Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced Subsidiary

Unit 1: The Core Principles of Chemistry

Friday 21 May 2010 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6CH01/01

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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7/7/7/4/

N 3 5 6 9 1 A 0 1 2 8

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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 The equations below show some reactions of magnesium and its compounds.

A $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

B $Mg(NO_3)_2(s) \rightarrow MgO(s) + 2NO_2(g) + O_2(g)$

C $MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(1)$

D $Mg(s) + CuSO_4(aq) \rightarrow MgSO_4(aq) + Cu(s)$

(a) Which equation is **not** balanced?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which equation can be classified as a displacement reaction?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 1 = 2 marks)

2 Which of these equations represents the electron affinity of chlorine?

☒ **A** $Cl_2(g) + 2e^- \rightarrow 2Cl^-(g)$

☒ **B** $Cl_2(g) - 2e^- \rightarrow 2Cl^-(g)$

☒ **C** $\frac{1}{2}Cl_2(g) + e^- \rightarrow Cl^-(g)$

☒ **D** $Cl(g) + e^- \rightarrow Cl^-(g)$

(Total for Question 2 = 1 mark)

3 Which of these equations represents the second ionization of magnesium?

☒ **A** $Mg^{+}(g) \rightarrow Mg^{2+}(g) + e^{-}$

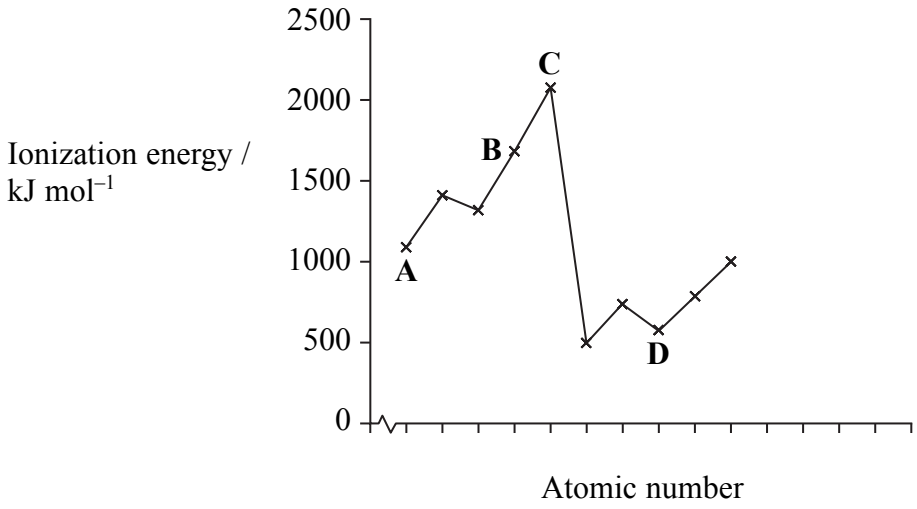
☒ **B** $Mg(g) \rightarrow Mg^{2+}(g) + 2e^{-}$

☒ **C** $Mg^{+}(g) + e^{-} \rightarrow Mg^{2+}(g)$

☒ **D** $Mg(g) + 2e^{-} \rightarrow Mg^{2+}(g)$

(Total for Question 3 = 1 mark)

4 The sketch graph below shows the trend in first ionization energies for some elements in Periods two and three.



Select, from the elements **A to D**, the one that

(a) has atoms with five p electrons.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) is a member of Group 3.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) is likely to be very unreactive.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(d) normally forms four covalent bonds per atom.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 4 = 4 marks)

5 Which of these ions has the greatest ability to polarize an anion?

☒ **A** Ba^{2+}

☒ **B** Ca^{2+}

☒ **C** Cs^{+}

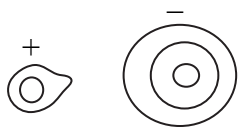
☒ **D** K^{+}

(Total for Question 5 = 1 mark)

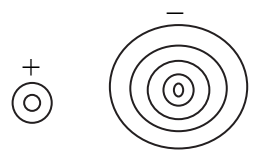
6 Which of these electron density maps best represents the bonding in the compound lithium iodide, LiI?

☒ **A**

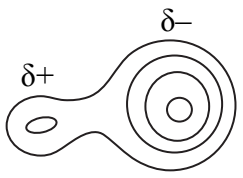
☒ **B**



☒ **C**



☒ **D**



(Total for Question 6 = 1 mark)

7 Which of these statements is **incorrect**?

☒ **A** The atomic radius of metals increases down a Group.

