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 1H

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	
7	
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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0 1 This question is about the periodic table.

0 1 . 1 **Figure 1** shows part of Mendeleev's version of the periodic table.

Figure 1

H							
Li	Be	B	C	N	O	F	
Na	Mg	Al	Si	P	S	Cl	
K Cu	Ca Zn		Ti	V As	Cr Se	Mn Br	Fe Co Ni
Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	I	Ru Rh Pd

Which group of elements had **not** been discovered when Mendeleev's version of the periodic table was published?

[1 mark]

(Group) 0 or noble gases

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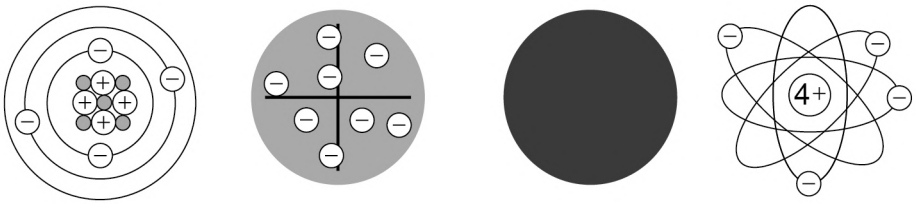
Figure 2 represents different models of the atom.

Figure 2



A **B** **C** **D**

0 1 . 2 Which model represents the plum pudding model?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☑ **C** ☐ **D** ☐

0 1 . 3 Which model resulted from Chadwick's experimental work?

[1 mark]

Tick (✓) **one** box.

A ☑ **B** ☐ **C** ☐ **D** ☐

Question 1 continues on the next page

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Potassium has different isotopes.

0 1 . 4 What is meant by 'isotopes'?

You should refer to subatomic particles.

[2 marks]

(atoms with the) same number of proton

(but with) different numbers of neutrons

0 1 . 5 **Table 1** shows the mass numbers and the percentage abundance of two isotopes of potassium.

Table 1

Mass number	Percentage abundance
39	93.1
41	6.9

Calculate the relative atomic mass (A_r) of potassium.

Give your answer to 1 decimal place.

[3 marks]

$$\frac{(39 \times 93.1) + (41 \times 6.9)}{100}$$

$= 39.138$

Relative atomic mass (1 decimal place) = $= 39.1$

8

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 2 Acids react to produce salts.

Universal indicator is added to water and then nitric acid is added to the mixture.

0 2 . 1 Give the colour change when nitric acid is added to the mixture of universal indicator and water.

[1 mark]

Tick (✓) **one** box.

- Blue to red ☐
- Green to purple ☐
- Green to red ☑
- Red to purple ☐

0 2 . 2 What happens to the pH of water when nitric acid is added?

[1 mark]

Tick (✓) **one** box.

- Decreases ☑
- Stays the same ☐
- Increases ☐

0 2 . 3 What is the state symbol for nitric acid?

[1 mark]

(aq)

Do not write outside the box

Zinc carbonate reacts with nitric acid.

The word equation for the reaction is:

zinc carbonate + nitric acid → zinc nitrate + water + carbon dioxide

white solid — colourless solution

0 2 . 4 Give **two** observations that would be made when zinc carbonate is added to nitric acid until the zinc carbonate is in excess.

[2 marks]

1 any two from:

• (white) solid disappears

2 • fizzing / bubbles / effervescence

• (then) stops fizzing

• (white) solid left at the end / bottom

0 2 . 5 The formula of the zinc ion is Zn^{2+}

The formula of the nitrate ion is NO_3^-

What is the formula for zinc nitrate?

[1 mark]

Tick (✓) **one** box.

$ZnNO_3$ ☐

$Zn(NO_3)_2$ ☑

Zn_2NO_3 ☐

$Zn_2(NO_3)_2$ ☐

Question 2 continues on the next page

Do not write outside the box

0 2 . 6 Acids react with insoluble metal oxides to produce salts.

Plan a method to produce a pure, dry sample of the soluble salt copper chloride from an acid and a metal oxide.

[6 marks]

Indicative Content:

- react hydrochloric acid
- (with) copper oxide
- in a suitable container
- warm (hydrochloric) acid
- add copper oxide
- until is in excess
- stir
- filter excess copper oxide
- pour solution / filtrate into evaporating basin
- use of water bath
- to heat gently
- leave to cool / crystallise

12

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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 This question is about energy change.

A student investigated the temperature change when 10 g of ammonium nitrate was added to 100 cm^3 of water.

This is the method used.

