

1. Chlorine is made by the electrolysis of sodium chloride solution.

Sodium hydroxide is also made in the electrolysis.

Chlorine and sodium hydroxide must be kept separate during the process.

Two industrial methods can be used for the electrolysis of sodium chloride solution.

Method 1: The mercury cell

- The cell uses mercury.
- The mercury keeps the chlorine and sodium hydroxide separate.
- Mercury is very toxic.
- Some of the mercury is lost from the cell into water supplies.
- The sodium hydroxide made is a concentrated solution.

Method 2: The membrane cell

- Chlorine and sodium hydroxide are kept separate by a membrane.
- No mercury is used.
- Some chlorine leaks into the sodium hydroxide made.
- The sodium hydroxide made is dilute and has to be concentrated by evaporation.

State and explain one disadvantage of each method.

mercury cell .....

.....  
.....

membrane cell .....

.....  
.....

[4]

2. Copper can be extracted from copper sulfate solution by passing an electric current through the solution.

(i) What is this process called?

----- [1]

(ii) Which two statements explain why copper sulfate solution conducts electricity?

Put ticks (✓) in the boxes next to the **two** correct answers.

Copper sulfate is an ionic compound.

Solid copper is a good electrical conductor.

When copper sulfate dissolves, ions are free to move.

The particles in copper sulfate have a regular arrangement.

Bonds in copper sulfate are very weak.

[2]

3(a). A factory electrolyses sodium chloride solution to make useful products.

The electrolysis produces chlorine.

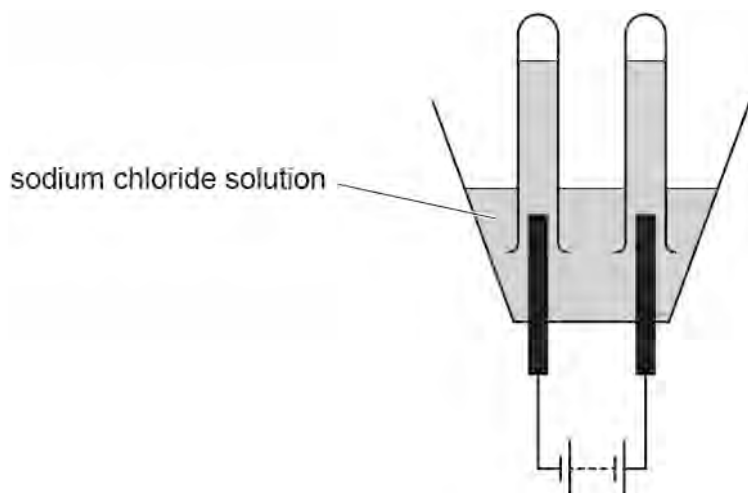
Complete the sentence by putting a **ring** around one word in each pair.

The **chlorine / chloride** ions are attracted to the **positive / negative** electrode, where they lose **electrons / protons**.

[3]

(b). Nina electrolyses a solution of sodium chloride.

She uses this apparatus.



Nina thinks that the experiment makes chlorine gas at one electrode.

She is not sure if the gas at the other electrode is hydrogen or oxygen.

Describe the tests Nina can do to identify chlorine, hydrogen and oxygen **and** the results she should expect.

Chlorine .....

.....

Hydrogen .....

.....

Oxygen .....

.....

[3]

**END OF QUESTION PAPER**

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			<p><b>mercury cell:</b> (mercury) is toxic (1) (mercury) is released into water supplies (1)</p> <p><b>membrane cell:</b> chlorine leaks into sodium hydroxide (1) and needs to be separated (1) <b>OR</b> sodium hydroxide is dilute (1) sodium hydroxide needs to be concentrated (1)</p>	4	<p><b>Examiner's Comments</b></p> <p>Candidates scored well here with most gaining 2 or 3 marks. Those who scored 3 rather than 4 did not link the aspects of the disadvantage of the membrane cell.</p>
			<b>Total</b>	<b>4</b>	
2		i	electrolysis	1	<p><b>ALLOW</b> phonetic spelling</p> <p><b>Examiner's Comments</b></p> <p>Many candidates were able to recall the name of the process which extracts metals using an electric current. There was a wide range of unsuccessful guesses.</p>
		ii	Box 1; Box 3;	2	<p><b>Examiner's Comments</b></p> <p>Most candidates understood that it was the ions that were responsible for the electrical conductivity of copper sulphate. The conductivity of solid copper was the most frequently chosen incorrect response.</p>
			<b>Total</b>	<b>3</b>	
3	a		chloride ✓ positive ✓ electrons ✓	3 (AO 1.1 × 3)	<p><b>Examiner's Comments</b></p> <p>Most candidates knew that the ions lose electrons, and many that they were chloride ions. The higher ability candidates knew which electrode the ions were attracted to.</p>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b	<p>Chlorine turns litmus (red then) bleached ✓</p> <p>hydrogen pops when lit ✓</p> <p>Oxygen should relight <b>glowing</b> splint / spill / AW ✓</p>	3 (AO 1.2 × 3)	<p>ALLOW lit splint burns brighter</p> <p><u>Examiner's Comments</u></p> <p>A significant minority of candidates omitted this question. However, the majority who did answer it showed clear experience of the two most memorable tests, those for hydrogen and oxygen. Unfortunately, a significant number of these answers used descriptions such as "the squeaky pop test", or did not say if the splint was lit or glowing, and so did not gain credit. The test for chlorine was not well known, though in such cases candidates almost always made intelligent suggestions.</p>
		<b>Total</b>	<b>6</b>	