
ADVERTISING
Sale
up to
20% off

Learning objectives

- understand electrochemical cells as a source of energy, including the constituents of commercial cells

- understand the processes of charging and discharging cells

Success criteria

- present the possible advantages of charging/discharging cells
- present the possible disadvantages of discharging/charging cells.
- present the possible improvement of batteries (as in electric vehicles) in terms of smaller size, lower mass and higher voltage

Students can present in free form

Keep 7 key criteria of a great advertisment:

- design matters
- simplicity is key
- reward your target
- benefit focus
- drama
- visualize the benefit
- clear reinforcement of your place promise

FUEL CELLS

Learning objectives

- understand the construction and operation of a hydrogen-oxygen fuel cell
- understand the benefits and potential risks of fuel cells

How does a fuel cell work?

- Hydrogen is a non-polluting fuel.
- When it burns in oxygen, water is the only product formed.
- We can use this reaction to supply electrical energy continuously.
- We do this by reaction hydrogen and oxygen in a **fuel cell**.
- A fuel cell consists of two platinum electrodes and an electrolyte.
- The platinum (Pt) is coated onto a porous material that allows gases to pass through it.
- Hydrogen gas and oxygen gas are bubbled through the porous electrodes where the reaction take place.
- Hydrogen gas is bubbled through the negative electrode and oxygen is bubbled through the positive electrode.
- There are two main types of fuel cell.
- One contains an acidic electrolyte, the other contains an alkaline electrolyte such as a concentrated solution of sodium hydroxide.

- At the negative electrode the hydrogen loses electrons and forms hydrogen ions (protons) in the electrolyte:

$$2H_{2(g)} \rightarrow 4H^{+}_{(aq)} + 4e^{-}$$

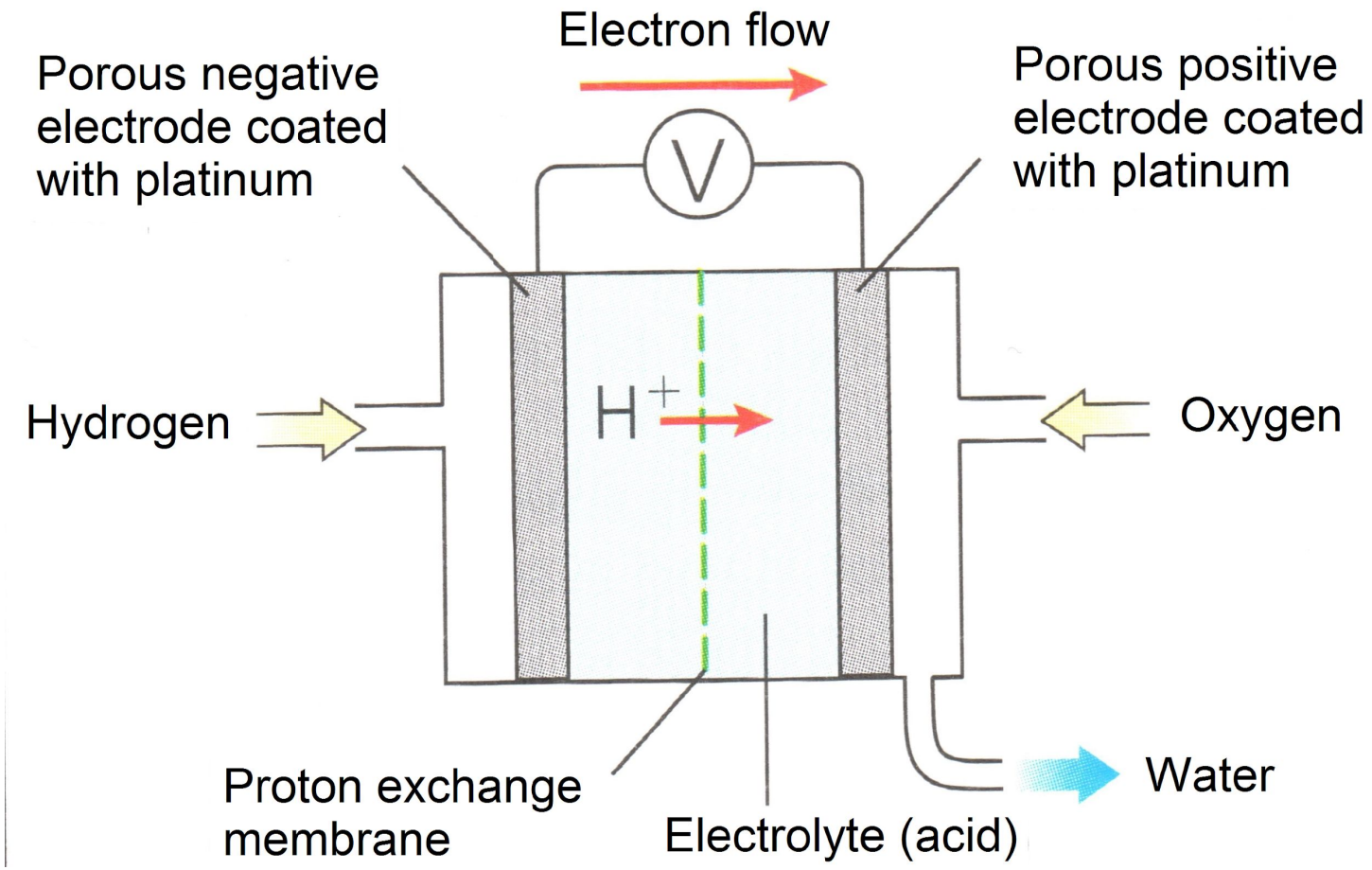
- The released electrons move around the external circuit to the positive electrode.
- At the positive electrode oxygen gains electrons and reacts with hydrogen ions from the acidic electrolyte:

$$O_{2(g)} + 4H^{+}_{(aq)} + 4e^{-} \rightarrow 2H_2O_{(l)}$$

- The hydrogen ions removed at the positive electrode are replaced by those produced at the negative electrode.
- The concentration of the electrolyte remains constant.
- The overall reaction is:

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$$

Acidic electrolyte



Alkaline electrolyte:

- At the negative electrode the hydrogen reacts with the hydroxide ions in the electrolyte and forms water:

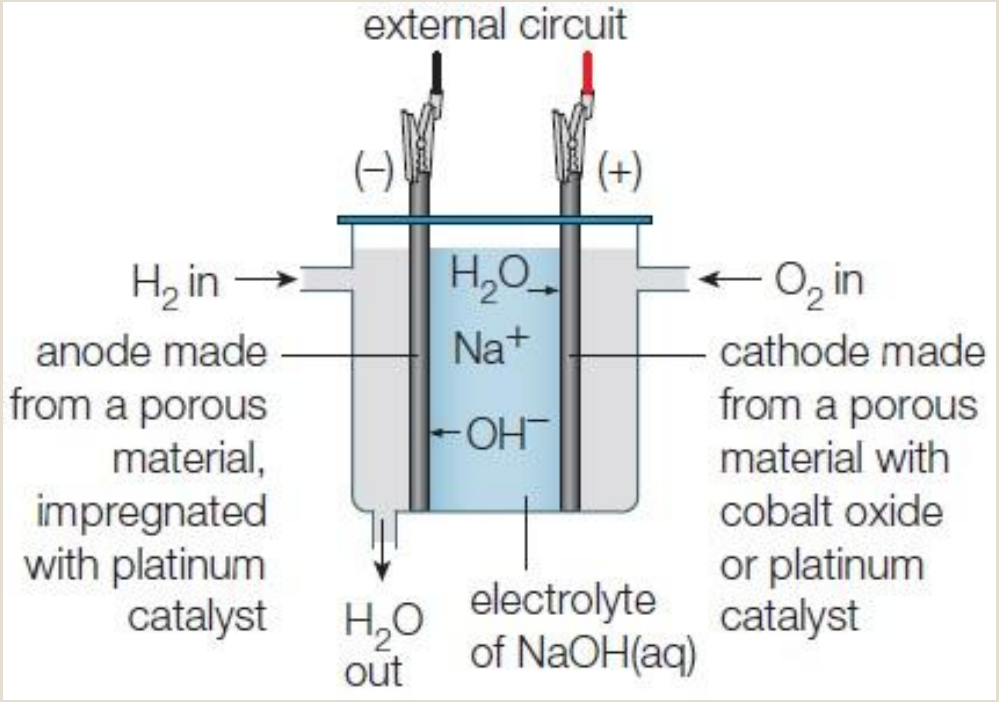
$$2H_{2(g)} + 4OH^-_{(aq)} \rightarrow 4H_2O_{(l)} + 4e^-$$

