OCR
Oxford Cambridge and RSA

Tuesday 13 June 2023 – Morning

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

J248/02 Paper 2 (Foundation Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Chemistry A (inside this document)

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

F

* J 2 4 8 0 2 *

* 9 1 2 9 7 4 0 9 0 7 *

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

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

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for a correct method, even if the answer is wrong.

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

ADVICE
- Read each question carefully before you start your answer.

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Section A

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

Write your answer to each question in the box provided.

1 A student does a flame test with a sample of potassium chloride.

Which colour is the flame?

A Lilac

B Green-blue

C Red

D Yellow

Your answer ☐ **[1]**

2 What is the test for chlorine gas?

A Damp universal indicator paper turns red then white

B Decolourises bromine water

C Limewater turns milky

D Relights a glowing splint

Your answer ☐ **[1]**

3 Why do marble chips react faster with **warm** hydrochloric acid than with cold hydrochloric acid?

A The warm hydrochloric acid acts as a catalyst.

B The warm hydrochloric acid has more crowded particles.

C The warm hydrochloric acid has particles with more energy.

D The warm hydrochloric acid has particles that move slower.

Your answer ☐ **[1]**

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4 Which conditions are needed for the rusting of iron to happen?

A Air and no water

B Air and oil

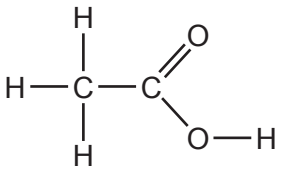
C Air and salt

D Air and water

Your answer ☐ **[1]**

5 What is the displayed formula of **ethanol**?

A



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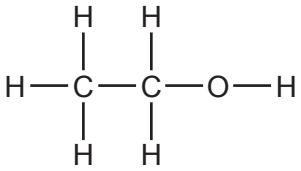

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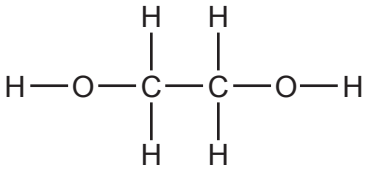

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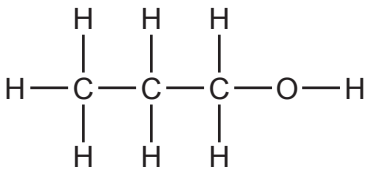

Your answer ☐ **[1]**

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6 Tap water is treated to make it safe to drink.

Which substance is added to the tap water to kill bacteria and microbes?

A Aluminium sulfate

B Carbon dioxide

C Chlorine

D Iodine

Your answer ☐ **[1]**

7 Methane is a hydrocarbon.

Which substance **cannot** be produced when methane burns in air?

A Carbon

B Carbon dioxide

C Hydrogen

D Water

Your answer ☐ **[1]**

8 Brass is an alloy used to make musical instruments.

What are the main metals in brass?

A Aluminium and copper

B Copper and tin

C Copper and zinc

D Lead and tin

Your answer ☐ **[1]**

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9 What was the main gas in the Earth's early atmosphere?

A Ammonia

B Carbon dioxide

C Nitrogen

D Oxygen

Your answer ☐ **[1]**

10 Bromine reacts with sodium iodide.

What is the **balanced symbol** equation for the reaction?

A $Br + NaI \longrightarrow NaBr + I$

B $Br_2 + NaI \longrightarrow NaBr + I_2$

C $Br_2 + 2NaI \longrightarrow 2NaBr + I_2$

D $Br_2 + NaI_2 \longrightarrow NaBr_2 + I_2$

Your answer ☐ **[1]**

11 Ammonia is made in the Haber process.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

What happens when this reaction reaches equilibrium?

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

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

C The forward and backward reactions stop happening.

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

Your answer ☐ **[1]**

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12 Iron objects can be protected from rusting by coating them with a layer of zinc.

What is this process called?

A Galvanising

B Insulating

C Oxidation

D Reduction

Your answer ☐ **[1]**

13 Calcium carbonate, $CaCO_3$, thermally decomposes to make calcium oxide, CaO, and carbon dioxide.

$CaCO_3 \rightarrow CaO + CO_2$

5.0 g of calcium carbonate makes 2.8 g of calcium oxide.

How much carbon dioxide is made?

