Specimen Paper

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

General Certificate of Secondary Education
Higher Tier

Chemistry

Unit Chemistry C3

Chemistry 3H

H

For this paper you must have:
- the Data Sheet (as an insert).

You may use a calculator.

Time allowed
- 60 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the space provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- Question 2(b) should be answered in continuous prose. In this question you will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Advice
- In all calculations, show clearly how you work out your answer.

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ANSWER IN THE SPACES PROVIDED

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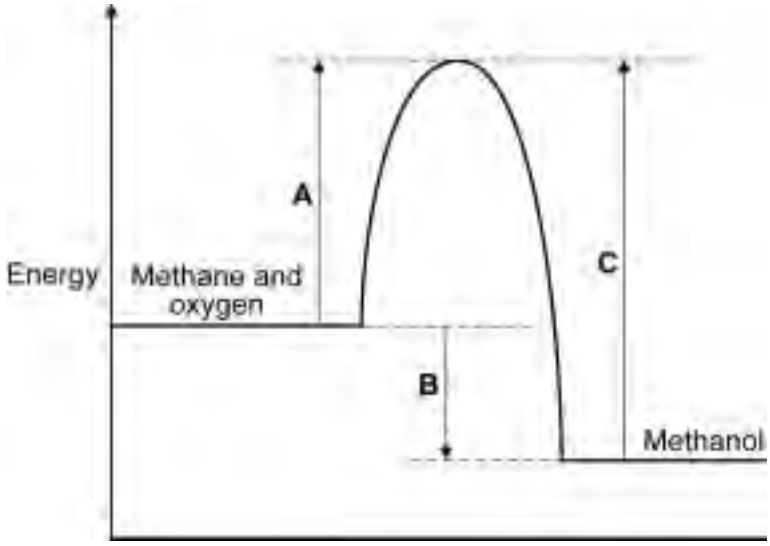
Answer **all** questions in the spaces provided.

1 Methanol can be made when methane reacts with oxygen.

1 (a) The energy level diagram for this reaction is shown below.



1 (a) (i) What is the energy change represented by **A**?

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(1 mark)

1 (a) (ii) Use the energy level diagram to explain how it shows that this reaction is exothermic.

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(2 marks)

Question 1 continues on the next page

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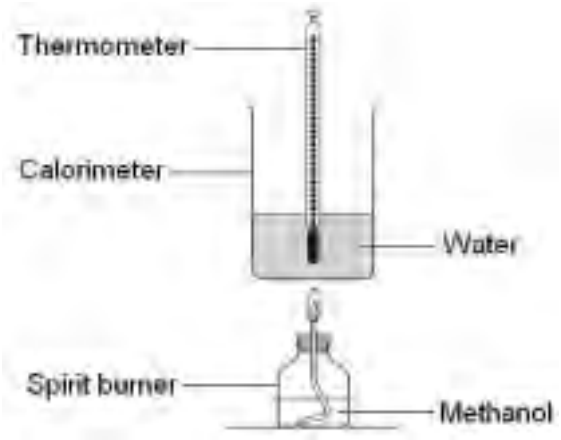
1 (b) A student did an experiment to find the energy released when methanol burns in air.

The student:

- weighed a spirit burner containing methanol
- set up the equipment as shown in the diagram
- recorded the initial temperature



- lit the spirit burner
- put out the flame when the temperature of the water had risen by about 20 °C
- stirred the water and recorded the highest temperature of the water
- reweighed the spirit burner containing the methanol.

The student repeated the experiment and recorded his results.

	Experiment 1	**Experiment 2**	**Experiment 3**
Initial mass of spirit burner and methanol in g	299.3	298.3	296.9
Final mass of spirit burner and methanol in g	298.3	297.1	295.9
Initial temperature in °C	23	22	23
Highest temperature in °C	45	50	43
Temperature change in °C	22	28	20

Use the diagram and the information in the table to answer the questions.

1 (b) (i) The main error in this experiment is energy loss.

Suggest **one** way that the equipment could be changed to reduce energy loss.

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(1 mark)

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1 (b) (ii) The temperature change in Experiment 2 is greater than the temperature change in Experiment 1 **and** Experiment 3.

Explain why.

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(2 marks)

1 (b) (iii) Suggest **one** reason why the student repeated the experiment.

