Required Practical Review

Chemistry Practical - Electrolysis

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GCSEpod: https://members.gcsepod.com/shared/podcasts/title/12343

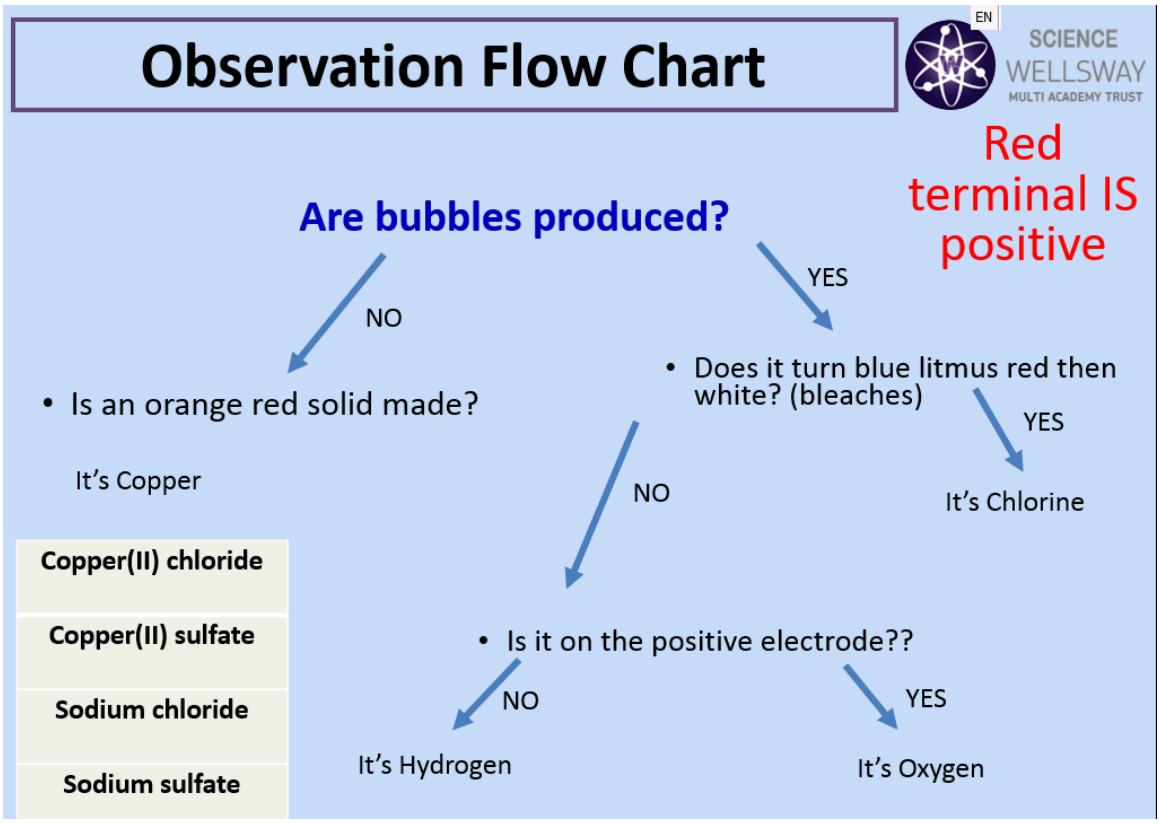
SCIENCE WELLSWAY MULTI ACADEMY TRUST

Know it

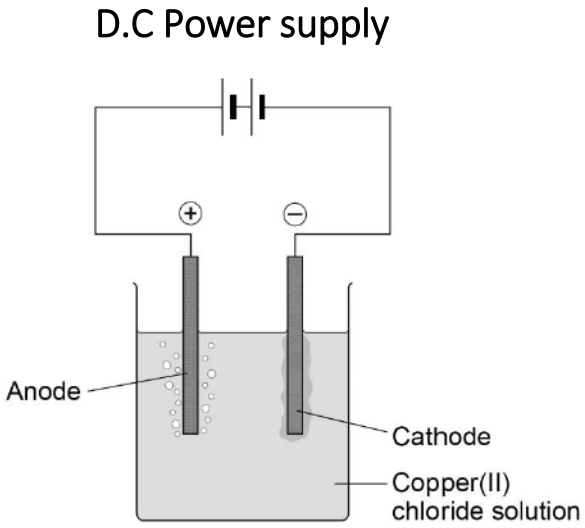
SUMMARY RULES FOR IONIC SOLUTIONS

+ ANODE	- CATHODE
Attracts – ions ('Anions')	Attracts + ions ('Cations')
If – ions are HALOGENS ie **chloride Cl^-** **bromide Br^-** **iodide I^-** the **HALOGEN** is produced.	If + ions (metals) are MORE REACTIVE than hydrogen **K, Na, Li, Ca, Mg, Zn, Fe** Then **HYDROGEN** is produced
If – ions are NOT HALOGENS Eg sulphate SO_4^{2-}, nitrate NO_3^- carbonate CO_3^{2-} OXYGEN is produced.	If + ions (metals) are LESS REACTIVE than hydrogen **Cu, Ag, Au** Then the METAL is produced

(REACTIVITY: **K^+ Na^+ Li^+ Ca^{2+} Mg^{2+} Zn^{2+} Fe^{3+} H^+ Cu^{2+} Ag^+ Au^+**)



Practical – you need to be able to draw set up:



Method

1. Pour approximately 50cm^3 of the solution being electrolysed into the beaker.
2. Insert the carbon rods into solution. The rods must not touch each other.
3. Attach crocodile leads to the rods. Connect the rods to the dc (red and black) terminals of a low voltage power supply (4V).
4. Look at both electrodes and record your observations.
5. Use forceps to hold a piece of blue litmus paper in the solution next to the anode (positive electrode) and identify the element?

Expected Results

Solution	Positive electrode (anode) (RED terminal)		Negative electrode (cathode) (BLACK terminal)	
	Observations	**Element formed**	**Observations**	**Element formed**
Copper (II) chloride	Fizzing Bleaches Blue litmus	**Chlorine**	Shiny pink metal	**Copper**
