

Fuel cells

4.5.2.2 · Energy changes · revision notes

Chemistry only (not in Combined Science). A fuel cell produces electricity from a fuel, such as hydrogen, and oxygen that are supplied from outside the cell. You need the overall reaction in a hydrogen fuel cell, and to evaluate hydrogen fuel cells compared with rechargeable cells and batteries.

Key facts

- Fuel cell: fuel and oxygen supplied from outside; the fuel is oxidised electrochemically to produce a potential difference
- Only product: water
- Hydrogen fuel cell overall: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
- Fuel cell: refuelled. Battery: recharged.

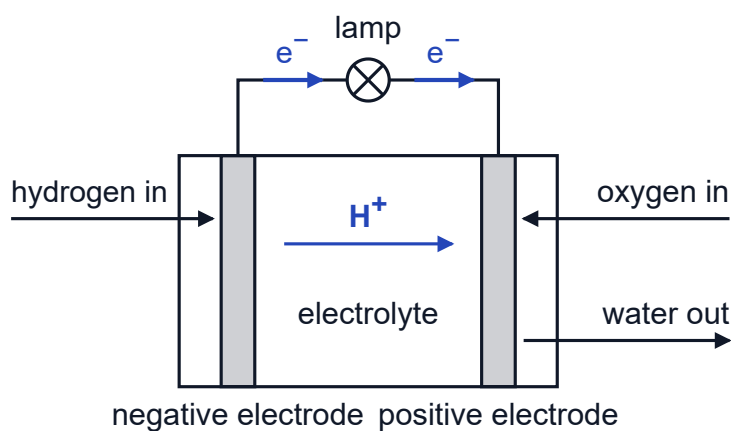
Notes

What a fuel cell is

- A **fuel cell** is supplied with a fuel (e.g. hydrogen) and oxygen or air from an external source.
- The fuel is **oxidised electrochemically** inside the cell to produce a **potential difference**. The fuel does not burn.
- A fuel cell keeps producing electricity for as long as fuel and oxygen are supplied. It is refuelled, not recharged.

The hydrogen fuel cell

- The overall reaction is the oxidation of hydrogen to produce water:
 $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$



Hydrogen and oxygen go in, water comes out, and electrons flow round the external circuit.

- Water is the only product, so the fuel cell releases no carbon dioxide or other pollutants while it is working.

Fuel cells compared with rechargeable batteries

- Hydrogen fuel cells are a possible alternative to rechargeable cells and batteries, for example in vehicles.
- For fuel cells: they are refuelled in a few minutes and keep working as long as fuel is supplied.
- Against fuel cells: hydrogen is a gas, so it takes up a large volume and is stored under high pressure; it is flammable (explosive when mixed with air); there are few filling stations; and it is often made using fossil fuels.
- For batteries: they can be recharged from the mains. Against batteries: recharging takes a long time, they can only be recharged a limited number of times, they are difficult to dispose of, and the electricity may come from fossil fuels.
- Neither releases carbon dioxide while it is being used, so 'no carbon dioxide' is not a difference between them.

How to answer each type of question

Recall: what goes in and what comes out

1 to 4 marks

Grade 4

1. Inputs: hydrogen and oxygen (or air).
2. Output: water only (and electricity).
3. For the balanced equation, check there are 4 H atoms and 2 O atoms on each side.

Example. (a) Name the **two** substances supplied to a hydrogen fuel cell. (2)
(b) Write a balanced symbol equation for the overall reaction in a hydrogen fuel cell. (2)

Model answer. (a) hydrogen (1); oxygen or air (1)
(b) correct formulae: $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$ (1); balanced: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ (1)

Don't lose marks

- ✗ Saying a fuel cell burns hydrogen. The hydrogen is oxidised electrochemically; there is no combustion.
- ✗ Saying hydrogen fuel cells produce 'no waste' or 'nothing'. They produce water.
- ✗ Saying hydrogen fuel cells cause no pollution at all. Making the hydrogen, or the electricity used to make it, often uses fossil fuels.
- ✗ Giving 'no carbon dioxide' as an advantage over batteries. Battery vehicles release no carbon dioxide while in use either.

More tips

Memory tricks

- Fuel cell = refuel; battery = recharge.
- The overall equation is the same as for burning hydrogen, but in a fuel cell there is no flame: the reaction produces a potential difference.

Exam technique

- In 'evaluate' questions, check what the fuel cell is compared with. 'Only water is produced' is a strong point against petrol engines, not against batteries.
- Use numbers from the table for both sides, add your own knowledge, and finish with a conclusion that follows from your points.
- Use the key phrase: the fuel is 'oxidised electrochemically' to produce a potential difference.

What each grade needs

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

Grade 3

Name what a hydrogen fuel cell uses

Hydrogen (the fuel) and oxygen or air are supplied to the cell from outside.

Grade 4

State the product of a hydrogen fuel cell

The only product is water: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$.

Grade 5

Describe how fuel cells produce a potential difference

The fuel is oxidised electrochemically inside the cell, which produces a potential difference.

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