Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
COMBINED SCIENCE: TRILOGY

H

Higher Tier
Chemistry Paper 2H

Time allowed: 1 hour 15 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions
- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

Information
- The maximum mark for this paper is 70.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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ANSWER IN THE SPACES PROVIDED

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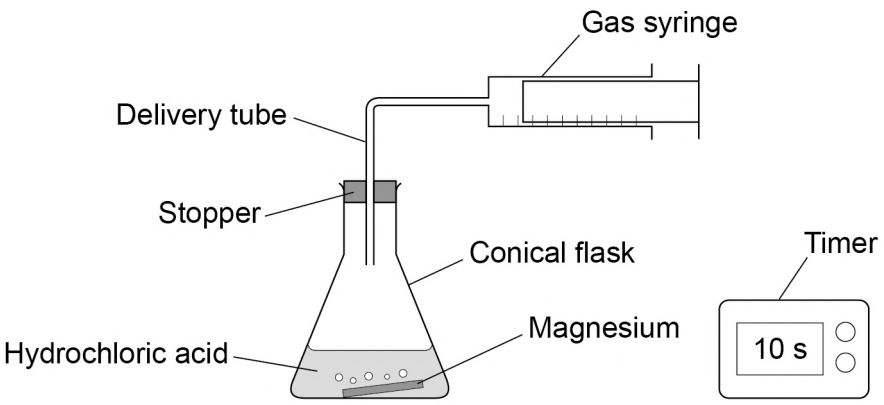
0 1 A student investigated the reaction between magnesium and excess hydrochloric acid.

Figure 1 shows the apparatus.

Figure 1



This is the method used.

1. Pour 50 cm^3 of hydrochloric acid into a conical flask.
2. Add a piece of magnesium.
3. Insert stopper and delivery tube and start a timer.
4. Collect the gas produced in a gas syringe.
5. Record the volume of gas produced every 20 seconds for 2 minutes.
6. Repeat steps 1 to 5 with higher concentrations of hydrochloric acid.

0 1 . 1 Give the independent variable and **one** control variable in this investigation.

[2 marks]

Independent variable: concentration (of hydrochloric acid

Control variable: volume of (hydrochloric) acid

Question 1 continues on the next page

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Table 1 shows the results from the first experiment using hydrochloric acid with a low concentration.

Table 1

Time in seconds	0	20	40	60	80	100	120
Volume of gas in cm^3	0	48	72	90	97	98	98

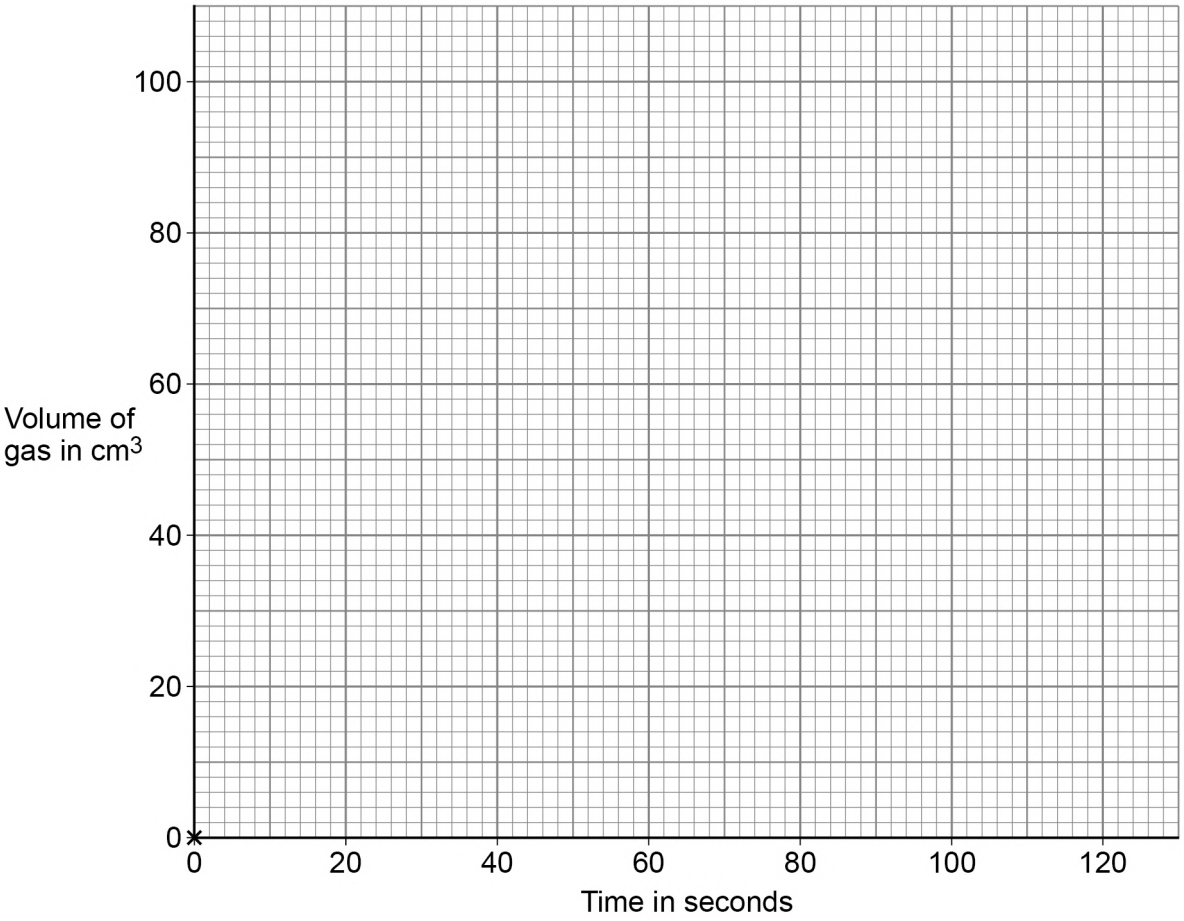
0 1 . 2 Complete **Figure 2**.