☒ **B** The trend in the melting temperature of successive elements across Period 2 is similar to that in Period 3.

☒ **C** A metallic structure is held together by attractions between metal atoms and delocalized electrons.

☒ **D** Na^+ and O^{2-} ions are isoelectronic.

(Total for Question 7 = 1 mark)

8 A sample of gas was prepared for use in helium-neon lasers. It contained 4 g of helium and 4 g of neon. What is the ratio of helium atoms to neon atoms in the sample?

☒ **A** 1 : 1

☒ **B** 2.5 : 1

☒ **C** 1 : 5

☒ **D** 5 : 1

(Total for Question 8 = 1 mark)

9 The overall equation for the reaction between sulfur and oxygen to form sulfur trioxide is shown below.

$$2S(s) + 3O_2(g) \rightarrow 2SO_3(g)$$

0.9 mol of $O_2(g)$ reacted completely with excess sulfur. What volume, in dm^3, of sulfur trioxide would form?

[Assume the molar gas volume = 24 dm^3 mol^{-1}]

☒ **A** $(0.9 \times 3/2) \times 24$

☒ **B** $(0.9 \times 3/2) \div 24$

☒ **C** $(0.9 \times 2/3) \times 24$

☒ **D** $(0.9 \times 2/3) \div 24$

(Total for Question 9 = 1 mark)

10 Which of these solutions does **not** contain the same total number of ions as the others?

☒ **A** 10.00 cm^3 of 0.100 mol dm^{-3} NaCl(aq)

☒ **B** 20.00 cm^3 of 0.050 mol dm^{-3} NaCl(aq)

☒ **C** 20.00 cm^3 of 0.050 mol dm^{-3} $MgCl_2$(aq)

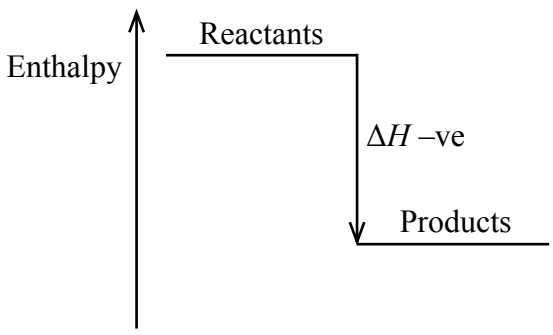
☒ **D** 13.33 cm^3 of 0.050 mol dm^{-3} $MgCl_2$(aq)

(Total for Question 10 = 1 mark)

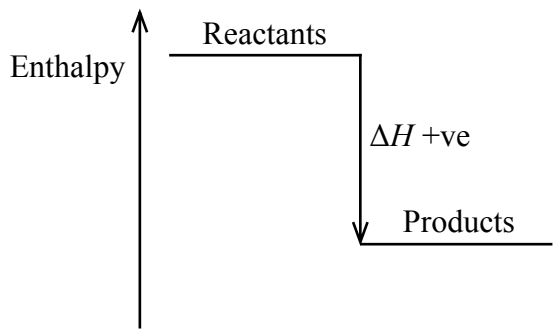
Use this space for any rough working. Anything you write in this space will gain no credit.

11 Which of these diagrams correctly represents an endothermic reaction?

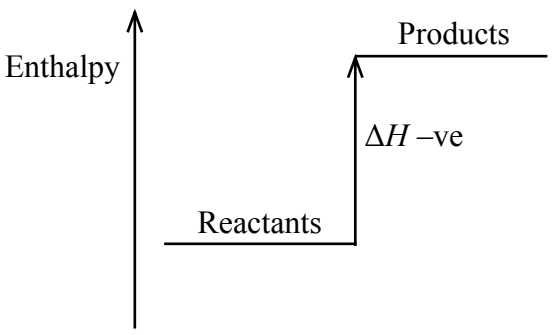
☒ **A**



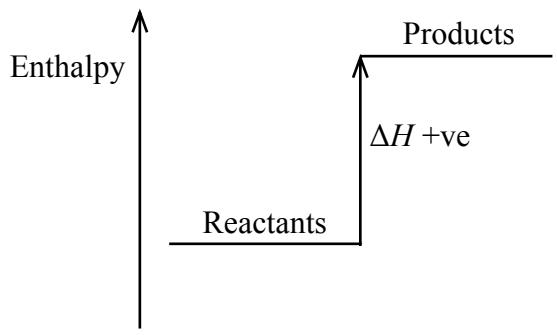
☒ **B**



☒ **C**



☒ **D**



(Total for Question 11 = 1 mark)

12 Which of these statements about carbon-carbon double bonds is **false**?

☒ **A** The two ends of a molecule cannot rotate relative to each other, about the axis of the double bond.

