

Quantitative Chemistry 1

Name: _____

Class: _____

Date: _____

Time: **43 minutes**

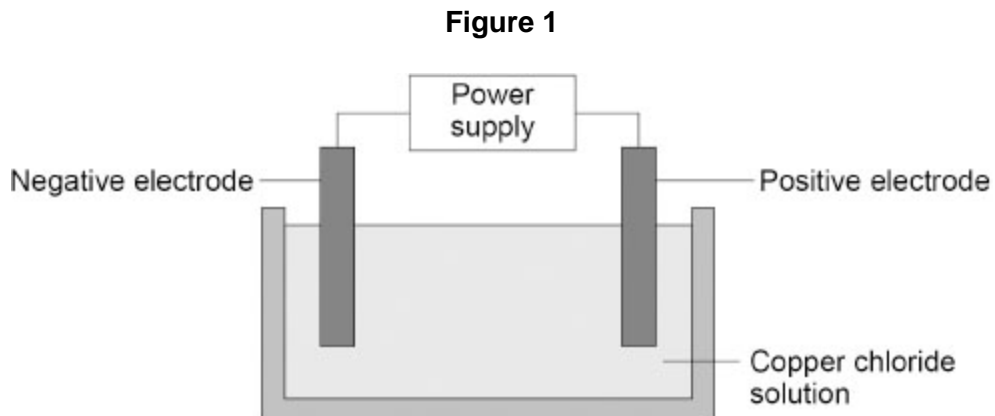
Marks: **39 marks**

Comments:

1.

A teacher demonstrated the electrolysis of copper chloride solution.

Figure 1 shows the apparatus.



The teacher measured the mass of the negative electrode every 60 seconds.

(a) Chlorine gas is given off during the electrolysis of copper chloride solution.

Chlorine gas is poisonous.

Give **one** way of reducing the risk of harm.

(1)

The table below shows the results.

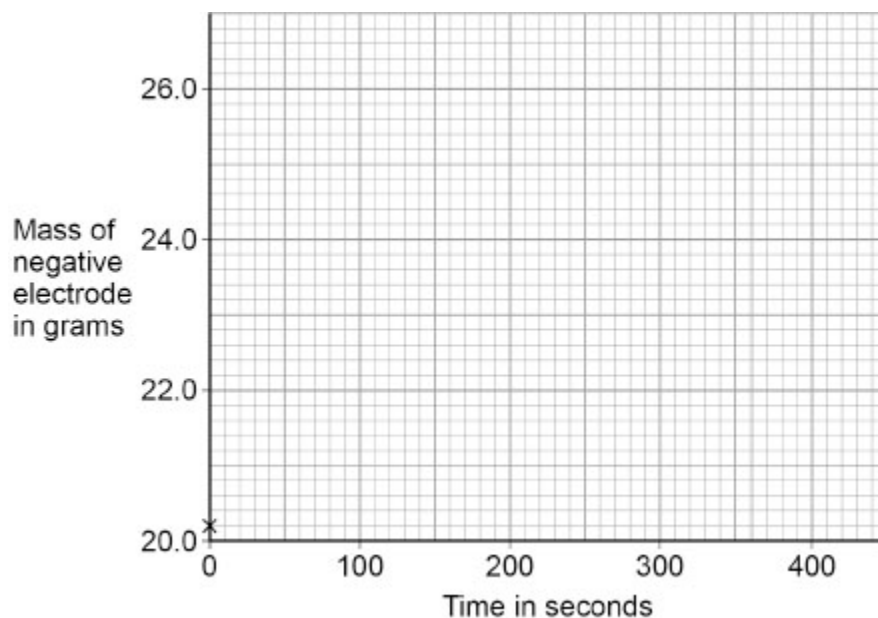
Time in seconds	Mass of negative electrode in grams
0	20.2
60	22.0
120	23.4
180	24.2
240	24.8
300	25.2
360	25.2

(b) Plot the data from the table above on **Figure 2**.

Draw a line of best fit.

The first point has been plotted for you.

Figure 2



(3)

(c) A student made the hypothesis:

'The negative electrode will increase by a constant mass every 60 seconds.'

How do the results in the table above show that the hypothesis is **not** correct?

(1)

(d) 25 cm³ of the solution of copper chloride contained 5.5 g of copper chloride.

Calculate the concentration of the solution in g/dm³.

$$1 \text{ dm}^3 = 1000 \text{ cm}^3$$

Concentration = _____ g/dm³

(3)

(e) The teacher also electrolysed potassium chloride solution.

Hydrogen gas was given off at the negative electrode.

Why was hydrogen gas given off?

Tick (✓) **one** box.

Hydrogen is less reactive than potassium.

Hydrogen has the same reactivity as potassium.

Hydrogen is more reactive than potassium.

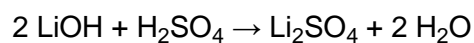
(1)

(Total 9 marks)

2.

