OCR
Oxford Cambridge and RSA

H

Wednesday 12 June 2019 – Morning

GCSE (9–1) Chemistry A (Gateway Science)

J248/04 Paper 4 (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet (for GCSE Chemistry A (inserted))

You may use:
- a scientific or graphical calculator
- an HB pencil

J248/04

Please write clearly in black ink. **Do not write in the barcodes.**

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

First name(s) _____

Last name _____

INSTRUCTIONS
- The data sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **28** pages.

SECTION A

You should spend a maximum of 30 minutes on this section.

Answer **all** the questions.

Write your answer to each question in the box provided.

1 Which statement describes the **advantages** of instrumental methods of analysis?

A Instruments can analyse very small amounts and carry out the analyses slowly.

B Instruments are very accurate and use large amounts of substances.

C Instruments are very accurate and carry out the analyses slowly.

D Instruments are very accurate and can run all the time.

Your answer ☐ **[1]**

2 The table shows the composition of the Earth's early atmosphere compared with the atmosphere today.

	Nitrogen	**Oxygen**	**Argon**	**Carbon dioxide**
Percentage of gas in the early atmosphere	4	0.5	0.5	95
Percentage of gas in the atmosphere today	78	21	0.9	0.04

Which gas has **changed by the largest percentage** from the early atmosphere to the atmosphere today?

A Nitrogen

B Oxygen

C Argon

D Carbon dioxide

Your answer ☐ **[1]**

3 Which of these pairs of gases are **both** greenhouse gases?

A Nitrogen and methane

B Nitrogen and oxygen

C Water vapour and methane

D Water vapour and oxygen

Your answer ☐ **[1]**

4 Which statement about **atom economy** is correct?

A A reaction that has only one product has a higher atom economy than a reaction that has two products, one of them being a waste product.

B A reaction with a low atom economy is more sustainable than a reaction with a high atom economy.

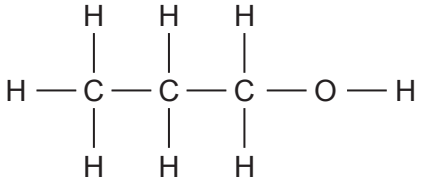
C A reaction with a low atom economy will usually produce less waste products than a reaction with a high atom economy.

D To calculate the atom economy of a reaction you need to know the expected yield and the actual yield of the products.

Your answer ☐ **[1]**

5 Which displayed formula shows butanol?

A



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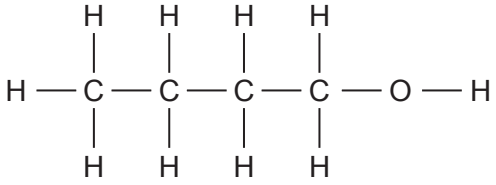

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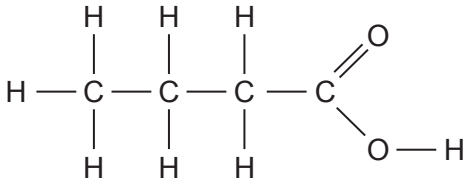

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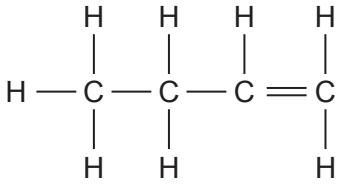


Your answer ☐ **[1]**

6 A student tests a solution for **chloride ions**.

She adds dilute nitric acid to the solution. She then adds a few drops of silver nitrate solution.

Why does she need to add dilute nitric acid in this test?

A To increase the pH of the solution.

B Nitrate ions are needed for the test to work.

C To make sure that no carbonate ions are present.

D The test only works in alkaline conditions.

Your answer ☐ **[1]**

7 Which statement describes what happens when a reaction **reaches** equilibrium?

A The forward reaction happens at a faster rate than the backwards reaction.

B The forward and backward reactions happen at the same rate.

C The forward and backward reactions stop happening.

