The periodic table and formulae

How do we use the periodic table and read chemical formulae?

By the end of this topic

- Find an element's name, symbol and atomic number.
- Identify groups and periods on the periodic table.
- Count atoms in a chemical formula.
- Use ion charges to work out simple compound formulae.

Key terms & definitions

Atomic number – The number of protons in an atom's nucleus.

Mass number – The total number of protons and neutrons in one atom.

Group – A vertical column in the periodic table.

Period – A horizontal row in the periodic table.

Chemical formula – Symbols and small numbers that show which elements are present and their amounts.

Subscript – A small number after a symbol or bracket that tells you how many atoms or groups are represented.

Understand the idea

What is the periodic table?

The periodic table is a chart of the chemical elements.

- Each box shows an element's name, symbol and atomic number.
- Atomic number = number of protons.
- Elements are arranged by increasing atomic number: hydrogen has 1 proton; helium has 2.

Groups and periods

The position of an element helps us predict how it behaves.

- Group: a vertical column. Modern groups are numbered 1–18.
- Period: a horizontal row.
- Elements in the same group often have similar properties.
- Group 1 includes the reactive metals lithium, sodium and potassium.
- Group 18 contains the very unreactive noble gases.

Electrons and patterns

In a simple atom diagram, electrons are arranged in shells around the nucleus.

- For the first 20 elements: put up to 2 electrons in the first shell, 8 in the second and 8 in the third before starting the fourth.
- Sodium: 11 electrons arranged 2, 8, 1. Chlorine: 17 electrons arranged 2, 8, 7.
- Outer electrons help explain reactions. Group 1 has one; group 2 has two; group 17 has seven.
- Occupied shells give the period. Sodium has three occupied shells, so it is in period 3.

Reading a chemical formula

A chemical formula uses symbols to show which elements are present.

- A subscript is the small number after a symbol. It tells you how many atoms of that element are represented.
- No subscript means one.

Formula	How to read it
H_2O	Each water molecule has 2 hydrogen atoms and 1 oxygen atom.
CO_2	Each carbon dioxide molecule has 1 carbon atom and 2 oxygen atoms.
O_2	Each oxygen molecule has 2 oxygen atoms.

A number in front of a formula

A coefficient is the large number before a formula. It multiplies everything in the formula.

- $3H_2O$ means three water molecules.
- Hydrogen atoms: $3 \times 2 = 6$.
- Oxygen atoms: $3 \times 1 = 3$.
- The molecules are still water: the formula H_2O has not changed.

What do brackets mean?

A small number outside brackets applies to everything inside the brackets.

- $Ca(OH)_2$ contains two OH groups: 1 calcium, 2 oxygen and 2 hydrogen atoms per formula unit.
- $3Ca(OH)_2$ multiplies every count by 3: 3 calcium, 6 oxygen and 6 hydrogen.

Ions and simple compound formulae

An ion is an atom or group of atoms with an electrical charge.

- Losing electrons makes an atom positive. Gaining electrons makes it negative.

- In simple ionic compounds: group 1 metals form +1 ions; group 2 metals form +2 ions; group 17 forms −1 ions; group 16 forms −2 ions.
- An ionic compound has no overall charge: positive and negative charges balance.
- Na^+ and Cl^- balance in a 1:1 ratio, giving NaCl.
- One Mg^{2+} needs two Cl^- ions, giving $MgCl_2$. Ionic formulae show the simplest ratio of ions.

Ions	Ratio needed	Formula
Na^+ and Cl^-	1 sodium : 1 chloride	NaCl
Mg^{2+} and Cl^-	1 magnesium : 2 chloride	$MgCl_2$
Na^+ and O^{2-}	2 sodium : 1 oxide	Na_2O
Mg^{2+} and O^{2-}	1 magnesium : 1 oxide	MgO

Atomic number and mass number

Atomic number and mass number tell you different things about an atom.

- Atomic number counts protons. Mass number counts protons + neutrons.
- Example: 8 protons and 10 neutrons give atomic number 8 and mass number 18. The atom is oxygen.
- Isotopes are atoms of the same element with different numbers of neutrons.
- Relative atomic mass on a periodic table is an average for the isotopes. It can be a decimal.

Worked examples

How many calcium, oxygen and hydrogen atoms are represented by $3Ca(OH)_2$?

Work through it

1. Start with $Ca(OH)_2$. Ca has no subscript, so it represents 1 calcium atom.
2. The 2 outside the brackets means 2 oxygen atoms and 2 hydrogen atoms.
3. The 3 in front multiplies all three counts: calcium = 3, oxygen = 6, hydrogen = 6.

Another example

1. To find the formula of magnesium chloride, use Mg^{2+} and Cl^-.
2. One Mg^{2+} has charge +2. Two Cl^- ions have total charge −2.
3. The charges balance in a 1:2 ratio, so write $MgCl_2$.