Lithium hydroxide reacts with sulfuric acid to produce lithium sulfate.

The equation for the reaction is:



(a) What type of reaction is this?

(1)

(b) Calculate the relative formula mass (M_r) of sulfuric acid (H_2SO_4).

Relative atomic masses (A_r): H = 1 O = 16 S = 32

Relative formula mass (M_r) = _____

(2)

(c) Calculate the percentage by mass of oxygen in lithium sulfate (Li_2SO_4).

Relative atomic mass (A_r): O = 16

Relative formula mass (M_r): $Li_2SO_4 = 110$

Give your answer to 2 significant figures.

Percentage by mass of oxygen (2 significant figures) = _____ %

(4)

(d) A solution of lithium sulfate contains 0.30 g of lithium sulfate in 25 cm^3 .

Calculate the concentration of lithium sulfate in g/dm^3 .

Concentration = _____ g/dm^3

(3)

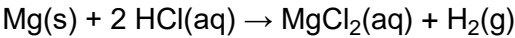
(Total 10 marks)

3.

Acids react with some metals to produce soluble salts.

A student adds magnesium to hydrochloric acid until no more acid reacts and excess magnesium remains.

The equation for the reaction is:



(a) Describe how solid magnesium chloride is obtained from the reaction mixture.

(2)

(b) The reaction between magnesium and hydrochloric acid is a redox reaction.

Explain what happens to the magnesium atoms in this reaction.

(2)

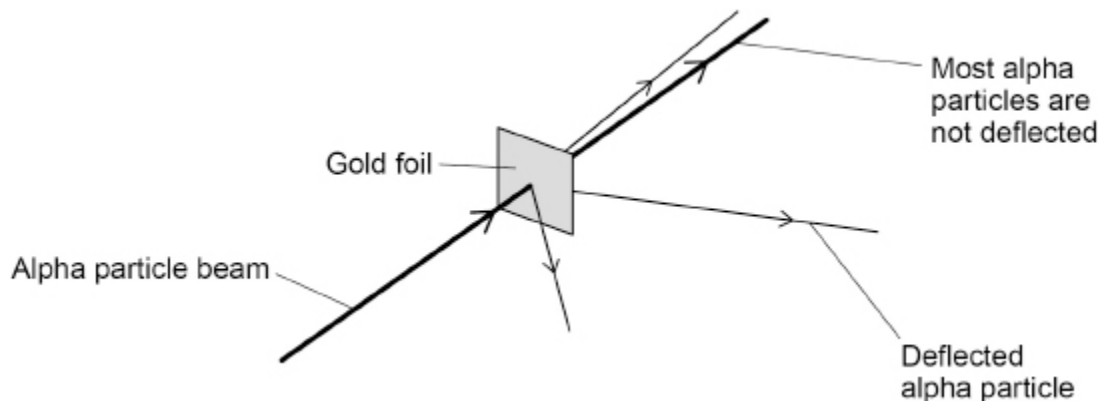
4.

This question is about gold and compounds of gold.

(a) In the alpha particle scattering experiment alpha particles are fired at gold foil.

Alpha particles are positively charged.

The diagram below shows the results.



What **two** conclusions can be made from the results?

Tick (✓) **two** boxes.

Atoms are balls of positive charge with embedded electrons.

Atoms are tiny spheres that cannot be divided.

Atoms have a positively charged nucleus.

Mass is concentrated in the nucleus in the centre of atoms.

Neutrons exist within the nucleus.

(2)

(b) The gold foil is:

- 4.00×10^{-7} metres thick
- 2400 atoms thick.

What is the diameter of one gold atom in metres?

Give your answer to 3 significant figures.

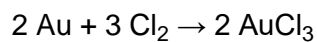
Diameter of one gold atom (3 significant figures) = _____ m

(3)

(c) Gold reacts with the elements in Group 7 of the periodic table.

0.175 g of gold reacts with chlorine.

The equation for the reaction is:



Calculate the mass of chlorine needed to react with 0.175 g of gold.

Give your answer in mg

Relative atomic masses (A_r): Cl = 35.5 Au = 197

Mass of chlorine = _____ mg

(5)

(Total 10 marks)

Mark schemes

1.

