Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced Subsidiary

Unit 2: Application of Core Principles of Chemistry

Wednesday 3 June 2009 – Morning
Time: 1 hour 15 minutes

Paper Reference
6CH02/01

Candidates may use a calculator.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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7/7/3/

H 3 4 4 7 2 A 0 1 2 4

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SECTION A

Answer ALL the questions in this section. You should aim to spend no more than 20 minutes on this section. For each question, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 What is the oxidation number of chlorine in the ClO_3^- ion?

☒ **A** –1

☒ **B** +4

☒ **C** +5

☒ **D** +6

(Total for Question 1 = 1 mark)

2 Which of these reactions is **not** a redox reaction?

☒ **A** $Mg(NO_3)_2(s) \rightarrow MgO(s) + 2NO_2(g) + ½O_2(g)$

☒ **B** $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

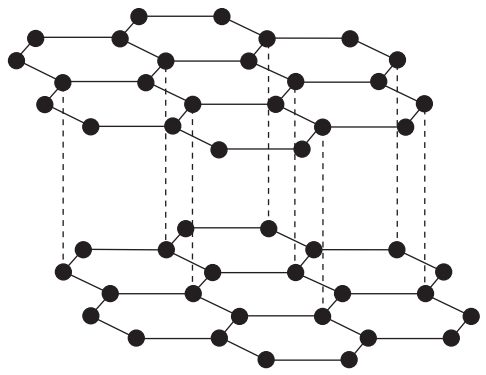
☒ **C** $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$

☒ **D** $Cl_2(aq) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(aq)$

(Total for Question 2 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

3 Which of these carbon structures is represented by the diagram below?



☒ **A** Graphite

☒ **B** Diamond

☒ **C** A fullerene

☒ **D** A carbon nanotube

(Total for Question 3 = 1 mark)

4 What colour precipitate would you expect to see if 1-bromopropane was heated with a solution of silver nitrate?

☒ **A** Orange

☒ **B** White

☒ **C** Yellow

☒ **D** Cream

(Total for Question 4 = 1 mark)

5 Which of these bond angles is the smallest?

☒ **A** HNH in NH_3

☒ **B** HCH in CH_4

☒ **C** HOH in H_2O

☒ **D** OCO in CO_2

(Total for Question 5 = 1 mark)

6 Which statement best describes the shape and bond angles in the molecule SF_6?

☒ **A** Octahedral, 90° and 180°

☒ **B** Trigonal bipyramidal, 90° and 180°

☒ **C** Octahedral, 90° and 120°

☒ **D** Trigonal bipyramidal, 90° and 120°

(Total for Question 6 = 1 mark)

7 Which of the following values for the mass/charge ratio for singly charged ions would be present in the mass spectrum of propanal, CH_3CH_2CHO, but not of propanone, CH_3COCH_3?

