AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.3.2.5

Concentration of solutions

Past-paper questions

Tier	**Higher**
Question groups	**9**
Available paper years	**2018–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

5.3.2.5 Concentration of solutions

Question 01

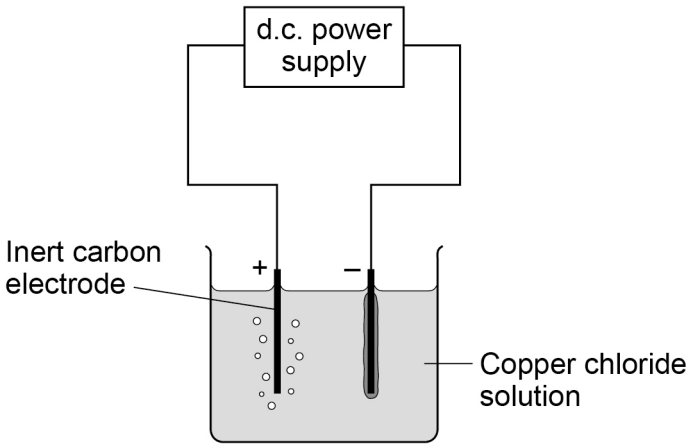
June 2018 | 8464/C/1H | Original Q1

0 1 This question is about electrolysis.

A student investigates the mass of copper produced during electrolysis of copper chloride solution.

Figure 1 shows the apparatus.

Figure 1



0 1 . 1 Which gas is produced at the positive electrode (anode)?

[1 mark]

Tick **one** box.

- carbon dioxide ☐
- chlorine ☐
- hydrogen ☐
- oxygen ☐

0 1 . 2 Copper is produced at the negative electrode (cathode).

What does this tell you about the reactivity of copper?

[1 mark]

Tick **one** box.

Copper is less reactive than hydrogen ☐

Copper is less reactive than oxygen ☐

Copper is more reactive than carbon ☐

Copper is more reactive than chlorine ☐

Table 1 shows the student's results.

Table 1

	Total mass of copper produced in mg			
Time in mins	**Experiment 1**	**Experiment 2**	**Experiment 3**	**Mean**
1	0.60	0.58	0.62	0.60
2	1.17	1.22	1.21	1.20
4	2.40	2.41	2.39	2.40
5	3.02	**X**	3.01	3.06

0 1 . 3 Determine the **mean** mass of copper produced after 3 minutes.

[1 mark]

Mass = _____ mg

Question 1 continues on the next page

5.3.2.5 Concentration of solutions

Question 01 · continued

0 1 . 4 Calculate the mass **X** of copper produced in **Experiment 2** after 5 minutes.

Use **Table 1** on page 3

[2 marks]

Mass **X** = _____ mg

0 1 . 5 The copper chloride solution used in the investigation contained 300 grams per dm^3 of solid $CuCl_2$ dissolved in 1 dm^3 of water.

The student used 50 cm^3 of copper chloride solution in each experiment.

Calculate the mass of solid copper chloride used in each experiment.

[3 marks]

Mass = _____ g

8

5.3.2.5 Concentration of solutions

Question 02

June 2019 | 8464/C/2H | Original Q4

0 4 This question is about copper and fuels.

0 4 . 1 Copper is extracted from low-grade ores by phytomining.

Describe how copper metal is produced by phytomining.

[4 marks]

0 4 . 2 Another method of extracting copper from low-grade ores is bioleaching.

A solution of copper sulfate ($CuSO_4$) produced by bioleaching has a concentration of 0.319 g/dm^3

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

Calculate the number of moles of copper that can be produced from 1 dm^3 of this solution.

[3 marks]

Number of moles of copper = _____ mol

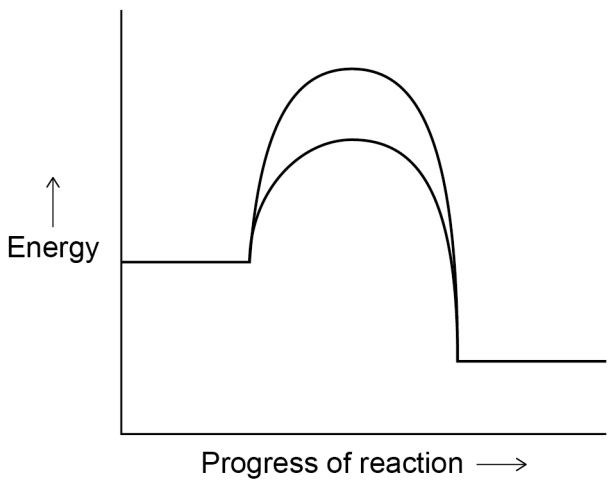
5.3.2.5 Concentration of solutions

Question 02 · continued

Copper is used as a catalyst.

