C6 Electrolysis Homework task 1

Q1.

This question is about electrolysis.

(a) Complete the sentence.

Choose the answer from the box.

gaseous	**molten**	**solid**

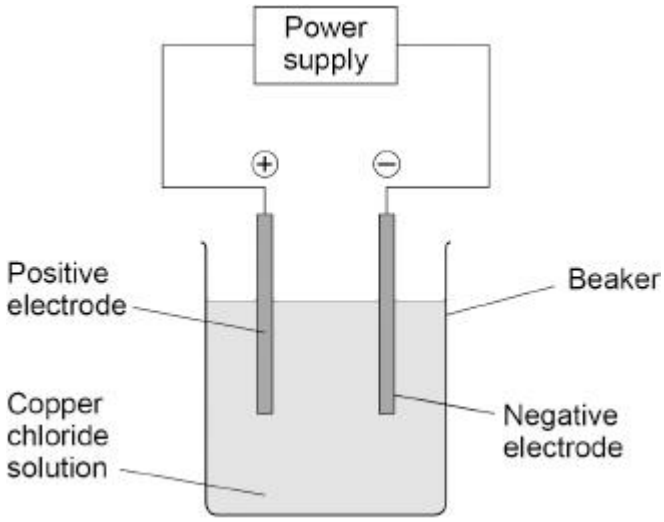
Copper chloride can conduct electricity when in solution or

when _____.

(1)

Figure 1 shows the apparatus used for the electrolysis of copper chloride solution.

Figure 1



There are four ions in copper chloride solution:

- Cu^{2+}
- Cl^-
- H^+
- OH^-

(b) Why do Cl^- ions and OH^- ions move to the positive electrode?

_____

_____

(1)

(c) Where do the H^+ and OH^- ions come from in the electrolysis of copper chloride solution?

Tick (✓) **one** box.

Air ☐

Copper chloride ☐

Water ☐

(1)

(d) Which ion produces a metal?

Tick (✓) **one** box.

Cu^{2+} ☐

Cl^- ☐

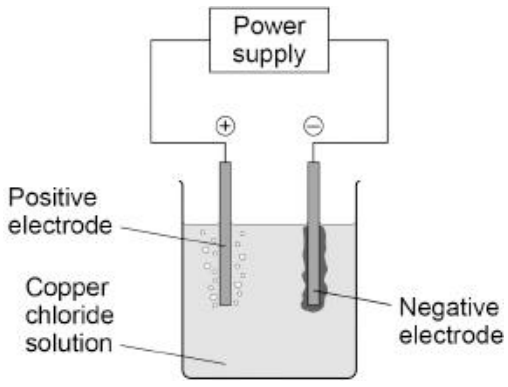
H_+ ☐

OH^- ☐

(1)

(e) **Figure 2** shows the apparatus during the electrolysis of copper chloride solution.

Figure 2



Describe what is seen at each electrode during the electrolysis of copper chloride solution.

Positive electrode _____

_____

Negative electrode _____

_____

(2)

(f) 500 cm^3 of copper chloride solution contains 6.50 g of copper chloride.

Calculate the mass of copper chloride in 40.0 cm^3 of this copper chloride solution.

_____

_____

_____

Mass = _____ g

(2)

(Total 8 marks)

Q2.

This question is about the extraction of aluminium.

(a) An aluminium atom is represented as:

$^{27}_{13}Al$

Give the number of electrons and neutrons in the aluminium atom.

