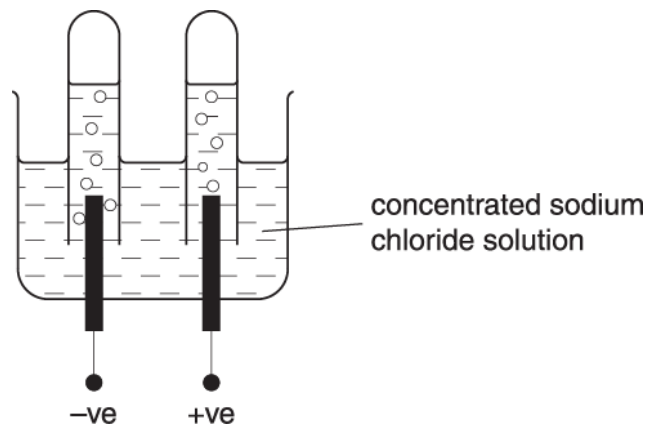


1. Sodium chloride (salt) is a very important chemical.

Concentrated sodium chloride solution can be electrolysed to make useful products.

Look at the diagram below. It shows how this can be done in the laboratory.



Sodium chloride solution contains the ions Na^+ , Cl^- , H^+ and OH^- .

What happens during the electrolysis of concentrated sodium chloride solution?

Your answer should include equations for the reactions at each electrode.

Use e^- to represent an electron.



The quality of written communication will be assessed in your answer to this question.

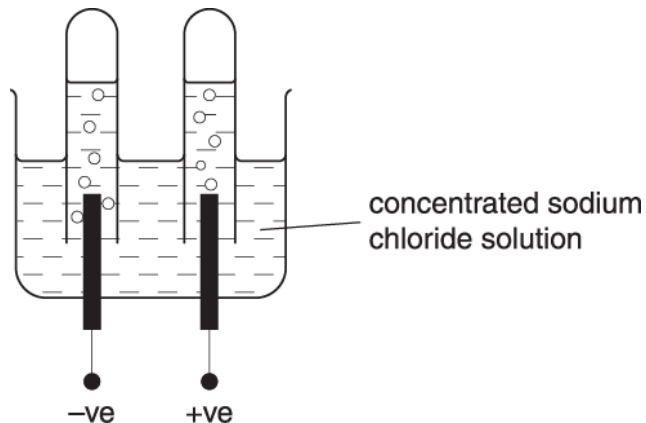
[6]

2. Sodium chloride (salt) is a very important chemical.

Sodium chloride can be extracted from salt deposits by solution mining.

Concentrated sodium chloride solution can be electrolysed to make useful products.

Look at the diagram. It shows how this can be done in the laboratory.



Write about how sodium chloride is extracted by **solution mining**.

What is made during the electrolysis of concentrated sodium chloride solution?



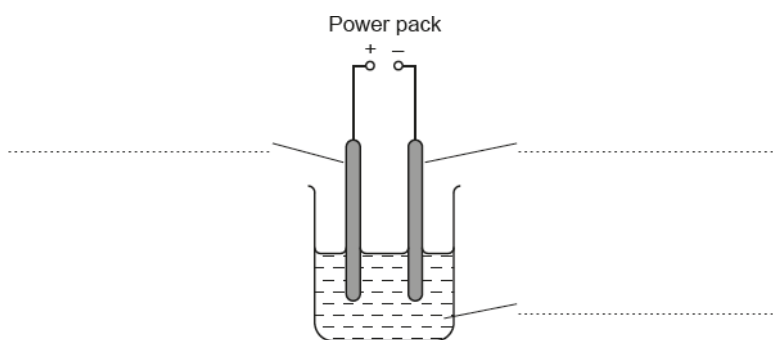
The quality of written communication will be assessed in your answer to this question.

[6]

3(a).

Look at the diagram of an electrolysis experiment.

(i) Complete the labels on the diagram.



[2]

(ii) Sodium chloride is an ionic compound.

