THIS IS A NEW SPECIFICATION

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Thursday 17 January 2013 – Afternoon

GCSE GATEWAY SCIENCE
CHEMISTRY B

B741/02 Chemistry modules C1, C2, C3 (Higher Tier)

B722200113

Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR supplied materials:
None

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour 15 minutes

B741 02

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (✎)
- The Periodic Table can be found on the back page.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **75**.
- This document consists of **20** pages. Any blank pages are indicated.

Answer **all** the questions.

SECTION A – Module C1

1 This question is about fuels.

(a) Crude oil is a fossil fuel.

Crude oil is being used up faster than it is being made.

Write about the problems this will cause in the future.

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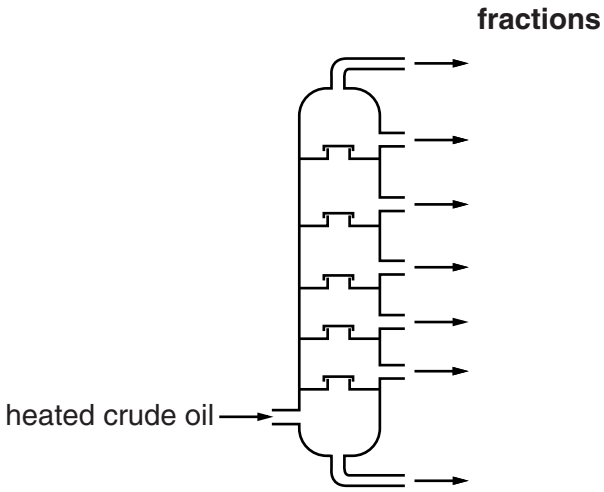
..... **[2]**

(b) Crude oil is separated into many fractions by fractional distillation.

The diagram shows a fractionating column.



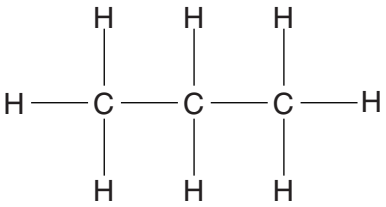
Look at the table. It shows the boiling point range for some of the fractions.

Fraction	Boiling point range in °C
bitumen	above 350
heating oil	240 to 350
paraffin	120 to 240
petrol	20 to 70
LPG	–160 to 20

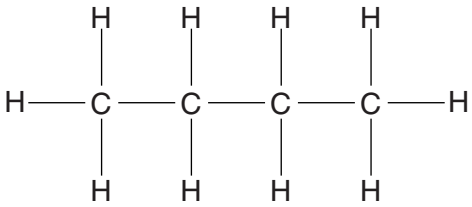
Write down the name of the fraction which 'exits' from the **bottom** of the fractionating column.

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

(c) LPG contains propane and butane.



propane



butane

(i) Write down the **molecular formula** of **butane**.

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

(ii) Look at the displayed formulas of propane and butane.

Propane and butane are **hydrocarbons**.

They are also **alkanes**.

Explain why they are both hydrocarbons and alkanes.

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

[Total: 7]

2 Jill wants to buy a sports jacket that she can wear **in all weathers**.

Look at the information about polymers **A**, **B**, **C**, **D** and **E**.

Polymer	Is it stiff or flexible?	Is it waterproof?	Is it breathable?
A	stiff	no	yes
B	flexible	no	yes
C	flexible	yes	yes
D	stiff	yes	yes
E	flexible	yes	no

Which polymer would be best for making Jill's sports jacket?

Explain your choice.

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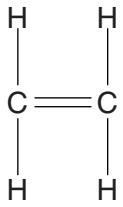
..... **[2]**

[Total: 2]

3 Look at the displayed formula of ethene.



(a) Why is ethene described as **unsaturated**?

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

(b) Bromine water is used to test for an alkene.

Ethene decolourises bromine water.

(i) What type of reaction is this?

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

(ii) What type of compound is formed in this reaction?

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

(c) Poly(ethene) is used to make plastic bags.

Draw the displayed formula of poly(ethene).

[2]

[Total: 5]

4 Perfumes, flavourings and nail varnish remover all contain an ester.

Esters are flammable.