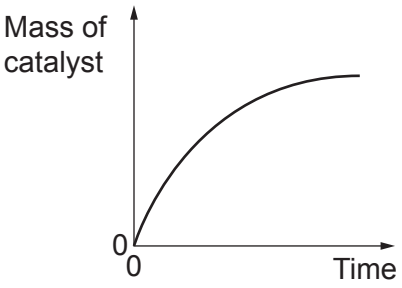
D The backward reaction happens at a faster rate than the forward reaction.

Your answer ☐ **[1]**

8 A catalyst can be used to increase the rate of a reaction.

Which graph shows the **mass of the catalyst** as the reaction takes place?

A



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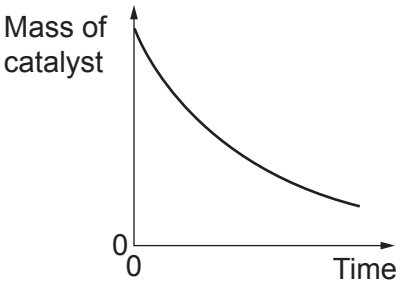

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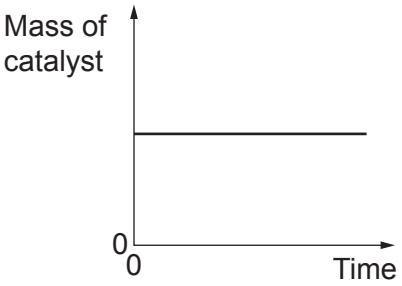

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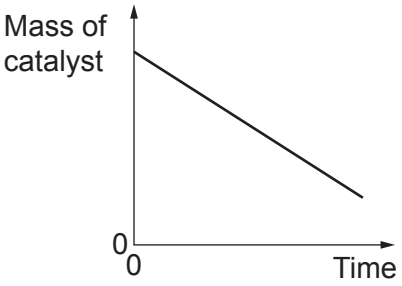


Your answer ☐ **[1]**

9 A hydrogen-oxygen fuel cell produces electricity.

Hydrogen reacts with oxygen to produce water.

What is the equation for the reaction that happens at the **anode**?

A $2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$

B $4H^+(aq) + 4e^- \longrightarrow 2H_2(g)$

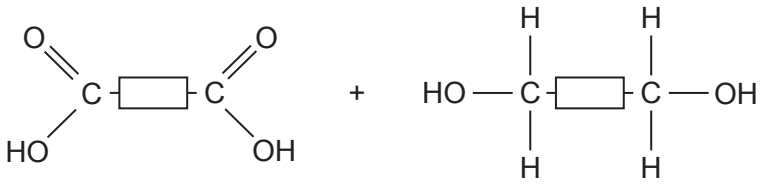
C $2H_2(g) \longrightarrow 4H^+(aq) + 4e^-$

D $4H^+(aq) + O_2(g) + 4e^- \longrightarrow 2H_2O(g)$

Your answer ☐ **[1]**

10 Which pairs of molecules would react to form a **polyester**?

A



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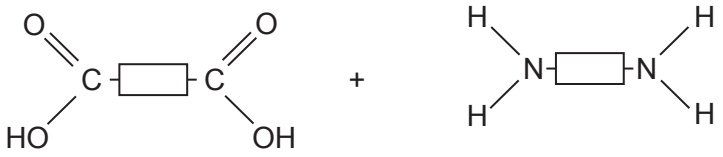

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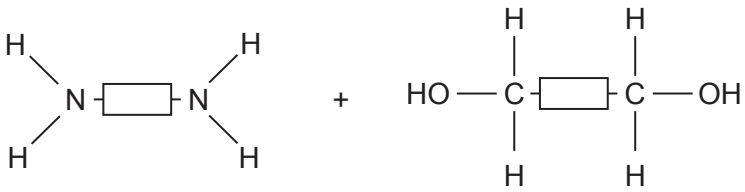

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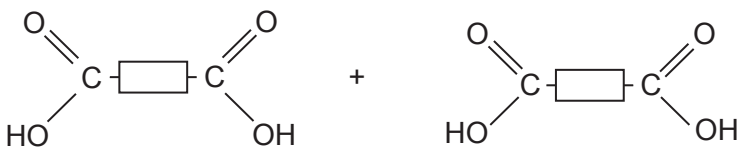

Your answer ☐ **[1]**

11 Phytoextraction is one way to extract copper from low-grade ores.

The table shows the main stages involved in phytoextraction.