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(1 mark)

1 (b) (iv) Use the temperature change in Experiments 1 **and** 3 to calculate how much energy is released when 1g of methanol burns. The equation that you need to use is:

Energy released in joules = 100 x 4.2 x mean temperature change

Show clearly how you work out your answer.

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Burning 1g of methanol releases ..... J

(2 marks)

9

Turn over for the next question

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2 *Drain Buster* is used to clear and degrease drains. Sodium hydroxide is the main chemical substance in *Drain Buster*.

2 (a) A student planned an experiment to find the concentration of the sodium hydroxide solution in *Drain Buster.*

The teacher had to dilute the *Drain Buster* before the student could use it.

Explain why.

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(2 marks)

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2 (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The student wanted to find the volume of hydrochloric acid that reacts with a known volume of diluted *Drain Buster.*

Describe how the student could do this by titration.
In your description you should include:

- the names of pieces of apparatus used
- the names of the substances used
- a risk assessment.

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(6 marks)

8

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3 Water is a natural resource. Drinking water in some parts of the UK is soft, but in other parts drinking water is hard. Calcium ions in water cause water to be hard.

There are two types of hard water, permanent hard water and temporary hard water.

- Permanent hard water can be caused by calcium sulfate ($CaSO_4$) dissolved in the water.
- Temporary hard water can be caused by calcium hydrogencarbonate ($Ca(HCO_3)_2$) dissolved in the water.

3 (a) Temporary hard water causes the formation of scale on heating elements.

3 (a) (i) Explain how scale forms on heating elements.

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(2 marks)

3 (a) (ii) Suggest why scale on heating elements causes problems.

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(1 mark)

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3 (b) Permanent hard water can be softened.

3 (b) (i) Explain how adding sodium carbonate (Na_2CO_3) softens permanent hard water.

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(2 marks)

3 (b) (ii) Explain how a water filter containing carbon, silver and ion exchange resin softens permanent hard water.

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(2 marks)

7

Turn over for the next question

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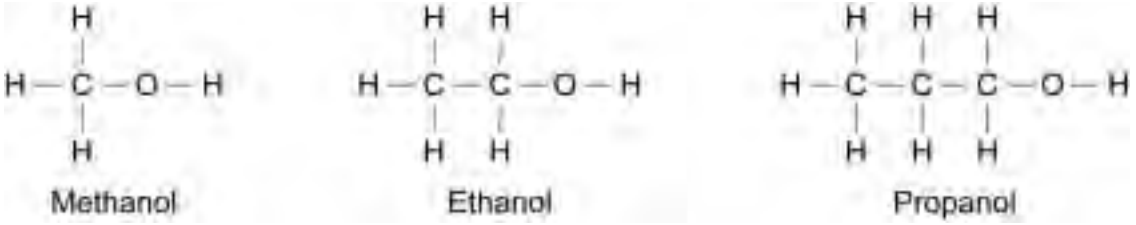
4 The structures shown are of the first three members of a homologous series of alcohols.



4 (a) (i) Draw a ring around the correct general formula for alcohols.

$C_nH_{2n+1}OH$ $C_{2n}H_{2n+1}OH$ $C_nH_{2n+2}OH$

(1 mark)

4 (a) (ii) What is the formula of the functional group for alcohols?

.....

(1 mark)

4 (b) Ethanol is the alcohol used in alcoholic drinks.

4 (b) (i) When ethanol dissolves in water the solution formed is **not** alkaline.

Tick (✓) the reason why the solution formed is **not** alkaline.

Reason	Tick (✓)
Ethanol can be used as a solvent.	
Ethanol dissolves in water to form hydroxide ions.	
Ethanol has only covalent bonds in its molecule.	

(1 mark)

4 (b) (ii) Ethanol is used as a fuel because ethanol burns in oxygen.

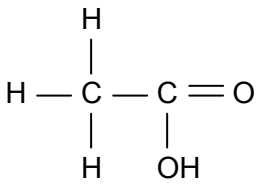
Complete and balance the chemical equation for this reaction.

C_2H_5OH + ...O_2 ⟶ $2\,CO_2$ + ...

(2 marks)

Do not write outside the box

4 (c) Ethanol can be oxidised to produce the compound shown.



4 (c) (i) Draw a ring around the correct answer to complete the sentence.

When this compound dissolves in water, the solution formed is

acidic.
alkaline.
neutral.

(1 mark)

4 (c) (ii) Ethanol reacts with this compound to produce the organic compound shown.