(a) any **one** from:

- do experiment in a fume cupboard
ignore references to safety glasses or gloves
allow use an extractor fan
- do experiment in a well-ventilated laboratory / room
allow descriptions of well-ventilated such as open windows
allow use a gas mask

1

(b) all 6 points plotted correctly

- allow a tolerance of $\pm \frac{1}{2}$ a small square*
- allow 1 mark for 4 or 5 points plotted correctly*

2

line of best fit

1

(c) any **one** from:

- the increase in mass (for successive 60 second intervals) decreases
allow evidence of two correctly determined changes in mass (for 60 second intervals) from the table
allow the difference in mass (every 60 seconds) is not the same
- after 300 seconds the mass remains constant

1

- (d) (volume conversion $25 \text{ cm}^3 =$
 $0.025 \text{ (dm}^3)$

1

$$\text{(concentration =) } \frac{5.5}{0.025}$$

allow correct use of an incorrect / no conversion of volume

1

$$= 220 \text{ (g/dm}^3)$$

OR

$$\text{(concentration =) } \frac{5.5}{25} \text{ (1)}$$

$$= 0.22 \text{ (g/cm}^3) \text{ (1)}$$

$$\text{(conversion = } 0.22 \times 1000) = 220 \text{ (g/dm}^3) \text{ (1)}$$

*allow correct use of an incorrectly determined concentration in
g/cm³*

using the values in the question

OR

$$\text{(ratio of volume } \frac{1000}{25} =) 40 \text{ (1)}$$

$$\text{(so ratio of mass =) } 40 \times 5.5 \text{ (1)}$$

$$= 220 \text{ (g/dm}^3) \text{ (1)}$$

1

- (e) hydrogen is less reactive than potassium

1

[9]

2.

- (a) neutralisation

allow exothermic

1

- (b) ($M_r =$
 $(1 \times 2) + 32 + (4 \times 16)$

1

$$= 98$$

1

(c) $(A_r \text{ O} \times 4 =)$
 4×16
or
64

1

(percentage of oxygen =)

$$\frac{64}{110} \times 100$$

allow correct use of incorrectly determined mass of oxygen

1

$$= 58.18$$

1

$$= 58 (\%)$$

allow a correctly calculated answer to 2 significant figures from an incorrect calculation which uses the values in the question

1

(d) (unit conversion)
 $(25 \text{ cm}^3 \div 1000) = 0.025 \text{ dm}^3$

1

$$(\text{conc} =) \frac{0.30}{0.025} \text{ (g/dm}^3\text{)}$$

allow correct use of incorrect / no unit conversion

1

$$= 12 \text{ (g/dm}^3\text{)}$$

1

alternative approach:

$$\frac{0.30}{25} \text{ (g/cm}^3\text{) (1)}$$

$$= 0.012 \text{ (g/cm}^3\text{) (1)}$$

(unit conversion)

$$(0.012 \times 1000)$$

$$= 12 \text{ (g/dm}^3\text{) (1)}$$

allow correct conversion of an incorrect concentration calculation

[10]

3. (a) filter (to remove excess magnesium) 1
- (then) crystallisation (of magnesium chloride solution)
allow (then) evaporation (of water from magnesium chloride solution) 1
- (b) (magnesium atoms are) oxidised 1
- (because the atoms) lose (two) electrons 1
- (c) (moles Mg =) $\frac{0.72}{24}$ 1
- = 0.03 1
- (moles Mg = moles MgCl₂)
 (so mass MgCl₂ =) 0.03 × 95
allow a correct calculation using an incorrectly calculated value of moles of magnesium
allow a correct calculation using an incorrectly calculated value of moles of magnesium chloride 1
- = 2.85 (g) 1
- (100.0 cm³ = 0.100 dm³)
- concentration = $\frac{\text{mass}}{\text{volume}}$
- = $\frac{2.85}{0.100}$
allow correct use of incorrectly calculated mass of magnesium chloride 1
- = 28.5 (g/dm³) 1
- [10]

4. (a) atoms have a positively charged nucleus. 1
- mass is concentrated in the nucleus in the centre of atoms. 1

(b)

$$\frac{4 \times 10^{-7}}{2400}$$

1

$$= 1.66666 \times 10^{-10}$$

1

$$= 1.67 \times 10^{-10} \text{ (m)}$$

allow 0.000 000 000 167 (m)

allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the values in the question

1

(c) (moles Au = $\frac{0.175}{197}$ =) 0.000888

1

(moles Cl₂ = 0.000888 × $\frac{3}{2}$ =) 0.00133

allow a correct calculation using an incorrectly calculated value of moles of gold

1

(mass Cl₂ =) 0.00133 × 71

allow a correct calculation using an incorrectly calculated value of moles of chlorine

1

= 0.0946 (g)

1

= 94.6 (mg)

allow a correct conversion using an incorrectly calculated mass of chlorine

1

alternative approach:

(from equation 2 moles of Au reacts with 3 moles of Cl₂)

(so) 394 g Au reacts with 213 g Cl₂ (1)

1 g Au reacts with ($\frac{213}{394}$ =)

0.54 g Cl₂ (1)

allow a correct calculation using an incorrectly calculated value of mass of gold and / or chlorine

0.175 g Au reacts with

0.54 × 0.175 g Cl₂ (1)

allow a correct calculation using an incorrectly calculated value of mass of gold and / or chlorine

= 0.0946 (g) (1)

= 94.6 (mg) (1)

allow a correct conversion using an incorrectly calculated mass of chlorine

[10]