1. Measure the temperature of 100 cm^3 of water.

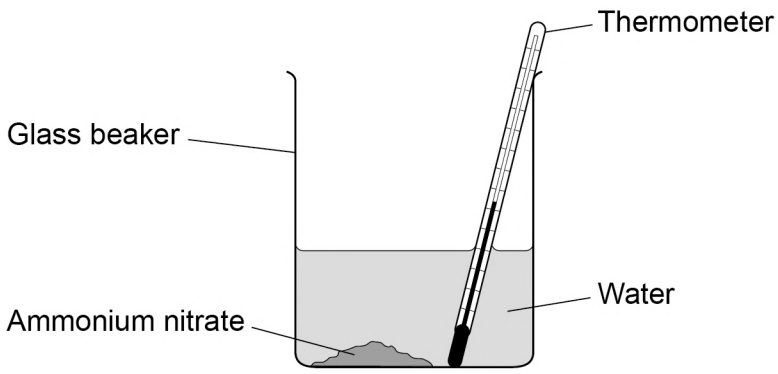
2. Add 10 g of ammonium nitrate.

3. Stir once.

4. Measure the temperature of the solution every minute for 7 minutes.

Figure 3 shows the apparatus.

Figure 3



0 3 . 1 What is the dependent variable in this investigation?

[1 mark]

temperature (of solution)

0 3 . 2 Give **three** improvements to the investigation to make the results more accurate.

[3 marks]

1 • insulate the beaker or use polystyrene cup

2 use larger mass of ammonium nitrate

3 stir more (times)

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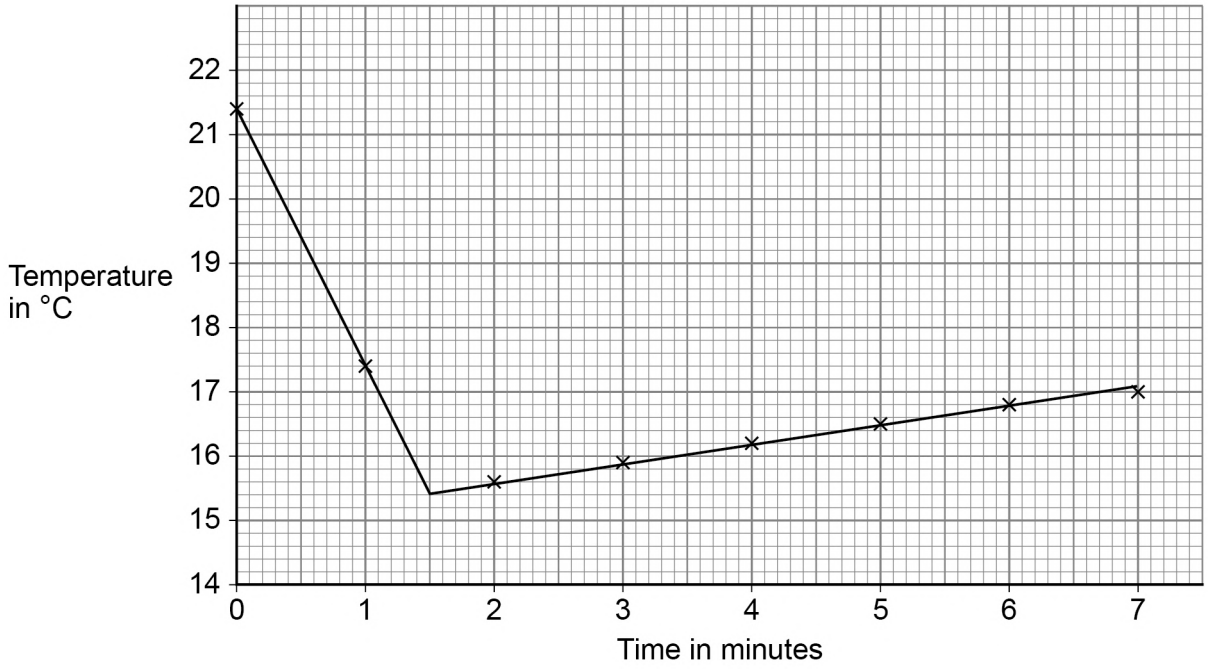
0 3 . 3 **Figure 4** shows the results.

Figure 4



Explain the results.

[4 marks]