Stage	Process
1	Copper ions accumulate in the roots, shoots and leaves of plants.
2	Copper is extracted from ash with a high concentration of copper compounds.
3	Plants absorb dissolved copper ions through their roots.
4	A crop is planted in soil containing low-grade copper ore.
5	Plants are harvested and burned.

What is the correct order for the stages?

A 1, 3, 4, 5, 2

B 4, 1, 3, 2, 5

C 4, 3, 1, 5, 2

D 1, 4, 3, 5, 2

Your answer ☐ **[1]**

12 Which statement about the greenhouse effect and greenhouse gases is correct?

A Greenhouse gases absorb all the infrared radiation that is emitted by the Earth's surface.

B The greenhouse effect is caused by the infrared radiation being absorbed and re-emitted by greenhouse gases.

C The lower the concentration of greenhouse gases in the Earth's atmosphere, the warmer the Earth becomes.

D Greenhouse gases are a large percentage of the Earth's current atmosphere.

Your answer ☐ **[1]**

13 Which statement explains why **polyamides** are condensation polymers?

A A molecule of water forms each time a hydroxyl link forms.

B A molecule of water forms each time an ester link forms.

C A molecule of water forms each time an amine group reacts with a carboxylic acid group.

D A molecule of water forms each time an alcohol group reacts with a carboxylic acid group.

Your answer ☐ **[1]**

14 Which statement about a **mass spectrum** of a molecule is correct?

A Each peak represents an atom in the molecule.

B The charge to mass ratio of the molecular ion peak is equal to the relative formula mass of the molecule.

C The peak with the highest relative abundance represents the molecular ion.

D The peak on the far right of the spectrum represents the molecular ion.

Your answer ☐ **[1]**

15 Which of the following is the expression used to calculate concentration in g/dm^3?

A $\text{Concentration} = \dfrac{\text{mass of solute in g}}{\text{volume of solution in dm}^3}$

B $\text{Concentration} = \dfrac{\text{mass of solvent in g}}{\text{volume of solution in dm}^3}$

C $\text{Concentration} = \text{mass of solute in g} \times \text{volume of solution in dm}^3$

D $\text{Concentration} = \dfrac{\text{mass of solute in g} \times \text{volume of solution in dm}^3}{1000}$

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

16 This question is about properties of materials.

Police bullet-resistant vests could be made from steel or Kevlar®.

The table shows some information about steel and Kevlar®.

	Steel	**Kevlar®**
Density (g / cm^3)	7.85	1.44
Relative strength	1	5
Flexibility	low	high
Resistance to corrosion	low	high

(a) Describe and explain **two** reasons why bullet-resistant vests are made from Kevlar® instead of steel.

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2 .....

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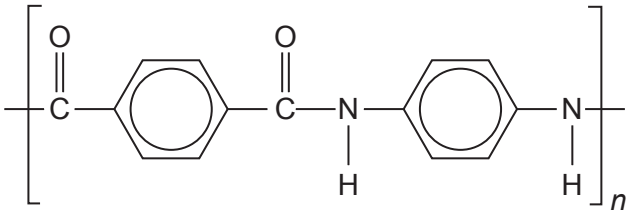
[4]

(b) Look at the structure of Kevlar®.



What type of molecule is Kevlar®?

..... **[1]**

(c) Nanoparticles are being used to make a material that is better than Kevlar® at resisting bullets.

Nanoparticles are often made of silicon dioxide.

A silicon dioxide nanoparticle has a diameter of 18 nm.

The diameter of a silicon atom is 0.22 nm.

(i) Estimate how many times larger the silicon dioxide nanoparticle is, compared to a silicon atom.

