

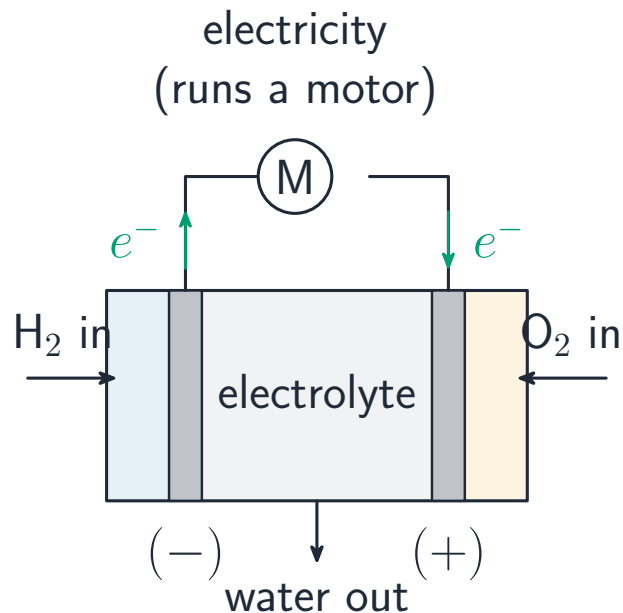
Exercise walk-through

4.2

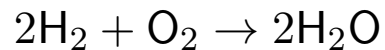
Hydrogen–oxygen fuel cells

IGCSE Chemistry

Hydrogen–oxygen fuel cells



A **fuel cell** makes electricity directly; the only product is water.



Clean, but hydrogen is hard to store safely.

Fuel cell against petrol engine

main product

fuel cell: **water only**. Engine: carbon dioxide and **pollutants**

effect on air

fuel cell: **clean**. Engine: adds to air pollution

efficiency

fuel cell converts chemical energy to electricity **efficiently**; the engine loses much of it as heat

fuel storage

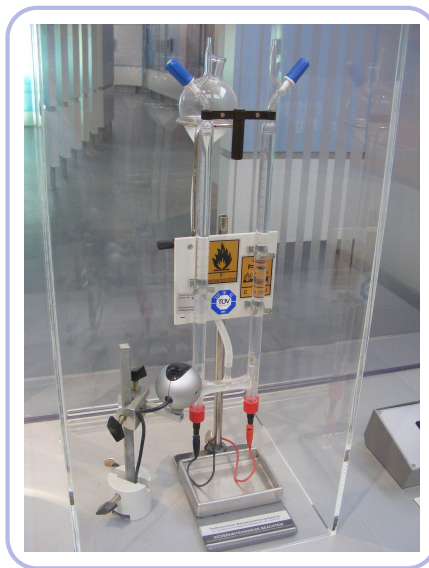
hydrogen is **hard and dangerous** to store – flammable, and needs high pressure. Petrol is easy

the source

hydrogen **may be made using fossil fuels**; petrol is made from crude oil

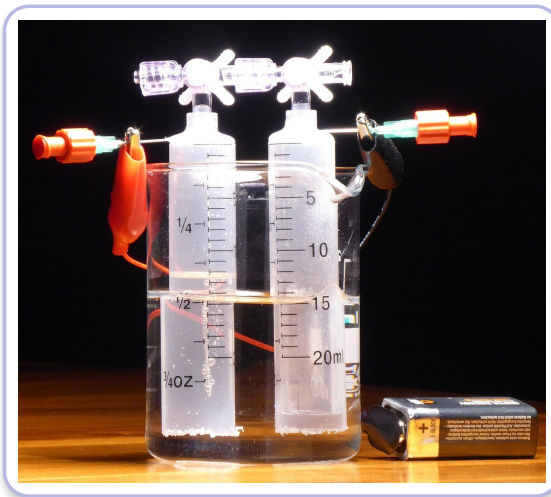
The fuel cell is clean *at the vehicle*. Whether it is clean overall depends entirely on how the hydrogen was made – and that is the evaluation mark.

Electrolysis



The set-up is an **electrolytic cell** : two **electrodes** dipping into the **electrolyte** – the molten or aqueous substance being broken up. The electrodes are usually **inert** , **platinum** or **graphite** , so they take no part in the reaction.

Electrolysis, continued



Electrolysis of water: gas bubbles off at each electrode and collects in the tubes above, with about twice as much hydrogen as oxygen

Exam tips

- At the **cathode** (negative) you get a metal or hydrogen; at the **anode** (positive) you get a non-metal. Positive ions move to the cathode, negative ions to the anode.
- A **molten** compound just gives its two elements. An **aqueous** solution can give something different (concentrated sodium chloride gives hydrogen and chlorine, not sodium).
- **Reduction** is *gain* of electrons (at the cathode); **oxidation** is *loss* of electrons (at the anode). Remember OIL RIG.
- In a **half-equation** the atoms and the charges must balance, with the electrons on the correct side: $\text{Pb}^{2+} + 2e^- \rightarrow \text{Pb}$ (cathode).
- To **electroplate** an object, make it the cathode, make the plating metal the anode, and use a solution containing ions of the plating metal.

Exercises 2.1·2.2

2.1 A hydrogen–oxygen fuel cell takes in 4 g of hydrogen. Write the overall equation for the cell, and state the only product. [2]

2.2 State the only chemical product of the fuel cell. [1]

Exercises 2.1·2.2

2.1 A hydrogen–oxygen fuel cell takes in 4 g of hydrogen. Write the overall equation for the cell, and state the only product. [2]

2.1

- overall: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
 - the only product is **water**, so the cell releases no carbon dioxide
-

2.2 State the only chemical product of the fuel cell. [1]

2.2

- the only chemical product is **water**

Exercise 3.1

3.1 A key advantage of a hydrogen fuel cell over a petrol engine is that it: [1]

☐

A is easier to refuel

B produces only water, not pollutants

C uses no energy

D stores its fuel more easily

Exercise 3.1

3.1 A key advantage of a hydrogen fuel cell over a petrol engine is that it: [1]

☐

A is easier to refuel

B produces only water, not pollutants

C uses no energy

D stores its fuel more easily

3.1 B

- it produces **only water, not pollutants**
- A and D are disadvantages; C is false

Exercise 3.2 (a)

3.2 Compare a hydrogen–oxygen fuel cell with a petrol engine.

(a) Give one advantage of the fuel cell.

[1]

Exercise 3.2 (a)

3.2 Compare a hydrogen–oxygen fuel cell with a petrol engine.

(a) Give one advantage of the fuel cell.

[1]

(a)

- the only product is water, so it **does not pollute the air**

Exercise 3.2 (b)

3.2 Compare a hydrogen–oxygen fuel cell with a petrol engine.

(b) Give one disadvantage of the fuel cell.

[1]

Exercise 3.2 (b)

3.2 Compare a hydrogen–oxygen fuel cell with a petrol engine.

(b) Give one disadvantage of the fuel cell.

[1]

(b)

- hydrogen is **hard/dangerous to store and transport**

Exercise 3.3

3.3 Explain why using a hydrogen fuel cell may still cause some pollution overall. [2]

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3.3

- hydrogen is often made using energy from **fossil fuels**
- burning those fuels releases **pollutants / CO₂ elsewhere**