New Document 1

Name: _____

Class: _____

Date: _____

Time: **39 minutes**

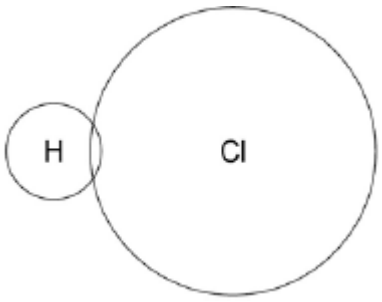
Marks: **36 marks**

Comments:

Q1.

Hydrogen chloride (HCl) is a gas.

(a) Complete the diagram to show all of the arrangement of the outer shell electrons of the hydrogen and chlorine atoms in hydrogen chloride.



(1)

(b) Hydrochloric acid is a strong acid.
Ethanoic acid is a weak acid.

Describe a reaction that could be used to show the difference between a weak acid and a strong acid.

You should explain why the weak acid and the strong acid give different results.

(6)

(Total 7 marks)

Q2.

Copper can be produced from copper(II) sulfate solution by two different methods.

Method 1 – Electrolysis

(a) To produce copper by electrolysis a student has inert electrodes, a d.c. power supply, a switch and electrical wires for the external circuit.

Draw and label the apparatus set up to produce copper from copper(II) sulfate solution by electrolysis.

(2)

(b) Suggest why the colour of the copper(II) sulfate solution fades during the electrolysis.

(3)

(c) Explain how copper is produced from copper(II) sulfate solution by electrolysis.

(4)

Method 2 – Displacement

(d) The chemical equation for the displacement of copper using iron is:

$$CuSO_4 + Fe \rightarrow Cu + FeSO_4$$

Calculate the minimum mass of iron needed to displace all of the copper from 50 cm^3 of copper(II) sulfate solution.

The concentration of the copper(II) sulfate solution is 80 g $CuSO_4$ per dm^3.

Relative atomic masses (A_r): O = 16; S = 32; Fe = 56; Cu = 63.5

Give your answer to 2 significant figures.

Mass of iron = _____ g

(4)

(Total 13 marks)

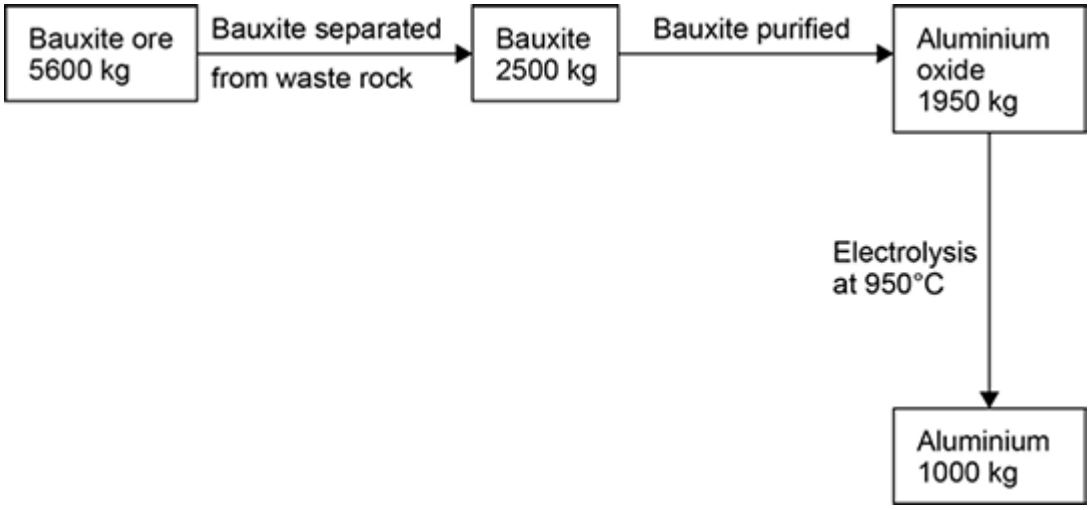
Q3.

Aluminium is produced from an ore called bauxite.

Bauxite contains aluminium oxide.

Look at **Figure 1**.

Figure 1



(a) Calculate the percentage of bauxite that is converted into aluminium oxide.

_____

_____

Percentage = _____

(2)

(b) Show by calculation that the mass of aluminium produced is less than that expected from 1 950 kg aluminium oxide (Al_2O_3).

You should state the difference in the mass of aluminium expected and the mass of aluminium produced to three significant figures.

