Q1. This question is about halogens and their compounds.

The table below shows the boiling points and properties of some of the elements in Group 7 of the periodic table.

Element	**Boiling point in °C**	**Colour in aqueous solution**
Fluorine	−188	colourless
Chlorine	−35	pale green
Bromine	X	orange
Iodine	184	brown

(a) Why does iodine have a higher boiling point than chlorine?

Tick **one** box.

Iodine is ionic and chlorine is covalent ☐

Iodine is less reactive than chlorine ☐

The covalent bonds between iodine atoms are stronger ☐

The forces between iodine molecules are stronger ☐

(1)

(b) Predict the boiling point of bromine.

.....

(1)

(c) A redox reaction takes place when aqueous chlorine is added to potassium iodide solution.

The equation for this reaction is:

$$Cl_2(aq) + 2KI(aq) \rightarrow I_2(aq) + 2KCl(aq)$$

Look at table above.

What is the colour of the final solution in this reaction?

Tick **one** box.

Brown ☐

Orange ☐

Pale green ☐

Colourless ☐

(1)

(d) What is the ionic equation for the reaction of chlorine with potassium iodide?

Tick **one** box.

$Cl_2 + 2K \rightarrow 2KCl$ ☐

$2I^- + Cl_2 \rightarrow I_2 + 2Cl^-$ ☐

$I^- + Cl \rightarrow I + Cl^-$ ☐

$I^- + K^+ \rightarrow KI$ ☐

(1)

(e) Why does potassium iodide solution conduct electricity?

Tick **one** box.

It contains a metal ☐

It contains electrons which can move ☐

It contains ions which can move ☐

It contains water ☐

(1)

(f) What are the products of electrolysing potassium iodide solution?

Tick **one** box.

Product at cathode	**Product at anode**	
hydrogen	iodine	☐
hydrogen	oxygen	☐
potassium	iodine	☐
potassium	oxygen	☐

(1)
(Total 6 marks)

Q2. This question is about metals and alloys.

(a) Explain how electricity is conducted in a metal.

To gain full marks you must include a description of the structure and bonding of a metal.

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(4)

(b) Describe how the structure of an alloy is different from the structure of a pure metal.

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(2)

(c) Alloys are used to make dental braces and coins.

(i) Nitinol is an alloy used in dental braces.

Why is Nitinol used in dental braces?

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(1)

(ii) Suggest **one** reason why coins are not made of pure copper.

Do **not** give cost as a reason.

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(1)

(iii) Some coins are made from an alloy of aluminium.

Complete the sentence.

Aluminium is manufactured by the electrolysis of a molten mixture of cryolite and

.....

(1)

(iv) Banks keep coins in poly(ethene) bags. These bags are made from low density poly(ethene).

High density poly(ethene) can also be made from the same monomer.

How can the same reaction produce two different products?

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(1)

(d) Give **two** reasons why instrumental methods of analysis are used to detect impurities in metals.

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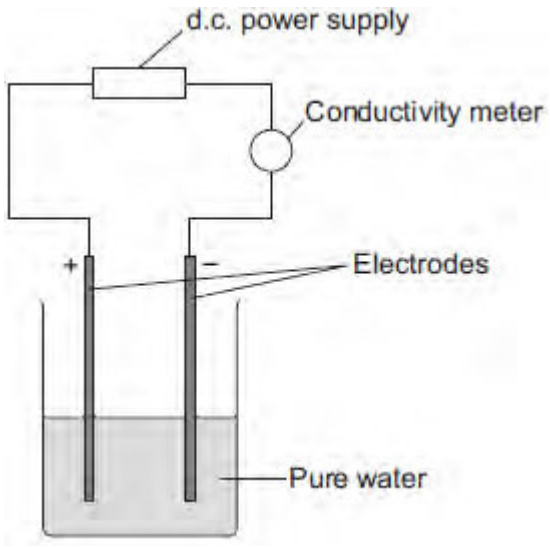
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(1)
(Total 11 marks)

Q3. A student investigated the conductivity of different concentrations of sodium chloride solution.

The student set the apparatus up as shown in **Figure 1**.