$C_2H_5OH + CH_3COOH \longrightarrow CH_3COOC_2H_5 + H_2O$

Complete the sentence.

The type of organic compound produced is ..... .

(1 mark)

7

Turn over for the next question

Do not write outside the box

5 The use of too much common salt (sodium chloride) in our diet increases the risk of heart problems. One way to reduce sodium chloride in our diet is to use Low Sodium Salt instead of common salt.

A student tested Low Sodium Salt to find out if it contained both potassium chloride and sodium chloride and what ions were in the anti-caking agent.

5 (a) The student did a flame test.

The flame colour showed that there were sodium ions in the Low Sodium Salt.

The student did **not** observe the colour in the flame which would show that there were potassium ions in the Low Sodium Salt.

Suggest why.

(You will need to state the flame colours of sodium ions **and** potassium ions in your answer.)

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(3 marks)

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5 (b) The student did a test to find which metal ion was in the anti-caking compound.

The student had **not** seen any red colour in the flame while doing the flame test.

The student added water to make a solution of Low Sodium Salt.
The student then added sodium hydroxide solution. A white precipitate formed that was insoluble in excess sodium hydroxide solution.

Use the information to draw a ring around the name of the metal ion that is in the anti-caking agent.

aluminium **calcium** **magnesium**

(1 mark)

Question 5 continues on the next page

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5 (c) A student was provided with the following reagents to test for non-metal ions in the Low Sodium Salt.

- Calcium hydroxide solution
- Dilute hydrochloric acid
- Silver nitrate in solution
- Dilute nitric acid

The table shows the tests that student did and the observations that the student made.

Tests	**Observations**
Dilute nitric acid was added to Low Sodium Salt.	The mixture fizzed and the gas given off turned limewater cloudy.
Excess nitric acid was added to the Low Sodium Salt, and then silver nitrate solution was added.	A white precipitate formed in the solution.

5 (c) (i) From the table what conclusions can you make about the non-metal ions that are in the Low Sodium Salt?

Explain your conclusions.

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(2 marks)

5 (c) (ii) Another student used hydrochloric acid instead of nitric acid for the tests shown in the table.
Describe what this student would observe and explain why this student's conclusions would not be valid.

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(3 marks)

9

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6 Hydrogen could be the fuel used in all cars. One advantage is that when hydrogen reacts with oxygen only water is produced.

The chemical equation for this reaction is:

$$2\,H_2 \quad + \quad O_2 \quad \longrightarrow \quad 2H_2O$$

This equation can be written showing the structural formulae.

6 (a) Use the bond energies in the table to calculate the energy change for this reaction.

Bond	Bond energy in kJ
H – H	436
O = O	498
O – H	464

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Energy change = ... kJ

(3 marks)

6 (b) Suggest why the bond energy of O = O is higher than the bond energies of both H – H and O – H.

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(1 mark)

6 (c) In terms of bond energies, explain why hydrogen can be used as a fuel.

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(2 marks)

6

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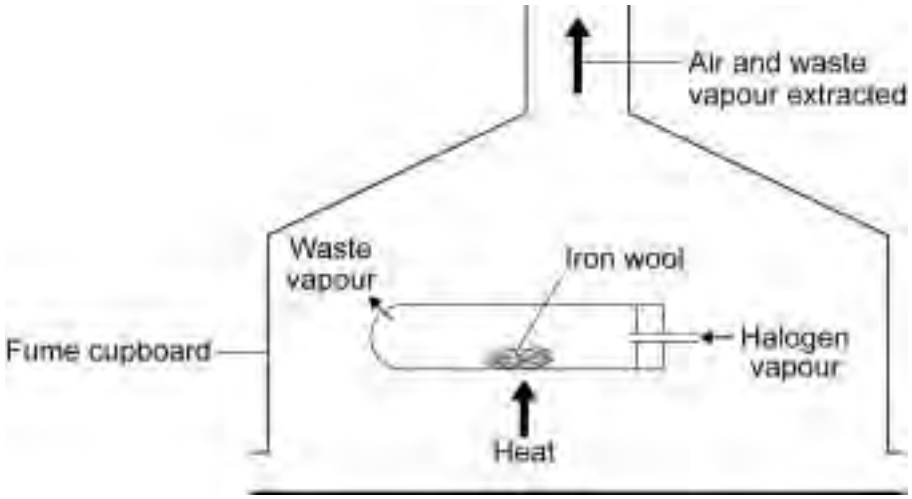
7 A teacher demonstrated the reactivity of the halogens to some students. Halogen vapour was passed over heated iron wool in a fume cupboard.