Figure 1 shows reaction profiles for a reaction with and without a catalyst.

Figure 1



0 4 . 3 How do the reaction profiles show that using a catalyst does **not** affect the overall energy change for the reaction?

[1 mark]

Tick (✓) **one** box.

Both reaction profiles show exothermic reactions. ☐

Both reaction profiles start at the same energy level and end at the same energy level. ☐

Both reaction profiles show the activation energy. ☐

The activation energy for the uncatalysed reaction is much lower than for the catalysed reaction. ☐

5.3.2.5 Concentration of solutions

Question 02 · continued

0 4 . 4 Copper is a catalyst in a reaction to produce ethanol from carbon dioxide.

Ethanol (C_2H_5OH) is used as a fuel.

Suggest why producing ethanol from carbon dioxide is sustainable.

[2 marks]

0 4 . 5 Chemistry plays an important role in sustainable development.

What is sustainable development?

[2 marks]

12

5.3.2.5 Concentration of solutions

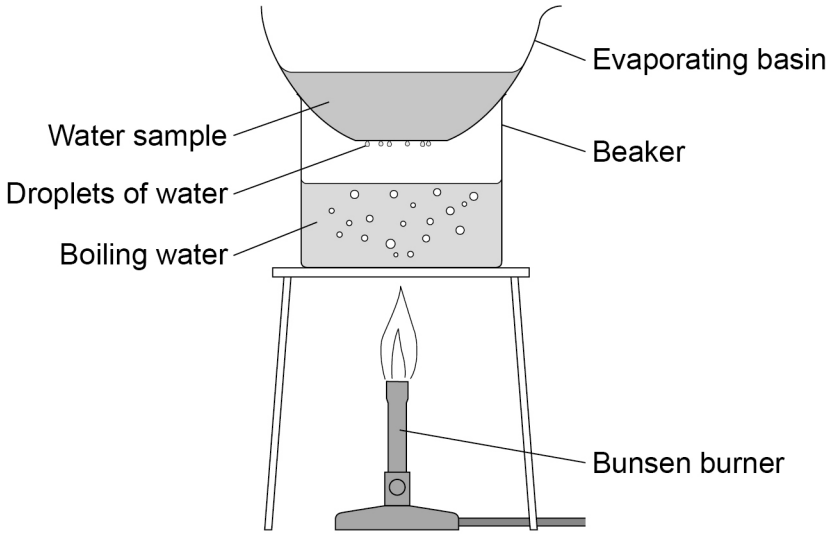
Question 03

November 2020 | 8464/C/2H | Original Q4

0 4 A student investigated the mass of dissolved solids in four water samples **A**, **B**, **C** and **D**.

Figure 4 shows the apparatus used.

Figure 4



This is the method used.

1. Record the mass of a dry evaporating basin.
2. Pour 25 cm^3 of water sample **A** into the evaporating basin.
3. Place the evaporating basin on the beaker for 10 minutes.
4. Record the mass of the evaporating basin and contents.
5. Repeat steps 1 to 4 with water sample **A** three more times.
6. Repeat steps 1 to 5 with water samples **B**, **C** and **D**.

5.3.2.5 Concentration of solutions

Question 03 · continued

0 4 . 1 What type of variable is the mass of dissolved solids?

[1 mark]

Tick (✓) **one** box.

- Categoric ☐
- Control ☐
- Dependent ☐
- Independent ☐

0 4 . 2 The method produced an error in the mass recorded in step 4.

Suggest what caused the error.

How could the error be avoided?

[2 marks]

Error _____

_____

Avoided by _____

_____

Question 4 continues on the next page

Question 03 · continued

Another student carried out the investigation correctly.

Table 1 shows the results.

Table 1

Water sample	Mass of dissolved solids in g				
	Test 1	Test 2	Test 3	Test 4	Mean
A	0.22	0.23	0.20	**X**	0.21
B	0.03	0.08	0.02	0.03	0.04
C	0.45	0.60	0.49	0.58	0.53
D	0.80	0.91	0.79	0.86	0.84

0 4 . 3 Calculate value **X** in **Table 1**.

[2 marks]

X = _____ g

0 4 . 4 Which water sample has the greatest range of masses of dissolved solids?

