Disclaimer: This document was created by department heads with many years of experience teaching the Pearson Edexcel IGCSE Chemistry course. We cannot however guarantee that it is an accurate representation of the Summer 2025 examinations and students should not treat it as such. Please use this as an aid, alongside other methods of revision.

Pearson Edexcel International GCSE (9-1)

Friday 13 June 2025

Morning (Time: 1 hour 15 minutes)

Chemistry

Unit: 4CH1

Paper: 2C

You must have:
Calculator, ruler

Instructions

- Use **black** ink or a ballpoint pen.
- Answer **all** questions.
- Answer the questions in the spaces provided.
    - *There may be more space than you need*.
- Show all the steps in any calculations and state the units.

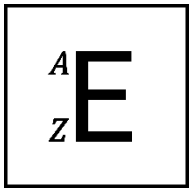
Information

- The total mark for this paper is 70.
- The marks for each question are shown in brackets.
    - *Use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over →



Answer all questions.

1. This question is about the extraction of metals.

(a) Which of the following elements is found in the Earth as an uncombined element? **(1)**

☒ **A** Iron

☒ **B** Gold

☒ **C** Aluminium

☒ **D** Zinc

(b) Lithium is found in which Group and Period of the periodic table? **(1)**

☒ **A** Group 1, Period 2

☒ **B** Group 2, Period 3

☒ **C** Group 3, Period 4

☒ **D** Group 1, Period 4

Lithium (Li) is a key component in rechargeable lithium-ion batteries, which are used in electric vehicles.

Lithium can be extracted from its ore in a three-stage process:

- **Stage 1:** Lithium ore is heated to convert it into a more reactive form.
- **Stage 2:** The treated ore reacts with sulphuric acid to form lithium sulphate (Li_2SO_4).
- **Stage 3:** Lithium sulphate is then converted into lithium carbonate (Li_2CO_3), which is used in the production of batteries.

A sample of lithium sulphate contains the following composition by mass:

Element	Mass (g)
Li	27.8
S	64.1
O	127.8

(c) Show by calculation that the empirical formula of this compound is Li_2SO_4. **(3)**

A chemist wants to confirm that lithium sulphate was obtained during **stage 2** of the extraction process.

(d) Describe the tests he could use to identify both lithium ions and sulphate ions. Include the expected results. **(5)**

(Total for Question 1 = 10 marks)

2. A student carries out a titration to determine the concentration of dilute sulphuric acid (H_2SO_4).

She is given:

- A supply of dilute H_2SO_4.
- Sodium hydroxide (NaOH) solution with a concentration of **0.200 mol/dm^3**.
- Apparatus suitable for carrying out a titration.
- Methyl orange indicator.

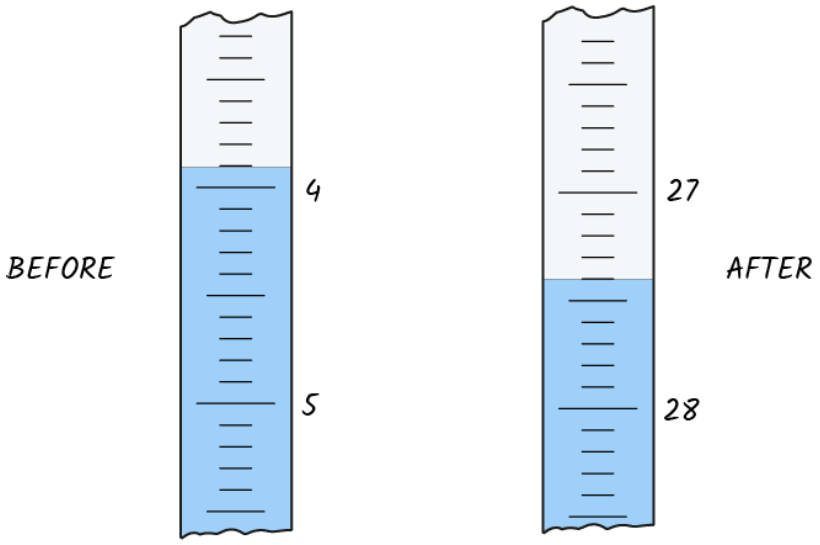
The student adds **25 cm^3** of NaOH to a conical flask and a few drops of methyl orange indicator. H_2SO_4 is added from a burette until the indicator changes colour.

