AQA

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

Tuesday 13 June 2023 Morning 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 The combustion of fuels is a source of atmospheric pollutants.

0 1 . 1 Methane is a fuel.

Balance the equation for the combustion of methane.

[1 mark]

$$CH_4 + \underline{2}\ O_2 \rightarrow CO_2 + \underline{2}\ H_2O$$

0 1 . 2 Many fuels are mixtures.

Petrol and diesel are mixtures of hydrocarbons.

Table 1 shows properties of petrol and of diesel.

Table 1

	Petrol	**Diesel**
Range of number of carbon atoms in a hydrocarbon molecule	4 to 12	12 to 20
Range of boiling points in °C	40 to 205	250 to 350

Compare the properties of petrol and diesel.

Use **Table 1**.

[2 marks]

hydrocarbon molecules in petrol have fewer carbon atoms than those in diesel

petrol has a lower boiling point (range) than diesel

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0 1 . 3 The gases released when a fuel is burned in car engines may include:

- oxides of nitrogen
- carbon monoxide
- water vapour.

Which chemical element do all these gases contain?

[1 mark]

Tick (✓) **one** box.

Carbon	
Hydrogen	
Nitrogen	
Oxygen	✓

0 1 . 4 When diesel burns in car engines, oxides of nitrogen are produced.

Where does the nitrogen come from?

[1 mark]

air

0 1 . 5 When diesel burns, particulates may be produced.

What environmental effect do particulates from burning diesel cause?

[1 mark]

global dimming

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0 1 . 6 Carbon monoxide may be produced when diesel burns.

Give **one** reason why carbon monoxide is difficult to detect.

[1 mark]

(carbon monoxide is) colourless
or (carbon monoxide is) odourless

0 1 . 7 Explain why water vapour and **not** liquid water is produced when diesel burns.

[2 marks]

(diesel) burns at a high temperature or
(diesel) burns at a temperature greater than 100 °C
(which is) above the boiling
point of water

0 1 . 8 Sulfur is a common impurity in diesel.

Explain why this causes an environmental problem.

[3 marks]

sulfur dioxide (is produced when diesel is burnt) (which causes) acid rain
(which results in)
any one from:
• damage to buildings /
statues / bridges
• damage to trees / plants
• damage to aquatic life
• acidification of lakes /
rivers / soil
• respiratory problems

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Turn over ►

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0 2 Chromatography is used to separate mixtures.

Chromatography involves a mobile phase and one other phase.

0 2 . 1 What is the other phase in chromatography?

[1 mark]

Tick (✓) **one** box.

Moving phase ☐

Recycled phase ☐

Stationary phase ☑

Viscous phase ☐

0 2 . 2 Why do the substances in the mixture separate in the mobile phase?

[1 mark]

(the substances)
• move at different speeds
or
• have different solubilities

0 2 . 3 How many spots will be produced on the chromatogram of a pure compound?

[1 mark]

Number of spots = 1

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0 2 . 4 In a chromatography experiment, a blue colour moved 4.77 cm.

The solvent moved 5.30 cm.

Calculate the R_f value for the blue colour.

[2 marks]

(Rf =)

$$\frac{4.77}{5.30}$$

R_f value = 0.9

Question 2 continues on the next page

Turn over ►

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0 2 . 5 Black ink is a mixture of several colours.

Plan an experiment using paper chromatography to:

- separate the colours in black ink
- identify the colours from their R_f values.

[6 marks]

Indicative content

- draw a pencil line
- near the bottom edge of the (chromatography) paper
- put a small dot of black ink on the pencil line
- put a small volume of water / solvent in a beaker
- place the (chromatography) paper in the solvent
- the dots of ink should be above the level of the water / solvent
- support the paper in this position
- put a lid on the beaker
- leave to run
- mark position of solvent front
- remove from beaker and leave to dry
- determine Rf values
- measure distance of all dots from start line
- measure distance of solvent front from start line
- calculate Rf values for all dots
- compare with known Rf values

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 3 Crude oil is a mixture of many different compounds.

0 3 . 1 Give **two** reasons why crude oil is **not** a formulation.

[2 marks]

1 (crude oil is a mixture but) not a useful product

2 (and) not mixed in carefully measured quantities

0 3 . 2 Describe how crude oil is separated into fractions.

