

# Atoms, elements and compounds

5.1.1.1 · Chemistry · revision notes

The basic language of chemistry: atoms, elements and compounds, chemical symbols and formulae, and how to write word equations and balanced symbol equations. It is tested all through both papers, often as tick-box, 'name the compound' and 'balance the equation' questions.

## Key facts

- Atom: the smallest part of an element that can exist
- Compound: two or more elements chemically combined in fixed proportions
- ide: usually just the two elements named, e.g. NaCl sodium chloride (hydroxide,  $\text{OH}^-$ , is an exception)
- Balanced equation: same number of each type of atom on both sides
- Element: contains only one sort of atom
- A compound can only be separated into its elements by chemical reactions
- ate: oxygen is also present, e.g.  $\text{CaCO}_3$  calcium carbonate
- Elements made of two-atom molecules:  $\text{H}_2$ ,  $\text{N}_2$ ,  $\text{O}_2$ ,  $\text{F}_2$ ,  $\text{Cl}_2$ ,  $\text{Br}_2$ ,  $\text{I}_2$

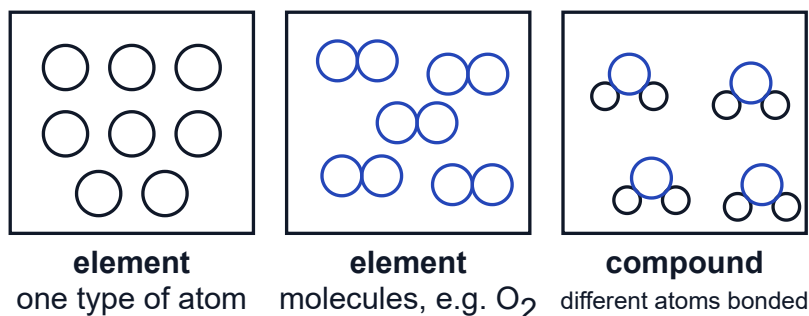
## Notes

### Atoms and elements

- All substances are made of **atoms**. An atom is the smallest part of an element that can exist.
- An **element** contains only one sort of atom. There are about 100 different elements, all listed in the periodic table.
- Each element has a **chemical symbol**: one capital letter, sometimes followed by one lower-case letter, e.g. C (carbon), Cl (chlorine), Cu (copper).
- Some elements exist as molecules of two atoms, e.g.  $\text{H}_2$ ,  $\text{N}_2$ ,  $\text{O}_2$  and  $\text{Cl}_2$ . They are still elements, because all the atoms are the same.

## Compounds

- A **compound** contains two or more elements **chemically combined in fixed proportions**. Water is always  $\text{H}_2\text{O}$ : two hydrogen atoms for every oxygen atom.



Each circle is an atom. A compound has two or more different atoms chemically combined.

- Compounds are made from elements by **chemical reactions**. A reaction always makes at least one new substance and often has an energy change you can detect, e.g. the mixture gets hot.
- A compound can only be separated into its elements by another chemical reaction, not by physical processes such as filtering or distilling.
- Naming: a metal with one non-metal ends in **-ide** ( $\text{MgO}$ , magnesium oxide). An ending of **-ate** means oxygen is also present ( $\text{CuSO}_4$ , copper sulfate;  $\text{KNO}_3$ , potassium nitrate).

## Formulae and equations

- A formula shows which elements are in a substance and the ratio of their atoms. In  $2\text{H}_2\text{O}$  the large 2 means two molecules; the small 2 means two H atoms in each molecule.
- Everything inside brackets is multiplied by the number after them:  $\text{Ca}(\text{OH})_2$  contains 1 Ca, 2 O and 2 H.
- A **word equation** names the reactants and products: magnesium + oxygen  $\rightarrow$  magnesium oxide.
- A **balanced symbol equation** has the same number of atoms of each element on both sides, because atoms are not made or destroyed in a reaction:  $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ .



Balanced:  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ . The atoms are rearranged, not made or destroyed.

- To balance, change only the large numbers in front of formulae. Never change a small number in a formula: that would make it a different substance.

## How to answer each type of question

### Identify elements and compounds, and explain why

1 to 2 marks

Grade 3

1. Element: only one type of atom (single atoms, or molecules such as  $O_2$ ).
2. Compound: two or more different types of atom bonded together.
3. To explain 'why it is a compound', give both ideas: different elements, and chemically combined.