(a) What type of reaction occurs when H_2SO_4 is added to NaOH? **(1)**

(b) Describe the colour change of the indicator when the end point of the titration is reached. **(1)**

(c) Suggest why it is better to use methyl orange rather than universal indicator in this titration. **(1)**

The diagram below shows the burette readings from one titration:



(d) Use the readings to complete the table below **(3)**

Burette reading before adding acid (cm^3)	
Burette reading after adding acid (cm^3)	
Volume of acid added (cm^3)	

The equation for the reaction between sulphuric acid and sodium hydroxide is:

$$H_2SO_{4\,(aq)} + 2NaOH_{(aq)} \rightarrow Na_2SO_{4\,(aq)} + 2H_2O_{(l)}$$

The state symbol (aq) is used to indicate that a substance is dissolved in water.

(e) Explain why H_2SO_4 is an aqueous solution. **(2)**

(f) Calculate the concentration, in mol/dm^3, of the sulphuric acid solution. **(3)**

(g) Calculate the concentration of H^+ ions in the sulphuric acid solution. *If you were unable to determine the concentration in (f), assume it is 0.25 mol/dm^3. This is not the correct answer*. **(1)**

(Total for Question 2 = 12 marks)

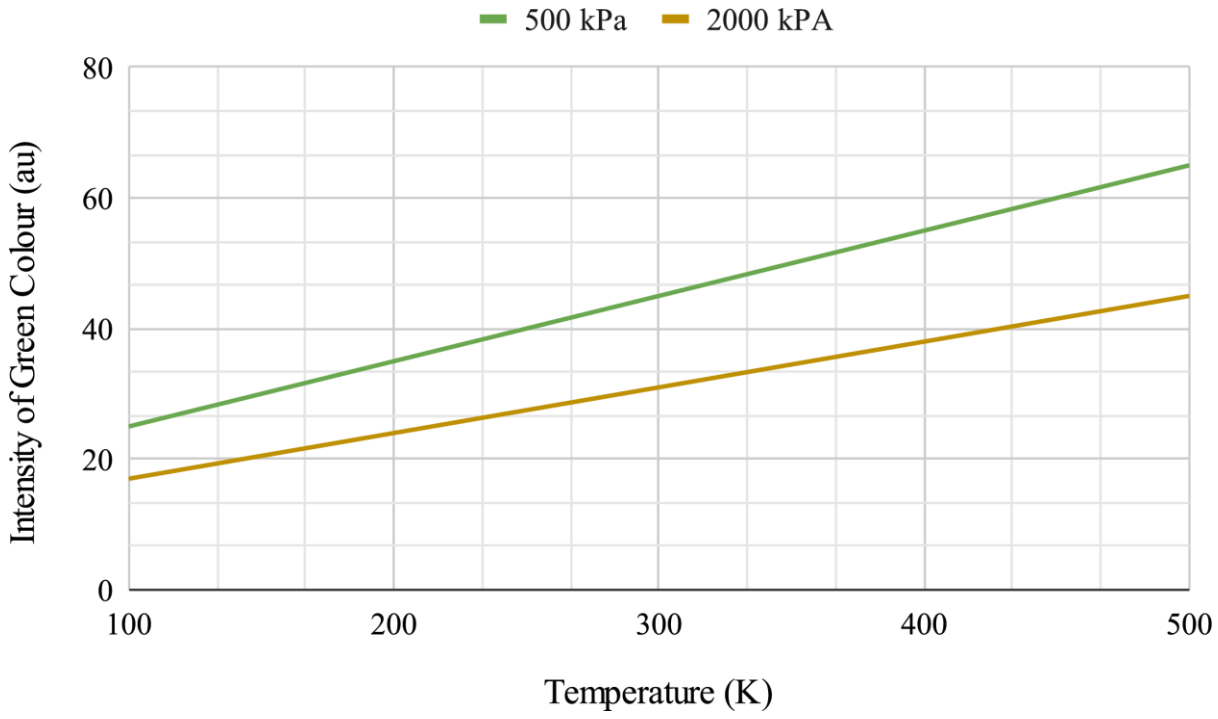
3. Phosphorous pentachloride can decompose into phosphorous trichloride and chlorine gas:

$$PCl_{5\,(g)} \rightleftharpoons PCl_{3\,(g)} + Cl_{2\,(g)}$$

- PCl_5 is a very pale-yellow.
- PCl_3 is colourless.
- Cl_2 is green.

A chemist sets up a colorimeter to measure the intensity of green light passing through the system at different temperatures and pressures.

The chemist's results are shown in the graph below:



(a) Explain why the chemist uses a colorimeter in this experiment. **(2)**

(b) Suggest why the green light intensity never reaches 100%. **(2)**

(c) Describe and explain the effect of pressure on the chemist's results. **(3)**

The chemist concludes that the decomposition of PCl_5 is an endothermic reaction.

(d) Explain how the data supports this conclusion. **(2)**

The chemist confirms his conclusion by calculating the enthalpy change of the reaction.

The bond enthalpies for the bonds involved in this reaction are:

Bond	Bond Enthalpy (kJ/mol)
P-Cl	326
Cl-Cl	242

(e) Using the table, calculate the enthalpy change for the decomposition of PCl_5. **(3)**

(Total for Question 3 = 12 marks)

4. Sustainable fuels such as bioethanol are increasingly being used to reduce reliance on fossil fuels.

These fuels are often blended with alkanes.

(a) Name the functional group present in all alcohols. **(1)**

A sustainable fuel mixture contains alkanes. One of the alkanes in the mixture has an M_r of 86.

(b) Determine the molecular formula of this alkane. **(2)**

(c) Suggest why alkanes are used in fuel mixtures. **(2)**

Ethanol can be produced in different ways. When it is made from renewable sources, such as from plant sugars, it is known as **bioethanol**. This is because the process uses biological materials that can be replaced rather than fossil fuels like crude oil.

(d) Compare the two main methods of ethanol production. You may use equations to support your answer. **(5)**

Ethanol can react with butanoic acid to form an ester.

(e) In the space below, draw the displayed structure of butanoic acid. **(1)**

(f) Name the ester produced in this reaction. **(1)**

(g) Give one way that this ester could be easily identified. **(1)**

(Total for Question 4 = 13 marks)

5. A student identifies the solubility of ammonium carbonate in water by measuring the mass of ammonium sulphate that dissolves in **30 cm^3 of water** at different temperatures.