Copper (II) sulfate	Fizzing **Does not** Bleaches Blue litmus	**Oxygen**	Shiny pink metal	**Copper**
Sodium chloride	Fizzing Bleaches Blue litmus	**Chlorine**	Fizzing **Does not** Bleaches Blue litmus	**Hydrogen**
Sodium sulfate	Fizzing **Does not** Bleaches Blue litmus	**Oxygen**	Fizzing **Does not** Bleaches Blue litmus	**Hydrogen**

Review it - Complete the tasks below into your book.

The list below is of ionic solutions you can use with the 'review it' questions:

Sodium iodide	Sodium nitrate	Lithium chloride
Lithium sulfate	Iron (II) bromide	Iron (II(carbonate
Copper (II) iodide	Coper (II) nitrate	

Up to grade 4

- What safety precautions should you take when carrying out this experiment and why?
- What did you observe at the anode?
- How do you explain the formation of the product at the anode?
- What did you observe at the cathode?
- How do you explain the formation of the product at the cathode?

For the electrolysis of copper sulfate solution using copper electrodes:

- Why is it necessary to clean the copper electrodes with emery paper before using them?
- Why might it necessary to measure the time taken for the electrolysis?
- Which factors should be kept the same during the electrolysis?

Grade 5-7

- What happens to the colour of the solution during the electrolysis of copper II sulfate?
- If the electrolysis is continued for a long time, what will be left in the solution?

Grade 7+

- Write the half equation for the formation of the product at the cathode and explain whether it is oxidation or reduction.
- Write the half equation for the formation of the product at the anode and explain whether it is oxidation or reduction.