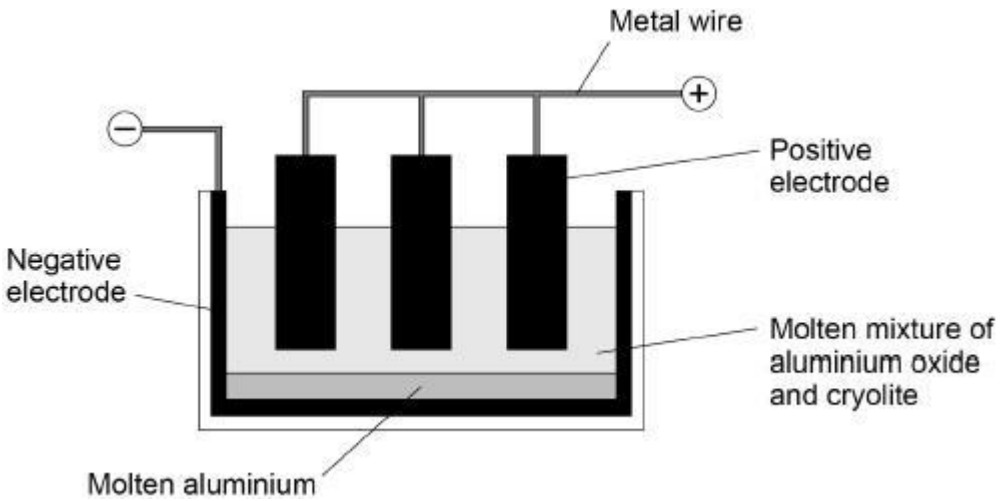
Number of electrons _____

Number of neutrons _____

(2)

Aluminium is extracted by the electrolysis of a molten mixture of aluminium oxide and cryolite.

The diagram below shows the cell used for the electrolysis.



(b) Aluminium is produced by the reduction of aluminium oxide (Al_2O_3).

What is meant by the term reduction?

_____

_____

(1)

(c) Oxygen is formed at the positive carbon electrodes.

Explain why the positive carbon electrodes must be continually replaced.

_____

_____

_____

_____

_____

_____

(3)

(d) A substance conducts electricity because of free moving, charged particles.

What are the free moving, charged particles in a:

- carbon electrode (made from graphite)
- molten mixture of aluminium oxide and cryolite
- metal wire?

Carbon electrode (made from graphite) _____

Molten mixture of aluminium oxide and cryolite _____

Metal wire _____

(3)

(Total 9 marks)

HIGHER TIER QUESTIONS

Q3.

A student investigates a potassium salt, **X**.

She finds that salt **X**:

- has a high melting point
- does not conduct electricity when it is solid
- dissolves in water and the solution does conduct electricity.

(a) What is the type of bonding in salt **X**?

Tick **one** box.

Covalent	☐
Giant molecular	☐
Ionic	☐
Metallic	☐

(1)

(b) What is the name given to solutions that conduct electricity?

_____

(1)

(c) Why does a solution of salt **X** in water conduct electricity?

_____

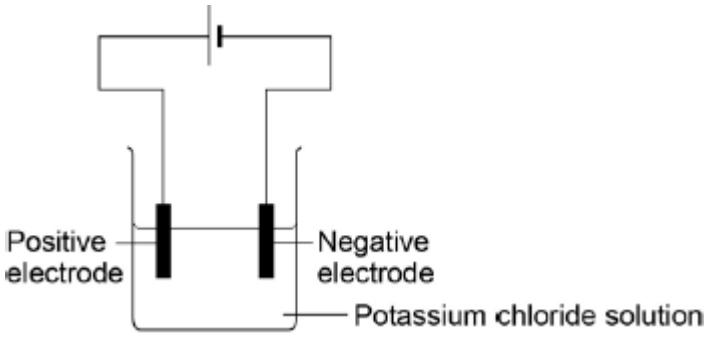
_____

(1)

(d) The student electrolyses a solution of potassium chloride.

Figure 1 shows the apparatus she uses.

Figure 1



When the current is switched on, bubbles of hydrogen gas are given off at the negative electrode.

Explain why hydrogen is produced and **not** potassium.