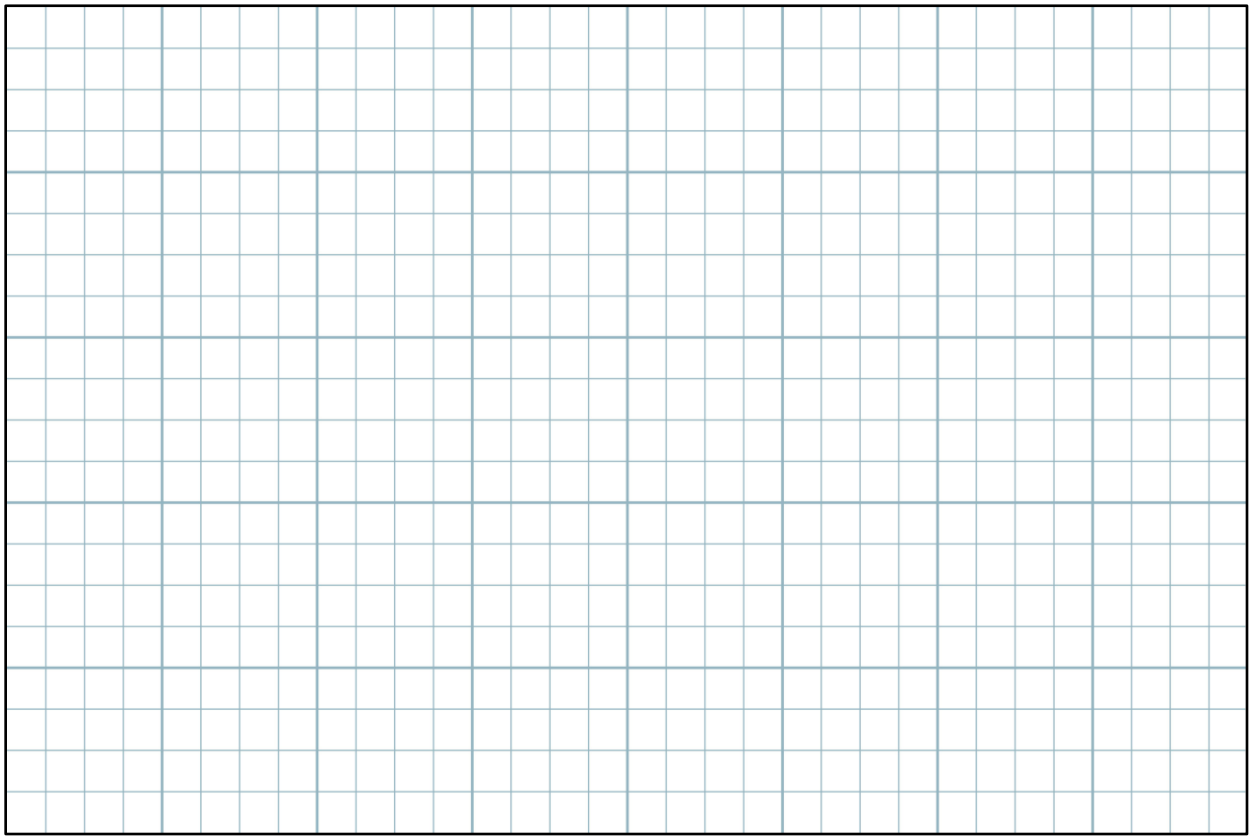
The table below shows the student's results. One of the results appears to be anomalous.

Temperature (°C)	10	20	30	40	50	60	70
Mass of ammonium carbonate dissolved (g)	25	35	48	63	92	105	130

(a) Plot the results on a grid. **(1)**

(b) Identify and circle the anomalous result. **(1)**

(c) Ignoring the anomalous result, draw a smooth curve of best fit. **(1)**



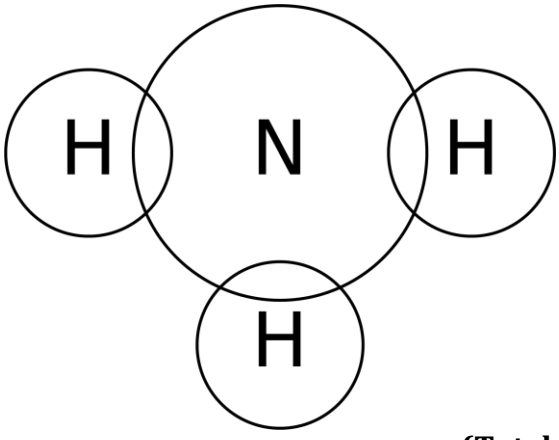
(d) Suggest two possible mistakes that could have caused the anomalous result. **(2)**

(e) Use your graph to find the maximum mass of ammonium carbonate that dissolves in 30 cm^3 of water at 80°C. *Show on your graph how you obtained your answer*. **(2)**

(f) Use your graph to calculate the solubility of ammonium carbonate in g/100 g of water at 25°C. *1.0 cm^3 of water has a mass of 1.0 g*. **(2)**

Ammonia (NH_3) contains covalent bonds.