☒ **A** 15

☒ **B** 29

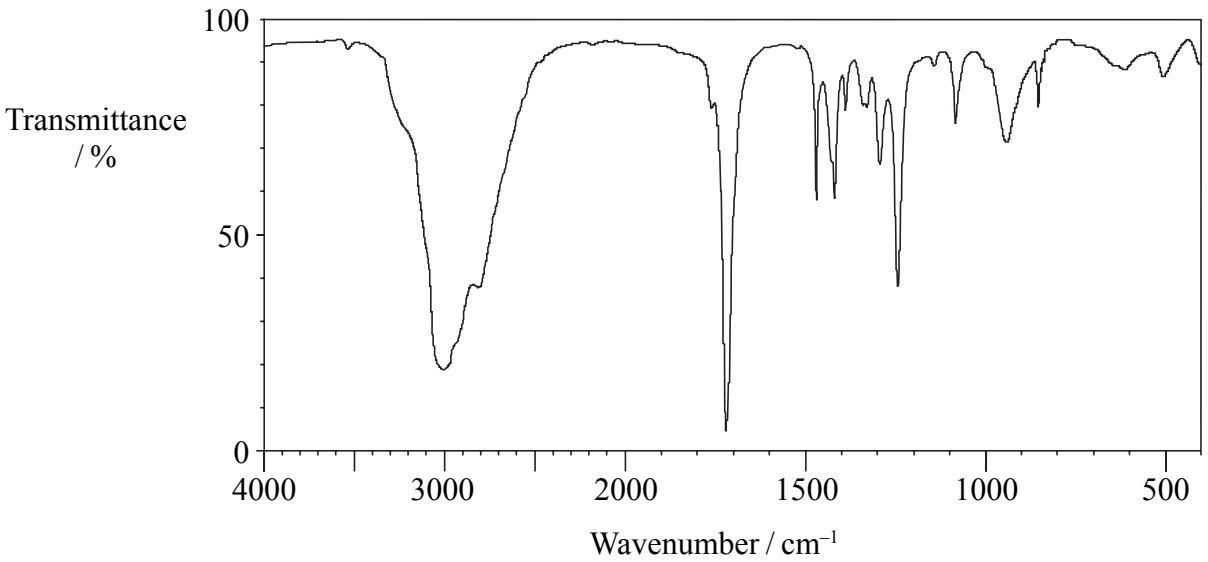
☒ **C** 43

☒ **D** 58

(Total for Question 7 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

8 The infrared spectrum below is most likely to be that of a member of which homologous series?



C—Cl stretching vibrations 600 – 800 cm^{-1}
O—H stretching vibrations 2500 – 3300 cm^{-1}
C═O stretching vibrations 1680 – 1740 cm^{-1}

☒ **A** Alcohol

☒ **B** Chloroalkane

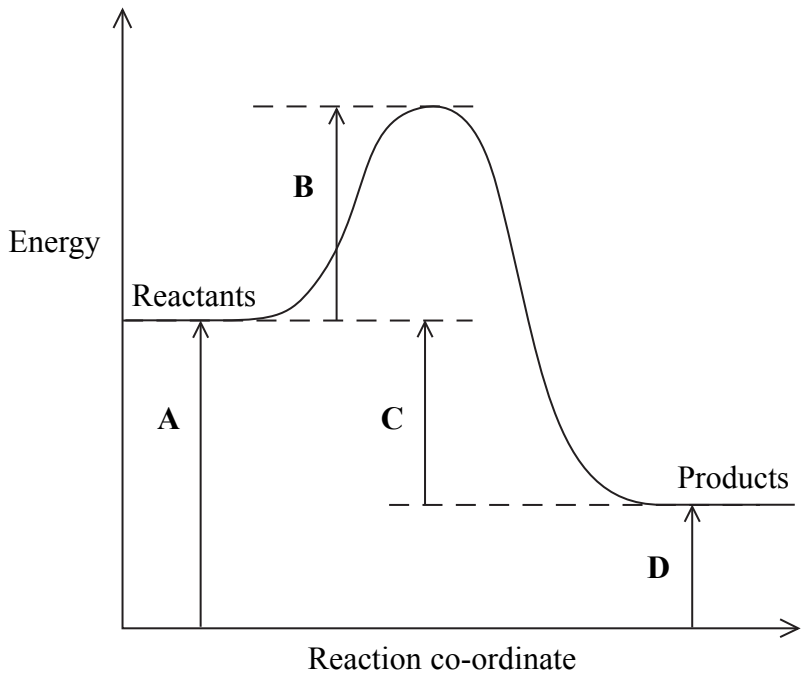
☒ **C** Aldehyde

☒ **D** Carboxylic acid

(Total for Question 8 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

9 In the reaction profile below, which energy change would alter if a catalyst was added to the reaction?



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 9 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

10 In the equilibrium below, what effect would the changes described have on the system?

$$2H_2S(g) + SO_2(g) \rightleftharpoons 3S(s) + 2H_2O(g) \qquad \Delta H \text{ is negative}$$

(a) Increase in temperature

(1)

☒ **A** increase rate, decrease yield

☒ **B** increase rate, increase yield

☒ **C** decrease rate, decrease yield

☒ **D** decrease rate, increase yield

(b) Decrease in pressure

(1)

☒ **A** increase rate, decrease yield

☒ **B** increase rate, increase yield

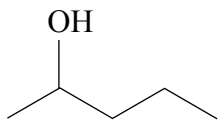
☒ **C** decrease rate, decrease yield

☒ **D** decrease rate, increase yield

(Total for Question 10 = 2 marks)

Use this space for any rough working. Anything you write in this space will gain no credit.

