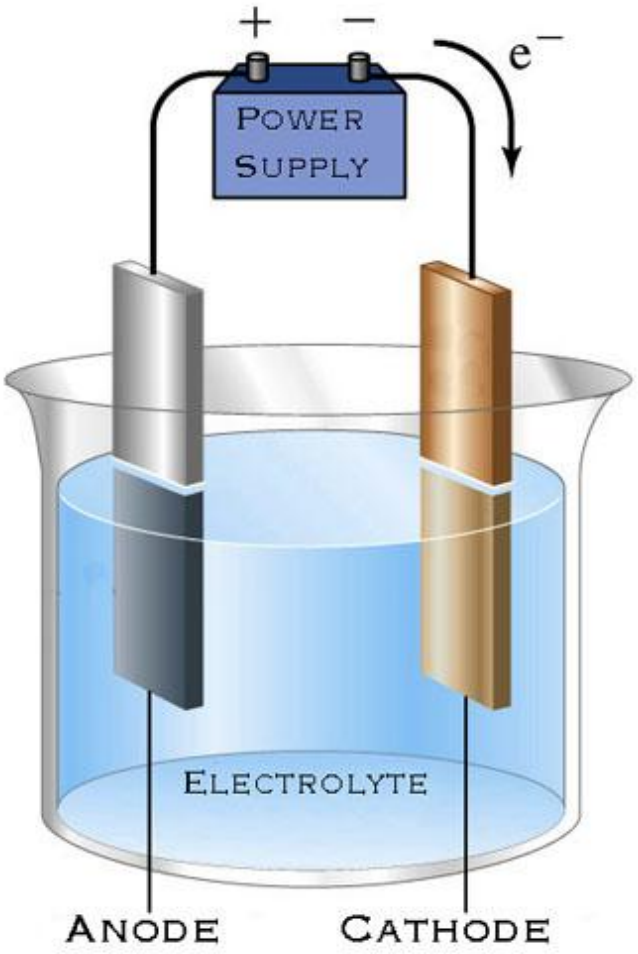
Caustic Soda

Learning Objectives:

- Describe the process of the electrolysis of brine
- Describe the uses of sodium hydroxide