(from 0 to 1.5 minutes the) temperature decreases

(because) ammonium nitrate dissolving is endothermic

(then) after 1.5 minutes the temperature increases

(because) energy transfers to the solution from the surroundings

Question 3 continues on the next page

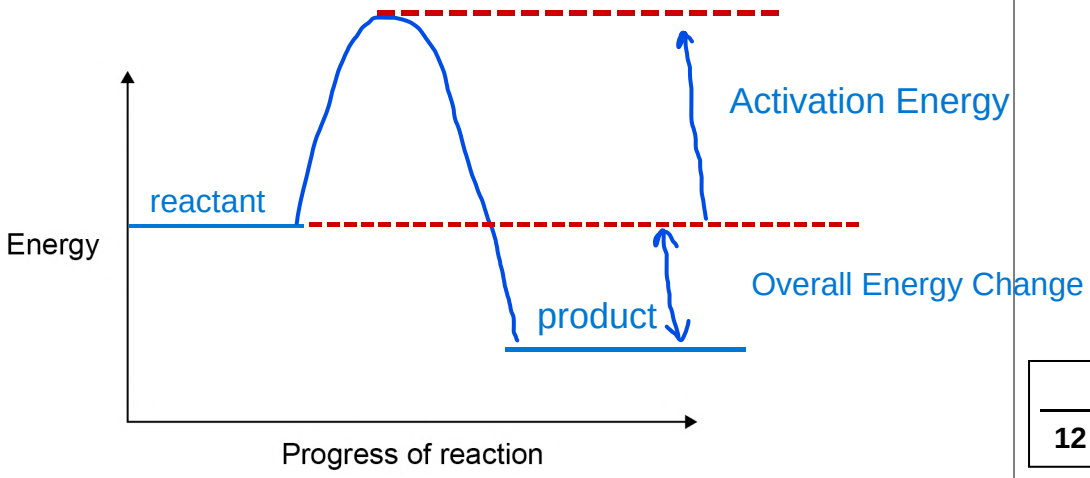
Do not write outside the box

0 3 . 4 Draw a reaction profile for an exothermic reaction.

You should label:

- the energy level of the reactants and of the products
- the activation energy
- the overall energy change.

[4 marks]



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ANSWER IN THE SPACES PROVIDED

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0 4 Carbon can exist in a number of different structures.

0 4 . 1 The first fullerene to be discovered was Buckminsterfullerene.

What is the formula of Buckminsterfullerene?

[1 mark]

Tick (✓) **one** box.

C_{40} ☐

C_{50} ☐

C_{60} ☑

C_{70} ☐

0 4 . 2 Graphite is a form of carbon.

Explain why graphite conducts electricity.

[2 marks]

(graphite has) delocalised electrons

(so the delocalised electrons) carry electrical charge through the structure

Do not write outside the box

Steel is an alloy of iron and carbon.

0 4 . 3 Explain why steel is harder than iron.

[3 marks]

carbon atoms have different sizes to iron atoms / ions

(so carbon atoms) distort the layers of iron atoms / ions

(therefore) the layers cannot slide

0 4 . 4 Iron is alloyed with carbon and other metals to make stainless steel.

A stainless steel fork contains 71.92% iron.

Table 2 shows the mass of each element in the fork.

Table 2

Element	Iron	Carbon	Chromium	Nickel
Mass of element in g	**X**	0.05	10.44	5.80

Calculate the mass of iron (**X**) in the fork.

[4 marks]

(percentage and mass of other elements)

28.08 (%) = 16.29 (g)

(mass of fork) = $\frac{16.29}{28.08} \times 100$ (g)

= 58.01 (g)

(mass of iron = $\frac{71.92}{100} \times 58.01$)

X = 41.72 g

10

Turn over ►

Do not write outside the box

0 5 This question is about the electrolysis of aqueous solutions.

Hydrogen gas and chlorine gas are produced when sodium chloride solution is electrolysed.

0 5 . 1 Hydrogen ions (H^+) are attracted to the negative electrode.

The half equation for the reaction at the negative electrode is:

$$2\,H^+ \quad + \quad 2\,e^- \quad \rightarrow \quad H_2$$

What type of reaction happens at the negative electrode?

Give the reason for your answer.

[2 marks]

Type of reaction reduction

Reason (as H+ ions) gain electrons

0 5 . 2 Chloride ions are attracted to the positive electrode.

Complete the half equation for the production of chlorine gas (Cl_2).

[2 marks]

2 Cl^- → Cl2 + 2 e–

Do not write outside the box

0 5 . 3 Hydrogen gas and oxygen gas are produced when sodium sulfate solution is electrolysed.

Explain how oxygen gas is produced in the electrolysis of sodium sulfate solution.

[4 marks]

water molecules

break down to produce OH– ions

(which are) attracted to the positive electrode

(where OH– ions are) oxidised or
(where OH– ions) lose electrons

8

Turn over for the next question

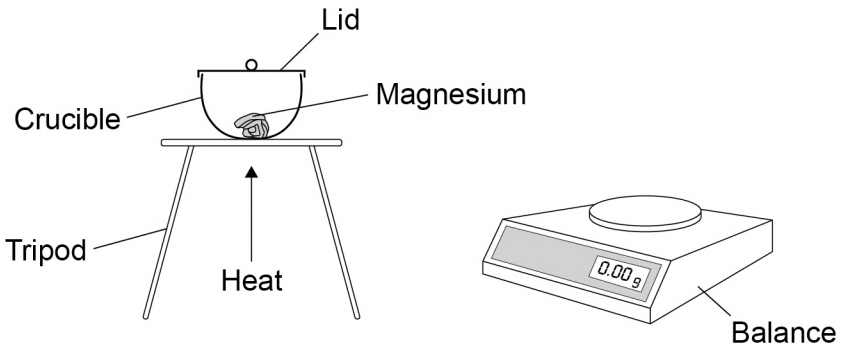
Do not write outside the box

0 6 Metal oxides are produced when metals are heated in air.