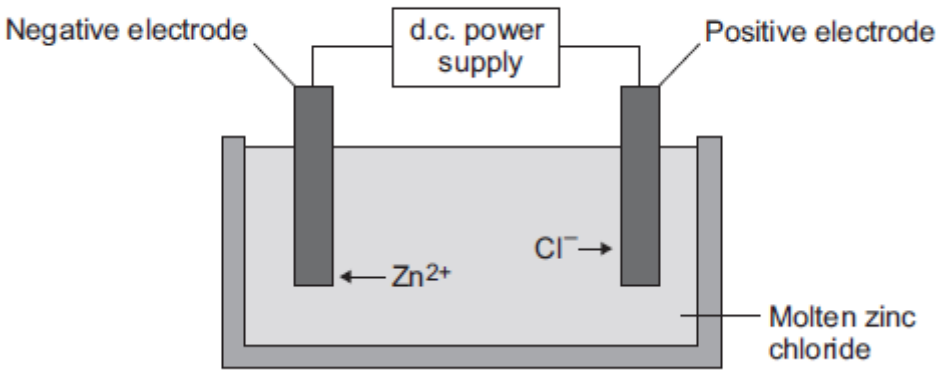
Test it - Answer the exam questions below into your book.

FOUNDATION

Q1. This question is about zinc.

Figure 1 shows the electrolysis of molten zinc chloride.

Figure 1



(a) Zinc chloride is an ionic substance.
Complete the sentence.

When zinc chloride is molten, it will conduct _____ .

(1)

(b) Zinc ions move towards the negative electrode where they gain electrons to produce zinc.

(i) Name the product formed at the positive electrode.

_____

(1)

(ii) Explain why zinc ions move towards the negative electrode.

_____

_____

_____

_____

(2)

(iii) What type of reaction occurs when the zinc ions gain electrons?

Tick (✓) **one** box.

Neutralisation ☐

Oxidation ☐

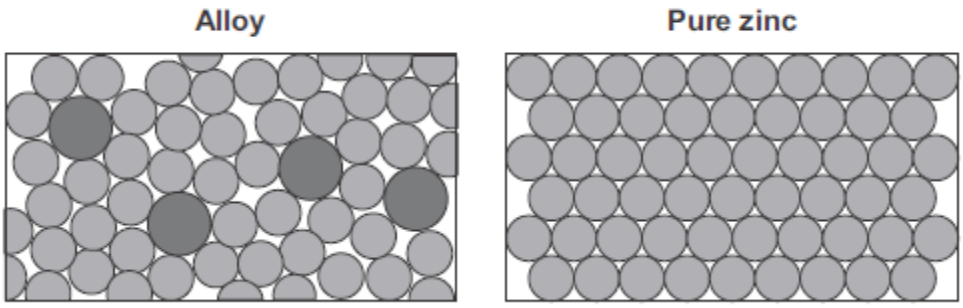
Reduction ☐

(1)

(c) Zinc is mixed with copper to make an alloy.

(i) **Figure 2** shows the particles in the alloy and in pure zinc.

Figure 2



Use **Figure 2** to explain why the alloy is harder than pure zinc.

_____

_____

_____

_____

(2)

(ii) Alloys can be bent. Some alloys return to their original shape when heated.

What name is used for these alloys?

_____

(1)

(Total 8 marks)

Q2.

The electrolysis of sodium chloride solution produces useful substances.

(a) (i) Choose a word from the box to complete the sentence.

covalent	**ionic**	**non-metallic**

Electrolysis takes place when electricity passes through _____ compounds when they are molten or in solution.

(1)

(ii) Choose a word from the box to complete the sentence.