Draw the practical set up you would need for electrolysis



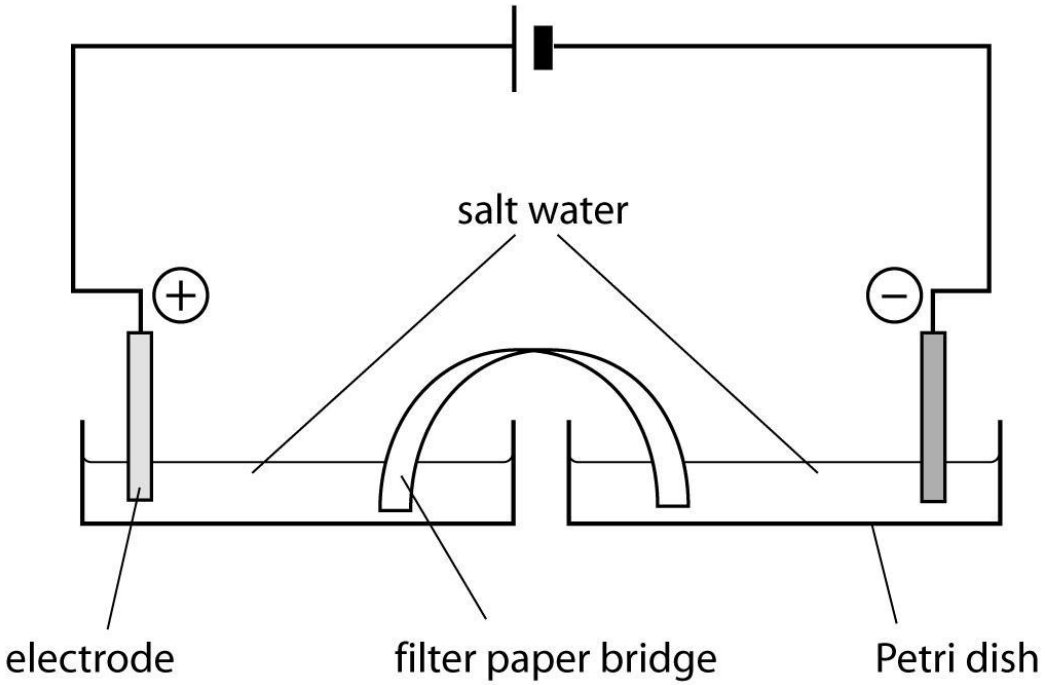
INDUSTRIAL USES OF ELECTROLYSIS

1. To **extract reactive metals** such as ALUMINIUM, sodium, magnesium etc from their compounds. This is EXPENSIVE due to the large amounts of electrical energy needed. Aluminium is extracted from bauxite (Al_2O_3).

2. **Electrolysis of BRINE** (salt solution) to produce
   CHLORINE (for disinfectants and plastics)
   HYDROGEN (for ammonia fertilisers, margarine)
   SODIUM HYDROXIDE (for soap and cleaning agents)
   see below

3. **Purifying copper**. The copper for wiring etc needs to be more pure than that produced in a blast furnace. see below
   Electrolysis is used to convert impure copper to pure copper

Electrolysis of Brine Practical



Chlorine gas will be produced in this experiment. Use a fume cupboard or a well-ventilated laboratory.

Keep the power pack on the lowest setting and turn the power off as soon as you have made your observations.

Questions

1 What did the universal indicator show you about the *type* of substance formed in:

a the anode dish **b** the cathode dish?

2 Chlorine gas is given off at the anode. How can you tell?

3 Suggest the name of an acid that might be formed in the anode dish.

4 Chlorine is an important ingredient in bleach. What observation can you make that shows the bleaching property of chlorine?

5 Why would the experiment not have worked without the filter paper between the two dishes?

6 What would be the problem with connecting the two dishes up with a piece of metal wire?

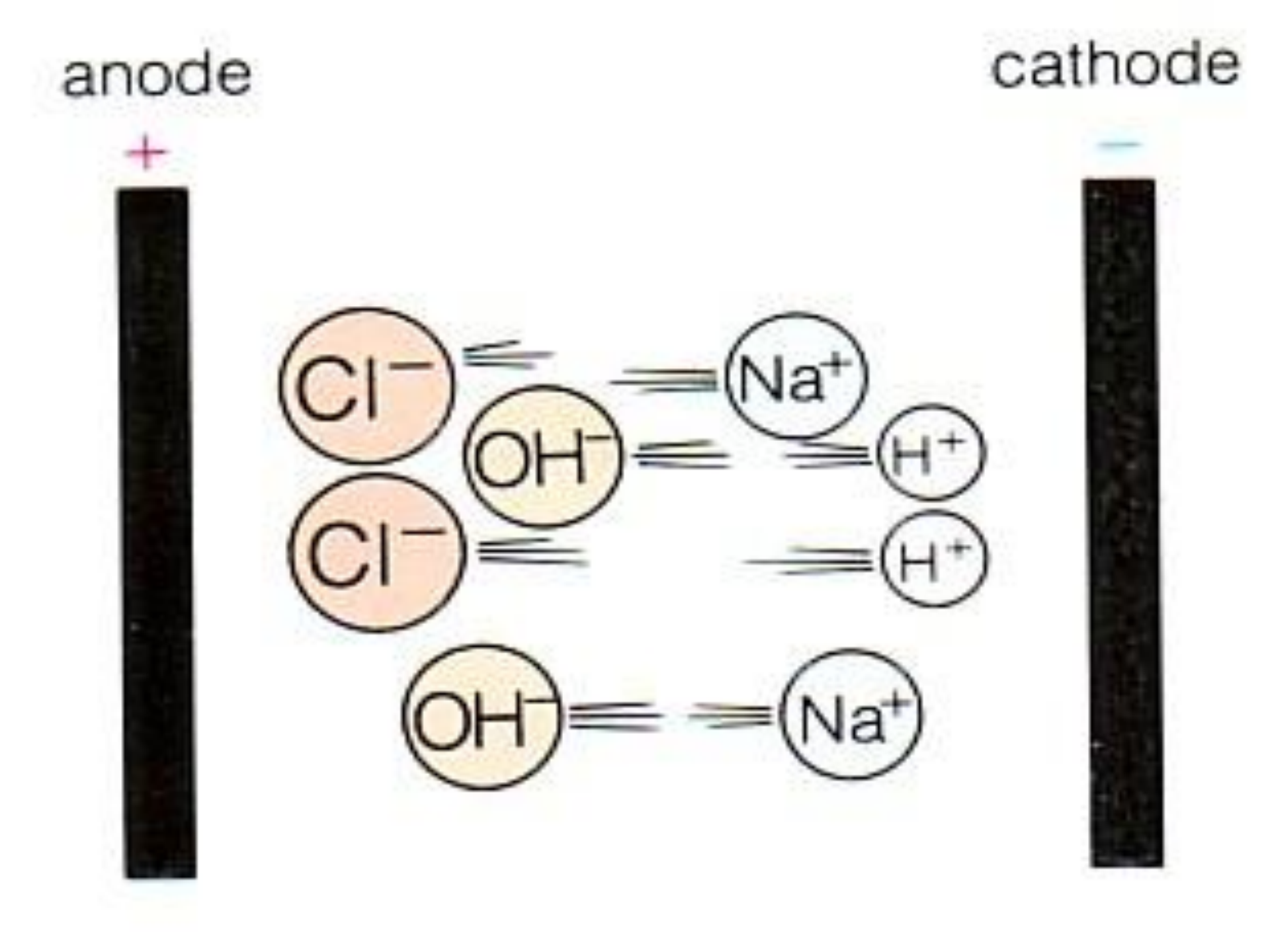
7 Give the formulae of the two ions found in sodium chloride.