11 What is the correct systematic name for the alcohol shown below?



- ☒ **A** hexan-4-ol
- ☒ **B** hexan-2-ol
- ☒ **C** pentan-4-ol
- ☒ **D** pentan-2-ol

(Total for Question 11 = 1 mark)

12 Which of these compounds is a secondary halogenoalkane?

- ☒ **A** $CH_3CH(OH)CH_3$
- ☒ **B** $CH_3CCl(CH_3)CH_3$
- ☒ **C** $CH_3CHClCH_3$
- ☒ **D** $CH_3CH_2CH_2Cl$

(Total for Question 12 = 1 mark)

13 The bonding in **gaseous** hydrogen halides is best described as

- ☒ **A** mainly covalent with an increasing tendency towards ionic as you go down the group.
- ☒ **B** mainly covalent with an increasing tendency towards ionic as you go up the group.
- ☒ **C** mainly ionic with an increasing tendency towards covalent as you go down the group.
- ☒ **D** mainly ionic with an increasing tendency towards covalent as you go up the group.

(Total for Question 13 = 1 mark)

14 What would be the colour of the solution when iodine is dissolved in a hydrocarbon solvent?

☒ **A** Grey

☒ **B** Brown

☒ **C** Yellow

☒ **D** Purple

(Total for Question 14 = 1 mark)

15 Starch is often used as an indicator in titrations between sodium thiosulfate and iodine solutions. What colour change would you see at the end-point as sodium thiosulfate is added to iodine solution in the presence of starch?

☒ **A** Yellow to colourless

☒ **B** Colourless to yellow

☒ **C** Blue-black to colourless

☒ **D** Colourless to blue-black

(Total for Question 15 = 1 mark)

16 An electric field can affect the direction of a stream of some liquids. Which of these liquids would be affected by an electric field?

☒ **A** 1-chloropropane

☒ **B** Pentane

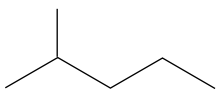
☒ **C** Tetrachloromethane

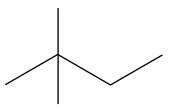
☒ **D** Cyclopentane

(Total for Question 16 = 1 mark)

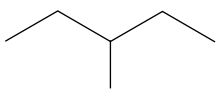
Use this space for any rough working. Anything you write in this space will gain no credit.

17 Which of these isomers has the highest boiling temperature?

☒ **A** 

☒ **B** 

☒ **C** 

☒ **D** 

(Total for Question 17 = 1 mark)

18 Which of the following statements is **true**?

☒ **A** Calcium hydroxide is more soluble in water than magnesium hydroxide.

☒ **B** Chlorine is more electronegative than fluorine.

☒ **C** Iodine is a stronger oxidizing agent than bromine.

☒ **D** The first ionization energy of barium is greater than that of strontium.

(Total for Question 18 = 1 mark)

19 Iodine can react with sodium hydroxide solution to form $NaIO_3(aq)$, according to the equation below.

$$3I_2(aq) + 6NaOH(aq) \rightarrow 5NaI(aq) + NaIO_3(aq) + 3H_2O(l)$$

Which of the statements about the reaction is **false**?

☒ **A** The oxidation number of some iodine atoms goes up.

☒ **B** At high temperatures NaIO(aq) also forms.

☒ **C** Sodium ions are spectator ions.

☒ **D** The oxidation number of some iodine atoms goes down.

