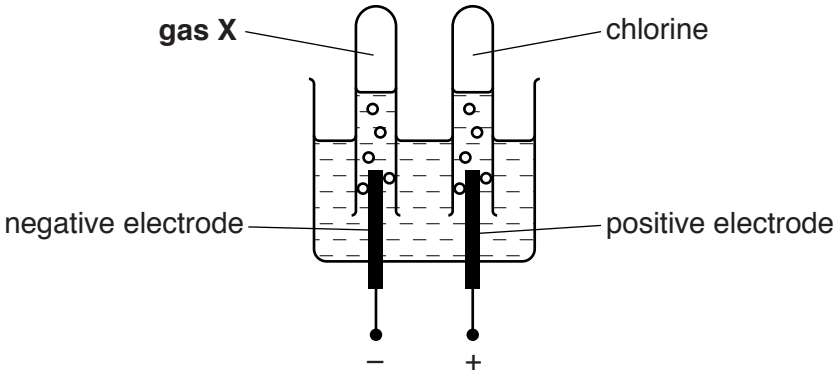
1 Anita investigates the electrolysis of concentrated sodium chloride solution (brine).

Look at the diagram. It shows the apparatus she uses.



(a) What is the name of gas **X**?

Choose your answer from the list.

carbon dioxide

hydrogen

hydrogen chloride

oxygen

answer ..... **[1]**

(b) It is important to use **inert electrodes** in the electrolysis of sodium chloride solution.

Explain why.

.....

..... **[1]**

(c) During the electrolysis of sodium chloride solution, the chloride ions are turned into chlorine molecules.

(i) Complete the equation for this reaction.

..... Cl^- − ..... e^- → Cl_2 **[1]**

(ii) Is this reaction **oxidation** or **reduction**?

Explain how you can tell from the equation.

.....

..... **[1]**

2 During the electrolysis of sodium bromide solution, bromide ions make bromine molecules.

(a) Complete the equation for this reaction.

…… Br^- – ……e^- $\rightarrow$ Br_2

[1]

(b) Explain why this reaction is an example of **oxidation**.

.....

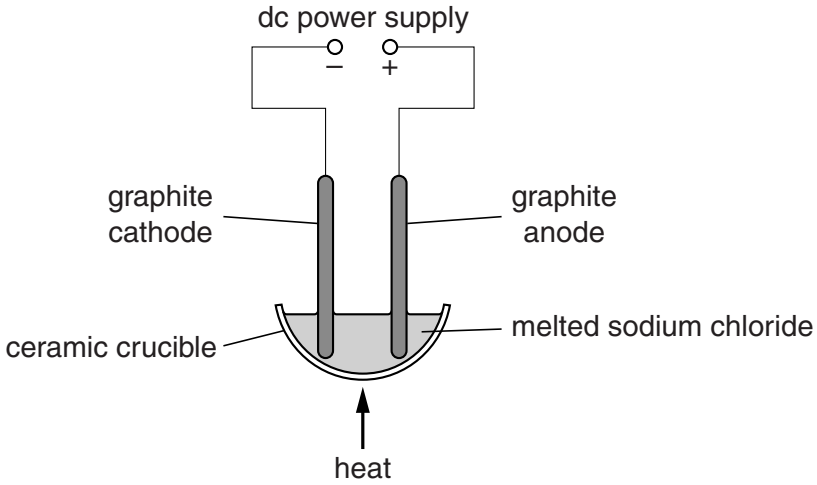
..... **[1]**

[Total: 2]

3 This question is about electrolysis.

(a) Joel's teacher investigates the electrolysis of melted sodium chloride.

Look at the apparatus he uses.



Sodium chloride contains sodium ions, Na^+, and chloride ions, Cl^-.

(i) Chloride ions, Cl^-, react at the anode.

Chlorine gas, Cl_2, and electrons are the products.

Write a **balanced symbol** equation for the electrode process at the anode.

Use $\mathbf{e^-}$ to show an electron.

..... **[2]**

(ii) **Solid** sodium chloride does **not** conduct electricity, but **melted** sodium chloride **does** conduct electricity.

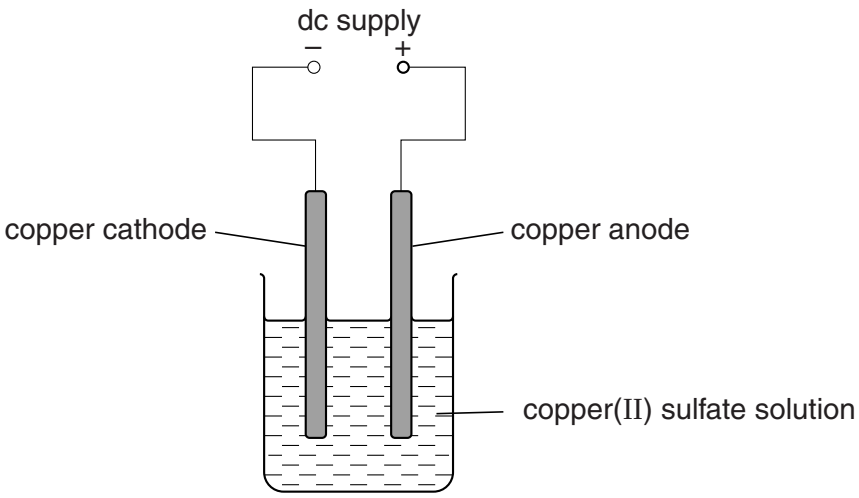
Explain why.

.....

.....

..... **[2]**

(b) Joel passes an electric current through **copper(II) sulfate solution**.



Joel does four experiments.

Joel changes either the **time** or the **current**.

Copper is made at the cathode.

He measures how much copper is made in each experiment.