A 2.2 g

B 2.8 g

C 4.4 g

D 7.8 g

Your answer ☐ **[1]**

14 Crude oil is a resource that is being made extremely slowly.

Which word describes a resource that is being made extremely slowly?

A Finite

B Hydrocarbon

C Non-renewable

D Petrochemical

Your answer ☐ **[1]**

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15 The Group 7 element fluorine is a gas at room temperature and pressure.

The Group 7 elements show a trend in boiling points going down the group.

Which row shows the boiling points of the Group 7 elements?

	Boiling Point (°C)			
	Fluorine	**Chlorine**	**Bromine**	**Iodine**
A	–188	59	184	–15
B	–188	–34	59	184
C	188	184	59	–15
D	–15	184	188	59

Your answer ☐ **[1]**

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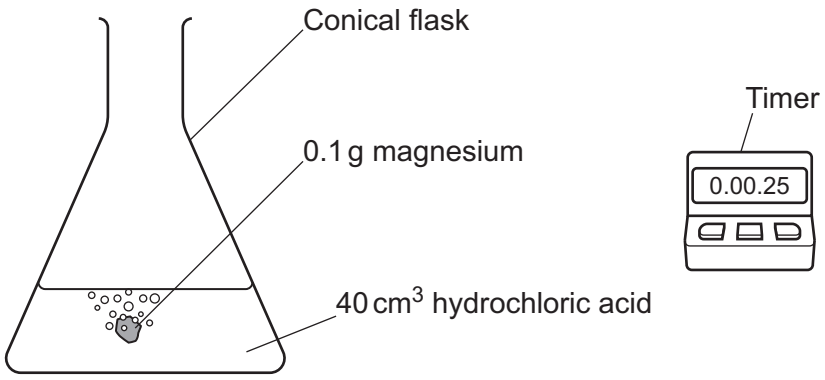
Section B

16 A teacher investigates the reaction between hydrochloric acid and magnesium.

The diagram shows the teacher's experiment.



- The teacher uses five different concentrations of hydrochloric acid.
- Each time they react the hydrochloric acid with 0.1 g of magnesium ribbon.
- They repeat the experiment with 0.1 g of magnesium powder.

The table shows the teacher's results.

	Time for magnesium to react (s)	
Concentration of hydrochloric acid (mol / dm^3)	**Magnesium ribbon**	**Magnesium powder**
0.5	201	117
1.0	158	89
1.5	77	48
2.0	51	24
2.5	37	16

(a) The teacher says that the reaction is faster with magnesium powder than with magnesium ribbon.

Use the results to explain why the teacher is **correct**.

.....

.....

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

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(b) **(i)** Describe how the rate of reaction changes when the concentration of the hydrochloric acid **increases**.

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

(ii) Explain your answer to **(i)** using ideas about particles.

.....

.....

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

(c) The teacher used 0.1 g of magnesium.

0.1 g of magnesium reacts with hydrochloric acid to make 0.008 g of hydrogen gas.

A student suggests that the rate of reaction could be investigated by measuring the loss in mass during the reaction.

Suggest why this method would **not** work well.

.....

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

(d) Describe the test for hydrogen gas.

.....

.....

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

(e) In another experiment, the teacher reacts 0.1 g of zinc with excess hydrochloric acid.

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

Calculate the **mass** of hydrogen gas made.

Relative atomic mass (A_r): H = 1.0 Zn = 65.4

Mass of hydrogen gas = ... g **[3]**

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17 The table shows information about the physical properties of four elements, **W**, **X**, **Y** and **Z**.

	W	**X**	**Y**	**Z**
Density (g / cm^3)	0.97	7.87	0.003	1.74
Melting point (°C)	98	1538	–102	650
Conducts electricity?	✓	✓	✗	✓

(a) Which element is a non-metal?

Give a reason for your answer.

Element .....

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

(b) One of the elements is sodium in Group 1.

Which element is sodium?

Give a reason for your answer.

Element .....

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

(c) One of the elements is a transition metal.

(i) Compare the physical and chemical properties of Group 1 metals and transition metals. Use the information in the table, and your own knowledge.

.....

.....

.....

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

(ii) Transition metals can be used as catalysts.

What is meant by a catalyst?

.....

.....

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

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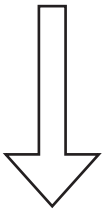
(d) Iron is a transition metal.

The list shows the reactivity series of some metals. The element carbon is also included.

