Neutralisation and salt production

4.4.2.2 · Chemical changes · revision notes

How acids are neutralised by alkalis, bases and metal carbonates to make salts, and how to work out the name and formula of the salt. Questions ask you to predict products, complete word and symbol equations, and work out formulae from ion charges.

Key facts

- acid + alkali → salt + water
- acid + metal carbonate → salt + water + carbon dioxide
- Alkali = a base that dissolves in water (e.g. NaOH, KOH)
- Carbon dioxide test: limewater turns milky
- acid + metal oxide or metal hydroxide → salt + water
- HCl → chlorides; HNO_3 → nitrates; H_2SO_4 → sulfates
- Ions: NO_3^-, SO_4^{2-}, CO_3^{2-}, OH^-, Cl^-

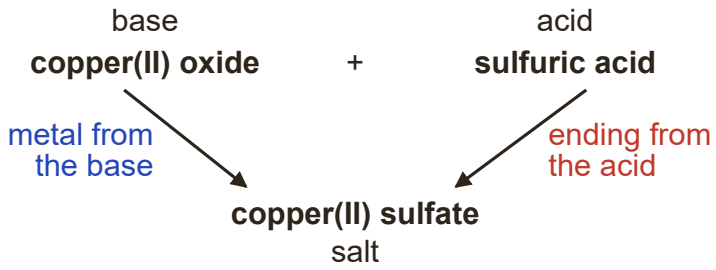
Notes

What neutralises an acid

- **Alkalis** are soluble bases, e.g. soluble metal hydroxides such as sodium hydroxide and potassium hydroxide.
- **Bases** include insoluble metal hydroxides, e.g. copper(II) hydroxide, and metal oxides, e.g. copper(II) oxide.
- acid + alkali → salt + water
- acid + base (metal oxide or metal hydroxide) → salt + water
- acid + metal carbonate → salt + water + carbon dioxide. You see fizzing. Carbon dioxide turns limewater milky (cloudy).

Naming the salt

- The first part of the name comes from the **positive ion** (the metal) in the base, alkali or carbonate.
- The second part comes from the **acid**: hydrochloric acid → **chloride**; nitric acid → **nitrate**; sulfuric acid → **sulfate**.



hydrochloric → chloride nitric → nitrate sulfuric → sulfate

First name from the metal; second name from the acid.

- Examples: copper(II) oxide + sulfuric acid → copper(II) sulfate + water; potassium hydroxide + nitric acid → potassium nitrate + water.

Formulae and equations

- Learn these ions: Cl^-, NO_3^-, SO_4^{2-}, OH^-, CO_3^{2-}, O^{2-}, Na^+, K^+, Mg^{2+}, Ca^{2+}, Cu^{2+}, Zn^{2+}, Al^{3+}.
- Balance the charges so the total is zero: NaCl, $MgCl_2$, Na_2SO_4, $CuSO_4$.
- Use brackets when you need more than one of an ion made of several atoms: $Ca(NO_3)_2$, $Al_2(SO_4)_3$.
- $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$
- $ZnO + 2HNO_3 \rightarrow Zn(NO_3)_2 + H_2O$
- $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

How to answer each type of question

Name the salt and predict the products

1 to 4 marks | **Grade 4**

1. Metal part of the name from the base, alkali or carbonate.
2. Ending from the acid: chloride, nitrate or sulfate.
3. Add water, and carbon dioxide too if a carbonate reacts.

Example. (a) Name the salt formed when potassium hydroxide reacts with nitric acid.
(b) Name the salt formed when zinc carbonate reacts with sulfuric acid.
(c) Name the other two products of the reaction in (b).

Model answer.

(a) potassium nitrate (1)
(b) zinc sulfate (1)
(c) water (1) and carbon dioxide (1)

Write the formula of a salt from its ions

1 mark each | Grade 5

1. Write the two ions with their charges.
2. Find how many of each ion make the total charge zero.
3. Put brackets round an ion of several atoms if you need more than one of it.

Example. Write the formula of:
(a) calcium chloride (Ca^{2+}, Cl^{-})
(b) aluminium sulfate (Al^{3+}, SO_4^{2-})
(c) magnesium nitrate (Mg^{2+}, NO_3^{-})

Model answer.

(a) $CaCl_2$ (1)
(b) $Al_2(SO_4)_3$ (1)
(c) $Mg(NO_3)_2$ (1)

Write a balanced symbol equation for a neutralisation

2 marks | Grade 7

1. Write the correct formula for every reactant and product.
2. Balance the metal and the acid's negative ion first, then hydrogen and oxygen.
3. Count every atom on both sides.

Example. Magnesium carbonate reacts with dilute nitric acid.
Write a balanced symbol equation for this reaction.

Model answer.

Correct formulae: $MgCO_3 + HNO_3 \rightarrow Mg(NO_3)_2 + H_2O + CO_2$ (1)
Balanced: $MgCO_3 + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2O + CO_2$ (1)

Don’t lose marks

- Leaving out carbon dioxide or water when a carbonate reacts.
- Missing brackets, e.g. writing $CaNO_{32}$ instead of $Ca(NO_3)_2$.
- Calling every base an alkali: only bases that dissolve in water are alkalis.
- Giving hydrogen as a product of an acid and a base: hydrogen only forms when an acid reacts with a metal.

More tips

Memory tricks

- Carbonate in, carbon dioxide out: any carbonate reacting with an acid fizzes and gives CO_2.
- Water is a product whenever an acid is neutralised by an alkali, a base or a carbonate.
- Formula check: add up the charges; they must come to zero.

Exam technique

- 'Predict the products' means all the products, including water and carbon dioxide.
- If the question gives you a formula, copy it exactly into your equation.
- Decide the ending of the salt name from the acid first, then add the metal.

What each grade needs

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

Grade 3 — **Name the salt type from each acid**
Hydrochloric acid gives chlorides, nitric acid gives nitrates and sulfuric acid gives sulfates.

Grade 4 — **Predict products of acid with base or alkali**
acid + metal oxide or metal hydroxide → salt + water.

Grade 4 — **Predict products of acid with a carbonate**
acid + metal carbonate → salt + water + carbon dioxide.

Grade 5 — **Tell the difference between bases and alkalis**
A base neutralises an acid; an alkali is a base that dissolves in water, such as a soluble metal hydroxide.

Grade 5 — **Work out salt formulae from ion charges**
Balance the charges so they add to zero, e.g. Ca^{2+} and NO_3^- give $Ca(NO_3)_2$.

Grade 7 — **Write balanced equations for neutralisation reactions**
For example, $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$.

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