Figure 1



The student measured the conductivity of the pure water with a conductivity meter.

The reading on the conductivity meter was zero.

(a) The student:

- added sodium chloride solution one drop at a time
- stirred the solution
- recorded the reading on the conductivity meter.

The student's results are shown in the table below.

Number of drops of sodium chloride solution added	**Relative conductivity of solution**
0	0
1	100
2	120
3	310
4	400
5	510

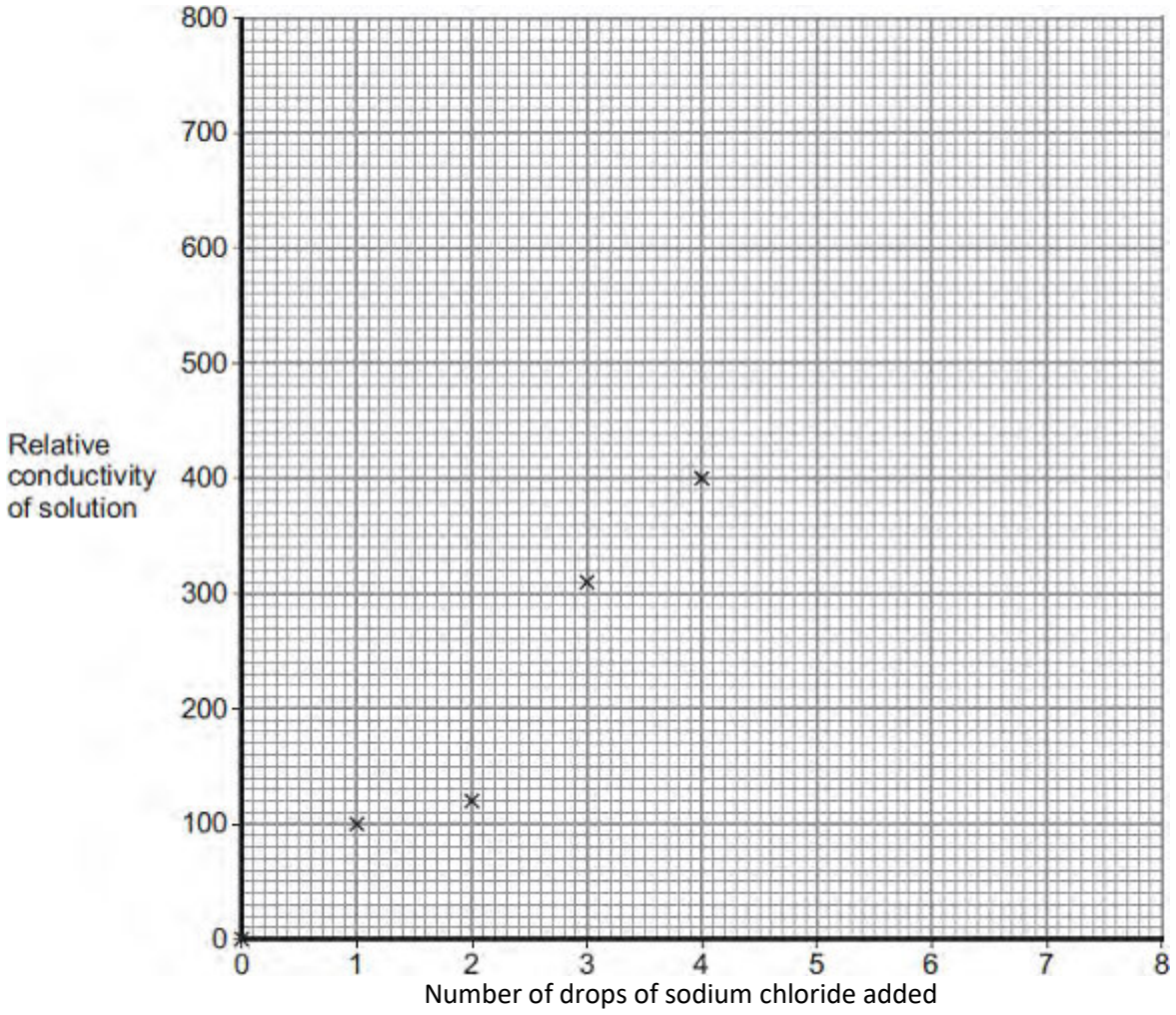
6	590
7	710
8	800

(i) The student plotted the results on the grid shown in **Figure 2**.