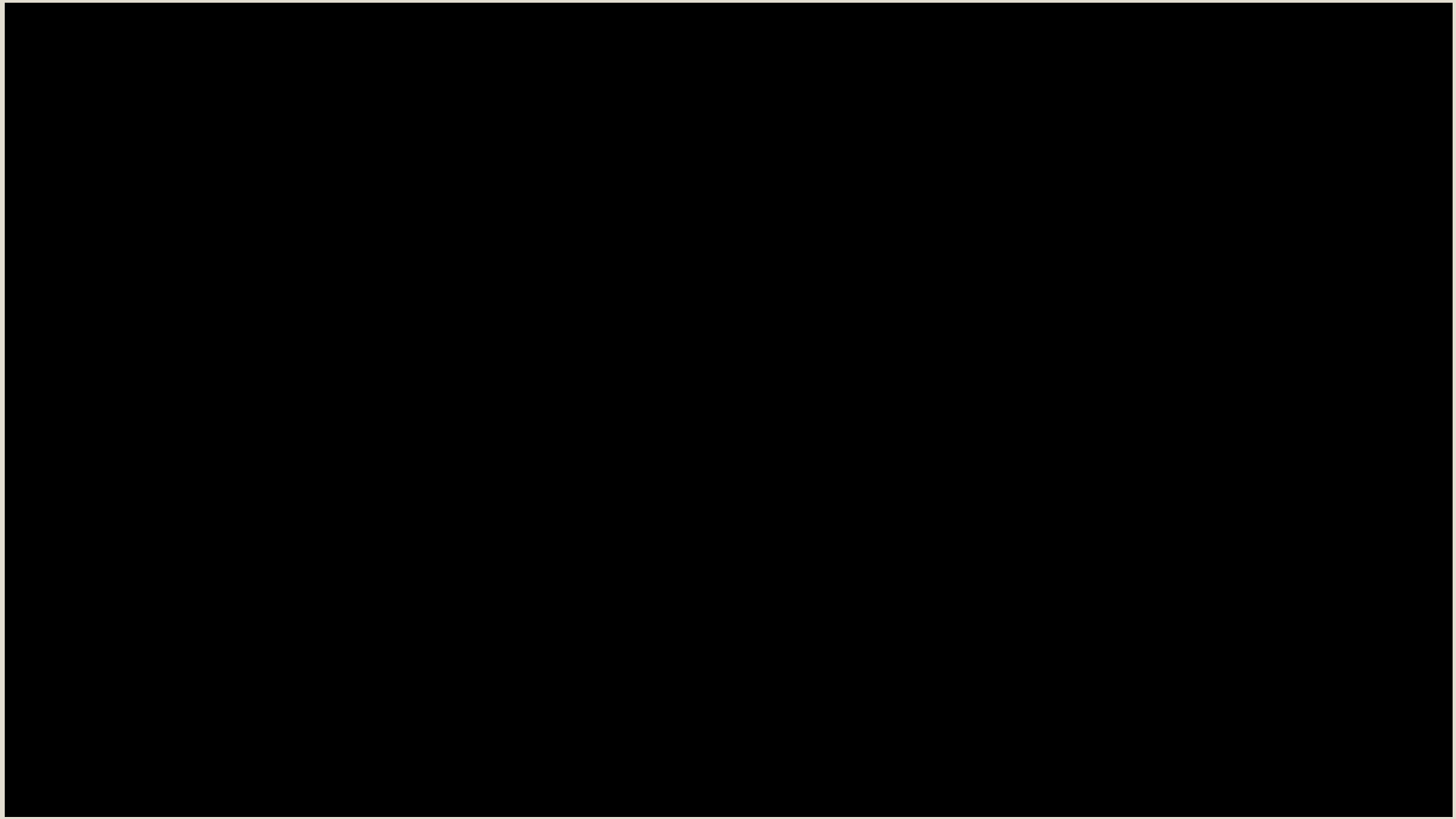
- At the positive electrode oxygen gains electrons and reacts with water to form hydroxide ions:

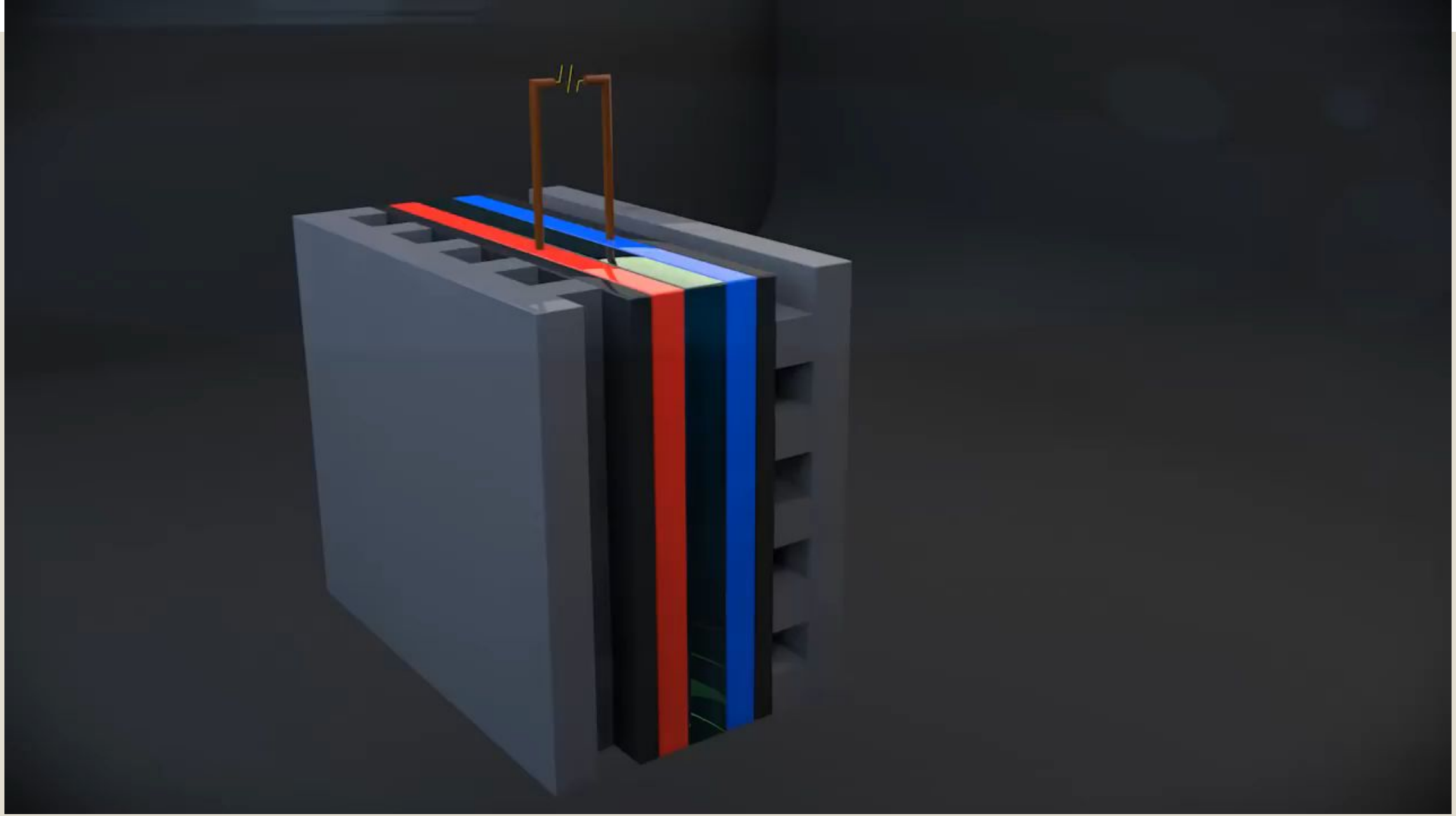
$$O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightarrow 4OH^-_{(aq)}$$

- The hydroxide ions removed at the negative electrode are replaced by those produced at the positive electrode.
- Again, the concentration of the electrolyte remains constant.
- The overall reaction is the same as for the acidic electrolyte:

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$$







Homework

make a table of the advantages and disadvantages of a hydrogen fuel cell

- non-waste technology
- sources of hydrogen
- hydrogen stability and sustainability
- risks in hydrogen and oxygen production and storage

What are advantages of fuel cells?

- Hydrogen fuel cells are used to provide electrical power in spacecraft.
- The water produced can be used for drinking.
- Fuel cells have many advantages over batteries and petrol-driven engines:
  1. Water is the only product made – no pollutants are formed.
  2. They produce more energy per gram of fuel than other fuels.
  3. They are lightweight.
  4. They don't need recharging like batteries.
  5. Fuel cell operates with high efficiency.
- Fuel cells seem to be the answer to many pollution problems.
- The hydrogen and oxygen needed for fuel cells to operate are usually produced using fossil fuels at present.

Limitations to hydrogen–oxygen fuel cells

1. High cost: the materials used to make the electrodes and membrane are expensive.
2. Manufacturing of fuel cells involves the production of toxic by-products.
3. Storage of hydrogen: high-pressure tanks are needed in order to store a sufficient amount of fuel. At present refuelling has to be done more often compared with a petrol engine.
4. Manufacturing hydrogen: the hydrogen needed for fuel cells can only be produced cheaply by using fossil fuels.
5. Fuel cells do not work well at low temperatures: if the temperature falls much below 0 °C, the fuel cell ‘freezes’.