[4 marks]

(crude oil) is heated to vaporise (the hydrocarbons)

temperature (of column) decreases from bottom to top

(so) the fractions / hydrocarbons condense at different heights (in the column)

(because) the fractions / hydrocarbons have different boiling points

0 3 . 3 The fractions from crude oil contain alkanes.

Explain why alkanes are cracked.

[2 marks]

(to make) smaller (hydrocarbon) molecules

any one from: (which are)

- more useful molecules
- useful as fuels
- starting materials

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Cracking produces a mixture of products.

0 3 . 4 An equation for cracking decane ($C_{10}H_{22}$) is:

$$C_{10}H_{22}(l) \rightarrow C_{10}H_{20}(l) + H_2(g)$$

Describe a test to identify the gas produced in the reaction.

[2 marks]

Test (burning / lit splint

Result burns with a (squeaky) pop sound

0 3 . 5 Alkenes are produced in cracking.

The general formula for the homologous series of alkenes is C_nH_{2n}

Which formula represents an alkene?

[1 mark]

Tick (✓) **one** box.

- C_2H_2 ☐
- C_2H_4 ☑
- C_2H_6 ☐
- C_3H_8 ☐

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Turn over for the next question

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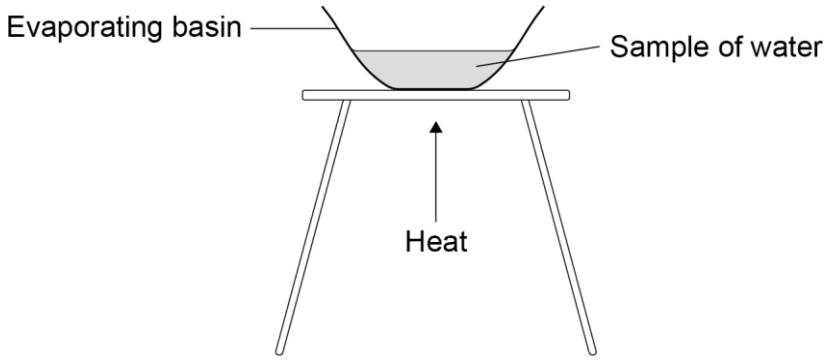
0 4 Some types of water contain dissolved substances.

A student investigated the mass of dissolved solids in distilled water and in sea water.

Figure 1 shows the apparatus.

Figure 1



This is the method used.

1. Weigh an evaporating basin.
2. Add 20 cm^3 of distilled water to the evaporating basin.
3. Weigh the evaporating basin and the water sample.
4. Heat the water sample for 2 minutes.
5. Weigh the evaporating basin and contents.
6. Repeat steps 1 to 5 two more times.
7. Repeat steps 1 to 6 with sea water.

0 4 . 1 The method used by the student did **not** give valid results.

Describe **one** improvement the student could make to obtain valid results.

[1 mark]

heat the evaporating basin and contents to constant mass

A different student used a method which gave valid results.

0 4 . 2 **Table 2** shows the results.

Table 2

	Mass of dissolved solids in grams			
Type of water	**Test 1**	**Test 2**	**Test 3**	**Mean**
Distilled water	0.00	0.00	0.00	0.00
Sea water	0.30	**X**	0.26	0.29

Calculate the value **X** for the mass of dissolved solids in sea water in **Test 2**.

[2 marks]

(mass X =)

[0.29 × 3] – [0.30 + 0.26]

Mass **X** = 0.31 g

0 4 . 3 The student concludes that distilled water is pure.

Describe a test to confirm that distilled water is pure.

[2 marks]

Test determine the boiling point

Result (pure water) boils at 100 °C

Turn over ►

Tap water is potable.

A stage in the production of potable water is sterilising.

A gas is used to sterilise water.

The equation for the reaction is:

$$Cl_2(g) + H_2O(l) \rightleftharpoons HOCl(aq) + HCl(aq)$$

0 4 . 4 What is meant by the symbol ⇌?

[1 mark]

reversible reaction

0 4 . 5 The reaction is at equilibrium.

The reaction is exothermic.

What happens to the equilibrium position when the temperature is increased?

[1 mark]

Tick (✓) **one** box.

Shifts towards the left-hand side ✓

Stays in the same place

Shifts towards the right-hand side

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0 4 . 6 Describe a test to identify the gas used to sterilise water.

[2 marks]

Test damp litmus paper

Result litmus paper bleached

0 4 . 7 Another stage in the production of potable water is filtering.

Explain why potable water contains dissolved solids after filtering.