Give your answer to **1** significant figure.

Number of times larger = ... **[3]**

(ii) Silicon dioxide is used as a **catalyst**.

Suggest why 1 g of silicon dioxide is **more effective** as a catalyst when used as nanoparticles rather than as a powder.

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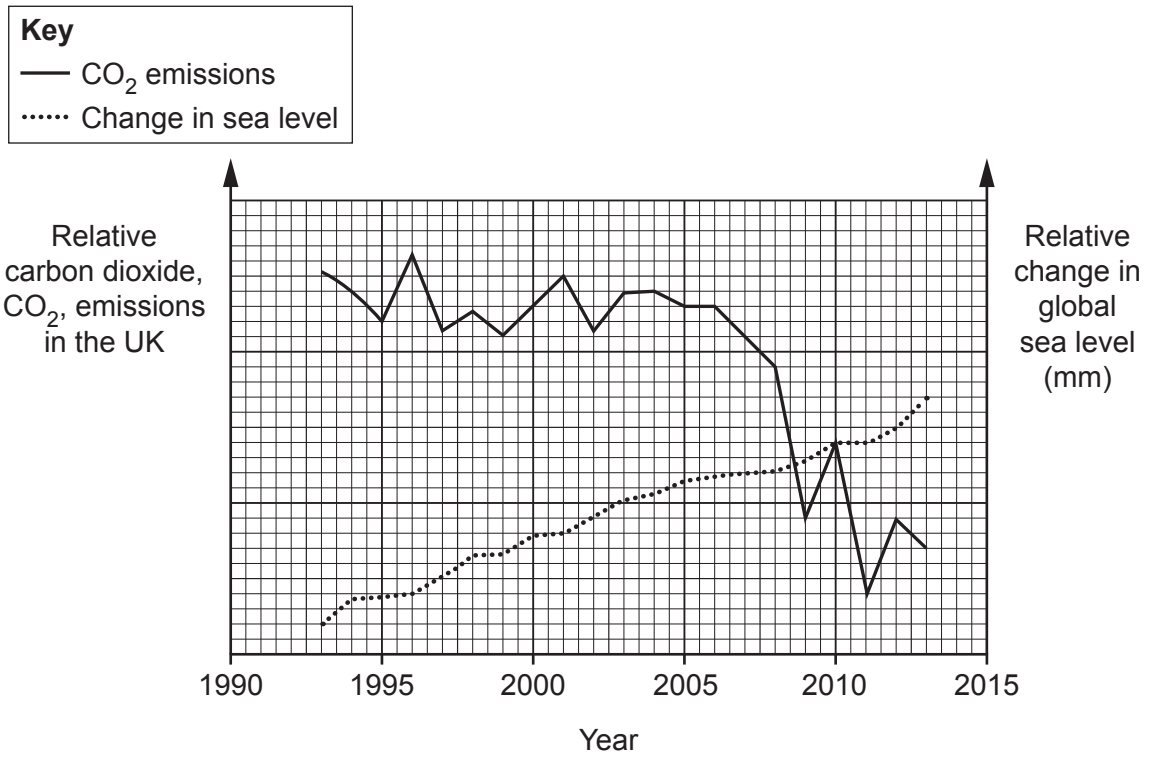
..... **[3]**

17 Some scientists believe that the increased burning of fossil fuels has contributed to global warming.

The scientists say that global warming is causing ice to melt, which results in sea levels rising.

Other scientists believe that rises in global temperatures are just natural variations.

The graph shows the carbon dioxide, CO_2, emissions by fossil fuels in the UK and the changes in global sea levels between 1993 and 2013.



(a) Evaluate the information shown in the graph.

To what extent does the graph support a link between human activity and global warming?

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..... **[3]**

(b) There are problems with using information about **CO_2 emissions by fossil fuels** to draw conclusions about the effect of carbon dioxide emissions on **global** sea levels.

Suggest what these problems are.

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..... **[2]**

(c) **(i)** Describe **one** effect on the Earth's climate of increased carbon dioxide levels, other than rising sea levels.