A student investigated the change in mass when 0.12 g of magnesium was heated in air.

Figure 5 shows the apparatus.

Figure 5



The student measured the mass of magnesium oxide produced.

0 6 . 1 0.12 g of magnesium reacted to produce 0.20 g of magnesium oxide.

Calculate the number of moles of oxygen gas (O_2) that reacted.

Relative atomic mass (A_r): O = 16

[3 marks]

(mass of oxygen = 0.20 – 0.12)
= 0.08 (g)

(moles of oxygen) = $\frac{0.08}{32}$

Moles of oxygen gas = 0.0025

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0 6 . 2 The student repeated the experiment **without** a lid on the crucible.

Suggest why the mass of magnesium oxide produced would be different without a lid on the crucible.

[2 marks]

(without a lid the) mass of magnesium oxide was less

(because) products escaped

0 6 . 3 Copper reacts with oxygen to produce copper oxide.

63.5 g of copper produces 79.5 g of copper oxide.

Calculate the mass of copper oxide produced when 0.50 g of copper reacts with oxygen.

Give your answer to 3 significant figures.

[3 marks]

(mass of copper oxide =)

$$\frac{79.5}{63.5} \times 0.5$$

= 0.62598 (g)

Mass (3 significant figures) = 0.626 g

Question 6 continues on the next page

Do not write outside the box

0 6 . 4 Iron reacts with oxygen to produce an oxide of iron.

0.015 moles of iron reacts with 0.010 moles of oxygen gas (O_2).

Determine:

- the formula of the iron oxide produced
- the balanced symbol equation for the reaction.

[4 marks]

3:2 ratio Fe : O2 (molecules)
or
3:4 ratio Fe : O (atoms)

Formula of iron oxide = (formula) Fe3O4

Balanced symbol equation

3 Fe + 2 O2 -------> Fe3O4

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 7 Methane, ethane, propane and butane all react with oxygen to produce carbon dioxide and water.

0 7 . 1 Suggest why a mixture of methane and oxygen does **not** react at room temperature.

Answer in terms of particles.

[2 marks]

particles collide

(but at room temperature) particles have insufficient energy

0 7 . 2 **Table 3** shows the energy released when methane, ethane and propane react with oxygen to produce carbon dioxide and water.

Table 3

	Compound reacted with oxygen		
	Methane	Ethane	Propane
Formula of compound	CH_4	C_2H_6	C_3H_8
Energy released in kJ/mol	680	1160	1640

Predict the energy released when butane (C_4H_{10}) reacts with oxygen to produce carbon dioxide and water.

[1 mark]

2120 (kJ/mol)

Energy released = 2120 kJ/mol

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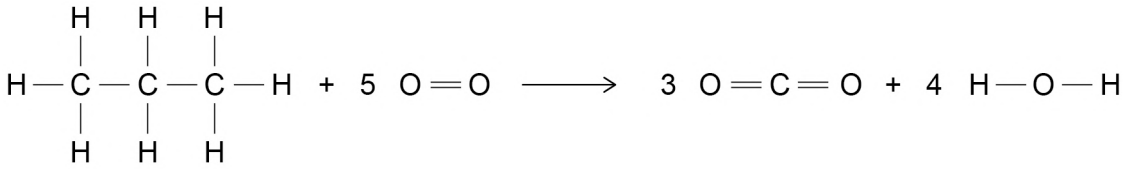
0 7 . 3 Propane reacts with oxygen to produce carbon dioxide and water.

The displayed formula equation for the reaction is:



The reaction is exothermic.

In the reaction, the energy released when forming new bonds is 1640 kJ/mol greater than the energy needed when breaking bonds.

Table 4 shows bond energies.

Table 4

Bond	**H–C**	**C–C**	**O=O**	**C=O**	**O–H**
Bond energy in kJ/mol	410	**X**	500	740	460

Calculate the C—C bond energy (**X**).

[5 marks]

(bonds broken = $(8 \times 410) + 2X + (5 \times 500)$

$= 5780 + 2X$

(bonds formed = $(6 \times 740) + (8 \times 460)$

$= 8120$

(bonds broken – bonds formed = energy released)

$(5780 + 2X) - 8120 = -1640$

$(2X =)\ 700$

X = 350 kJ/mol

8

END OF QUESTIONS

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