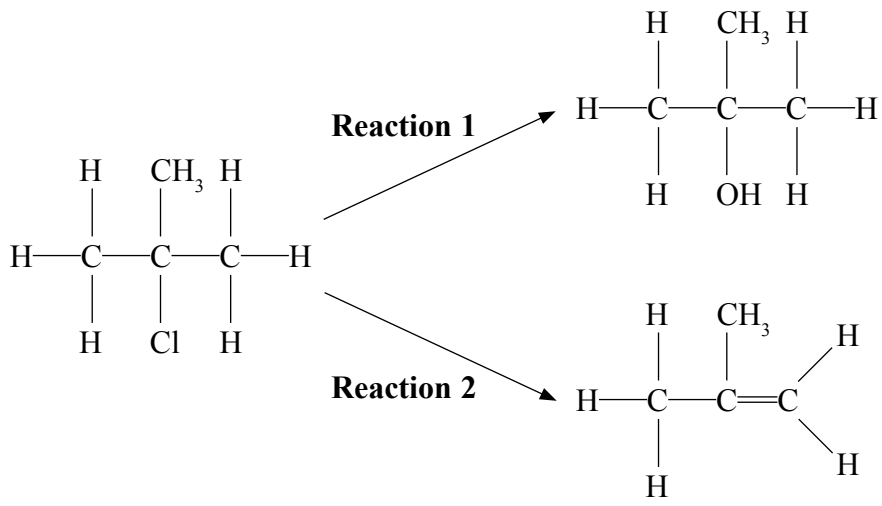
(Total for Question 19 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

Answer ALL the questions. Write your answers in the spaces provided.

20 When 2-chloro-2-methylpropane is heated in a mixture of water and ethanol at 65 °C, two types of reaction occur. A mixture of two organic products, 2-methylpropan-2-ol and 2-methylpropene, is formed.



(a) (i) Name the two reaction types that are taking place.

(2)

Reaction 1 .....

Reaction 2 .....

*(ii) Explain how the two products form, by describing the role of the water in each case.

(4)

Reaction 1 .....

.....

.....

.....

.....

Reaction 2 .....

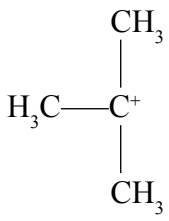
.....

.....

.....

.....

(b) A proposed mechanism for **Reaction 1** involved the formation of the carbocation,



(i) What type of bond breaking must have occurred during the carbocation formation?

(1)

(ii) Suggest why 1-chlorobutane reacts with water via a different mechanism.

(2)

(c) Another halogenoalkane, 2-chlorobutane, behaves in a similar way to 2-chloro-2-methylpropane but in **Reaction 2** can form three different alkenes. Suggest how **three** different alkenes can form and give their displayed formulae.

(4)

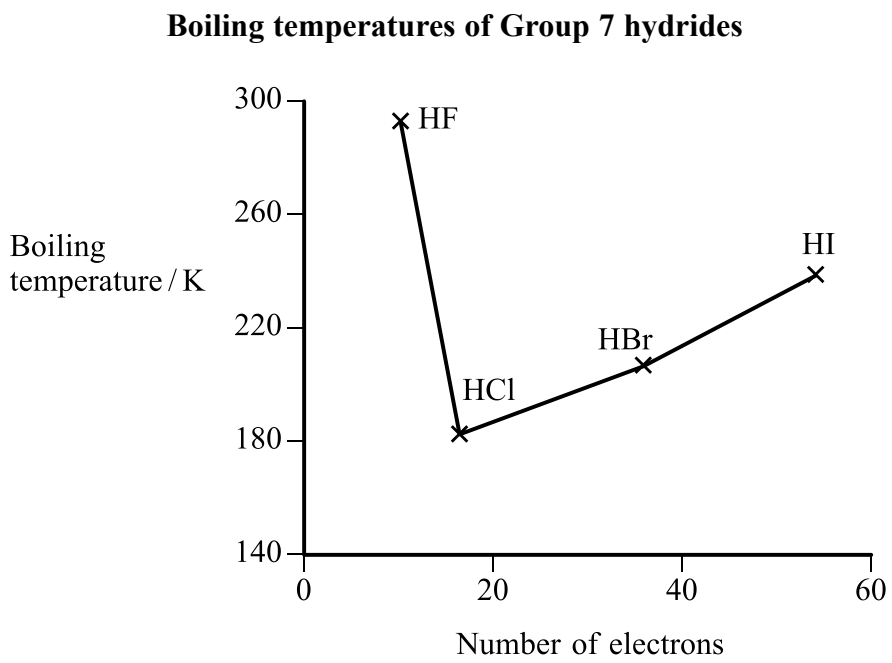
(d) Suggest why 2-fluoro-2-methylpropane would react more slowly than 2-chloro-2-methylpropane in **Reaction 1**.

What reagent could you use instead of water to increase the rate of this reaction involving 2-fluoro-2-methylpropane? Explain why the reagent would have this effect.