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..... **[1]**

(ii) Suggest how we can lower carbon dioxide levels.

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..... **[1]**

18 In the Haber process nitrogen gas, N_2, reacts with hydrogen gas.

Ammonia, NH_3, is made. The reaction is a reversible reaction.

(a) Write the **balanced symbol** equation for the reaction.

..... **[2]**

(b) The conditions used to make ammonia in the Haber process are:

- a pressure of 200 atmospheres
- a temperature of 450 °C.

The reaction is an exothermic reaction.

A company making ammonia increases the temperature used to 550 °C.

(i) What happens to the **rate of the reaction** when the temperature is increased?

..... **[1]**

(ii) The company thinks that the increase in temperature will increase the **yield** of ammonia.

Is the company correct? Explain your answer.

.....

.....

..... **[2]**

(c) The company wants to reduce the cost of making the ammonia.

They decide to reduce the pressure used to 150 atmospheres.

Write about **two** disadvantages of using a lower pressure to make ammonia.

1 .....

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2 .....

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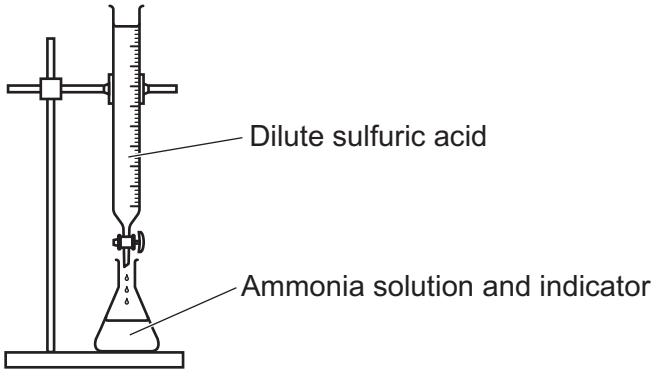
[2]

(d) Ammonia is used to make fertilisers such as ammonium sulfate.

A student makes some ammonium sulfate crystals in a laboratory.

She uses a titration method, as shown in the diagram.



She adds an indicator to ammonia solution in a conical flask. She then adds dilute sulfuric acid from a burette until the indicator changes colour.

The student then crystallises the solution. She is left with **impure** ammonium sulfate crystals.

(i) What should the student have done to obtain **pure** ammonium sulfate crystals?

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..... **[2]**

(ii) In industry the same reaction is used to make ammonium sulfate.

The method used is different.

Give **one** reason why the laboratory method to make ammonium sulfate is **not** used in industry.

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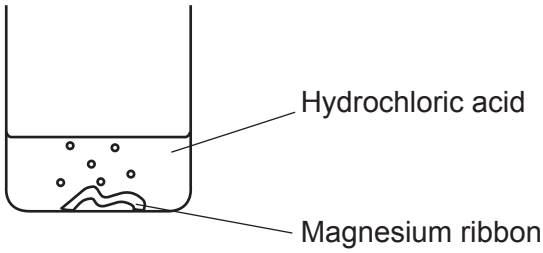
..... **[1]**

19 A student investigates the reaction between magnesium and dilute hydrochloric acid, HC*l*.

The student adds magnesium ribbon to hydrochloric acid in a beaker, as shown in the diagram.



(a) Write the **balanced symbol** equation for this reaction.

..... **[2]**

(b)* The student measures the time it takes for all the magnesium to react. This is the reaction time.

The student does five experiments.

This is the student's prediction:

"The smaller the volume of acid and the greater the concentration of acid, the faster the reaction rate."

Look at the student's results.

Experiment	Mass of magnesium used (g)	Volume of acid used (cm^3)	Concentration of acid (mol/dm^3)	Reaction time (s)
1	0.05	25	1.0	30
2	0.05	50	1.0	30
3	0.05	50	2.0	15
4	0.10	25	1.0	30
5	0.10	50	2.0	15

Describe and explain whether the student's results support his prediction.

Include ideas about the reacting particle model in your answer.