Describe how to do a simple experiment to make an ester including an explanation of the safety precautions you should take.

The quality of written communication will be assessed in your answer to this question.

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

[Total: 6]

5 This question is about foods.

(a) Mayonnaise is made by mixing oil, water and egg yolk.

Egg yolk acts as an emulsifier and stops the oil and water from separating.

Look at the diagram.

It shows a molecule of an emulsifier.

Explain how the emulsifier stops oil and water from separating.

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

(b) When eggs are cooked, a chemical change happens.

Explain why the texture of the egg changes during this chemical change.

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

(c) Baking powder is used to make cakes rise.

Baking powder contains sodium hydrogencarbonate.

Sodium hydrogencarbonate decomposes when it is heated.

Write the **balanced symbol** equation for the decomposition of sodium hydrogencarbonate.

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

[Total: 5]

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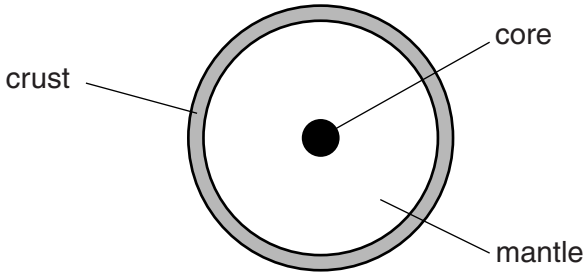
PLEASE DO NOT WRITE ON THIS PAGE

SECTION B – Module C2

6 Look at the diagram. It shows the structure of the Earth.



(a) The **lithosphere** is part of the structure of the Earth.

What is the lithosphere?

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

(b) Scientists study volcanoes.

Explain why.

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

[Total: 4]

7 An acid reacts with a base to make a salt and water.

$$\text{acid} + \text{base} \longrightarrow \text{salt} + \text{water}$$

Look at the table. It shows some acids, bases and the salts made from them.

Acid	Base	Salt
sulfuric acid	copper oxide	copper sulfate
nitric acid	sodium carbonate	.....
.....	zinc oxide	zinc chloride
sulfuric acid	.....	magnesium sulfate

(a) Complete the table. **[3]**

(b) Hydrochloric acid, HCl, reacts with calcium carbonate, $CaCO_3$.

Calcium chloride, $CaCl_2$, carbon dioxide and water are made.

Write a **balanced symbol** equation for this reaction.

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

(c) Acids contain hydrogen ions, H^+. Alkalis contain hydroxide ions, OH^-.

Write the **ionic** equation for neutralisation.

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

(d) Many fertilisers are made by neutralisation.

Fertilisers can cause **eutrophication**.

Explain what happens during eutrophication.

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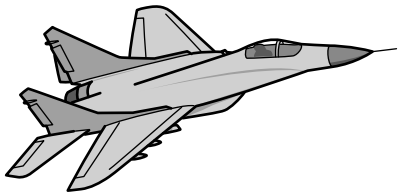
..... **[3]**

[Total: 9]

8 Look at the table. It gives information about the properties of some metals.

Metal	Melting point in °C	Density in g/cm^3	Relative strength (1 = weak, 10 = strong)	Relative heat conductivity (1 = low, 10 = high)	Cost per tonne in £
A	1660	4.5	6.4	8.6	5000
B	420	7.1	4.3	9.0	870
C	1535	7.9	8.2	7.3	400

Look at the picture of a military aircraft. Only small numbers of these aircraft are made.



Evaluate the advantages and disadvantages of each metal for making the **body** and **wings** of this military aircraft. Which metal, **A**, **B** or **C**, would you choose and why?

The quality of written communication will be assessed in your answer to this question.