_____

_____

_____

_____

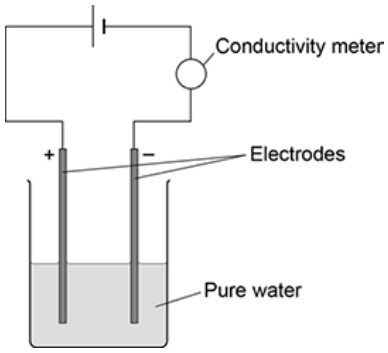
_____

(2)

(e) The student then compares the relative conductivity of different concentrations of potassium chloride.

Figure 2 shows the apparatus she uses.

Figure 2



This is the method used.

1. Add potassium chloride solution to the water one drop at a time.

2. Stir the mixture.

3. Record the reading on the conductivity meter.

The table below shows the student's results.

Number of drops of potassium chloride solution	Relative conductivity of solution
0	0
1	90
2	180
3	270
4	360
5	450
6	540

When there is no potassium chloride in the beaker no electrical charge flows.

Suggest why pure water does **not** conduct electricity.

_____

_____

_____

_____

(2)

(f) Describe the relationship shown in the table above.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q4.

This question is about the electrolysis of aqueous solutions.

Hydrogen gas and chlorine gas are produced when sodium chloride solution is electrolysed.

(a) Hydrogen ions (H^+) are attracted to the negative electrode.

The half equation for the reaction at the negative electrode is:

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

What type of reaction happens at the negative electrode?

Give the reason for your answer.

Type of reaction _____

Reason _____

_____

(2)

(b) Chloride ions are attracted to the positive electrode.

Complete the half equation for the production of chlorine gas (Cl_2).

$$\_\_\_\ Cl^- \quad \rightarrow \_\_\_\_\_ + \_\_\_\_\_$$

(2)

(c) Hydrogen gas and oxygen gas are produced when sodium sulfate solution is electrolysed.

Explain how oxygen gas is produced in the electrolysis of sodium sulfate solution.

_____

_____

_____

_____

(4)

(Total 8 marks)

Q1.

(a) molten

1

(b) opposite (charges) attract
or
(the ions) are negative(ly charged)

1

(c) water

1

(d) Cu^{2+}

1

(e) (positive electrode) bubbles / effervescence / fizzing
allow gas (is produced)

1

(negative electrode)
(pink / orange / red / brown) solid
allow copper (plating)
allow metal for solid

1

(f) $\frac{40.0}{500} \times 6.50$

1

= 0.52 (g)

1

[8]

Q2.

(a)

this order only

13

1

14

1

(b) loss of oxygen
allow (Al^{3+}) gain of electrons
allow aluminium oxide loses oxygen

1

(c)

allow anode for (positive) electrode

(at high temperature) oxygen reacts with carbon / electrode

1

(so the positive) electrode burns / wears away

1

to produce carbon dioxide

$C + O_2 \rightarrow CO_2$ scores MP1 and MP3

1

(d) (delocalised) electron(s)

1

ion(s)

1

(delocalised) electron(s)

1

[9]

Q3.

(a) Ionic

1

(b) electrolyte

1

(c) because the ions are free to flow

1

(d) because potassium is higher in the reactivity series than hydrogen

1

so it is less easily discharged than hydrogen

1

(e) because water is covalent / molecular / contains molecules

1

so there are no free electrons to move **or** does not have an overall electrical charge

1

(f) conductivity of the solution increases with concentration

1

in a linear relationship **or** directly proportional

1

[9]

Q4.

(a) reduction

ignore electrolysis

1

(as H^+ ions) gain electrons

1

(b) $2\ Cl^- \rightarrow Cl_2 + 2\ e^-$

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

ignore state symbols

*allow **1** mark for $Cl_2 + e^-$*

*allow **1** mark for $– e^-$ (on lhs) **and** Cl_2 (on rhs)*

2

(c) water molecules

1

break down to produce OH^- ions

allow dissociate to produce OH^- ions

1

(which are) attracted to the positive electrode

1

(where OH^- ions are) oxidised

or

(where OH^- ions) lose electrons

ignore discharged

ignore oxygen is produced as no halide is present

1

[8]