Plot the four remaining results.

Draw a line of best fit, ignoring the anomalous result.

Figure 2



(3)

(ii) One of the points is anomalous.

Suggest **one** error that the student may have made to cause the anomalous result.

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(1)

(iii) The student wanted to compare the conductivity of sodium chloride solution with the conductivity of potassium chloride solution.

State **one** variable he should keep constant when measuring the conductivity of the two solutions.

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(1)

(b) (i) Explain, in terms of bonding, why pure water does **not** conduct electricity.

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(2)

(ii) Explain why sodium chloride solution conducts electricity.

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(2)

(iii) After he had added sodium chloride solution, the student noticed bubbles of gas at the negative electrode.

Complete the sentence.

The gas produced at the negative electrode is .....

(1)

(Total 10 marks)

Q4. Metals are extracted from their ores.

Many copper ores contain only 2% of copper compounds.

(a) Copper is now extracted from ores containing a low percentage of copper compounds.

Suggest **two** reasons why.

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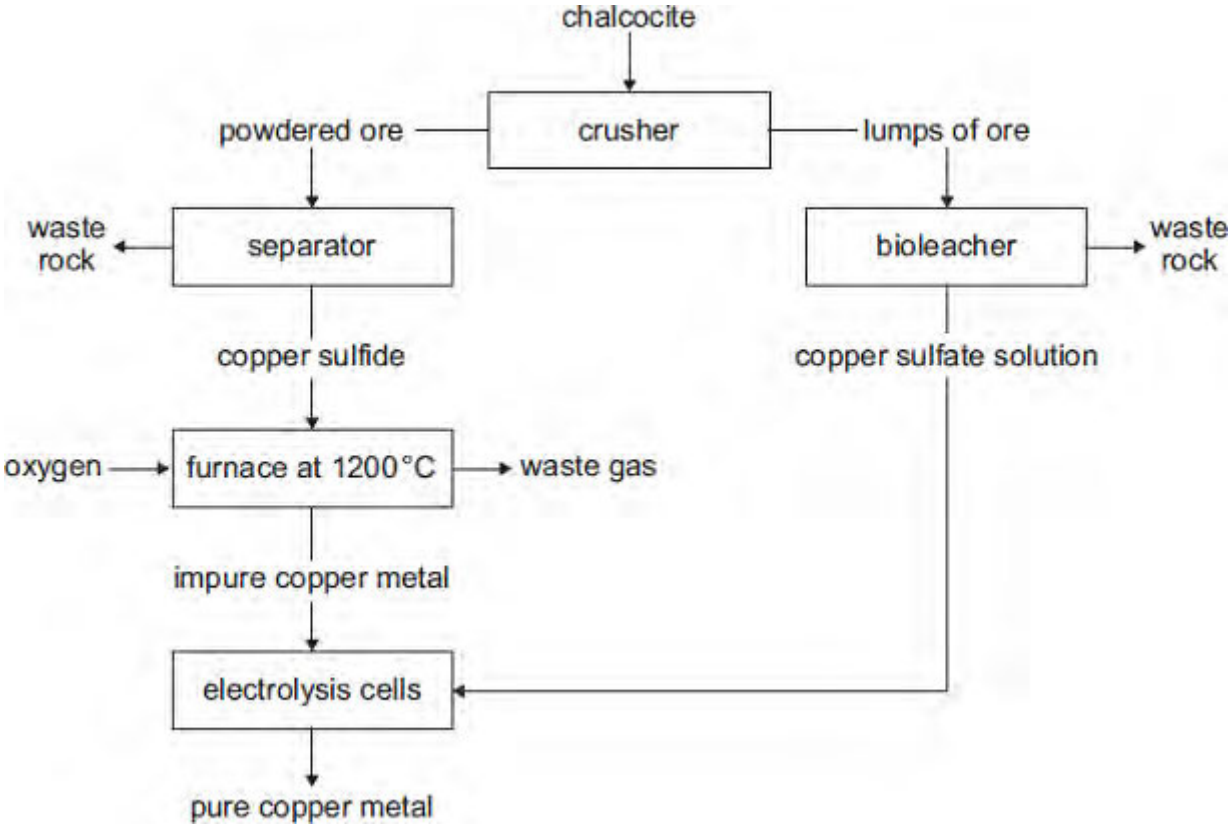
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(2)

(b) Chalcocite, an ore of copper, contains copper sulfide.