Give the reason for your answer.

[2 marks]

Water sample _____

Reason _____

5.3.2.5 Concentration of solutions

Question 03 · continued

0 4 . 5 Water companies measure the volume of water used by households in cubic metres (m^3).

25 cm^3 of a different water sample contained 0.016 g of dissolved solids.

Calculate the mass of dissolved solid in 1 m^3 of this water sample.

1 m^3 = 1000 dm^3

Give your answer in standard form.

[4 marks]

Mass (in standard form) = _____ g

11

5.3.2.5 Concentration of solutions

Question 04

November 2021 | 8464/C/2H | Original Q5

0 5 Atmospheric pollution is emitted by cars.

Some car emissions contain nitrogen dioxide.

0 5 . 1 Describe how nitrogen dioxide (NO_2) is produced in the engine of a car that burns fossil fuels.

[3 marks]

Table 3 shows the concentration of nitrogen dioxide in the air in three different areas for 1 week.

Table 3

	Concentration of nitrogen dioxide in the air in micrograms per m^3		
Day	**City centre**	**Countryside**	**Motorway**
Monday	35	8	22
Tuesday	37	8	23
Wednesday	37	8	23
Thursday	34	8	23
Friday	37	8	23
Saturday	29	7	20
Sunday	**X**	6	17

5.3.2.5 Concentration of solutions

Question 04 · continued

0 5 . 2 The mean value for nitrogen dioxide in the air for the whole week in the city centre is 33 micrograms per m^3.

Calculate the value (**X**) for the concentration of nitrogen dioxide in the air in the city centre on Sunday.

[2 marks]

X = _____ micrograms per m^3

0 5 . 3 Each value in **Table 3** has an uncertainty of ± 2 micrograms per m^3.

Explain why this uncertainty is **most** significant for countryside data.

[2 marks]

Question 5 continues on the next page

5.3.2.5 Concentration of solutions

Question 04 · continued

Nitrogen dioxide is removed from car emissions by catalytic converters.

0 5 . 4 In a catalytic converter nitrogen dioxide (NO_2) reacts to produce nitrogen and oxygen.

Complete the equation for the reaction.

You should balance the equation.

[2 marks]

_____ $NO_2 \rightarrow$ _____ + _____

0 5 . 5 The catalyst in a catalytic converter contains platinum.

Platinum is a finite resource.

What is meant by a 'finite resource'?

[1 mark]

0 5 . 6 Emissions from cars contain carbon dioxide.

Explain why carbon dioxide emissions during use and operation are **not** the total carbon footprint for a car.

Refer to the stages of the life cycle assessment of a car in your answer.

[3 marks]

13

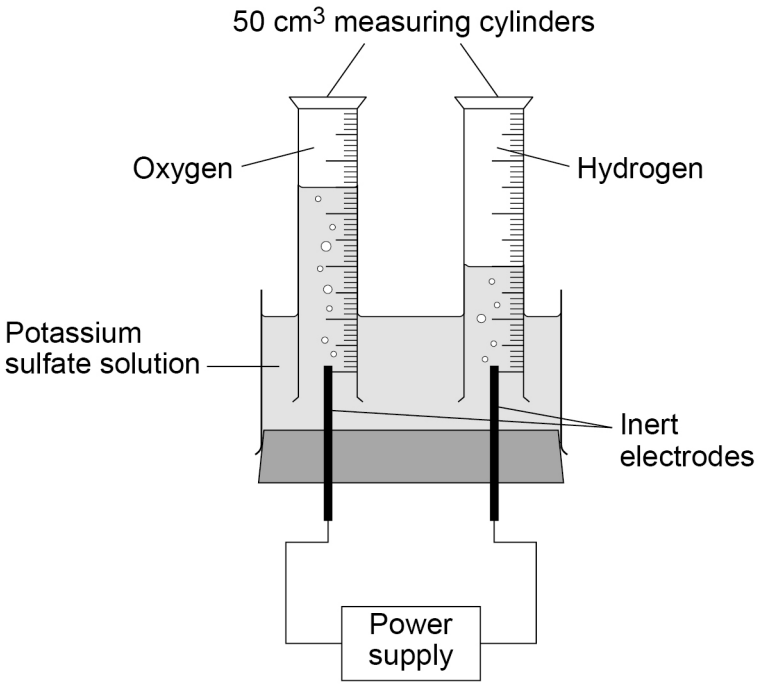
5.3.2.5 Concentration of solutions

Question 05

0 2 This question is about electrolysis.