Sodium
Calcium
Magnesium
Carbon
Zinc
Iron
Copper

Most reactive



Least reactive

Iron can be extracted from the compound iron oxide.

How is iron extracted from iron oxide? Explain your answer.
Use the information in the list.

.....

.....

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

(e) Iron reacts with dilute sulfuric acid, H_2SO_4.

Iron sulfate, $FeSO_4$, and hydrogen gas, H_2, are made.

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

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

(ii) A student reacts 2.8 g of iron with dilute sulfuric acid.

The student makes 5.4 g of iron sulfate.

They predicted that they should have made 7.6 g of iron sulfate.

Calculate their **percentage yield**.

Give your answer to **1** decimal place.

Percentage yield of iron sulfate = ... % **[3]**

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18 Propane, C_3H_8, is an alkane.

Propane undergoes complete combustion in oxygen. Carbon dioxide and water are made.

(a) Write the **balanced symbol** equation for the complete combustion of propane.

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

(b) The table shows the energy given out when 1 g of different alkanes burn.

Alkane	Number of carbon atoms	Energy given out (kJ)
methane	1	55.6
ethane	2	52.6
propane	3	50.4
butane	4	
pentane	5	48.7
hexane	6	48.4

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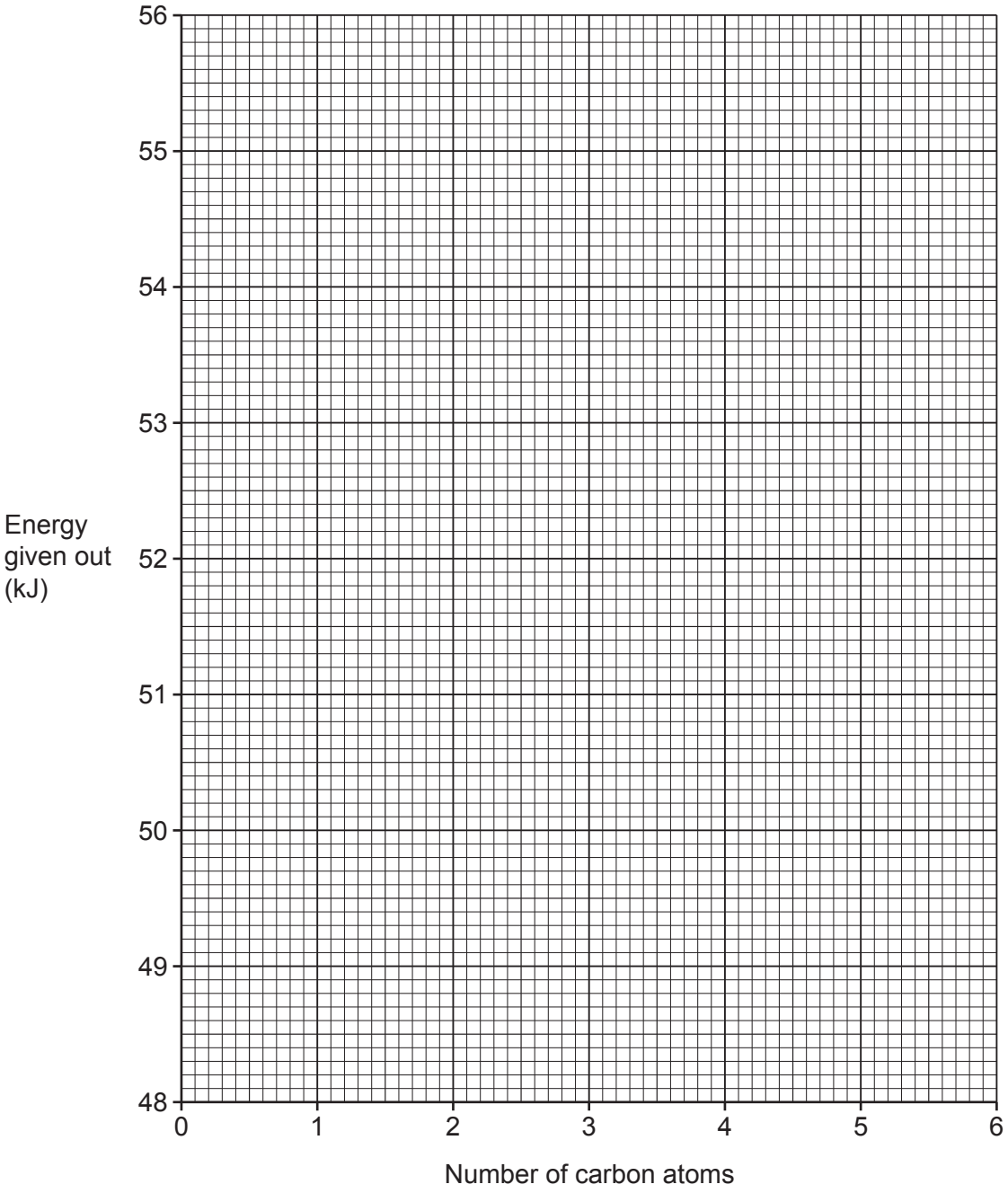
(i) Plot a graph of the data from the table. **[2]**