The flow diagram shows how copper metal is extracted from chalcocite.



(i) Suggest **one** reason why it is difficult to dispose of the waste rock.

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(1)

(ii) The reaction in the furnace could cause environmental pollution.
Explain how.

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(2)

(iii) The extraction of pure copper is expensive.
Give **one** reason why.

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(1)

(iv) Pure copper is produced by electrolysis of copper sulfate solution.

Which electrode do the copper ions move towards?
Give a reason for your answer.

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(2)

(v) Large areas of land are contaminated with copper compounds.
Phytomining can be used to remove these copper compounds from the land.

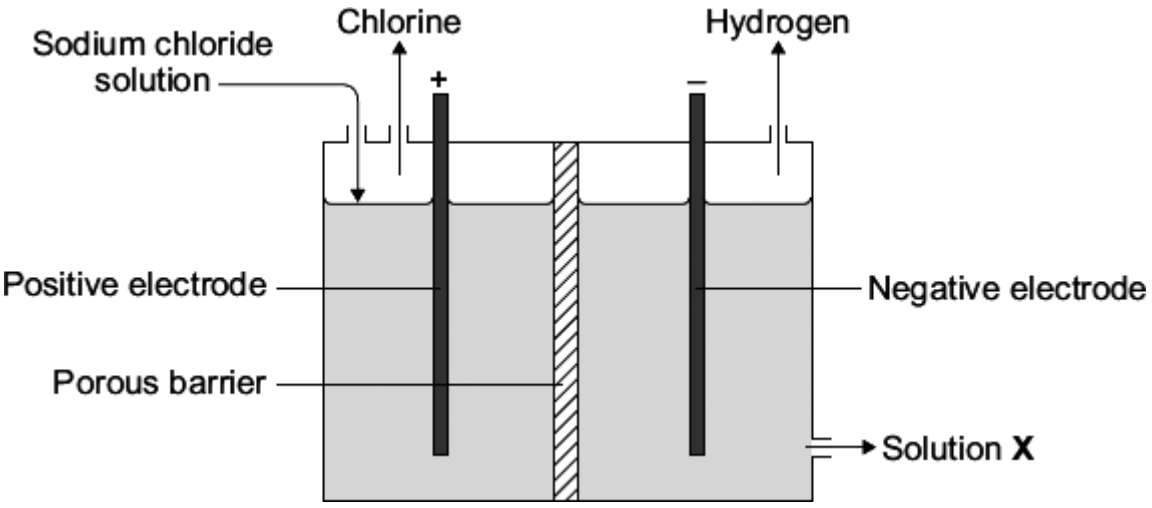
What is used in phytomining to remove copper compounds from the land?

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(1)
(Total 9 marks)

Q5. The electrolysis of sodium chloride solution is an industrial process.



(a) Why do chloride ions move to the positive electrode?

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(1)

(b) Sodium chloride solution contains two types of positive ions, sodium ions (Na^+) and hydrogen ions (H^+).

Tick (✓) the reason why hydrogen is produced at the negative electrode and **not** sodium.

Reason	Tick (✓)
Hydrogen is a gas.	
Hydrogen is less reactive than sodium.	
Hydrogen is a non-metal.	
Hydrogen ions travel faster than sodium ions.	

(1)

(c) Solution **X** is alkaline.