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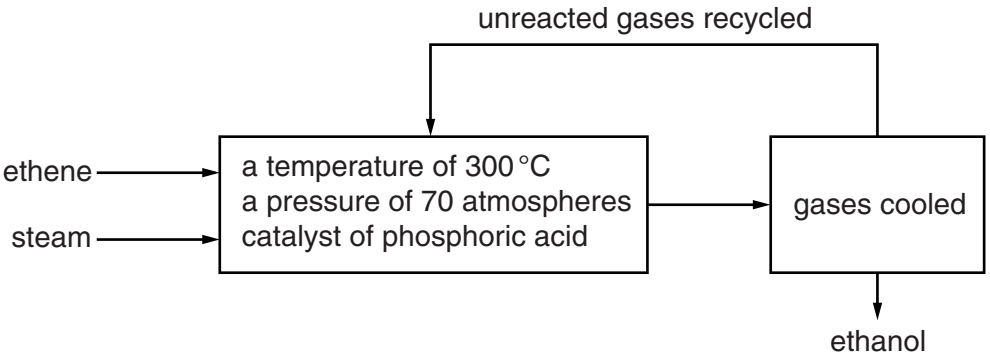
..... **[6]**

[Total: 6]

9 Ethanol (alcohol) is made by reacting ethene with steam.

$$\text{ethene} + \text{steam} \rightleftharpoons \text{ethanol}$$

Look at the flowchart.



Look at the table.

It gives some information about the percentage yield of ethanol at different temperatures and pressures.

Pressure in atmospheres	Percentage yield		
	200 °C	300 °C	400 °C
40	16	12	6
80	30	22	12
120	42	30	17
160	50	36	21

(a) (i) What happens to the percentage yield as the **pressure** increases?

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

(ii) What happens to the percentage yield as the **temperature** increases?

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

(b) The highest percentage yield is achieved with a temperature of 200 °C and 160 atmospheres.

The actual conditions used to make ethanol are:

- catalyst of phosphoric(V) acid
- a pressure of 70 atmospheres
- a temperature of 300 °C.

Use ideas about percentage yield and rate of reaction to suggest why each condition is used.

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

(c) This process is automated.

Explain why automation is used.

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

[Total: 6]

SECTION C – Module C3

10 Stowmarket Synthetics manufacture ethanoic acid, $C_2H_4O_2$, by two different processes.

Process **1** $C_2H_6O + O_2 \rightarrow C_2H_4O_2 + H_2O$

Process **2** $CH_4O + CO \rightarrow C_2H_4O_2$

Look at the table of relative formula masses.

Compound	Formula	Relative formula mass, M_r
ethanol	C_2H_6O	46
oxygen	O_2	32
ethanoic acid	$C_2H_4O_2$	60
water	H_2O	18
methanol	CH_4O	32
carbon monoxide	CO	28

The relative atomic mass of H = 1, of C = 12, and of O = 16.

(a) In process **2**, Stowmarket Synthetics use 320 g of methanol.

Calculate the maximum mass of ethanoic acid that can be made.

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

(b) Stowmarket Synthetics know that the **atom economy** of a process is important.

Water is a waste product in process **1**.

Show that the atom economy for making ethanoic acid by process **1** is 77%.

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

(c) Stowmarket Synthetics also know that the **percentage yield** of a process is important.

The factory uses 5.2 tonnes of methanol in process **2**.

A scientist predicts they should make 9.8 tonnes of ethanoic acid.

They actually make 9.5 tonnes of ethanoic acid.

Show that the percentage yield of ethanoic acid is 97%.

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

(d) Look at the table.

It gives information about the atom economy and percentage yield for making ethanoic acid.

Process	Atom economy (%)	Percentage yield (%)
1	77	85
2	100	97

Process **2** has a higher atom economy and a higher percentage yield.

(i) Explain one advantage, other than cost, of a very high atom economy.

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

(ii) Explain one advantage, other than cost, of a very high percentage yield.

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

[Total: 8]

11 Nitrogen molecules react with oxygen molecules.

Nitrogen monoxide molecules are made.

$$N_2 + O_2 \rightarrow 2NO$$

The reaction is endothermic.

(a) Explain, in terms of bond breaking and bond making, why this reaction is endothermic.

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

(b) Nitrogen molecules and oxygen molecules react extremely slowly, even at 200 °C.

The reaction between nitrogen and oxygen becomes faster as both the temperature and the pressure increase.

Explain why, using the reacting particle model.

The quality of written communication will be assessed in your answer to this question.