(ii) Draw a curve of best fit on your graph. **[1]**



(iii) The energy given out when 1 g of butane burns is missing from the table.

Use the graph to estimate the energy given out by butane.

Energy given out by butane = ... kJ **[1]**

(iv) What name is given to the type of reaction that **gives out energy**?

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

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(c) Complete the **displayed formula** of propane, C_3H_8.

[1]

(d) Combustion of alkanes makes carbon dioxide gas.

(i) State an environmental problem caused by increased levels of carbon dioxide gas.

.....

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

(ii) Explain how this environmental problem can be reduced.

.....

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

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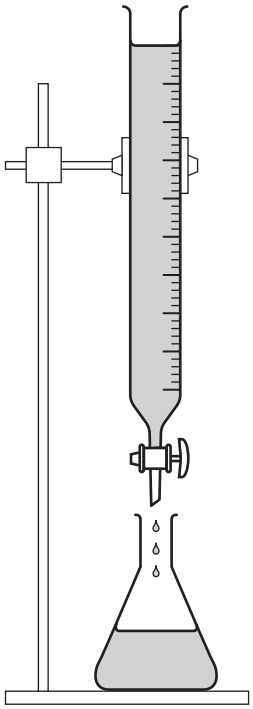
19 A student plans a titration experiment.

The diagram shows some of the apparatus they use.



(a) The student writes their method.

A Add a few drops of methyl orange indicator.

B Fill the burette with dilute hydrochloric acid. Record the initial reading on the burette.

C Empty the sodium hydroxide solution from the pipette into a conical flask.

D Stop adding the dilute hydrochloric acid when the indicator just changes colour.

E Repeat these steps until you have two concordant results.

F Use a pipette filler to fill a glass pipette with 25.0 cm^3 of sodium hydroxide solution.

G Add the dilute hydrochloric acid to the sodium hydroxide solution while swirling the conical flask.

The steps in the method are **not** in the correct order.

Write the letters in the boxes to show the correct order of the steps. The first and last steps have been filled in for you.

B						**E**

[4]

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(b) This is the equation for the reaction in the experiment.

$NaOH + HCl \longrightarrow NaCl + H_2O$

(i) What type of reaction is this?

Tick (✓) **one** box.

Polymerisation	☐
Neutralisation	☐
Reversible	☐
Thermal decomposition	☐

[1]

(ii) Water is a waste product in this reaction.

Calculate the **atom economy** for the reaction.

Relative atomic mass (A_r): H = 1.0 O = 16.0 Na = 23.0 Cl = 35.5

Atom economy = ... % **[3]**

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20 Crude oil is separated into different fractions by fractional distillation.

Table 20.1 shows information about three of the molecules that are found in three different fractions.

Table 20.1

Molecule	Formula	Boiling point (°C)
nonane	C_9H_{20}	151
heptadecane	$C_{17}H_{36}$	302
octacosane	$C_{28}H_{58}$	436

(a) Which of these three molecules would be separated **highest** up the fractionating column?

Explain your answer using ideas about molecular size and boiling point.

Molecule .....

Reason .....

.....

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

(b) Cracking breaks down large molecules produced in fractional distillation into more useful molecules.

The equation shows the cracking of octacosane.

$$C_{28}H_{58} \longrightarrow C_{12}H_{26} + 8C_2H_4$$

octacosane dodecane molecule **X**

(i) State the name of molecule **X**, C_2H_4.