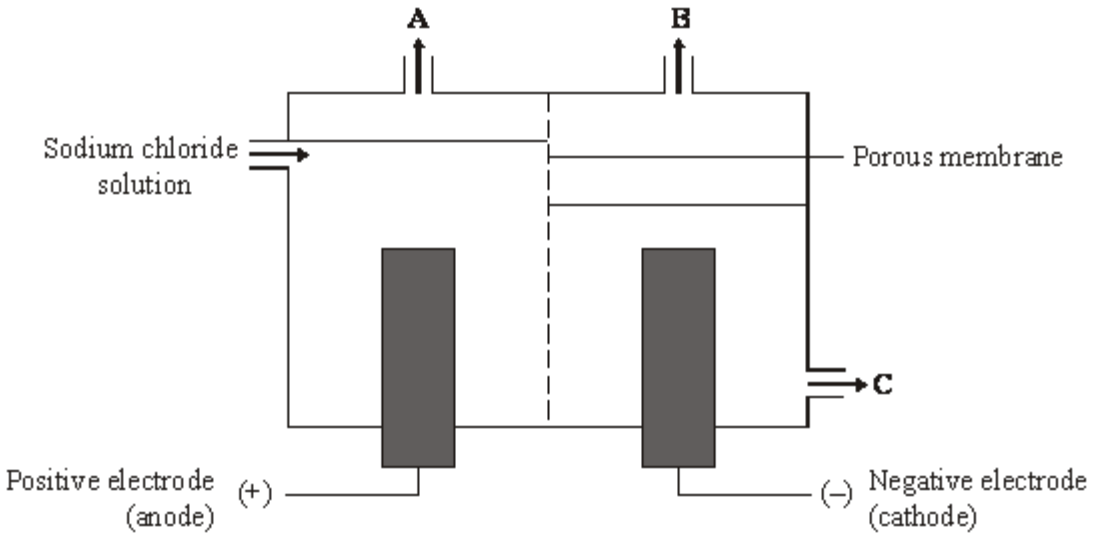
alkenes	**elements**	**salts**

During electrolysis the compound is broken down to form_____

(1)

(b) The table of ions on the Data Sheet may help you to answer this question.

The diagram shows an apparatus used for the electrolysis of sodium chloride solution.



Identify the products **A**, **B** and **C** on the diagram using substances from the box.

chlorine gas	**hydrogen gas**	**oxygen gas**
sodium hydroxide solution		**sodium metal**

(i) **A** is _____

(1)

(ii) **B** is _____

(1)

(iii) **C** is _____

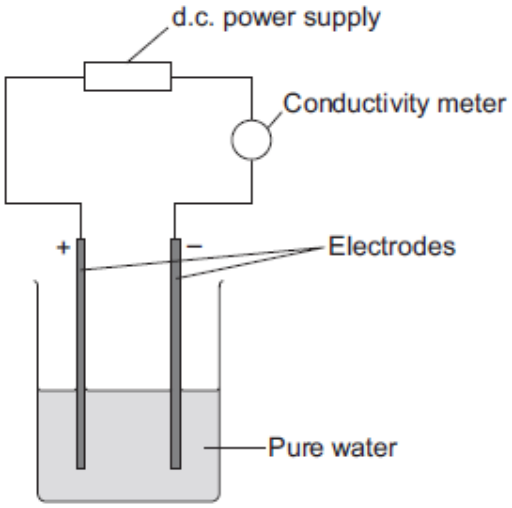
(1)

(Total 5 marks)

BOTH TIERS

Q3.

A student investigated the conductivity of different concentrations of sodium chloride solution.
The student set the apparatus up as shown in **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.