Figure 2 shows the apparatus used to investigate the electrolysis of potassium sulfate solution.

Figure 2



0 2 . 1 Potassium sulfate contains K^+ and SO_4^{2-} ions.

What is the formula of potassium sulfate?

[1 mark]

Tick (✓) **one** box.

KSO_4 ☐

K_2SO_4 ☐

$K(SO_4)_2$ ☐

$K_2(SO_4)_2$ ☐

5.3.2.5 Concentration of solutions

Question 05 · continued

0 2 . 2 What are the volumes of gases collected in the electrolysis experiment?

Use **Figure 2**.

[1 mark]

Volume of hydrogen = _____ cm^3

Volume of oxygen = _____ cm^3

0 2 . 3 A student made the following hypothesis:

'The volumes of gases collected in this electrolysis experiment are in the same ratio as hydrogen atoms to oxygen atoms in a water molecule.'

Explain how the volumes of gases collected in the experiment in **Figure 2** support the student's hypothesis.

Use your answer to Question **02.2**

[2 marks]

Question 2 continues on the next page

0 2 . 4 The experiment is repeated 4 times.

The volumes of oxygen collected in the 4 experiments are:

6 cm^3 9 cm^3 10 cm^3 11 cm^3

The mean volume of oxygen collected in the 4 experiments is 9 cm^3

The measure of uncertainty is the range of a set of measurements about the mean.

What is the measure of uncertainty in the 4 experiments?

[1 mark]

Tick (✓) **one** box.

9 ± 1 cm^3 ☐

9 ± 2 cm^3 ☐

9 ± 3 cm^3 ☐

0 2 . 5 The potassium sulfate solution has 0.86 g of potassium sulfate dissolved in 25 cm^3 of water.

Calculate the mass of potassium sulfate needed to make 1.0 dm^3 of solution.

[3 marks]

Mass = _____ g

8

5.3.2.5 Concentration of solutions

Question 06

June 2022 | 8464/C/2H | Original Q2

0 2 . 1 Water that is safe to drink is called potable water.

Compare how easily potable water can be obtained from:

- waste water (sewage)
- ground water (fresh water).

[6 marks]

Question 2 continues on the next page

5.3.2.5 Concentration of solutions

Question 06 · continued

A scientist produced potable water from 150 cm^3 of salty water.

0 2 . 2 Which process can be used to produce potable water from salty water?

[1 mark]

Tick (✓) **one** box.

- Distillation ☐
- Electrolysis ☐
- Filtration ☐
- Sterilisation ☐

0 2 . 3 The salty water contains sodium chloride.

The scientist collected 2.40 g of sodium chloride from 150 cm^3 of salty water.

Calculate the concentration of sodium chloride in grams per dm^3

[3 marks]

Concentration of sodium chloride = _____ g/dm^3

10

5.3.2.5 Concentration of solutions

Question 07

June 2023 | 8464/C/1H | Original Q2

0 2 Lithium hydroxide reacts with sulfuric acid to produce lithium sulfate.

The equation for the reaction is:

$$2\,LiOH + H_2SO_4 \longrightarrow Li_2SO_4 + 2\,H_2O$$

0 2 . 1 What type of reaction is this?

[1 mark]

0 2 . 2 Calculate the relative formula mass (M_r) of sulfuric acid (H_2SO_4).

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

[2 marks]

Relative formula mass (M_r) = _____

5.3.2.5 Concentration of solutions

Question 07 · continued

0 2 . 3 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.

[4 marks]

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

0 2 . 4 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.

[3 marks]

Concentration = _____ g/dm^3

10

5.3.2.5 Concentration of solutions

Question 08

June 2023 | 8464/C/1H | Original Q6

0 6 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:

$$Mg(s) + 2\,HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

0 6 . 1 Describe how solid magnesium chloride is obtained from the reaction mixture.

[2 marks]

0 6 . 2 The reaction between magnesium and hydrochloric acid is a redox reaction.

Explain what happens to the magnesium atoms in this reaction.

[2 marks]

5.3.2.5 Concentration of solutions

Question 08 · continued

0 6 . 3 0.72 g of magnesium is added to 100 cm^3 of hydrochloric acid.

The hydrochloric acid is in excess.

Calculate the concentration of the magnesium chloride ($MgCl_2$) solution produced in g/dm^3.