☒ **B** They are twice as strong as a carbon-carbon single bond.

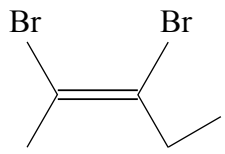
☒ **C** They have a higher electron density than a single bond.

☒ **D** They consist of a sigma bond and a pi bond.

(Total for Question 12 = 1 mark)

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

13 What is the correct name for the compound below?



☒ **A** *E*-2,3-dibromopent-2-ene

☒ **B** *E*-2,3-dibromopent-3-ene

☒ **C** *Z*-2,3-dibromopent-3-ene

☒ **D** *Z*-2,3-dibromopent-2-ene

(Total for Question 13 = 1 mark)

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

14 The equations below show some of the processes that occur when methane and chlorine react.

A $Cl_2(g) \rightarrow 2Cl\bullet(g)$

B $Cl\bullet(g) + CH_4(g) \rightarrow CH_3\bullet(g) + HCl(g)$

C $CH_3\bullet(g) + CH_3\bullet(g) \rightarrow C_2H_6(g)$

D $Cl_2(g) + CH_4(g) \rightarrow CH_3Cl(g) + HCl(g)$

(a) Which equation shows a propagation step?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which equation shows an initiation step?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) Which equation shows a termination step?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 14 = 3 marks)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

15 This question is about the properties of ions and ionic compounds.

(a) Solid calcium carbonate, $CaCO_3$, has a giant ionic structure.

(i) Draw a diagram (using dots or crosses) for a calcium **ion**. Show **ALL** the electrons and the charge on the ion.

(2)

(ii) Complete the electronic configuration for a calcium **ion**.

(1)

$1s^2$

(iii) Would you expect a calcium ion to be bigger, smaller or the same size as a calcium atom? Give TWO reasons to explain your answer.

(2)

(iv) Explain why ionic compounds have relatively high melting temperatures.

(2)

(b) Changes in the concentration of ions in a solution can be estimated by measuring the electrical conductivity of the solution.

(i) Explain why solutions of ions are able to conduct electricity.

(1)

.....

.....

(ii) Suggest why aqueous solutions of calcium chloride, $CaCl_2(aq)$, and barium chloride, $BaCl_2(aq)$, of the same molar concentration, have different electrical conductivities.

(1)

.....

.....

.....

(iii) 1 kg of a solution contains 0.100 mol of calcium ions, Ca^{2+}.

What is the concentration of the calcium ions by mass in parts per million (ppm)?

[Assume the relative atomic mass of calcium is 40.]

(2)

..... ppm

*(c) Some buildings are made from limestone, which is mainly calcium carbonate. Gases in the atmosphere such as sulfur dioxide, SO_2, and nitrogen dioxide, NO_2, can be responsible for damaging these buildings.

Describe how these gases come to be present in the atmosphere and explain how they can damage a limestone building.

(3)