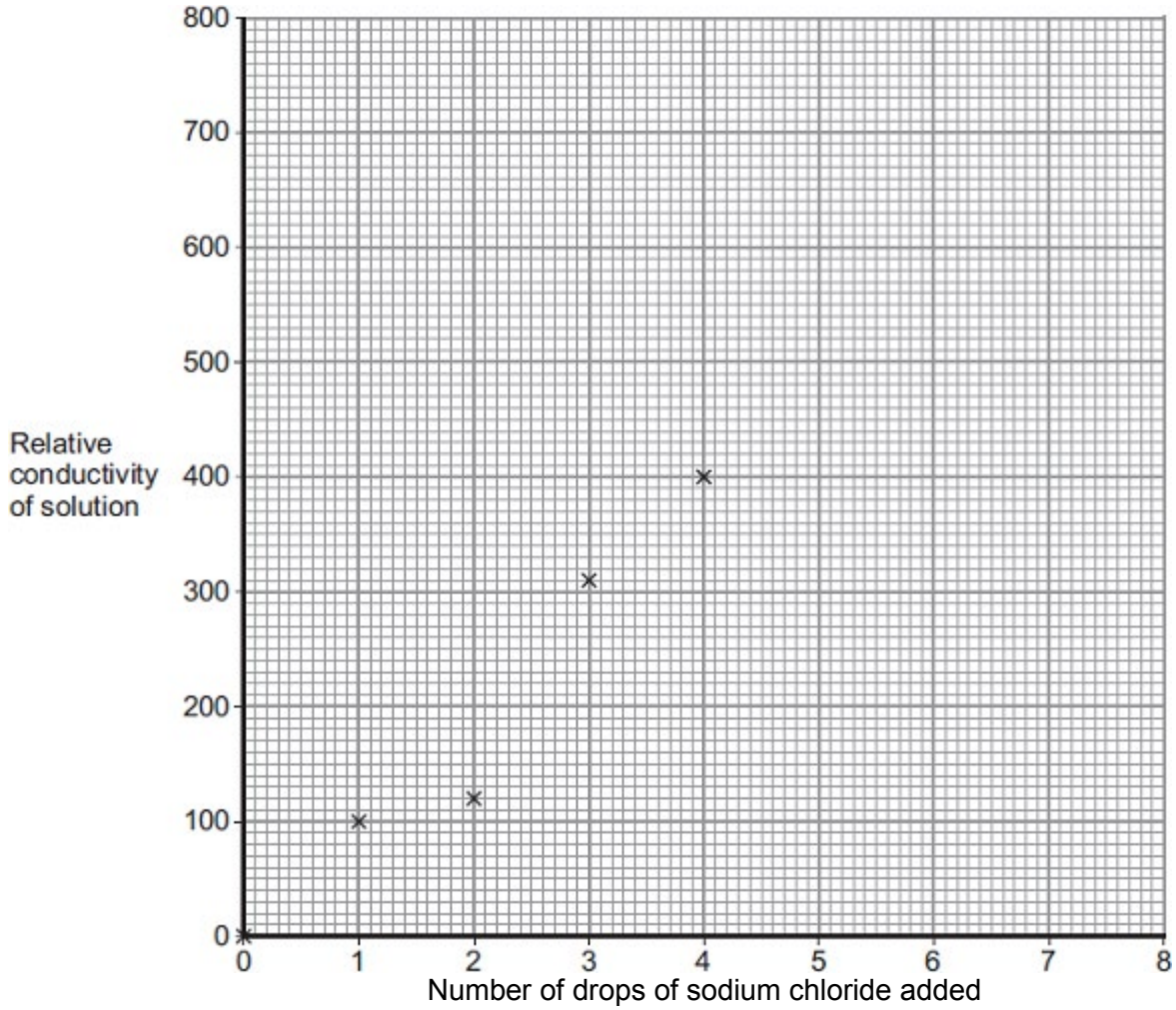
Number of drops of sodium chloride solution added	Relative conductivity of solution
0	0
1	100
2	120
3	310
4	400
5	510
6	590
7	710
8	800

(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.

_____

_____

(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.

_____

(1)

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

_____

_____

_____

_____

(2)

(ii) Explain why sodium chloride solution conducts electricity.

_____

_____

_____

_____

(2)

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

Complete the sentence.

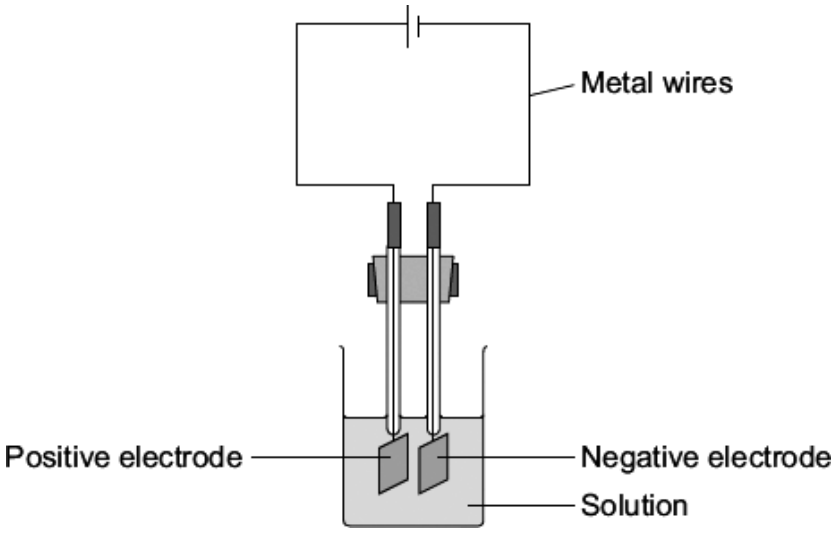
The gas produced at the negative electrode is _____

(1)

(Total 10 marks)

Q4.