Common mistakes

Common mistake: A group is a horizontal row.

Remember: A group is a vertical column; a period is a horizontal row.

Common mistake: $3H_2O$ contains only two hydrogen atoms.

Remember: The coefficient multiplies the whole formula: $3H_2O$ contains 6 hydrogen atoms and 3 oxygen atoms.

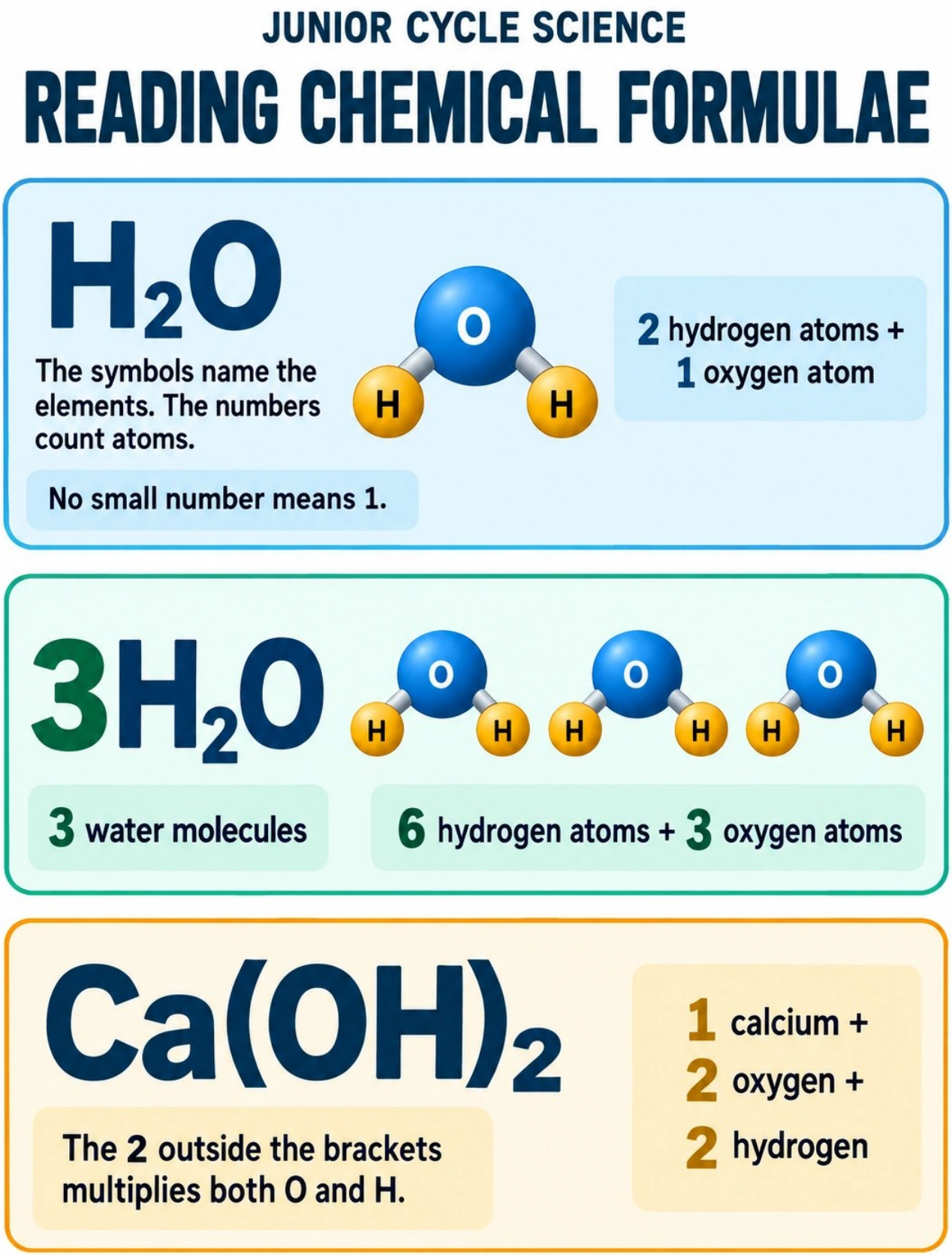
Answering questions

- When counting atoms, apply bracket subscripts first, then multiply every count by the coefficient.
- For a simple ionic formula, write the ion charges and choose the smallest whole-number ratio that balances them.

Try an investigation

Find sodium, magnesium and chlorine on a periodic table. Record each symbol, atomic number, group and period. Use coloured counters to represent atoms, then build the examples H_2O, CO_2 and $3H_2O$.

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

Open this topic online for videos, reference diagrams and practice.

Visual summary