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..... **[6]**

(c) The student repeats experiment **1**. This time he uses acid at a **higher** temperature.

Explain, using the reacting particle model, **what happens to the rate of reaction** and **predict the reaction time** for this reaction.

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..... **[3]**

(d) Another student investigates the reaction between marble chips and hydrochloric acid.

She times how long it takes for all the marble chips to react.

Look at her results.

Experiment	Size of marble chips	Reaction time (s)	Mean rate of reaction (g/s)
1	large	240	8.33×10^{-4}
2	large	120	
3	large	100	2.00×10^{-3}
4	small	50	4.00×10^{-3}

Look at the student's results for experiment **2**.

Calculate the **mean rate of reaction** in experiment **2**.

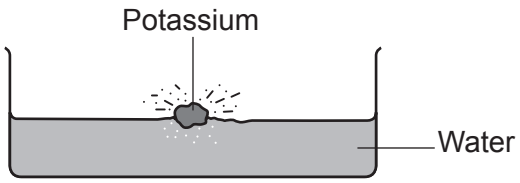
Give your answer to **3** significant figures and in **standard form**.

Mean rate of reaction = ... g/s **[3]**

20 This question is about the properties of elements in Groups 1, 7 and 0.

(a) Lithium, sodium and potassium are all Group 1 elements.

A teacher adds a small piece of potassium to a trough of water, as shown in the diagram.



The potassium fizzes and a gas is produced.

Describe what else you would observe.

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..... **[2]**

(b) Reactivity **increases** going down Group 1 from lithium to potassium.

Explain this trend in reactivity.

Use ideas about the electronic configurations of the atoms in your answer.

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..... **[2]**

(c) Look at the table. It shows information about the Group 7 elements.

Complete the table.

Element	Formula	Colour	State at room temperature
Fluorine	F_2	pale yellow	gas
Chlorine	Cl_2	.....	.....
Bromine	Br_2	brown	liquid
Iodine	I_2	grey	.....

[3]

(d) The Group 7 elements exist as simple molecules.

Fluorine boils at −188 °C.

Explain why fluorine has a low boiling point.

.....

.....

..... **[2]**

(e) The elements in Group 0 (the noble gases) are unreactive.

Explain why, in terms of their electronic configurations.

.....

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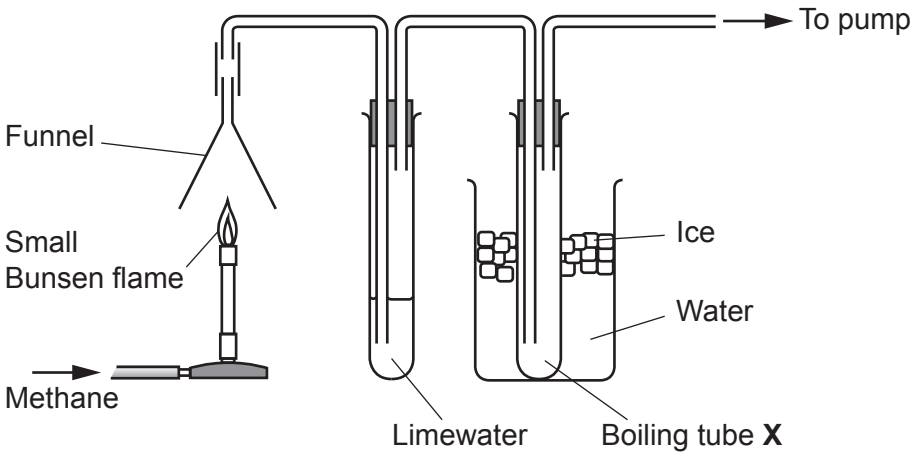
..... **[2]**

21 A student did an experiment to prove that methane gas, CH_4, produces carbon dioxide and water when it burns.

Look at the diagram of her experiment.



(a) The limewater turned milky showing that carbon dioxide had been formed.

A small amount of a colourless liquid condensed in boiling tube **X**. The student said that this proved that burning methane produced water.