The diagram shows apparatus used by a student to investigate electrolysis.



The student was given a solution by the teacher. The solution contained a mixture of ionic compounds.

(a) Name the particles which carry the electric current through:

(i) the metal wires _____ **(1)**

(ii) the solution. _____ **(1)**

(b) The table shows the ions in the solution.

Positive ions in the solution	Negative ions in the solution
Zinc ion (Zn^{2+})	Chloride ion (Cl^-)
Iron(III) ion (Fe^{3+})	Hydroxide ion (OH^-)
Hydrogen ion (H^+)	Nitrate ion (NO_3^-)
Copper(II) ion (Cu^{2+})	Sulfate ion (SO_4^{2-})

The reactivity series on the Data Sheet may help you to answer this question.

(i) Which element is most likely to be formed at the negative electrode?

_____

(1)

(ii) Explain, as fully as you can, why you have chosen this element.

_____

_____

_____

_____

(2)

(c) The electrolysis of sodium chloride solution is an industrial process.

(i) The reaction at one of the electrodes can be represented by the equation shown below.

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

The chloride ions (Cl^-) are oxidised.

Explain why.

_____

_____

(1)

(ii) The reaction at the other electrode can be represented by an equation.

Complete and balance the equation for the reaction at the other electrode.

$$H^+ \rightarrow H_2$$

(1)

(Total 7 marks)

HIGHER ONLY

Q5.

Sando-K is a medicine. It is given to people whose bodies contain too little of a particular element.

Sando-K is a mixture of two compounds. The formulae of the two compounds are given below.

$KHCO_3$ **KC1**

(a) Which metal do people given Sando-K need?

_____

(1)

(b) Sando-K contains the ion, CO_3^{2-}. Which gas would be produced if a dilute acid was added to Sando-K? (The Data Sheet may help you to answer this question.)

_____

(1)

(c) The compounds in Sando-K contain ions.

Complete the two sentences below.

Atoms change into positive ions by _____ one or more

_____ .

Atoms change into negative ions by _____ one or

more _____ .

(4)

(d) Electricity can be used to show that an aqueous solution of Sando-K contains ions.

(i) Draw a diagram of an apparatus that you could use to prove that Sando-K contains ions.

(4)

(ii) Explain, as fully as you can, what would happen when the electricity is switched on.

_____

_____

_____

_____

(3)

(Total 13 marks)

Q6.

Read the passage carefully and then answer the questions.

The electrolysis of acidified water

After a few drops of dilute sulphuric acid have been added to some distilled water, there will be three types of ion in solution:

from the water, $H_2O(l) \rightarrow H^+(aq) + OH^-(aq)$

from the acid, $H_2SO_4(aq) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$

When the electrodes (anode and cathode) in a circuit are put into the acidified water, the hydroxide ions and the sulphate ions are both attracted to the electrode called the anode. However, it is harder for the sulphate ions to give up their electrons than for the hydroxide ions to do this. So the hydroxide ions are the ones which react and bubbles of oxygen are formed at the anode.

There are only hydrogen ions to be attracted towards the cathode and, when they get there, they take up electrons to form hydrogen molecules.

From Chemistry Matters by Richard Hart, reproduced by permission of Oxford University Press

Even in a small volume of water acidified with dilute sulphuric acid there will be billions of ions. Some will be anions and some will be cations.

(i) Name the ions in water acidified with dilute sulphuric acid.

_____

(1)

(ii) Explain why only some of the ions are attracted to the anode.

_____

_____

_____

(2)

(iii) Balance the equation for the reaction of hydroxide ions at the anode.

$4OH^- \rightarrow H_2O + O_2 + e^-$

(1)

(Total 4 marks)

Q7.

This question is about potassium.

(a) Humphrey Davy was a professor of chemistry.