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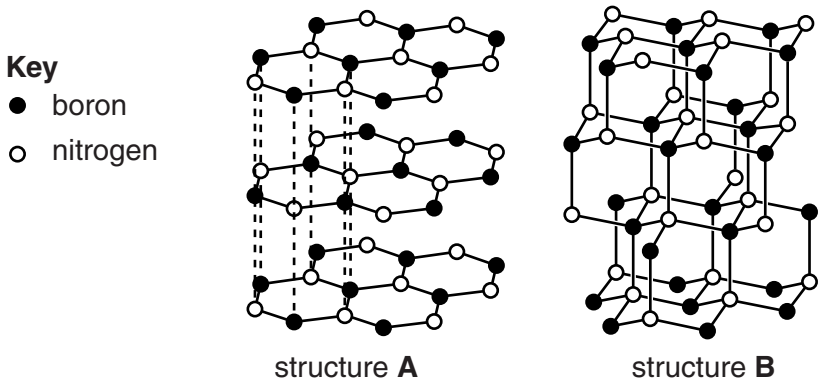
..... **[6]**

[Total: 9]

12 Boron nitride, BN, exists in two physical forms.

The structures of these forms are shown below.



structure **A** structure **B**

These two forms of boron nitride resemble graphite and diamond, the two allotropes of carbon.

(a) Boron nitride, with structure **A**, is slippery.

Explain why, in terms of structure and bonding.

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

(b) Boron nitride, with structure **B**, has a very high melting point.

Explain why, in terms of structure and bonding.

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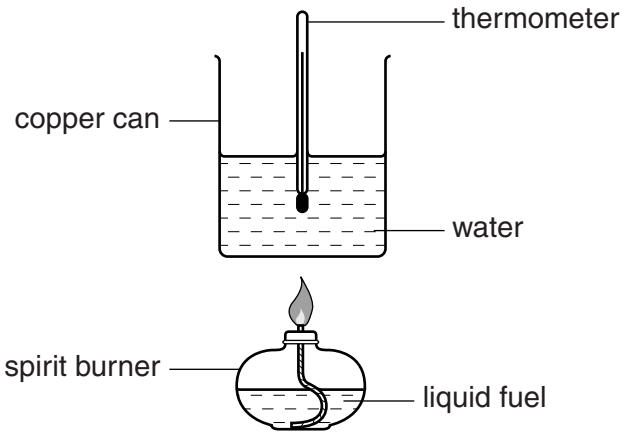
..... **[2]**

[Total: 4]

13 Eva is investigating liquid fuels. She wants to find out which liquid fuel gives out the most energy per gram.

Look at the apparatus she uses.

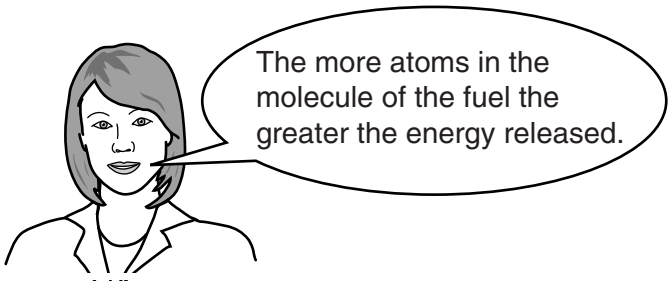


She heats 100 cm^3 of water.

Eva uses five liquid fuels.

Each time she burns 1.0 g of liquid fuel.

She makes a prediction.



Look at Eva's results.

Fuel	Molecular formula	Number of atoms in a molecule	Temperature of water before heating in °C	Temperature of water after heating in °C	Temperature increase in °C
methanol	CH_4O	6	20	29	9
ethanol	C_2H_6O	9	18	30	12
propanol	C_3H_8O	12	18	32	14
butanol	$C_4H_{10}O$	15	18	34	16
pentanol	$C_5H_{12}O$	18	20	35	15

The energy released is given by the equation

energy = mass × specific heat capacity × temperature change

where specific heat capacity of water = 4.2 J/g °C.

(a) Calculate the energy released by methanol.

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energy released = ... J **[2]**

(b) Do Eva's results support her prediction?

Explain your answer.

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

[Total: 4]

END OF QUESTION PAPER

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.