The teacher said that the experiment had been set up incorrectly.

The teacher said that the student's conclusion about water was not valid.

Describe and explain how the student could change how the experiment is set up to prove that water is produced **by burning methane**.

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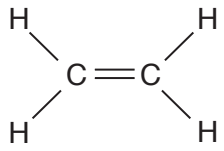
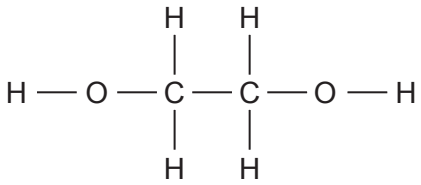
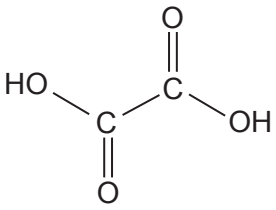
..... **[2]**

(b) Look at the monomers shown in the table.

Monomer	Structure
Ethene	
Ethane-1,2-diol	
Ethanedioic acid	

Two of the monomers from the table react to form a polymer which is a **polyester**.

Explain, using the appropriate monomers from the table, how the polyester is formed.

Include the **type of polymerisation** and an **equation for the reaction** in your answer.

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..... **[4]**

(c) DNA and proteins are biological polymers.

(i) How many **different** monomers are found in a DNA polymer?

..... **[1]**

(ii) What are the monomers in **proteins** called?

..... **[1]**

(d) An alcohol, **X**, has the formula C_3H_7OH.

Alcohol **X** can be oxidised to a compound, **Y**, with the molecular formula $C_3H_6O_2$.

(i) Compound **Y** is **not** an alcohol but is a member of another homologous series.

Write down the name of this homologous series.

..... **[1]**

(ii) Draw the **displayed formula** of a molecule of alcohol **X** and of a molecule of compound **Y**.

Show all the covalent bonds.

Alcohol **X**

Compound **Y**

[2]

22 **(a)** In an experiment, a mixture of ammonium chloride and calcium hydroxide is heated.

Ammonia gas, NH_3, is made.

$2NH_4Cl + Ca(OH)_2 \longrightarrow CaCl_2 + 2NH_3 + 2H_2O$

A student adds 5.00 g of ammonium chloride to an excess of calcium hydroxide.

Calculate the maximum **volume of ammonia gas** that could be made at room temperature and pressure.

One mole of a gas occupies 24 dm^3 at room temperature and pressure.

Volume of ammonia gas = ... dm^3 **[2]**

(b) In another experiment a student reacts sodium hydroxide solution with dilute hydrochloric acid.

$NaOH + HCl \longrightarrow NaCl + H_2O$

(i) 35.0 cm^3 of 0.075 mol / dm^3 hydrochloric acid, HCl, are added to 25.0 cm^3 of 0.100 mol / dm^3 sodium hydroxide solution, NaOH.

Use the information to determine which reactant is **in excess**.

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..... **[3]**

(ii) To find the exact amount of dilute hydrochloric acid that reacts with 25.0 cm^3 of the sodium hydroxide solution, the student does a titration.

Look at the student's results. The rough titration is **not** shown.

	Titration 1	**Titration 2**	**Titration 3**	**Titration 4**
Final burette reading (cm^3)	36.30	38.60	39.25	38.30
Initial burette reading (cm^3)	0.00	2.80	4.05	2.10
Volume of acid used (cm^3)	36.30	35.80	35.20	36.20

Use the student's **concordant** results to calculate the mean volume of hydrochloric acid required.

Mean volume = ... cm^3 **[2]**

(c) In another titration 25.0 cm^3 of potassium hydroxide solution, KOH, are titrated with 0.200 mol/dm^3 sulfuric acid, H_2SO_4.

$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$

24.80 cm^3 of sulfuric acid are needed to neutralise 25.0 cm^3 of the potassium hydroxide solution.

Calculate the concentration of the potassium hydroxide solution in mol/dm^3.

Concentration = ... mol/dm^3 **[4]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).