In 1807 Davy did an electrolysis experiment to produce potassium.

(i) Davy first tried to electrolyse a solid potassium salt to produce potassium.

Explain why this electrolysis did **not** work.

_____

_____

_____

_____

(2)

(ii) Humphrey Davy was the first person to produce potassium.

Humphrey Davy's experiment to produce this new element was quickly accepted by other scientists.

Suggest why.

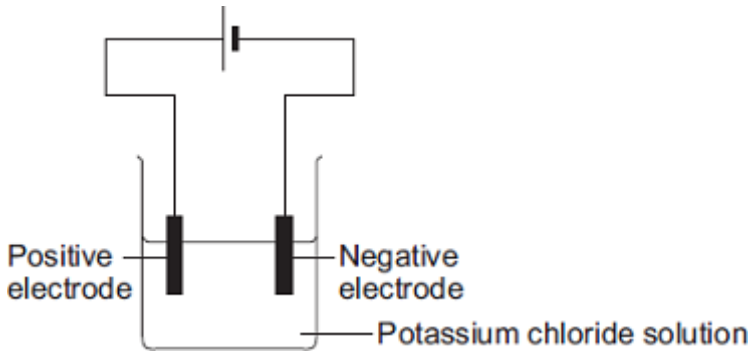
_____

_____

(1)

(b) A student dissolved some potassium chloride in water. The student tried to electrolyse the potassium chloride solution to produce potassium.

The apparatus the student used is shown in the diagram.



The student expected to see potassium metal at the negative electrode, but instead saw bubbles of a gas.

- Name the gas produced at the negative electrode.
- Explain why this gas was produced at the negative electrode **and** why potassium was not produced.

The reactivity series of metals on the Chemistry Data Sheet may help you to answer this question.

_____

_____

_____

_____

_____

_____

(3)

(c) The student tried to electrolyse molten potassium chloride to produce potassium.

(i) Potassium metal was produced at the negative electrode.

Describe how potassium atoms are formed from potassium ions.

_____

_____

_____

_____

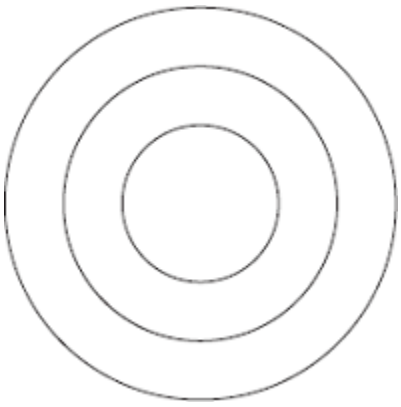
(2)

(ii) Complete and balance the equation for the reaction at the positive electrode.

$$\_\_\_\_\_Cl^- \longrightarrow Cl_2 + \_\_\_\_\_$$

(1)

(iii) Complete the diagram to show the electronic structure of a chloride ion (Cl^-).



(1)

(Total 10 marks)

Mark it

Q1. (a) electricity *allow an electric current*

1

(b) (i) chlorine/Cl_2 *do **not** accept chloride*

1

(ii) (zinc ions are) positive *ignore to gain electrons*

1

and (opposite charges) attract

1

(iii) reduction

1

(c) (i) in alloy:
accept converse
different sized atoms/particles
or
no layers/rows *accept layers distorted*

1

so cannot slide

1

(ii) shape memory (alloys) *accept smart*

1

[8]

Q2. (a) (i) ionic

1

(ii) elements

1

(b) (i) chlorine (gas) *allow Cl_2 / Cl / Cl^2* *allow chloride*

1

(ii) hydrogen (gas) *allow H / H_2 / H^2*

1

(iii) sodium hydroxide (solution) *allow NaOH* *allow sodium solution*

1

[5]

Q3. (a) (i) points correctly plotted (± ½ small square)
*four points = **2** marks*
*three points = **1** mark*

Max 2

straight line of best fit using full range of points from 0,0

1

(ii) any **one** from:
must explain why the point is below the line

- the solution may not have been properly stirred
- the electrodes may have been a larger distance apart
- the drop of sodium chloride may have been a smaller volume / smaller

allow not enough sodium chloride added
allow smaller amount of sodium chloride
*do **not** allow too few drops added*
ignore the student may have misread the conductivity meter