(g) Complete the diagram below to show the bonding in an ammonia molecule. **(2)**



(Total for Question 5 = 11 marks)

6. A brine cell is used in the electrolysis of seawater. Brine contains aqueous sodium chloride.

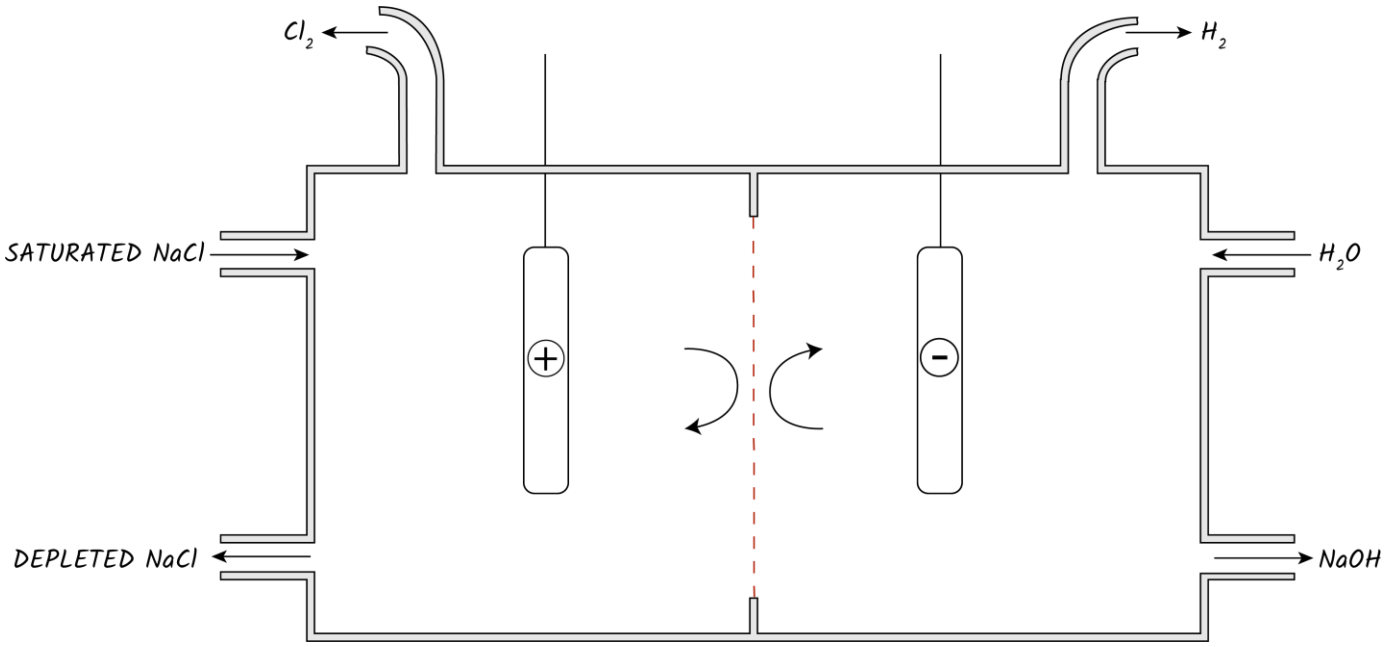
This process is important for industry as it produces three valuable chemicals.

The overall reaction is as follows:

$$2NaCl_{(aq)} + 2H_2O_{(l)} \rightarrow Cl_{2\,(g)} + H_{2\,(g)} + NaOH_{(aq)}$$

(a) Explain why aqueous sodium chloride conducts electricity. **(2)**

A diagram of a brine cell is shown below.



During the electrolysis of brine, H_2 and Cl_2 gas are produced.

(b) Use half-equations to explain how these gases are formed. **(4)**

Sodium metal is **not obtained** during this process.

(c) Suggest how the process could be modified to produce sodium metal instead. Give a reason for your answer. **(2)**

This brine cell produces 40 cm^3 of 0.5 mol/dm^3 NaOH solution per minute.

(d) Calculate the total volume of gas produced in 1 hour by the brine cell at room temperature and pressure (rtp). *For a gas, molar volume = 24 dm^3 at rtp*. **(4)**

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 70 MARKS