The teacher's observations are shown in the table below.

	Observations	
	During the reaction	**After the reaction**
Bromine	The iron wool glowed	A red–brown solid had been produced
Chlorine	The iron wool glowed	A dark brown solid had been produced
Iodine	The iron wool did not glow	A black solid had been produced

7 (a) From these observations what conclusion can be made about the order of reactivity of the three halogens?

Explain your conclusion.

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(2 marks)

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7 (b) In terms of electronic structures, explain why iodine is **less reactive** than bromine.

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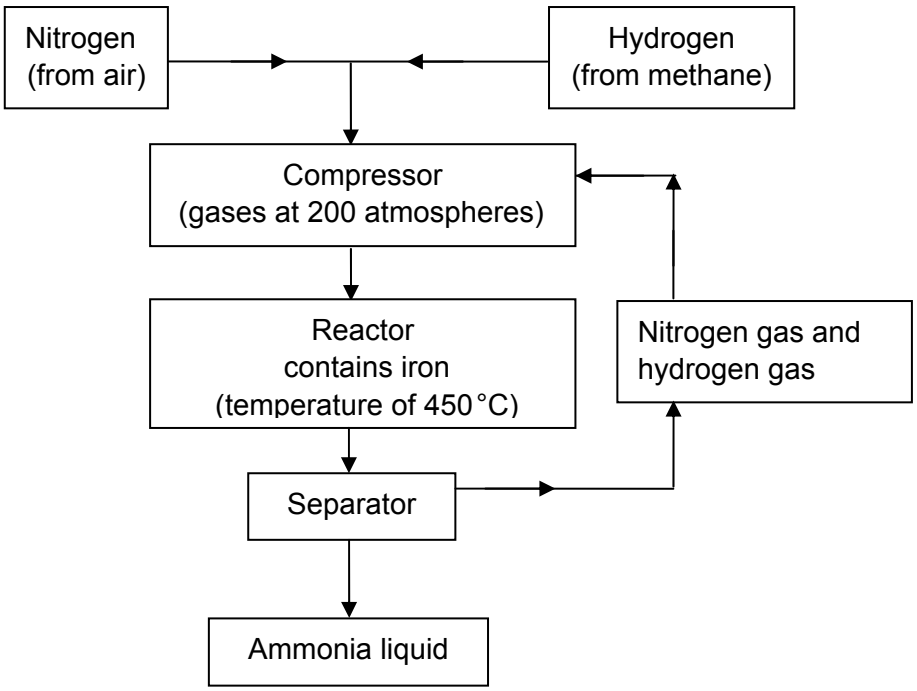
(3 marks)

5

Turn over for the next question

8 Ammonia is used in the production of fertilisers. The flow diagram shows the main stages in the manufacture of ammonia.

Study the flow diagram and then answer the questions.



8 (a) What is the purpose of the iron in the reactor?

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(1 mark)

8 (b) In the reactor the equation to produce ammonia is:

$$N_2(g) + 3H_2(g) \underset{\text{endothermic}}{\overset{\text{exothermic}}{\rightleftharpoons}} 2NH_3(g)$$

8 (b) (i) The equation shows that the reaction is reversible.

Explain how the reaction reaches an equilibrium.

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(1 mark)

Do not write outside the box

8 (b) (ii) The best yield of ammonia at equilibrium is produced at a low temperature.

Explain why.

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(2 marks)

8 (b) (iii) The best yield of ammonia at equilibrium is produced at a high pressure.

Explain why.

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(1 mark)

5

Turn over for the next question

9 The periodic table was developed over about 200 years.

In 1869, a Russian scientist, Mendeleev, arranged the 60 known elements into his periodic table.

Mendeleev put the elements in order of their increasing atomic weights.
Then he put elements with similar chemical properties in the same columns.
He left gaps in his periodic table.

The modern periodic table on the Data Sheet may help you to answer these questions.

9 (a) Mendeleev's periodic table was produced without any knowledge of the atomic structure of elements.

State why Mendeleev left gaps in his periodic table.

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(1 mark)

9 (b) The modern periodic table was produced with knowledge of the atomic structure of elements.

The modern periodic table is an arrangement of the elements in terms of their atomic structures.

Explain how.

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(3 marks)

4

END OF QUESTIONS

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