1

(iii) any **one** from:

- the volume of pure water
  allow amount
- the concentration (of the solutions added)
- the volume (of the drops) of solution added
  ignore number of drops
- the distance between the electrodes
- the same electrodes **or** electrodes made of the same material
- same depth **or** surface area of electrodes in the water
- constant power supply
  ignore current
- stirred

1

(b) (i) because (pure) water is covalent / molecular (simple) **or** contains molecules

1

therefore (pure) water has no free / mobile electrons **or** ions
*molecules do not have a charge **or** molecules do not contain ions*
*gains **2** marks*

1

(ii) because there are ions in sodium chloride
*allow Na^+ and / or Cl^-(ions) **or** ionic bonding.*
Ignore particles other than ions for MP1.

1

which can move **or** carry the current / charge
MP2 must be linked to ions only.

1

(iii) Hydrogen *allow H_2 / H*

1

[10]

Q4. (a) (i) electron(s)
allow free / delocalised / negative electrons
*do **not** accept additional particles*

1

(ii) ion(s)
allow named ions from table
ignore positive or negative
*do **not** accept additional particles*

1

(b) (i) copper *accept Cu* *do **not** accept Cu^{2+}*

1

(ii) it is / they are positive (ions) *accept formula of positive ion*

1

and it is the least reactive

1

(c) (i) loss of electron(s) *ignore numbers*

1

(ii) $2H^+ + 2e^- \rightarrow H_2$

accept correct multiples / fractions

accept e / e^-

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

1

[7]

Q5. (a) potassium / K *for 1 mark*

1

(b) carbon dioxide / CO_2 *for 1 mark*

1

(c) losing
electrons
gaining
electrons *for 1 mark each*

4

(d) (i) power supply, (not mains)
beaker containing solution,
(inert) electrodes and circuit
ammeter or bulb/
(or see bubbling etc. at electrodes written by drawing)

for 1 mark each

4

(ii) reading on ammeter/bulb lights / (solution) conducts (electricity)
bubbling / gas produced
hydrogen produced
chlorine / oxygen produced
ions move
to electrodes (must be linked to ions move)
negative ions move to the positive electrode
<u>and/or</u> positive ions move to the negative electrode
negative ions lose electrons
<u>and/or</u> positive ions gain electrons

any 3 for 1 mark each

3 **[13]**

Q6. (i) hydrogen, hydroxide and sulphate

*all **three** and no others in any order*

do not credit any formula(e)

1

(ii) the anode is positive

1

(so) only the negative ions are attracted to it

***or** (so) only the hydroxide ions and the sulphate ions are attracted (to it)*

***or** (so) only the anions are attracted (to it)*

1

(iii) $2H_2O + O_2 + 4e^-$

1

[4]

Q7. (a) (i) current / charge couldn't flow

allow could not conduct (electricity)

1

because the ions / particles couldn't move

*do **not** accept electrons/ molecules / atoms*

or

(salt) needs to be molten / (1) dissolved (to conduct electricity)

so that the ions / particles can move (1)

*do **not** accept electrons / molecules / atoms*

1

(ii) he had status

*accept he had authority **or** experience*

or

he had evidence / proof

accept the experiment could be repeated

1

(b) hydrogen / H_2

*do **not** allow hydrogen ions*

1

the ions are positive

accept because opposite (charges) attract

1

potassium is more reactive (than hydrogen)

accept potassium ions are less easily discharged (than hydrogen)
***or** potassium ions are less easily reduced (than hydrogen)*

1

(c) (i) gain electron(s)

*accept fully balanced correct equation for **2** marks*

1

one electron

*if no other marks awarded allow (potassium ions) reduced for **1** mark*

1

(ii) $2\ Cl^- \rightarrow Cl_2 + \mathbf{2e}^-$

must be completely correct, including charge on electron
accept correct multiples

1

(iii) 2, 8, 8

accept any combination of dots, crosses, "e" or any other relevant symbol
ignore any charges if given