Relative atomic mass (A_r): Mg = 24

Relative formula mass (M_r): $MgCl_2$ = 95

[6 marks]

Concentration = _____ g/dm^3

10

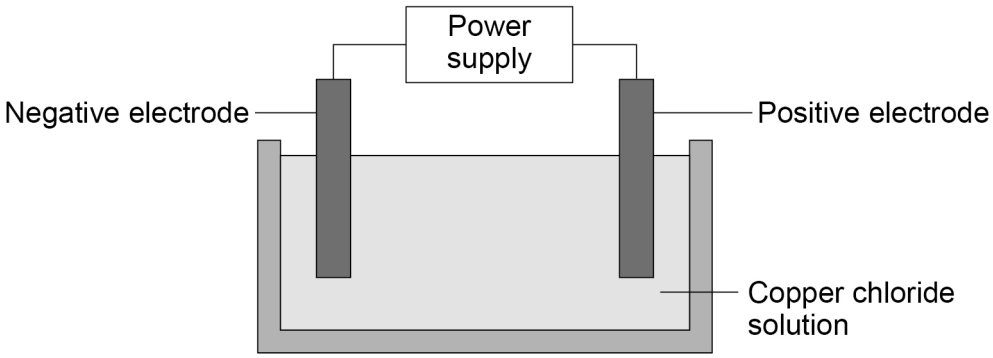
5.3.2.5 Concentration of solutions

Question 09

0 1 A teacher demonstrated the electrolysis of copper chloride solution.

Figure 1 shows the apparatus.

Figure 1



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

0 1 . 1 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 mark]

Question 1 continues on the next page

Question 09 · continued

Table 1 shows the results.

Table 1

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

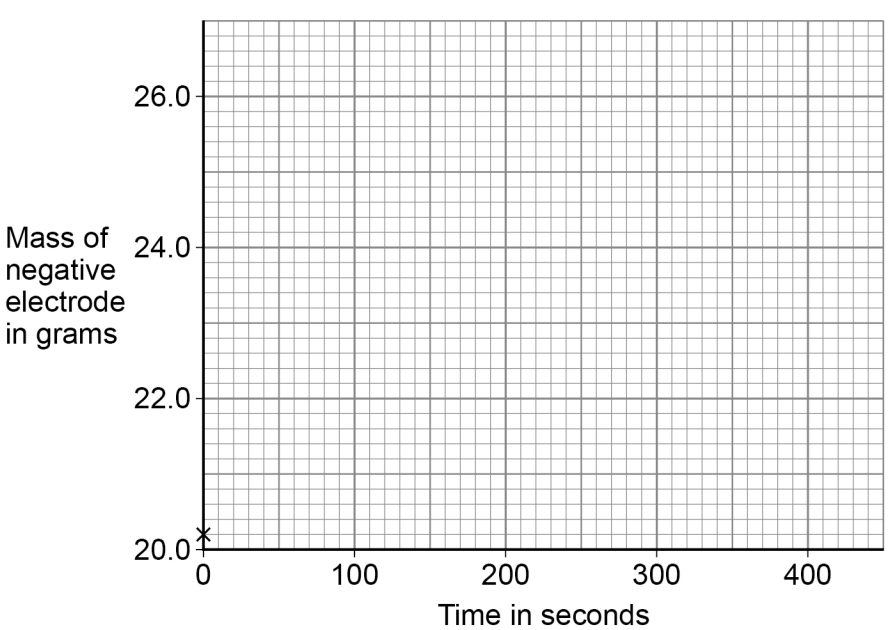
0 1 . 2 Plot the data from **Table 1** on **Figure 2**.

Draw a line of best fit.

The first point has been plotted for you.

[3 marks]

Figure 2



5.3.2.5 Concentration of solutions

Question 09 · continued

0 1 . 3 A student made the hypothesis:

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

How do the results in **Table 1** show that the hypothesis is **not** correct?

[1 mark]

0 1 . 4 25 cm^3 of the solution of copper chloride contained 5.5 g of copper chloride.

Calculate the concentration of the solution in g/dm^3.

1 dm^3 = 1000 cm^3

[3 marks]

Concentration = _____ g/dm^3

Question 1 continues on the next page

5.3.2.5 Concentration of solutions

Question 09 · continued

0 1 . 5 The teacher also electrolysed potassium chloride solution.

Hydrogen gas was given off at the negative electrode.

Why was hydrogen gas given off?

[1 mark]

Tick (✓) **one** box.

Hydrogen is less reactive than potassium. ☐

Hydrogen has the same reactivity as potassium. ☐

Hydrogen is more reactive than potassium. ☐

9