Sodium chloride

- Will **not** conduct electricity when it is solid
- Will conduct electricity when it is dissolved in water.

Explain why.

[2]

(b). A scientist electrolyses three different compounds.

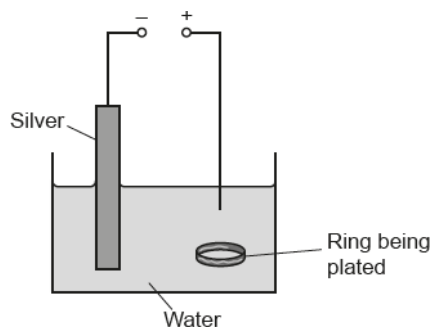
Complete the table below to show what products will be formed.

Compound	Product formed at negative electrode	Product formed at positive electrode
Molten PbBr_2	Lead	-----
A solution of KBr	Hydrogen	-----
A solution of CuCl_2	Copper	-----

[3]

(c). Electrolysis can also be used to **electroplate** one metal onto another.

Look at the diagram of this experiment.



The experiment shown in this diagram will **not** work.

Suggest **two** things that must be changed to make the experiment work.

[2]

4. Which of the following happens at a **cathode**?

A Gain of electrons by anions

B Gain of electrons by cations

C Loss of electrons by anions

D Loss of electrons by cations

Your answer

[1]

END OF QUESTION PAPER

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
1	<p>Level 3 All three of the products are correctly identified AND one correct equation for the reaction at one of the electrodes is written. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>Level 2 Two of the products are correctly identified with at least one correct location Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>Level 1 One of the products is correctly identified OR a sensible attempt at an equation for the reaction at one of the electrodes is made Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>Level 0 Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to A/A*.</p> <p>Indicative scientific points may include:</p> <p>Products</p> <ul style="list-style-type: none"> • chlorine at the anode • hydrogen at the cathode • sodium hydroxide <p>Equations</p> <ul style="list-style-type: none"> • $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ • $2\text{Cl}^- \rightarrow 2\text{e}^- + \text{Cl}_2$ / $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$ <p>Other</p> <ul style="list-style-type: none"> • Na^+ and OH^- remain in the solution making sodium hydroxide <p>allow products and location from (incorrect) equation</p> <p>At Level 1 allow correct identification of electrodes to which ions are attracted i.e. Na^+ and H^+ attracted to cathode or negative electrode and Cl^- and OH^- attracted to anode or positive electrode. At Level 1 allow oxidation at anode or positive electrode and reduction at cathode or negative electrode.</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p> <p>Examiner's Comments</p> <p>About half of candidates either failed to score or omitted this question. Electrolysis continues to be a part of the specification</p>