Experiment	Current in amps	Time in minutes	Mass of copper made in g
1	0.15	5	0.20
2	0.30	5	0.40
3	0.15	10	0.40
4	0.60	10	1.60

Joel concludes that the amount of copper made is **proportional** to both the current and to the time.

Show how the results support this conclusion.

.....

.....

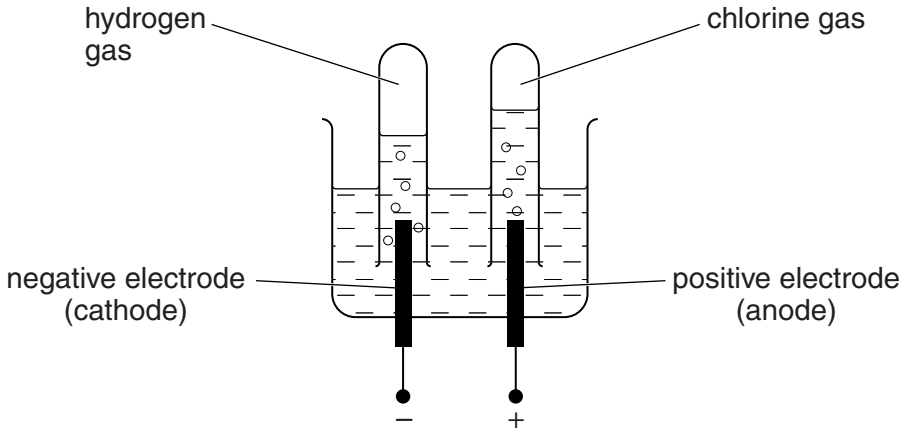
..... **[2]**

[Total: 6]

4 Chlorine is made by the electrolysis of **concentrated** sodium chloride solution.

Sarah investigates this electrolysis.

Look at the apparatus she uses.



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

(a) At the positive electrode, chloride ions lose electrons to make chlorine gas, Cl_2.

Write the **balanced ionic** equation for this reaction.

Use e^- to represent an electron.

..... **[2]**

(b) Look at the list of ions in sodium chloride solution.

Two ions do not react at the electrodes.

Write down the name of the solution these ions make.

..... **[1]**

[Total: 3]

5 This question is about metals.

(a) Phil wants to buy a new bicycle.

He uses the internet to research which metal is the most suitable for making the bicycle frame.

Look at the table.

It shows the information he finds out.

Metal	Density in g/cm^3	Relative strength (1= low, 10 = high)	Resistance to corrosion	Cost per tonne in £
aluminium	2.7	0.9	very good	2220
copper	8.9	2.1	good	5550
stainless steel	7.8	7.3	very good	900
titanium	4.5	10	very good	17000

Which metal is the most suitable for making Phil's bicycle frame?

.....

Explain your answer using information from the table.

.....

.....

.....

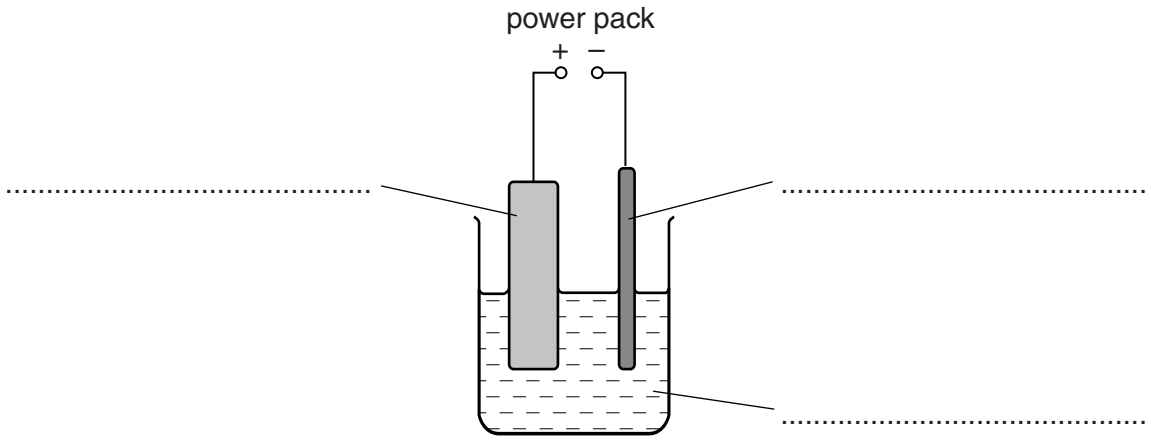
.....

..... **[3]**

(b) Pure copper is used for electrical wiring.

The copper is purified by **electrolysis**.

The diagram shows the apparatus used to purify copper.



Complete the labels on the diagram.

Choose your answers from the list.

copper sulfate solution

dilute sulfuric acid

impure copper anode

impure copper cathode

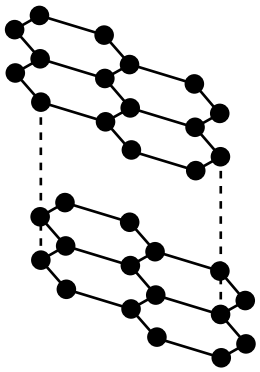
pure copper anode

pure copper cathode

[2]

[Total: 5]

6 Graphite is one of the allotropes of carbon.



(a) Graphite is used to make pencil leads.

Explain why the properties of graphite make it suitable for pencil leads.

.....

.....

.....

..... **[2]**

(b) Graphite is used as an electrode in electrolysis.

This is because it conducts electricity and has a high melting point.

(i) Explain why graphite can conduct electricity. Use the diagram to help you.

.....

..... **[1]**

(ii) Explain why graphite has a high melting point. Use the diagram to help you.

.....

.....

.....

..... **[2]**

[Total: 5]