You should:

- plot the data from **Table 1** (the point 0,0 has been plotted for you)
- draw a line of best fit.

[3 marks]

Figure 2



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0 1 . 3 How does the **rate** of this reaction change with time?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

The rate decreases. ☑

The rate stays the same. ☐

The rate increases. ☐

0 1 . 4 The student repeated the experiment using hydrochloric acid with a higher concentration.

Which statement is correct?

[1 mark]

Tick (✓) **one** box.

The activation energy for the reaction was higher. ☐

The magnesium reacted more quickly. ☑

The reaction finished at the same time. ☐

The total volume of gas collected was smaller. ☐

Question 1 continues on the next page

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0 1 . 5 Temperature also affects the rate of the reaction.

Explain how increasing the temperature affects the **rate** of the reaction.

You should refer to particles and collisions.

[3 marks]

rate increases (because) particles have more energy

(so) more frequent collisions

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0 2 Crude oil is a resource found in rocks.

Most of the compounds in crude oil are hydrocarbons.

0 2 . 1 Complete the sentence.

[1 mark]

Crude oil is formed by the decomposition of plankton or (ancient) biomass.

0 2 . 2 Alkanes are hydrocarbons.

Give the name of the alkane molecule that has three carbon atoms.

[1 mark]

propane

Question 2 continues on the next page

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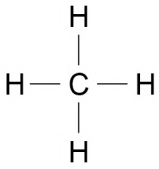
0 2 . 3 **Figure 3** shows two alkane molecules.

Figure 3

Methane



Hexane

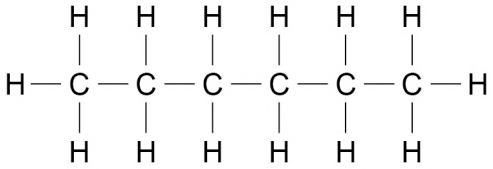


Table 2 shows the melting points and boiling points of methane and hexane.

Table 2

	Melting point in °C	Boiling point in °C
Methane	−183	−162
Hexane	−95	69

Compare the structure and properties of methane and hexane.

[6 marks]

Indicative content

- methane has 1 carbon atom, hexane has 6
- methane has 4 hydrogen atoms, hexane has 14
- both contain C – H bonds
- only hexane contains C – C bonds
- both are hydrocarbons
- hexane has a higher melting point than methane (or converse)
- hexane has a higher boiling point than methane (or converse)
- methane is a gas at room temperature
- hexane is a liquid at room temperature
- both are small molecules
- hexane has larger molecules than methane
- weak forces between molecules
- forces between hexane molecules stronger than between methane molecules
- hexane is more viscous than methane
- both are flammable
- methane is more flammable than hexane (or converse)
- possible products of combustion from both are: carbon, carbon monoxide, carbon dioxide, water
- neither conduct electricity

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Hydrocarbons are cracked to produce more useful alkanes and alkenes.

