atom's mass is in the nucleus.

The particles inside an atom

> **Proton**
> A positively charged particle in the nucleus of an atom.
>
> **Neutron**
> A particle in the nucleus with no electrical charge.
>
> **Electron**
> A negatively charged particle found around the nucleus.

Protons and electrons have opposite charges. The table shows relative charges and masses.

Particle	Position	Charge	Relative mass
Proton	In the nucleus	+1	1
Neutron	In the nucleus	0	1
Electron	Around the nucleus	−1	About $^{1}/_{1836}$



The nucleus contains protons and neutrons; electrons are outside it. This is a simplified shell model, not drawn to scale.

Counting the particles

Atomic number identifies the element: every carbon atom has 6 protons.

- Atomic number = number of protons.
- Mass number = protons + neutrons.
- Neutral atom: electrons = protons, so their charges balance.
- Example: 6 protons and 6 neutrons give atomic number 6 and mass number 12. A neutral atom also has 6 electrons.

Elements

> **Element**
> A pure substance made of only one type of atom.

- Each element has a symbol: Cu is copper; O is oxygen.
- Atoms can join to form molecules. An O_2 molecule contains two oxygen atoms.
- O_2 is still an element because only one type of atom is present.

Compounds

> **Compound**
> A substance made of two or more different elements chemically joined in a fixed ratio.

A compound contains different elements chemically joined in a fixed ratio.

- Each water molecule, H_2O, has two hydrogen atoms and one oxygen atom.
- A compound has its own properties: hydrogen and oxygen are gases at room temperature, but water is a liquid.

• A chemical reaction is needed to separate a compound into simpler substances.

Mixtures

A mixture contains substances together without being chemically joined to each other.

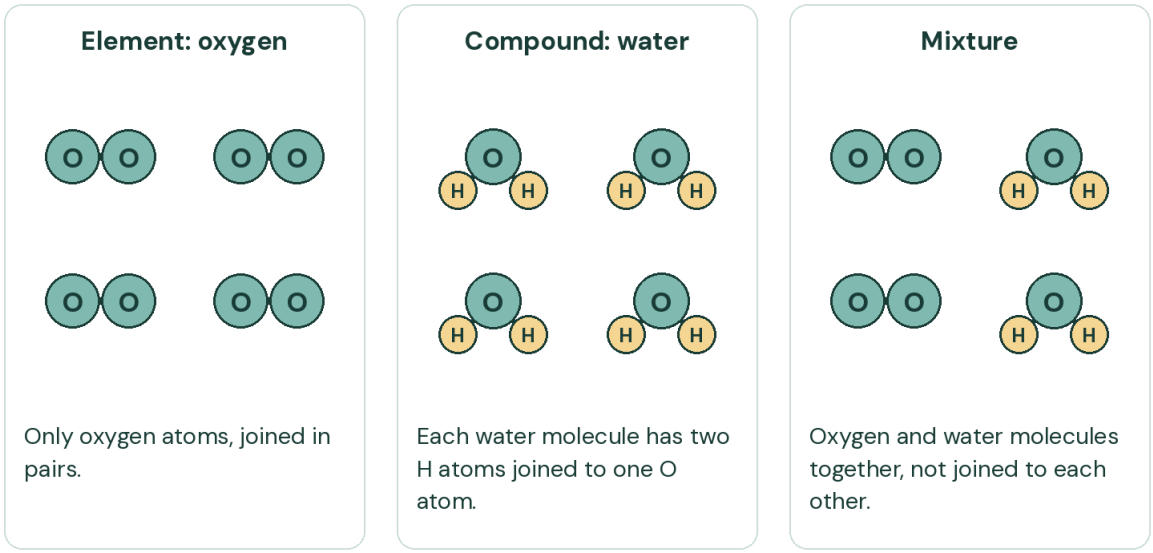
• Examples: air is a mixture of gases; salt water contains salt and water.

• The amounts can vary: salt water can contain a little salt or a lot.

• Mixtures can be separated by physical methods such as filtration, evaporation or distillation.

Type	What it contains	Example
Element	One type of atom.	Copper, Cu.
Compound	Different elements chemically joined in a fixed ratio.	Water, H_2O.
Mixture	Substances together without being chemically joined to each other.	Salt water.

Elements, compounds and mixtures



Circles represent atoms; lines show atoms joined within molecules. Models are not to scale.

An element contains one type of atom. A compound has different atoms joined in a fixed ratio. A mixture contains substances together without joining them to one another.

Metals and non-metals

Elements can be grouped as metals or non-metals.

• Metals usually conduct heat and electricity well and can be shaped without breaking.

• Many solid non-metals are brittle and poor electrical conductors.

• Exceptions: graphite conducts electricity; mercury is a metal that is liquid at room temperature.

- Copper is both an element and a metal.
- An alloy is a mixture containing a metal and other elements. Brass contains copper and zinc.

Worked examples

A neutral atom has 6 protons and 6 neutrons. Find its atomic number, mass number and number of electrons.

Work through it

1. Atomic number = number of protons = 6. The element is carbon.
2. Mass number = protons + neutrons = 6 + 6 = 12.
3. The atom is neutral, so electrons = protons = 6.

Another example

1. A sample contains copper atoms only, so it is an element.
2. Copper is also a metal because of its properties.
3. Brass contains copper and zinc, so it is a mixture rather than a pure element.

Common mistakes

Common mistake: Any molecule with more than one atom is a compound.

Remember: A compound needs different elements. O_2 contains only oxygen, so it is an element.

Common mistake: Mass number is the number of protons only.

Remember: Mass number = protons + neutrons. Atomic number = protons.

Answering questions

- In particle diagrams, count the types of atom and check which are joined before classifying the sample.
- For a neutral atom, calculate protons, neutrons and electrons separately. Use neutrons = mass number − atomic number.

Try an investigation

Sort particle diagrams into elements, compounds and mixtures. For each diagram, count the different types of atom and check whether they are joined. Compare metal and non-metal samples using a teacher-supervised low-voltage conductivity test.

Plan, record and review

- Question and prediction: What are you testing, and what do you think will happen? Give a reason.
- Change, measure, keep the same: What will you deliberately change? What will you measure, and in what units? What stays the same to make it a fair test? For an observation, say what you will record consistently instead.
- Record and look for a pattern: Use a table with headings and units. Look for a pattern or a result that does not fit.
- Conclude from evidence: Answer your question using a result or observation. Say if the evidence is unclear.
- Improve the investigation: What would you repeat or change, and how would that make the evidence better?

Do practical work with your teacher and follow the laboratory safety instructions.