8 Which of these ions will be attracted to: **a** the anode **b** the cathode?

Electrolysis of brine

- The NaCl will split into Na^+ ions and Cl^- ions.
- Water splits into H^+ ions and OH^- (hydroxide) ions.

- So what do we think will happen during electrolysis?
- Remember – Na is VERY reactive, it is much more likely to exist as an ion than hydrogen.


anode
cathode
+
−
Cl⁻
Na⁺
OH⁻
H⁺
Cl⁻
H⁺
OH⁻
Na⁺

Now let’s see what actually happens

Electrolysis of brine

- The H^+ and Cl^- ions are discharged at the electrodes.

Electrolysis of brine

- **Hydrogen** comes off at the cathode (-)
- $2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$
- Hydrogen is …… oxidised or reduced?

Electrolysis of brine

- **Chlorine** comes off at the anode (+)
- $2Cl_{(aq)} - 2e^{-} \longrightarrow Cl_{2(g)}$
- Chlorine is …… oxidised or reduced?

Electrolysis of brine

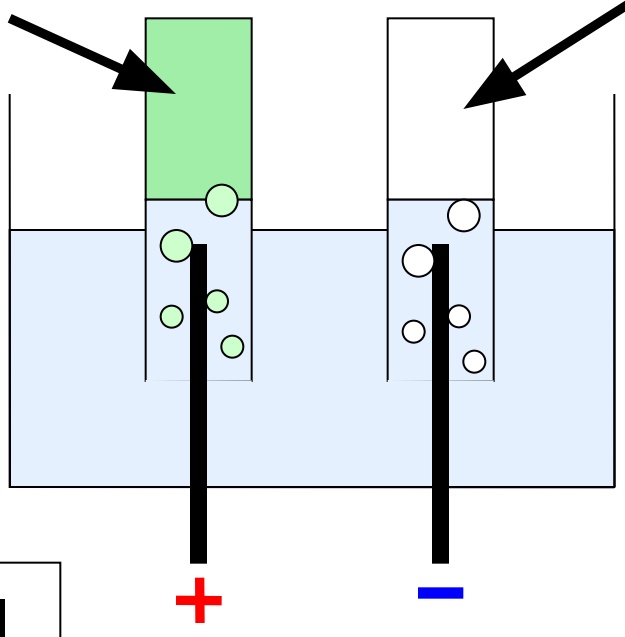
- The Na^+ and OH^- ions stay in solution.
- They join together to form **sodium hydroxide**.
- This is a very important alkali

