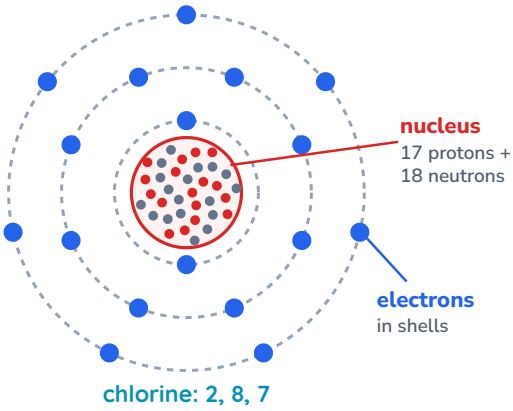
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# Atomic structure & isotopes

Learn with Fred
cheat sheet

The number of **protons** decides which element an atom is. **Isotopes** are the same element with a different number of **neutrons**.

## 1 Inside an atom




| Particle | Where | Charge | Relative mass |
|---|---|---|---|
| **proton** | nucleus | +1 | 1 |
| **neutron** | nucleus | 0 | 1 |
| **electron** | shells | −1 | very small |

An atom has a radius of about **0.1 nm**. The radius of the nucleus is less than 1/10,000 of that, yet it holds almost all the mass.

A neutral atom has **protons = electrons**, so the charges cancel.

## 2 Reading the symbol

$$^{35}_{17}\mathrm{Cl}$$

**Mass number** (top) = protons + neutrons. **Atomic number** (bottom) = protons.

1. **protons** = 17 (the atomic number)
2. **electrons** = 17 (same as protons)
3. **neutrons** = 35 − 17 = **18**

## 3 Electron shells

Fill from the inside out. For the first 20 elements:

| | | |
|---|---|---|
| **2** 1st shell | **8** 2nd shell | **8** 3rd shell |
| **2, 8, 1** sodium (11) | **2, 8, 7** chlorine (17) | **2, 8, 8, 2** calcium (20) |

✅ Check: the numbers add up to the **atomic number**.

## 4 Isotopes

**Same element, same protons, different neutrons**

| chlorine-35 | chlorine-37 |
|---|---|
| 17 protons · 18 neutrons · 17 electrons | 17 protons · 20 neutrons · 17 electrons |

**Same:** number of electrons, so the same chemical reactions

**Different:** mass number, so a slightly different mass

## 5 Relative atomic mass ($A_r$)

$$A_r = \frac{(\text{mass} \times \%) + (\text{mass} \times \%)}{100}$$

**Example: chlorine**

75% is chlorine-35, 25% is chlorine-37

**(35 × 75) + (37 × 25) = 3,550**

**3,550 ÷ 100 = 35.5**

It's an average, so it's often **not a whole number**.

## Watch out

- ✕ Mixing up the numbers. **Atomic number** is protons only; **mass number** is protons + neutrons (the bigger one).
- ✕ Saying isotopes react differently. Same electrons means **the same chemistry**.
- ✕ More than 2 electrons in the first shell, or more than 8 in the second.

## Exam tips

- Always **show the subtraction** for neutrons: 35 − 17 = 18.
- "Explain why isotopes react the same": say **same number of electrons**, and that reactions depend on electrons.
- Learn the particle table by heart: it is quick marks.

**Try it: how many neutrons are in sodium-23 (atomic number 11)?**

Check your answer with Fred: scan the code or go to **learnwithfred.co.uk/cs** to try Learn with Fred free.