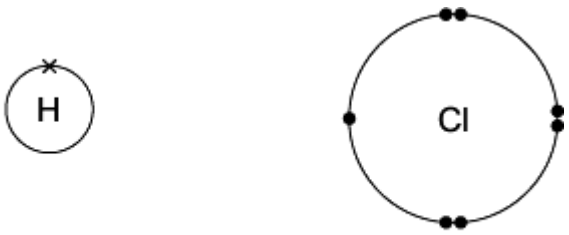
Which ion makes solution **X** alkaline?

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(1)

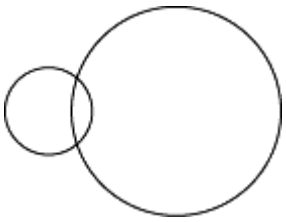
(d) Electrolysis of sodium chloride solution produces hydrogen and chlorine.
The hydrogen and chlorine can be used to make hydrogen chloride.

(i) The diagrams show how the outer electrons are arranged in atoms of hydrogen and chlorine.



Hydrogen atom Chlorine atom

Complete the diagram to show how the electrons are arranged in a molecule of hydrogen chloride (HCl).



(1)

(ii) Name the type of bond between the hydrogen and the chlorine atoms in a molecule of hydrogen chloride.

.....

(1)

(iii) Some hydrogen chloride was bubbled into water. This made a solution with a pH of 1.

Which ion gave the solution a pH of 1?

.....

(1)
(Total 6 marks)

Q6. The flow diagram shows the main stages used to extract a metal from its ore.

mining the ore → purifying the ore → extracting the metal

The table shows some information about three metals.

Metal	Metal ore	Purified ore	% of metal in the ore	% of metal in the Earth's crust
aluminium	bauxite	aluminium oxide, Al_2O_3	28.0	8.0
copper	chalcocite	copper sulfide, Cu_2S	0.5	0.001
iron	haematite	iron oxide, Fe_2O_3	29.0	5.0

(a) Use the information in the table and your knowledge and understanding to help you to answer the questions.

(i) Suggest why purifying the copper ore produces large quantities of waste.

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(1)

(ii) Suggest why the annual world production of iron is forty times greater than that of aluminium.

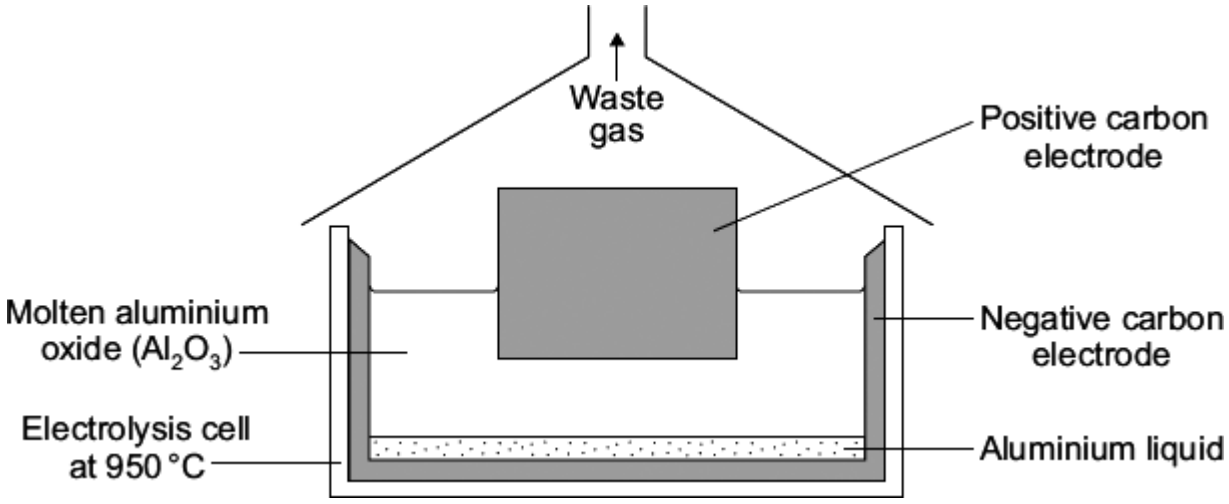
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(1)

(b) Aluminium is used for drinks cans.
Aluminium is extracted from its purified ore by electrolysis.



(i) Suggest why the aluminium produced in the electrolysis cell is a liquid.