**Example.** The formulae of four substances are:  $N_2$ ,  $NaF$ ,  $Fe$ ,  $SO_2$

- (a) Give the formulae of the **two** elements.  
(b)  $SO_2$  is a compound. Explain why.

**Model answer.** (a)  $N_2$  and  $Fe$  (1) (both needed)

(b) It contains two different elements, sulfur and oxygen (1), which are chemically combined / bonded together (1).

### Name a compound or write a word equation

1 mark

Grade 4

1. Name the metal first, unchanged.
2. Change the non-metal ending to -ide, or use the -ate name for a group containing oxygen (sulfate, carbonate, nitrate).
3. In a word equation, use an arrow ( $\rightarrow$ ), never an equals sign.

**Example.** (a) Potassium reacts with bromine to form potassium bromide. Write a word equation for the reaction.

(b) Name the compound with the formula  $MgSO_4$ .

**Model answer.** (a) potassium + bromine  $\rightarrow$  potassium bromide (1)

(b) magnesium sulfate (1)

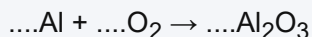
### Balance a symbol equation

1 mark

Grade 5

1. Count the atoms of each element on each side.
2. Balance one element at a time, starting with one that appears in only one substance on each side.
3. Leave elements that are on their own (e.g.  $O_2$ ) until last.
4. Recount every element at the end.

**Example.** Balance the equation for the reaction of aluminium with oxygen.



**Model answer.**  $4Al + 3O_2 \rightarrow 2Al_2O_3$  (1)

Check: Al 4 on each side; O 6 on each side.

## Don't lose marks

- ✗ Changing the small numbers in a formula (e.g. writing  $\text{H}_2\text{O}_2$  for water) to balance an equation. This changes the substance.
- ✗ Naming  $\text{NaCl}$  'sodium chlorine'. The compound is sodium chloride.
- ✗ Saying a compound contains elements that are 'mixed'. They are chemically combined (bonded).
- ✗ Wrong capital letters:  $\text{CO}$  (carbon monoxide) and  $\text{Co}$  (cobalt) are different substances.
- ✗ Using  $=$  instead of  $\rightarrow$  in an equation.

## More tips

### Memory tricks

- Symbols: one capital letter, then at most one lower-case letter.  $\text{Co}$  is cobalt;  $\text{CO}$  is carbon monoxide.
- Two-atom elements: 'HON plus the halogens':  $\text{H}_2$ ,  $\text{O}_2$ ,  $\text{N}_2$  and all of Group 7 ( $\text{F}_2$ ,  $\text{Cl}_2$ ,  $\text{Br}_2$ ,  $\text{I}_2$ ).
- When balancing, write a tally of each element under both sides and update it every time you change a number.

### Exam technique

- To explain why a substance is a compound, use both key phrases: 'two or more different elements' and 'chemically combined'.
- Copy formulae from the question exactly as they are printed; don't change them to make balancing easier.
- Balancing questions are usually 1 mark for the whole equation, so check every element before you move on.

## What each grade needs

What you need to be able to do, from the first marks up to the top grade.

### Grade 3

#### Tell elements from compounds using formulae

An element's formula has one symbol ( $\text{Fe}$ ,  $\text{O}_2$ ); a compound's formula has two or more different symbols ( $\text{CO}_2$ ,  $\text{NaCl}$ ).

### Grade 3

#### Recall symbols of the first 20 elements

Also the Group 1 and Group 7 elements and others in the course, with the correct capital and lower-case letters.

### Grade 4

#### Name compounds from their formulae

A metal with a non-metal ends in -ide ( $\text{NaCl}$ , sodium chloride); -ate means oxygen is also present ( $\text{CaCO}_3$ , calcium carbonate).

### Grade 4

#### Count the atoms in a formula

In  $\text{Ca}(\text{OH})_2$  the 2 multiplies everything in the brackets: 1  $\text{Ca}$ , 2  $\text{O}$  and 2  $\text{H}$ , so 5 atoms.

### Grade 5

#### Write word equations for reactions

Reactants on the left, products on the right, joined by an arrow, e.g. magnesium + oxygen  $\rightarrow$  magnesium oxide.

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