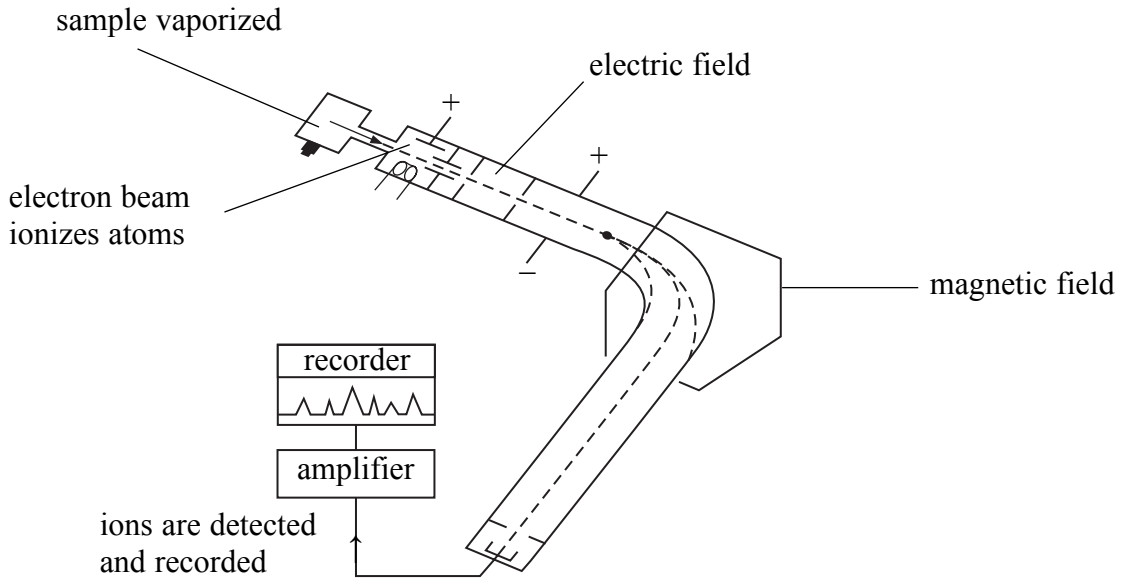
(d) The lattice energy of calcium chloride, $CaCl_2$, is -2258 kJ mol^{-1} based on an experimental Born-Haber cycle and -2223 kJ mol^{-1} based on theoretical calculations.

Would you expect its bonding to match the ionic model? Justify your answer.

(1)

(Total for Question 15 = 15 marks)

16 The diagram below shows a mass spectrometer, which can be used to determine the percentage abundances of isotopes in an element.



(a) Explain, in terms of sub-atomic particles, what is meant by the term **isotopes**.

(2)

(b) Describe the role of the following parts of the mass spectrometer.

(i) Electric field

(1)

(ii) Magnetic field

(1)

(c) A sample of the element barium is made up of four isotopes. The data below were taken from a mass spectrum of this sample.

Mass/charge ratio	% abundance
135	9.01
136	10.81
137	12.32
138	67.86

Calculate the relative atomic mass of the sample, giving your answer to **one** decimal place.

(2)

(d) The element bromine has two stable isotopes, ^{79}Br and ^{81}Br. How many peaks corresponding to Br_2^+ ions would be seen in the mass spectrum of bromine? Justify your answer.

(2)

(e) Suggest another application of mass spectrometry, other than to determine the relative atomic mass of an element.

(1)

(Total for Question 16 = 9 marks)

17 This question is about methanol and the energy changes that accompany some of its reactions.

(a) Complete the diagram (using dots and crosses) to show the bonding in methanol, CH_3OH. You should show outer electrons only.

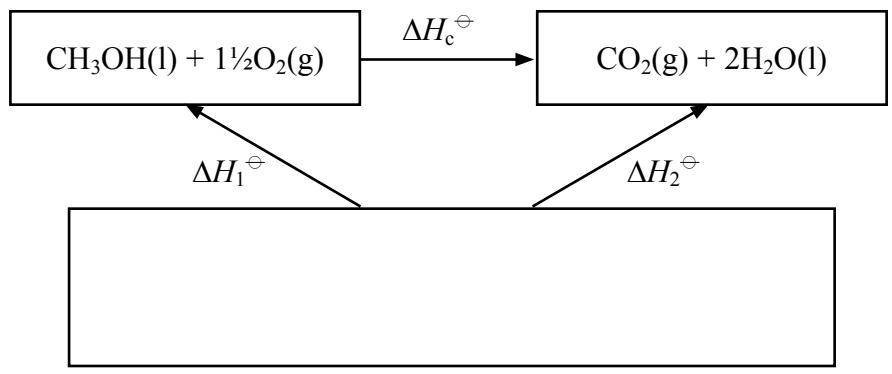
(2)

H

H C O H

H

(b) The Hess cycle below can be used to calculate the standard enthalpy change of combustion of methanol, using standard enthalpy changes of formation.



(i) Complete the cycle by filling in the empty box.

(2)

*(ii) Define the term **standard enthalpy change of formation** of a compound, making clear the meaning of **standard** in this context.