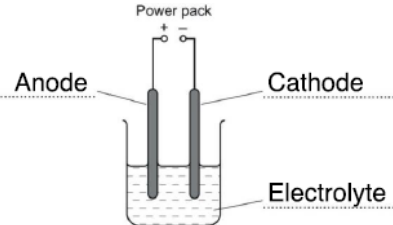
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					that candidates find difficult. Good candidates gave some excellent answers, correctly identifying the products and the electrodes at which they are formed and writing correct half equations. There was considerable confusion with last year's question on the purification of silver and/or copper. Many candidates gave irrelevant answers referring to copper purification. A number of candidates thought that there were both positive and negative electrons moving in the solution. Some candidates gained level 1 (1 or 2 marks) by correctly identifying the electrodes that the ions were attracted to.
			Total	6	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
2	<p>Level 3 Gives a complete description of solution mining AND names at least two products of the electrolysis. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>Level 2 Gives a rudimentary description of solution mining AND names one product of the electrolysis</p> <p>OR names all three products of electrolysis. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>Level 1 Gives a rudimentary description of solution mining OR names one product of the electrolysis. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>Level 0 Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to C.</p> <p>Indicative scientific points may include: Solution mining</p> <ul style="list-style-type: none"> • water pumped into mine / add water • sodium chloride dissolves in water • sodium chloride or salt (solution) is pumped out <p>allow idea of evaporation to get the salt</p> <p>Products of electrolysis</p> <ul style="list-style-type: none"> • chlorine • hydrogen • sodium hydroxide <p>check for names of gasses labelled correct electrode not required</p> <p>on diagram ignore location of products</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p> <p>Examiner's Comments</p> <p>Only a very small minority of candidates produced a level three response to this question. Candidates did not seem to know how salt was obtained from solution mining or the products of the electrolysis of sodium chloride solution. Many attempted to describe the electrolysis of copper, confusing this with a question that had appeared on a previous paper.</p>
	Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
3	a	i	<p>Anode (+) AND cathode (-) ✓</p> <p>Electrolyte ✓</p> 	<p>2 (AO2 × 1.1)</p>	<p>ALLOW for electrolyte: solution of metal salt / metal salt / solution containing ions / salt solution / molten salt / named electrolyte such as sodium chloride</p> <p>DO NOT ALLOW solvent, water</p> <p>IGNORE solution unless qualified</p> <p>Examiner's Comments This question was a good discriminator. Some higher ability candidates could name the anode and cathode correctly, but fewer could label the electrolyte. However, some gained credit by giving a correct example of an electrolyte instead. Some stated sodium chloride, having presumably seen it in the question that followed. Common incorrect responses were positive or negative terminal / rod for the electrodes and solution or water for the electrolyte. A few thought the dashes in the beaker were electrons.</p>
		ii	<p>The ions cannot move in NaCl/ solid ✓</p> <p>The ions are free to move in NaCl/ solution ✓</p>	<p>2 (AO2 × 2.1)</p>	<p>DO NOT ALLOW electrons instead of ions But ALLOW electrical conduction requires the movement of ions and the ions cannot move in NaCl/ solid / ora for 2 marks</p> <p>IGNORE charged particles</p> <p>Examiner's Comments Some of the highest ability candidates were able to explain that ions are only able to freely in solution. Most answers were irrelevant. Candidates frequently wrote about electricity / electrons having space to move through liquids not solids. They often referred to electrons, sometimes delocalised electrons, instead of ions.</p>

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b	bromine ✓ bromine ✓ chlorine ✓	3 (AO3 × 2.1)	ALLOW Br ₂ DO NOT ALLOW bromide or Br ALLOW Br ₂ DO NOT ALLOW bromide or Br ALLOW Cl ₂ DO NOT ALLOW chloride or Cl <u>Examiner's Comments</u> Higher ability candidates mostly scored at least 2 marks with the answers to PbBr ₂ and CuCl ₂ most often being correct. For KBr, potassium and hydrogen were common incorrect answers. Lower ability candidates did not always even name an element and there were a wide range of incorrect responses. A significant number lost marks by writing bromide / chloride instead of bromine / chlorine. Many candidates did not attempt this question.
	c	Any two from: Circuit not complete / wire not connected to ring ✓ Silver / ring connected to wrong electrode / side of battery ✓ Water will not work / idea that metal ions needed in solution ✓	2 (AO2 × 3.3a)	ALLOW The silver should be on the positive side / the ring should be on the negative / Silver should not be at cathode / Anode & cathode wrong way round ALLOW any named metal salt solution ALLOW use an electrolyte <u>Examiner's Comments</u> Where marks were credited it was mostly for the idea of swapping the anode and cathode, and for connecting the ring. Many candidates struggled to articulate their answer clearly enough to gain credit. Candidates were able to gain a mark by stating that water would not work but an alternative was to name a suitable electrolyte. Most could not do this and did not realise that metal ions were required in solution. Some lower ability candidates thought that there was no power source.
		Total	9	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
4			B ✓	1 (AO 1.1)	<p><u>Examiner's Comments</u></p> <p>Less than half of candidates could identify the correct statement explaining the process that takes place at the cathode. The most common incorrect response was 'D' showing a lack of understanding of the charges on cations. There is often a misconception regarding the charge on the ions and whether there has been an initial loss or gain of electrons to create the ion.</p>
			Total	1	