[2 marks]

the dissolved solids pass through filter pape

(because) the dissolved solid (particles) are very small

11

Turn over for the next question

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0 5 An increase of greenhouse gases in the Earth's atmosphere is causing global warming.

Global warming is causing global climate change.

0 5 . 1 Give **one** effect of global climate change.

[1 mark]

any one from:
- melting ice
- rising sea levels

0 5 . 2 Explain how greenhouse gases cause global warming.

[4 marks]

(greenhouse gases) allow short wavelength radiation to enter the atmosphere

(which are) absorbed by the earth and re-emitted as longer wavelength radiation

(which is) absorbed by (greenhouse gases in) the atmosphere

(this) increases the temperature leading to global warming

0 5 . 3 Explain how planting trees reduces global warming.

[3 marks]

trees use carbon dioxide (for) photosynthesis

(and) carbon dioxide causes global warming

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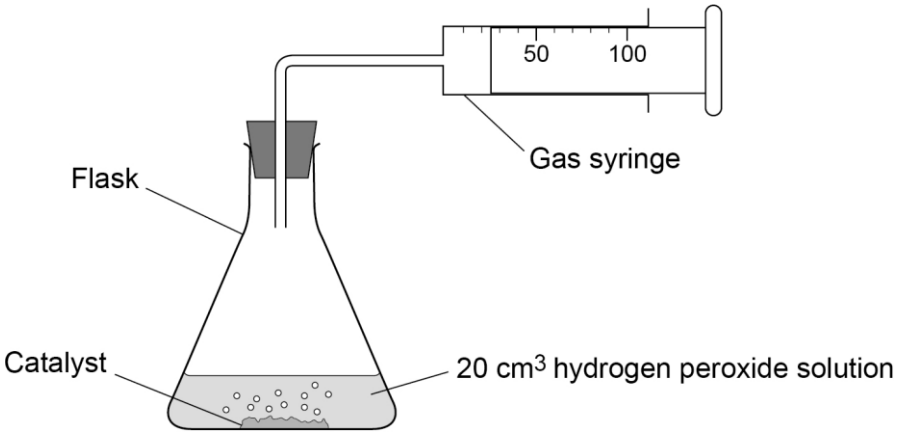
0 6 A student investigated the rate of decomposition of hydrogen peroxide using three different catalysts:

- manganese dioxide
- copper oxide
- zinc oxide.

Figure 2 shows the apparatus.

Figure 2



This is the method used.

1. Measure 20 cm^3 of hydrogen peroxide solution into a flask.

2. Add 0.5 g of manganese dioxide catalyst to the flask.

3. Attach a gas syringe to the flask.

4. Measure the volume of oxygen produced every 30 seconds for 180 seconds.

5. Repeat steps 1 to 4 two more times.

6. Repeat steps 1 to 5 using copper oxide catalyst.

7. Repeat steps 1 to 5 using zinc oxide catalyst.

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0 6 . 1 The equation for the decomposition of hydrogen peroxide is:

$$2\,H_2O_2 \rightarrow 2\,H_2O + O_2$$

Describe a test to identify the gas produced in the reaction.

[2 marks]

Test glowing splint

Result relights

0 6 . 2 Using 10 cm^3 of hydrogen peroxide solution gives less accurate results than using 20 cm^3 of hydrogen peroxide solution of the same concentration.

Explain why.

[2 marks]

smaller volume of gas produced (per unit time)

(so) error in reading is a larger percentage of the total volume

0 6 . 3 Suggest **one** possible source of systematic error in the investigation.

[1 mark]

measuring vessel (for hydrogen peroxide or gas)