(3)

(Total for Question 20 = 16 marks)

21 The graph below shows the boiling temperatures of the hydrides of Group 7.



(a) (i) Identify the type of intermolecular force that gives rise to the unusually high boiling temperature of hydrogen fluoride.

(1)

(ii) State and explain whether the electronegativity of fluorine is greater than, similar to or less than, that of bromine.

Hence explain why hydrogen fluoride can form the type of intermolecular force named in (a)(i) but hydrogen bromide cannot.

(3)

(iii) Use the graph to predict what the boiling temperature of hydrogen fluoride would be without the presence of the type of intermolecular force named in (a)(i).

(1)

(b) Propanone, CH_3COCH_3, is a useful solvent for cleaning glassware in laboratories.

(i) Why is propanone able to dissolve a wide range of substances?

(1)

(ii) Propanone can be used to remove both water and octane from glassware.

For each of these substances, identify the strongest intermolecular force formed with propanone and the feature of the propanone molecule involved.

(2)

Water

Octane

(Total for Question 21 = 8 marks)

22 Calcium oxide, known as quicklime, is produced by the thermal decomposition of calcium carbonate, found naturally in limestone.

(a) (i) Explain what is meant by the term **thermal decomposition**.

(2)

(ii) Write an equation for the thermal decomposition of calcium carbonate, including state symbols.

(1)

(iii) Other Group 2 carbonates can also undergo thermal decomposition. Describe and explain the trend in thermal stability of carbonates down Group 2.

(3)

(b) 0.121 g of an impure sample of quicklime was dissolved in 50.0 cm^3 of hydrochloric acid, concentration 0.100 mol dm^{-3}. The excess hydrochloric acid was titrated with sodium hydroxide solution, concentration 0.100 mol dm^{-3}, and 18.0 cm^3 was needed to just neutralize the acid. The indicator used was methyl orange.

The equations for the reactions involved are shown below.

$$CaO(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l)$$

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

(i) What colour would the indicator be at the end-point?

(1)

(ii) Calculate the number of moles of hydrochloric acid that reacted with the sodium hydroxide solution.

(1)

(iii) Calculate the number of moles of hydrochloric acid originally added to the quicklime. Use this answer and your answer to (b)(ii) to calculate the number of moles of quicklime that reacted with the hydrochloric acid.

(2)

(iv) Calculate the percentage purity of the sample of quicklime. Give your answer to **three** significant figures.

(2)

(c) (i) Describe how to carry out a flame test on the impure sample of quicklime to confirm that it contains calcium ions.

(3)

(ii) If the flame test gave a green colour, in addition to the expected brick red flame, which Group 2 metal is also likely to be present?

(1)

(Total for Question 22 = 16 marks)

TOTAL FOR SECTION B = 40 MARKS

SECTION C

Answer ALL the questions. Write your answers in the spaces provided.

23 As levels of fossil fuel resources are getting lower, society is increasingly looking at the use of biofuels as alternatives to coal, oil and gas. Biofuels are derived from plants and examples include bioethanol, biodiesel and *Miscanthus*, a plant more commonly known as elephant grass. These fuels have the advantage of being renewable and the plants take in carbon dioxide as they grow.

Bioethanol is produced from crops such as sugar cane or corn. The raw plant material is treated to produce a sugary solution which is then fermented to produce ethanol, water and carbon dioxide gas. The ethanol is removed by distillation. The resulting solution contains about 96 % ethanol. The remaining water has to be removed by absorption using a suitable drying agent so that the ethanol can burn efficiently. The bioethanol can then be burnt alone or mixed with petrol in vehicle engines.

Biodiesel is formed by the hydrolysis of vegetable oils using sodium hydroxide solution, followed by esterification with methanol and a sodium hydroxide catalyst. Biodiesel can then be used on its own in diesel-engined vehicles or mixed with diesel derived from crude oil. Plants which are used to produce the vegetable oils include rapeseed in the UK, soya bean in the USA and palm oil in Asia.

Miscanthus, or elephant grass, is a quick growing, high-yield plant that grows up to four metres in height. After harvesting, the grass is left to dry and then burnt in power stations designed to run on solid fuels such as coal. In the United Kingdom, farms that produce elephant grass are normally situated within 50 miles of such a power station.