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(1)

(ii) In this electrolysis, aluminium and oxygen gas are produced from the aluminium oxide.

Use the information in the diagram to suggest why most of the waste gas is carbon dioxide and not oxygen.

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(2)

(iii) Aluminium is the most abundant metal in the Earth's crust.

Suggest **two** reasons why we should recycle aluminium drinks cans.

1 .....

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2 .....

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(2)
(Total 7 marks)

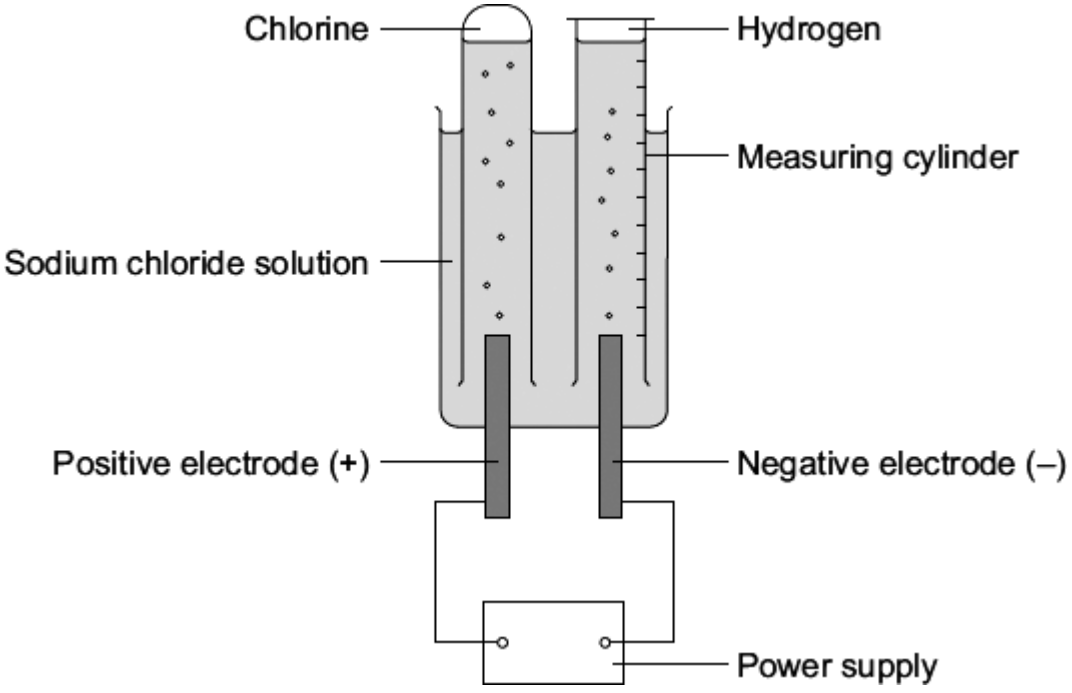
Q7. A student investigated the electrolysis of sodium chloride solution.

Five sodium chloride solutions were made. Each solution had a different concentration.

To make each solution the student:

- weighed the amount of sodium chloride needed
- dissolved it in water
- added more water until the total volume was one cubic decimetre (1 dm^3).

The solutions were placed one at a time in the apparatus shown below.



The student measured the volume of hydrogen gas produced in ten minutes.

The results are shown on the graph below.

(a) Sodium chloride does not conduct electricity when it is solid.

Explain, in terms of ions, why sodium chloride solution conducts electricity.

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(1)

(b) Chlorine is produced at the positive electrode.

Why are chloride ions attracted to the positive electrode?