Question 6 continues on the next page

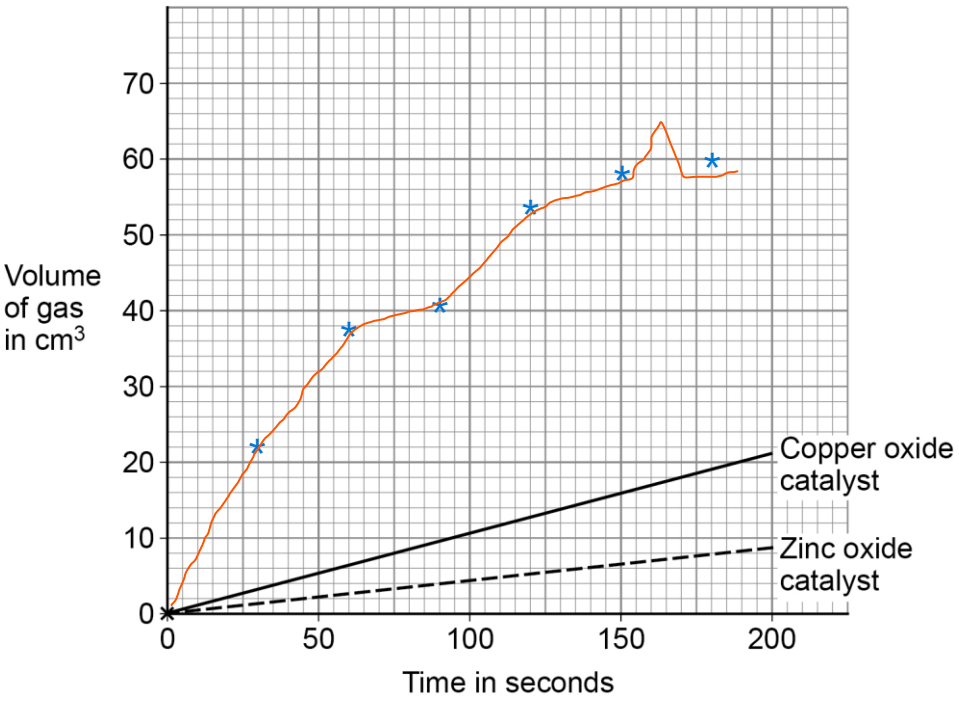
Table 3 shows the results for manganese dioxide catalyst.

Table 3

Time in seconds	0	30	60	90	120	150	180
Volume of gas in cm^3	0	22	38	41	54	58	60

Figure 3 shows a graph of the results with copper oxide catalyst and with zinc oxide catalyst.

Figure 3



0 6 . 4 Complete **Figure 3**.

You should:

- plot the data from **Table 3**
- draw a line of best fit.

The first point has been plotted for you.

[3 marks]

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0 6 . 5 Which catalyst gives the fastest **rate** of reaction?

Give **one** reason for your answer.

Use the completed **Figure 3**.

[2 marks]

Catalyst manganese dioxide

Reason (because manganese dioxide) has the steepest gradient

0 6 . 6 The rate of reaction is **not** dependent on the volume of hydrogen peroxide solution.

Explain why.

[2 marks]

same number of particles per unit volume

(so) same frequency of collisions (with catalyst)

Question 6 continues on the next page

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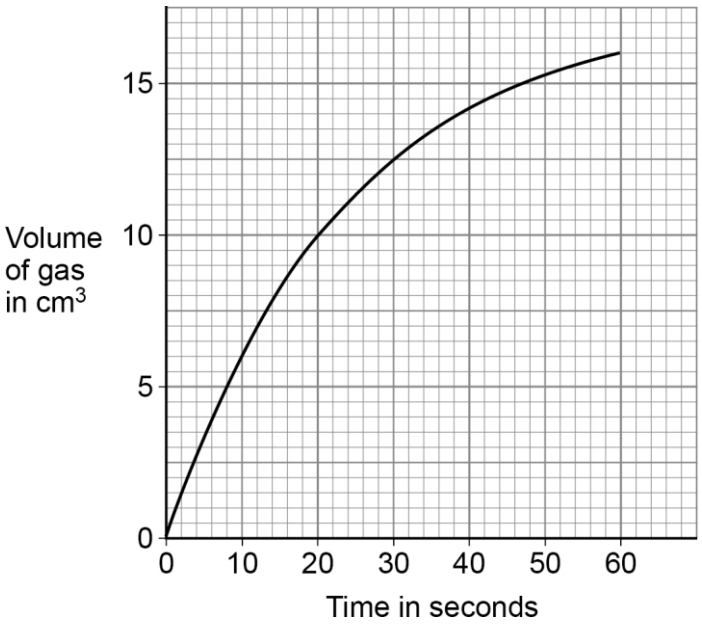
0 6 . 7 **Figure 4** shows the results from a different investigation.

Figure 4



Determine the rate of reaction at 20 seconds.

Show your working on **Figure 4**.

Give your answer to 3 significant figures.

[5 marks]

tangent drawn at 20 s

value for x step and y step from tangent

(rate =) value for y step / value for x step

correctly calculated

to 3 significant figures

Rate (3 significant figures) = _____ cm^3/s

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END OF QUESTIONS

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