Relative atomic masses (A_r): O = 16; Al = 27

_____

_____

_____

_____

_____

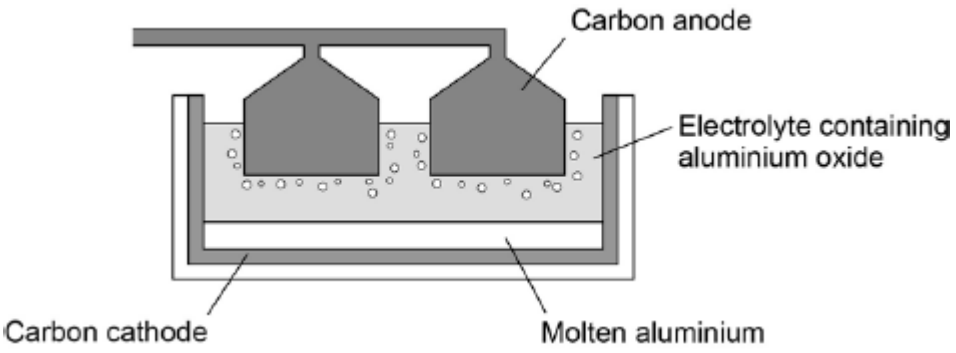
_____

_____

(3)

(c) **Figure 2** shows an electrolysis cell used to extract aluminium.

Figure 2



Why does the carbon anode used in the electrolysis cell need to be continually replaced?

_____

_____

_____

_____

(3)

(d) In an electrolysis cell the current is 1.5×10^5 A, at a potential difference of 4V.

Calculate the energy transferred by the electrolysis cell in 24 hours.

_____

_____

_____

_____

_____

_____

Energy transferred = _____ J

(5)

(e) The half equation at the cathode is:

$Al^{3+} + 3\,e^- \longrightarrow Al$

Calculate the number of moles of electrons needed to produce 1 000 kg of aluminium.

Give your answer to three significant figures.

Relative atomic mass (A_r): Al = 27

_____

_____

Answer = _____ moles

(3)

(Total 16 marks)

Mark schemes

Q1.

(a) bonded pair of electrons and

6 non-bonded electrons on chlorine

1

(b) **Level 3 (5–6 marks):**
A detailed and coherent explanation of comparative results of a reaction in terms of concentration and ionisation. The response makes logical links between the points raised and uses sufficient examples to support these links.

Level 2 (3–4 marks):
A description of a reaction with results is given but may miss some details. Links are made but may not be fully articulated and / or precise.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content

Indicative content

Simple statements / descriptions of a reaction

- correct comparative pH, such as, 0–3 (strong) 4–6 (weak)
- named reaction, such as, with a reactive metal or a named carbonate
- comparative results or observations of the named reaction, such as, faster reaction (strong) or greater volume of gas produced in a given time (strong)

Explanations of different results

- weak acids are only partially ionised in aqueous solution
- strong acids are completely ionised in aqueous solution / greater concentration of H^+ ions
- aqueous solutions of acids at the same concentration / same state of division
  of metal / powder, same temperature

6

[7]

Q2.

(a) electrodes connected to d.c. power supply by wires

for this diagram ignore the material used for the electrodes as long as they are made from carbon or metals that are inert

1

electrodes labelled anode (+) and cathode (−)

1

(b) copper ions cause the blue colour

answer must be in terms on copper ions

1

copper ions are reduced / converted to copper ions

1

so the concentration of copper ions decreased

1

*if no other mark awarded allow **1** mark for copper ions are used up during electrolysis*

(c) copper ions are positive

1

so are attracted to the inert cathode **or** inert negative electrode

1

copper ions gain electrons at the inert cathode **or** inert negative electrode

1

so they are reduced to form copper atoms

1

(d) 50 cm^3 contains 4 g $CuSO_4$

1

M_r $CuSO_4$ = 159.5

1

4 g $CuSO_4$ reacts with $\frac{4}{159.5}$ × 56 g Fe

= 1.40(43877)

1

= 1.4 (g)

1

*accept 1.4(g) with no working shown for **4** marks*
*allow 1.40(43887) without working shown for **3** marks*

[13]

Q3.

(a) 1 950 / 2 500 × 100

1

78 (%)

1

(b) expected mass of aluminium

1950 × 54 / 102

1

= 1032.35

1

mass not collected

1032.35 − 1 000

= 32.4

*allow 32.4 with no working shown for **3** marks*

1

*incorrect number of sig. figs max **2** marks*

(c) because oxygen is formed at the anode **1**

which reacts with the carbon anode to produce carbon dioxide **1**

and wears it away **1**

(d) power = $1.5 \times 10^5 \times 4$ **1**

$= 6.0 \times 10^5$ W **1**

24 hours = $24 \times 60 \times 60 = 8.64 \times 10^4$ seconds **1**

energy transferred = $6.0 \times 10^5 \times 8.64 \times 10^4$

allow ecf from power calculation **1**

$= 5.184 \times 10^{10}$

*allow 5.184×10^{10} with no working for **5** marks* **1**

(e) 3 moles of electrons are needed to produce 27 g or 0.027 kg aluminium **1**

so moles of electrons to produce 1 000 kg = 1 000 / 0.027 × 3 **1**

= 111 000

*allow 111 000 with no working shown for **3** marks* **1**

*incorrect no. of sig. figs max **2** marks*

[16]