

State symbols

4.2.2.2 · Bonding, structure and the properties of matter · revision notes

The four state symbols, (s), (l), (g) and (aq), and how to add them to equations. They are usually worth 1 or 2 marks in equation questions anywhere on either paper, and you should include them whenever a question asks for them.

Key facts

- (s) solid (l) liquid (g) gas (aq) aqueous = dissolved in water
- Dilute acids and alkalis: (aq)
- Molten substance: (l)
- Water made in a reaction: $\text{H}_2\text{O}(\text{l})$
- Metals and insoluble compounds: (s); a precipitate is (s)
- Neutralisation: $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$

Notes

The four state symbols

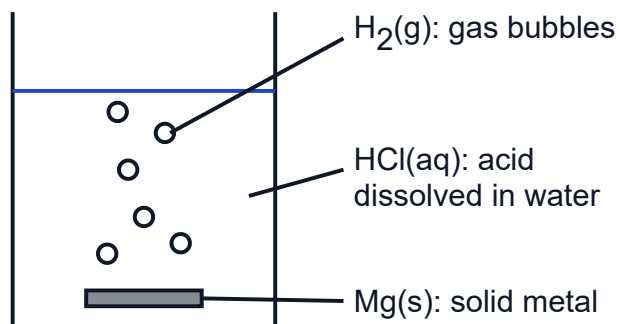
- **(s)** solid
- **(l)** liquid: a pure liquid or a molten (melted) substance
- **(g)** gas
- **(aq)** aqueous: dissolved in water (a solution in water)
- Write the symbol in brackets straight after the formula, e.g. $\text{CO}_2(\text{g})$, and give one to every reactant and product.

Choosing the right symbol

- Metals, and oxides and carbonates added as powders or lumps, are solids: $\text{Mg}(\text{s})$, $\text{CuO}(\text{s})$, $\text{CaCO}_3(\text{s})$.
- Acids and alkalis used in the lab are solutions: $\text{HCl}(\text{aq})$, $\text{H}_2\text{SO}_4(\text{aq})$, $\text{NaOH}(\text{aq})$.
- Water made in a reaction is **(l)**, never (aq): water cannot be dissolved in itself.
- Gases given off, e.g. $\text{H}_2(\text{g})$, $\text{O}_2(\text{g})$, $\text{CO}_2(\text{g})$, $\text{Cl}_2(\text{g})$.
- A **precipitate** (an insoluble solid that forms when solutions are mixed) is (s). A soluble salt that stays dissolved is (aq).
- A molten ionic compound is (l), e.g. molten lead bromide is $\text{PbBr}_2(\text{l})$.
- If you are given melting and boiling points, use them to decide the state at the temperature of the reaction.

Examples

- $\text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$



- $\text{CaCO}_3\text{(s)} \rightarrow \text{CaO(s)} + \text{CO}_2\text{(g)}$
- $2\text{Na(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{NaOH(aq)} + \text{H}_2\text{(g)}$
- $\text{HCl(aq)} + \text{NaOH(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)}$
- Ionic equations use them too: $\text{H}^+\text{(aq)} + \text{OH}^-\text{(aq)} \rightarrow \text{H}_2\text{O(l)}$

How to answer each type of question

Give the meaning of a state symbol

1 mark

Grade 3

- (s) solid, (l) liquid, (g) gas.
- For (aq), explain it: 'dissolved in water'.

Example. $\text{NaOH(aq)} + \text{HCl(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)}$

What does the state symbol (aq) mean?

Model answer. Dissolved in water / in aqueous solution (1)

Add state symbols to an equation

1 to 2 marks

Grade 5

1. Go through the formulae one at a time.
2. Ask: is it a solid, a pure liquid, a gas, or dissolved in water?
3. Use clues in the question: 'solution', 'bubbles', 'precipitate', 'molten'.
4. Check that water on its own is (l).

Example. Zinc reacts with dilute sulfuric acid. The zinc sulfate formed stays dissolved and bubbles of hydrogen are given off.

Complete the equation by adding state symbols.



Model answer. $\text{Zn}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{H}_2(\text{g})$

All four correct (2); two or three correct (1)

Don't lose marks

- ✗ Writing $\text{H}_2\text{O}(\text{aq})$. Water is (l).
- ✗ Using (l) for a solution, e.g. $\text{HCl}(\text{l})$ for hydrochloric acid. Hydrochloric acid is a solution, so it is (aq); (l) is only for pure liquids and molten substances.
- ✗ Giving a precipitate (aq). A solid that forms in a solution is (s).
- ✗ Leaving out state symbols when the question asks for them: you can lose the mark even if the equation is balanced.

More tips

Memory tricks

- Aq sounds like aqua (water): aqueous means dissolved in water.
- Bubbles or fizzing → a (g) product. Precipitate → (s). Solution → (aq).
- Water is (l) in these equations, not (aq).

Exam technique

- Add state symbols whenever a question asks for them, and check each one against the information given.
- Read the question for clues about states: 'molten', 'solution', 'gas given off', 'white precipitate'.
- Write the symbols in lower case, in round brackets, straight after each formula.

What each grade needs

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

Grade 3

Recall the four state symbols

(s) solid, (l) liquid, (g) gas, (aq) aqueous: dissolved in water.

Grade 4

Know that aqueous means dissolved in water

Any solution in water, such as sodium chloride solution or dilute hydrochloric acid, is (aq).

For example, $\text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$.

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