INDUSTRIAL ELECTROLYSIS OF BRINE

Chlorine gas

Hydrogen gas

BRINE
(NaCl solution)



ANODE

OH^- and Cl^-

$$2Cl^- \rightarrow 2e^- + Cl_2$$

OH^- left in solution so concentration grows

CATHODE

H^+ and Na^+

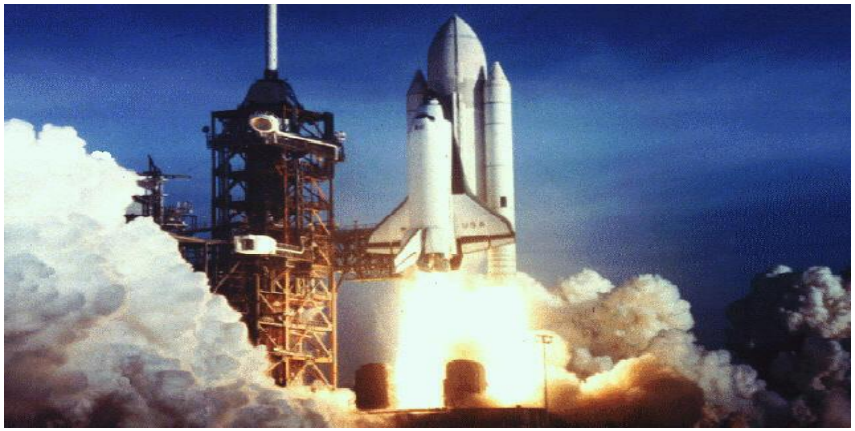
$$2H^+ + 2e^- \rightarrow H_2$$

Na^+ left in solution so concentration grows

Start: Sodium chloride solution (neutral)
End: **sodium hydroxide** solution (alkaline)

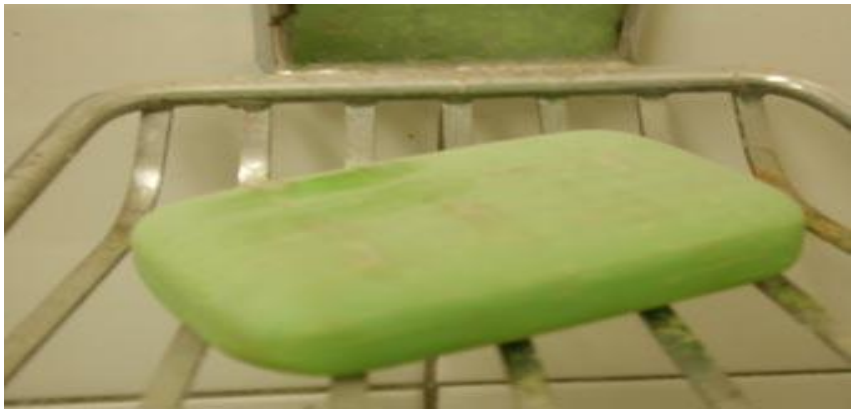
Industrial chlorine production from electrolysis of brine

Hydrogen



- Used to make margarine (helps to make the oils in the margarine spread on your bread)
- Used as a fuel (already important in space rockets, but may be the fuel of cars after the oil age)

Sodium hydroxide



- Detergents and soap

- Paper

Sodium hydroxide

- Purifying bauxite to extract aluminium
- Rayon and acetate fibres

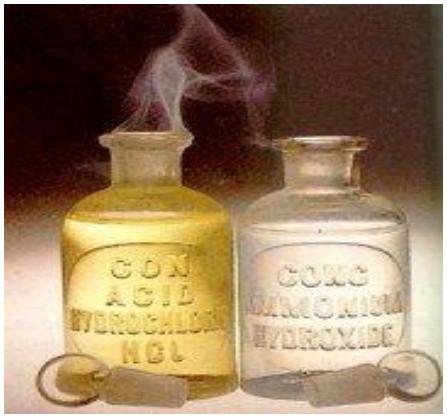
Chlorine

- Bleach

- Killing bacteria in water

Chlorine

- Solvents (used in dry cleaning)



- Hydrochloric acid (HCl)

Summary

1. What are the 3 products?
2. What they used for?
3. Why do the dishes need to kept separate?