0 2 . 4 Decane ($C_{10}H_{22}$) is cracked to produce **two** products.

Complete the equation for the reaction.

[1 mark]

$$C_{10}H_{22} \rightarrow \text{C8H18} + C_2H_4$$

0 2 . 5 C_2H_4 is an alkene.

What is the test for alkenes?

Give the result of the test if an alkene is present.

[2 marks]

Test bromine (water)

Result turns (from orange / brown) to colourless

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Turn over for the next question

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0 3 The methods used to produce potable water depend upon available sources of water.

0 3 . 1 Suggest how copper sulfate can be used as a test for the presence of water.

[3 marks]

add water to anhydrous copper sulfate

colour changes from white to blue

The boiling point is used to check the purity of a sample of water.

0 3 . 2 In chemistry, what is meant by a 'pure substance'?

[1 mark]

a single element or compound

Do not write outside the box

0 3 . 3 The boiling point of a 250 g sample of water was 100.60 °C.

The boiling point of pure water in a data book is 100.00 °C.

Each 1% of impurity increases the boiling point of water by 0.12 °C.

Calculate the mass of the impurity in the sample of water.

[3 marks]

(% impurity = $\frac{0.6}{0.12}$ = 5

(mass impurity) = $\frac{5}{100}$ × 250

Mass of the impurity = 12.5 g

0 3 . 4 Explain how distillation is used to obtain potable water from salty water.

[4 marks]

heat salty water

(so) water evaporates (as water vapour)

cool the (water) vapour

(which) condenses to form potable / liquid water

Question 3 continues on the next page

Turn over ►

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0 3 . 5 Obtaining potable water from salty water is more expensive than obtaining potable water from ground water.

Explain why.

Refer to the processes used in both methods in your answer.

[2 marks]

distillation requires energy (to boil salty water)

(but) ground water only needs filtering and sterilising

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Turn over for the next question

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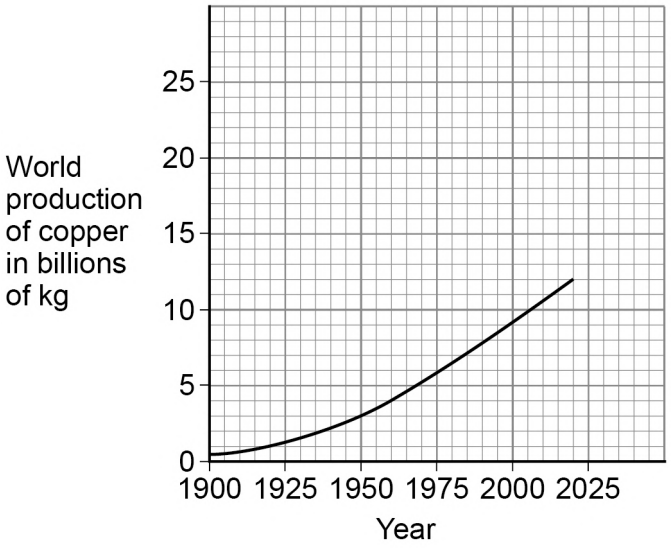
0 4 Industries use the Earth's natural copper resources to produce useful products.

Figure 4 shows the world production of copper from 1900 to 2020.

Figure 4



0 4 . 1 Describe the trend shown by the graph in **Figure 4**.

[2 marks]

production of copper is increasing

at an increasing rate

0 4 . 2 Suggest **one** reason for the trend in **Figure 4**.

[1 mark]

increase in population / demand

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0 4 . 3 Suggest **one** reason why the trend cannot be used to accurately predict the future world production of copper.

[1 mark]

copper is a finite resource and may run out

Question 4 continues on the next page

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0 4 . 4 High-grade copper resources are now difficult to find.

Phytomining is used to extract copper from low-grade ores.

There are five stages, **A**, **B**, **C**, **D** and **E**, in phytomining.