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(1)

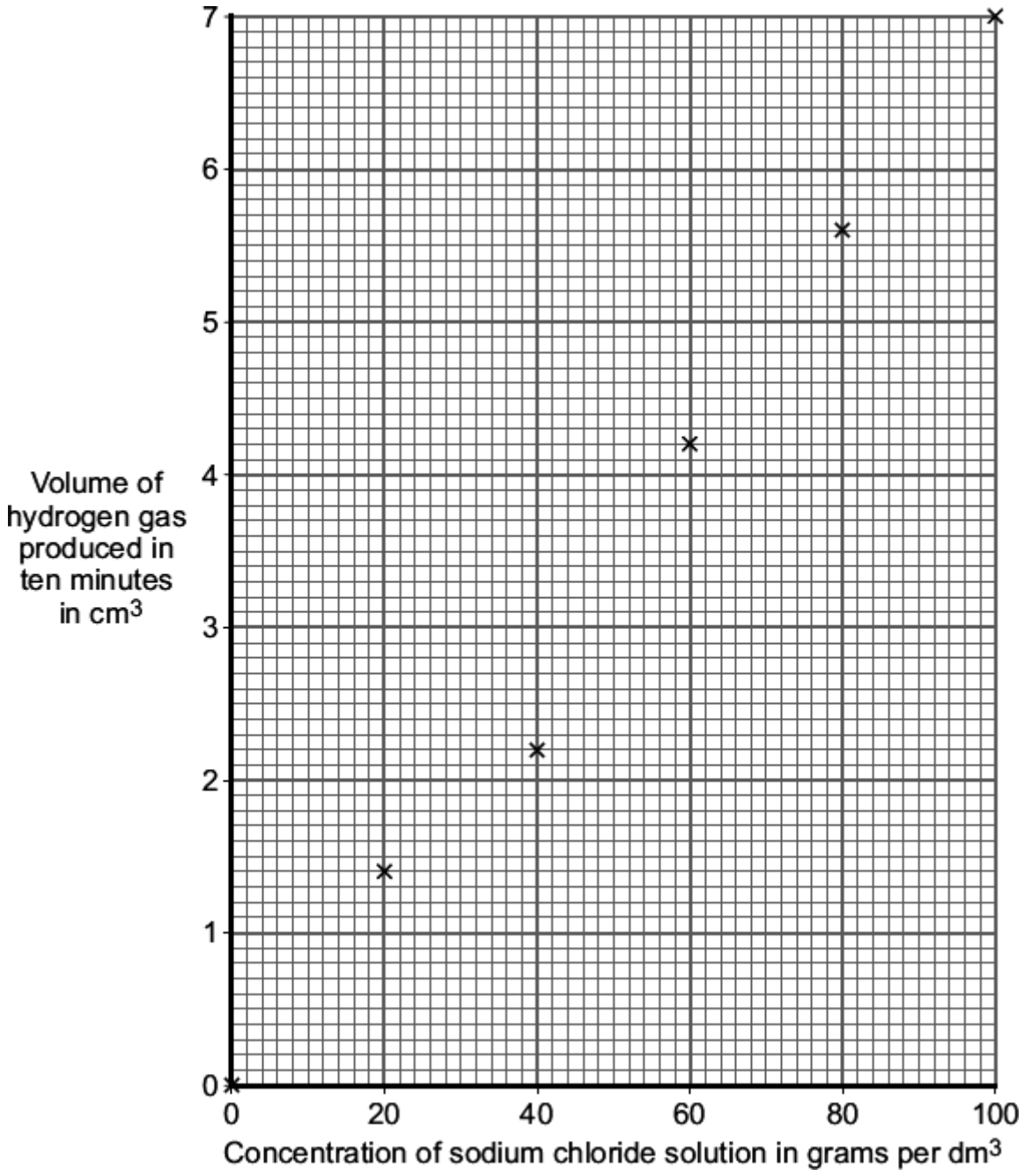
(c) The solution left at the end of each experiment contains sodium hydroxide.

Draw a ring around **one** number which could be the pH of this solution.

2 **5** **7** **13**

(1)

(d) The results for the experiment above are shown on the graph.



(i) Draw a line of best fit on the graph.

(1)

(ii) The result for one concentration is anomalous.
Which result is anomalous?

The result at concentration ..... grams per dm^3

(1)

(iii) Suggest **two** possible causes of this anomalous result.

1 .....

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2 .....

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(2)

(iv) Suggest how the student could check the reliability of the results.

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(1)

(iv) How did an increase in the concentration of the sodium chloride solution affect the volume of hydrogen gas produced in ten minutes?

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(1)
(Total 9 marks)