Name: ..... Date: .....

Future fuels

Splitting water - making hydrogen and oxygen

Experiment

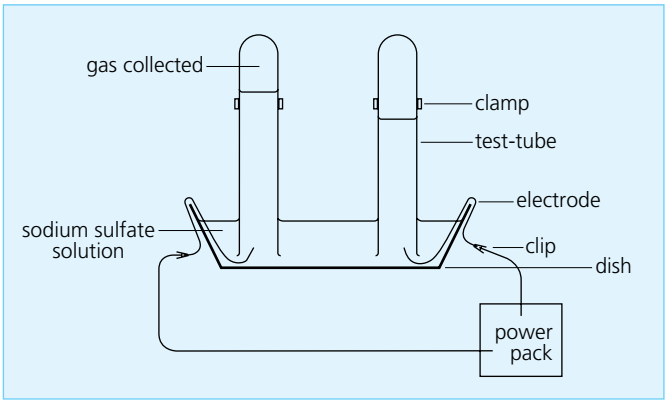
Hydrogen is needed to power most fuel cells. Some fuel cells can work using other substances, but hydrogen will probably be the main fuel for cars. To drive hydrogen fuel cell cars, we would need to buy hydrogen, not petrol, at the garage. A supply of hydrogen is therefore required, otherwise we would not be able to use the cars. Where can the hydrogen come from? This experiment shows one answer.

Water can be split into hydrogen and oxygen using electricity (find out about electrolysis using the **Key words**).

What you need

- 250 cm^3 shallow dish, *eg* empty margarine tub
- Power pack supplying 12 V DC
- 3 connecting leads with clips
- 12 V bulb
- 2 platinum metal strips 2 cm wide and 6–10 cm long
- 150 cm^3 tap water
- 2–4 small spatula measures solid sodium sulfate (**Minimal hazard**)
- Bromothymol blue indicator, enough to make a strong colour
- Water
- Splint
- Bunsen burner and heat proof mat
- Sticky tape
- Eye protection
- Few drops of 0.1 mol dm^{-3} sulfuric acid (**Minimal hazard**)
- Few drops of 0.1 mol dm^{-3} sodium hydroxide (**Irritant**).

Extras for stage 2 only:
- 2 boiling tubes with stoppers to fit
- 2 clamp stands, bosses and clamps.



What you do

Stage 1: Splitting water

1. Connect the circuit: clip one lead to each metal strip. Connect the other end of one lead to the black terminal on the power pack. Connect the second lead to the bulb. Use the third lead to connect the bulb to the red terminal on the power pack (see diagram).
2. Put the metal strips into the dish, at opposite ends. These are the electrodes. Do not allow them to touch. Bend the metal so the ends can be taped on the outside.
3. Pour water into the dish to about 2/3 full.

continued on next page

Future fuels

continued from previous page

4. Add indicator to the water to make a strong colour. The starting colour should be green. If the water is blue, add a few drops of sulfuric acid until the solution turns green. If the water is yellow, add a few drops of sodium hydroxide solution until the solution turns green.
5. Switch on the power pack. A very small number of bubbles will form at the electrodes.
6. Switch off the power pack.
7. Add two spatula measures of sodium sulfate to the water. Stir to dissolve.
8. Switch on the power pack again. This time more bubbles will be produced and the bulb should light. If there are still not many bubbles, switch off, add two more spatula measures of sodium sulfate, stir to dissolve and then switch on again. The bubbles are hydrogen and oxygen gases. In the next stage, collect and test the gases.

Stage 2: Collecting and testing the gases

9. Switch off the circuit. Disconnect the bulb and take this out of the circuit. Connect the power pack leads to the two electrodes directly.
10. Put two boiling tubes in the dish so they fill with water.
11. Lift the boiling tubes up so that the open end stays underwater. Move one tube towards the positive terminal (anode) and the other to the negative terminal (cathode). Tuck the electrodes into the tubes.
12. Clamp the tubes into position so the electrodes stay inside.
13. Switch on the power again. This time the gas bubbles will be collected in the tubes.
14. When a boiling tube is filled with gas, all the water is displaced. Put a thumb or finger over the open end, release the clamp and lift it out of the water. Test the anode gas with a glowing splint and the cathode gas with a lighted splint.
15. Switch off the power pack, disconnect the leads and pour the water away.

Safety

Wear eye protection 

Observations

Write down observations about:

- the amounts of gas produced at the positive and negative terminals; .....

  .....

- the colours produced as the electrolysis happens; .....

  .....

- results of the gas tests. .....

  .....

Questions

1. Name the gas produced at:

   (a) the negative terminal (cathode) .....

   (b) the positive terminal (anode). .....

2. At which terminal was there the most gas? .....

3. Write a word equation for the reaction to split water into gases.

   .....

   .....

continued on next page

Name: ..... Date: .....

Future fuels

continued from previous page

4. How could splitting water be used to make hydrogen cars work? .....

.....

.....

Alternative Questions

1. Explain why the ratio of hydrogen gas to oxygen gas is 2:1. .....

.....

.....

.....

2. Write the equations for the reactions at the two terminals. Remember that acid and alkali are also produced. .....

.....

.....

3. Write an overall equation for the reaction. .....

.....

.....

.....

4. What do you notice about this reaction compared to the 'making water' demonstration? .....

.....

.....

.....

5. How can electrolysing water help our use of fuel cells? .....

.....

.....

.....

.....