In an experiment to simulate the production of bioethanol, a student produced a water/ethanol mixture by fermentation of sucrose solution using yeast. It was then proposed to separate the ethanol from water by carrying out a distillation on the mixture. The mixture would then be dried using a suitable drying agent.

(a) Draw a diagram to show the most significant intermolecular force between an ethanol molecule and a water molecule. Label the bond angle between the molecules and state its value.

(2)

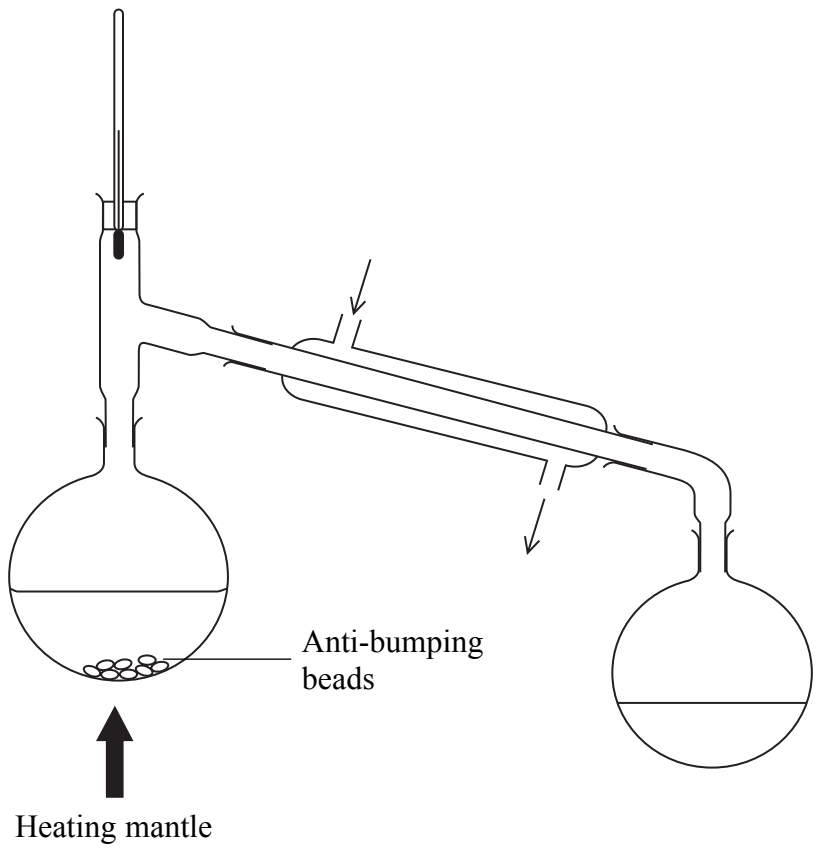
(b) The student proposed to set up the apparatus as shown below to carry out the distillation to try to separate the ethanol from water.

There are **three** errors with the set-up. Draw a circle around each error.

Describe what effect these errors would have if the student attempted to carry out the separation as shown.

[Clamps are not shown in the diagram but you can assume the apparatus is supported adequately.]

(6)



(c) If a balance accurate to two decimal places was used to record the mass of ethanol collected, what would be the percentage error due to the balance readings if the total mass of ethanol collected was 20.10 g?

(1)

(d) Suggest a suitable drying agent to absorb the water remaining with the ethanol after distillation. Describe how you would use it to produce a dry sample of ethanol.

(2)

(e) Describe a chemical test you could carry out to confirm the presence of the –OH group in ethanol. What result would you expect to see?

(2)

Test .....

.....

Result .....

(f) *(i) Explain what is meant by a **carbon neutral fuel**.

(2)

*(ii) Suggest TWO reasons why these biofuels may **not** be carbon neutral and describe TWO effects that large scale production of biofuels may have on society. Which of the three biofuels do you think is the most sustainable? Justify your choice.

(5)

(Total for Question 23 = 20 marks)

TOTAL FOR SECTION C = 20 MARKS
TOTAL FOR PAPER = 80 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 4.0 He helium 2
(1)	(2)											(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 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							

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series	140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
* Actinide series	232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103