The stages are **not** in the correct order.

Stage **A** Copper compounds from ash are dissolved in acid.

Stage **B** Plants absorb metal compounds.

Stage **C** Plants are burned.

Stage **D** Plants are harvested.

Stage **E** Solution of copper compound is electrolysed.

What is the correct order of stages **A**, **B**, **C**, **D**, and **E**?

[1 mark]

Tick (✓) **one** box.

B, **C**, **D**, **E**, **A** ☐

B, **D**, **C**, **A**, **E** ☑

D, **B**, **C**, **E**, **A** ☐

D, **C**, **B**, **A**, **E** ☐

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0 4 . 5 Give **two** disadvantages of phytomining compared with traditional mining methods.

Do **not** refer to cost in your answer.

[2 marks]

1 • (phytomining is) slower to produce copper

2 • large area of land required

0 4 . 6 In one year, 8.89×10^9 kg of copper was produced.

41.0% of this copper was produced from recycled copper.

The energy needed to produce 1 kg of copper from copper ore is 70.4 MJ.

The energy needed to produce 1 kg of recycled copper is 27.2 MJ.

Calculate the difference in energy used if all the copper was produced from recycling.

Give your answer to 3 significant figures.

[5 marks]

(energy use through recycling) $= 27.2 \times 8.89 \times 10^9 \times \frac{41}{100}$

$= 9.914 \times 10^{10}$

(energy use through extraction $= 70.4 \times 8.89 \times 10^9 \times \frac{59}{100}$ $= 3.693 \times 1011$

(total consumption today = $9.914 \times 1010 + 3.693 \times 10^{11}$ $= 4.6844 \times 10^{11}$

(energy use if only recycling used $= 27.2 \times 8.89 \times 10^9$ $= 2.418 \times 10^{11}$

(energy saving = $4.6844 \times 1011 - 2.418 \times 10^{11}$

Difference in energy used (3 significant figures) = 2.27×10^{11} MJ

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Turn over ►

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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]

at high temperatures (in the engine)

nitrogen

reacts with oxygen (to produce nitrogen dioxide)

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

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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=
(33×7) – [(37×3)+35+34+29]

= 22 (micrograms per m3)

X = 22 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]

countryside data has smallest values

(so) 2 is a higher proportion / percentage of the value

Question 5 continues on the next page

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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]

2 NO_2 → N2 + 2 O2

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]

a resource which will run out

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]

(because carbon dioxide is emitted in) extracting / processing raw materials

(and) manufacturing

(and) disposal at the end of its useful life

13

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0 6 Ammonia is produced when a mixture of nitrogen and hydrogen reacts.

The equation for the reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

0 6 . 1 Nitrogen is obtained from the air.

The mixture of nitrogen and hydrogen must **not** contain carbon dioxide and oxygen.

Explain how a sample can be tested to show that carbon dioxide is **not** present in the mixture.

[2 marks]

use calcium hydroxide solution

(which) does not turn milky / cloudy

0 6 . 2 A catalyst is used in the reaction.

Explain how a catalyst increases the rate of a reaction.

[2 marks]

provides an alternative pathway

(which has) a lower activation energy

Question 6 continues on the next page

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The equation for the reaction to produce ammonia is repeated here.

$$N_2\,(g) + 3\,H_2\,(g) \rightleftharpoons 2\,NH_3\,(g)$$

0 6 . 3 The reaction reaches equilibrium.

Explain how an equilibrium is reached.

[2 marks]

(when) the apparatus prevents the escape of reactants and products

(and the) forward and reverse reactions occur at same rate

0 6 . 4 Suggest how the catalyst affects the equilibrium position.

Give **one** reason for your answer.

[2 marks]

equilibrium position stays the same

increases the rate of the forward and the reverse reaction by the same amount

0 6 . 5 What is the effect of increasing the pressure on the reaction to produce ammonia?

[1 mark]

Tick (✓) **one** box.

The yield of ammonia decreases. ☐

The yield of ammonia stays the same. ☐

The yield of ammonia increases. ☑

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0 6 . 6 The forward reaction is exothermic.

Explain the effect of increasing the temperature on the yield of ammonia gas produced at equilibrium.

[2 marks]

yield of ammonia decreases

(because) system shifts in endothermic direction

11

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