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

(ii) Molecule **X** has the general formula C_nH_{2n}.

Octacosane and dodecane are both alkanes and have a different general formula.

State the general formula of the alkanes.

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

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(c) **Table 20.2** shows the percentage supply and percentage demand for some of the different fractions obtained from crude oil.

Table 20.2

Fraction	Percentage supply (%)	Percentage demand (%)
LPG	2	4
petrol	5	23
naphtha	8	
kerosene	12	7
diesel oil	17	23
fuel oil	56	38

(i) Calculate the percentage demand for naphtha.

Percentage demand for naphtha = ... % **[1]**

(ii) Suggest why fuel oil, rather than diesel oil, is cracked to obtain petrol.

.....

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

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21* A life-cycle assessment looks at the potential environmental impact at each stage of the life of a product.

Cat food is sold in plastic packets or metal cans.

The table shows information about these two containers.

	Plastic packet	**Metal can**
Raw Materials	Crude oil	Aluminium ore
Manufacture	Fractional distillation Cracking Polymerisation	Aluminium ore is mined Aluminium is extracted by electrolysis
Using the product	Usually single use	Usually single use but easily repurposed or upcycled
Disposal of the product	Harder to recycle Not biodegradable so takes up space in landfill 90% energy saved by recycling	Easier to recycle Not biodegradable so takes up space in landfill 95% energy saved by recycling

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21

Evaluate which type of container has the smallest environmental impact over its lifetime.
Use the information in the table, and your own scientific knowledge.

.....

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

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22 A student investigates two solutions, **A** and **B**.

They know that
- one solution contains a halide ion
- the other solution contains a different anion.

They test 2 cm^3 of each solution for the halide ion using this method:

- Add a few drops of dilute hydrochloric acid and shake.
- Add a few drops of silver nitrate solution.
- Record the colour of the precipitate.

(a) The teacher says that the student should have used a different acid instead of dilute hydrochloric acid.

(i) State the name of the acid the student should have used.

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

(ii) Explain why using dilute hydrochloric acid would affect the results of this test.

.....

.....

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

(b) The student repeats the test for halide ions using the correct acid and silver nitrate solution.

They also test each solution using a few drops of dilute hydrochloric acid followed by a few drops of barium chloride solution.

The table shows their results.

Solution	Observation with silver nitrate solution	Observation with barium chloride solution
A	cream precipitate	no change
B	no change	white precipitate

State the name of the anion in each solution.

Solution **A** .....

Solution **B** ..... **[2]**

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(c) Solution **A** also contains copper ions, Cu^{2+}.

Copper ions react with hydroxide ions, OH^-, to make a precipitate of copper(II) hydroxide.

Write the **balanced ionic** equation for this reaction. Include the state symbols.

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

(d) Barium chloride solid is toxic if swallowed and harmful if inhaled.

Barium chloride solutions with concentrations of 21 g / dm^3 are suitable for experiments in school.

Calculate the mass of barium chloride that should be dissolved in 25 cm^3 of water to make a solution with a concentration of 21 g / dm^3.

Use the equation:

$$\text{concentration} = \frac{\text{mass}}{\text{volume}}$$

Give your answer to **2** significant figures.

Mass of barium chloride = ... g **[3]**

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23 The table shows information about three different polymers, **A**, **B** and **C**.

Tensile strength is the amount of load a material can take before it breaks.

	Melting point (°C)	**Softening temperature (°C)**	**Stiffness (MPa)**	**Tensile strength (MPa)**
A	130	72	980	15
B	240	95	3200	65
C	250	75	2400	50

(a) A company wants to use a polymer to make a disposable cup for hot drinks.

Suggest and explain which polymer, **A**, **B or C**, the company should use.

Polymer .....

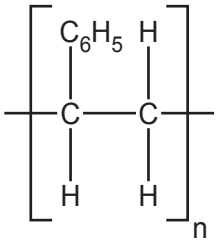
Reason .....

.....

.....

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

(b) This is the repeating unit in polymer **B**.



Draw the structure of the **monomer** from which polymer **B** is made.

[2]

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(c) Some substances are naturally occurring polymers.

Draw lines to connect each **monomer** with its naturally occurring **polymer**.

Monomer	Polymer
amino acids	DNA
nucleotides	proteins
sugars	starch

[2]

END OF QUESTION PAPER

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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).

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