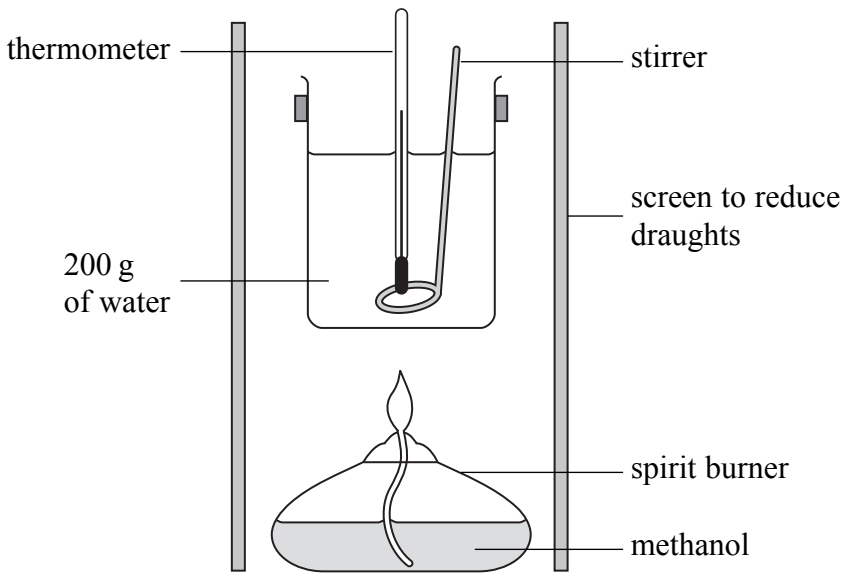
(3)

(iii) Use your cycle and the data below to calculate the standard enthalpy change of combustion of methanol, $\Delta H_c^{\ominus}$.

	$\Delta H_f^{\ominus}$/kJ mol^{-1}
$CO_2(g)$	–393.5
$H_2O(l)$	–285.8
$CH_3OH(l)$	–239.1

(2)

(c) An experiment was carried out, using the apparatus below, to estimate the standard enthalpy change of combustion of methanol.



After burning the methanol for a few minutes, the temperature of water in the beaker had risen by 20.7 °C and the mass of methanol burnt was 0.848 g.

(i) Calculate the amount of energy transferred to the water.

Energy transferred (J) = mass of water × 4.18 × temperature change

(1)

(ii) Calculate the number of moles of methanol, CH_3OH, burnt during the experiment.

(1)

(iii) Use your answers to (c)(i) and (ii) to calculate the experimental value for the standard enthalpy change of combustion. Include a sign and units in your answer, which should be given to **three** significant figures.

(1)

(iv) Compare your answers to (b)(iii) and (c)(iii) and give TWO reasons to explain any differences.

(2)

.....

.....

.....

.....

.....

.....

(Total for Question 17 = 14 marks)

18 This question is about ethene and related compounds.

(a) One way to manufacture ethene is by cracking hydrocarbon molecules such as liquid paraffin.

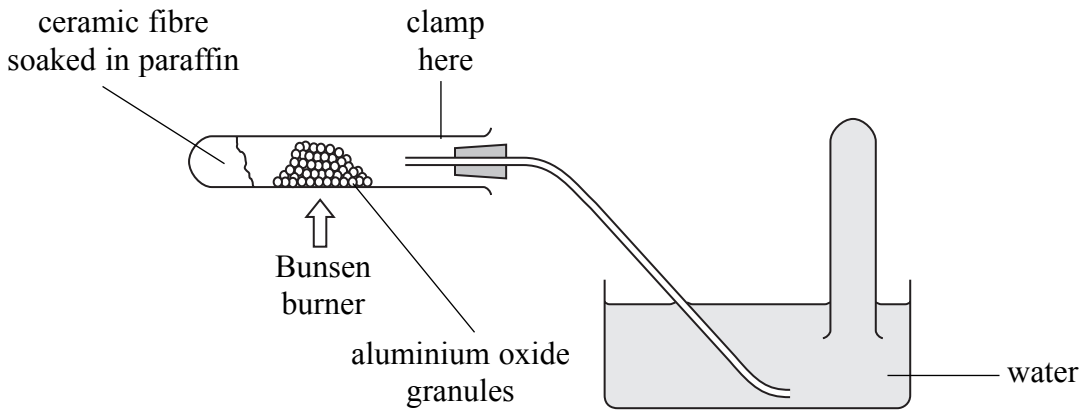
(i) Name a raw material from which liquid paraffin can be obtained.

(1)

(ii) Describe what is meant by **cracking**.

(2)

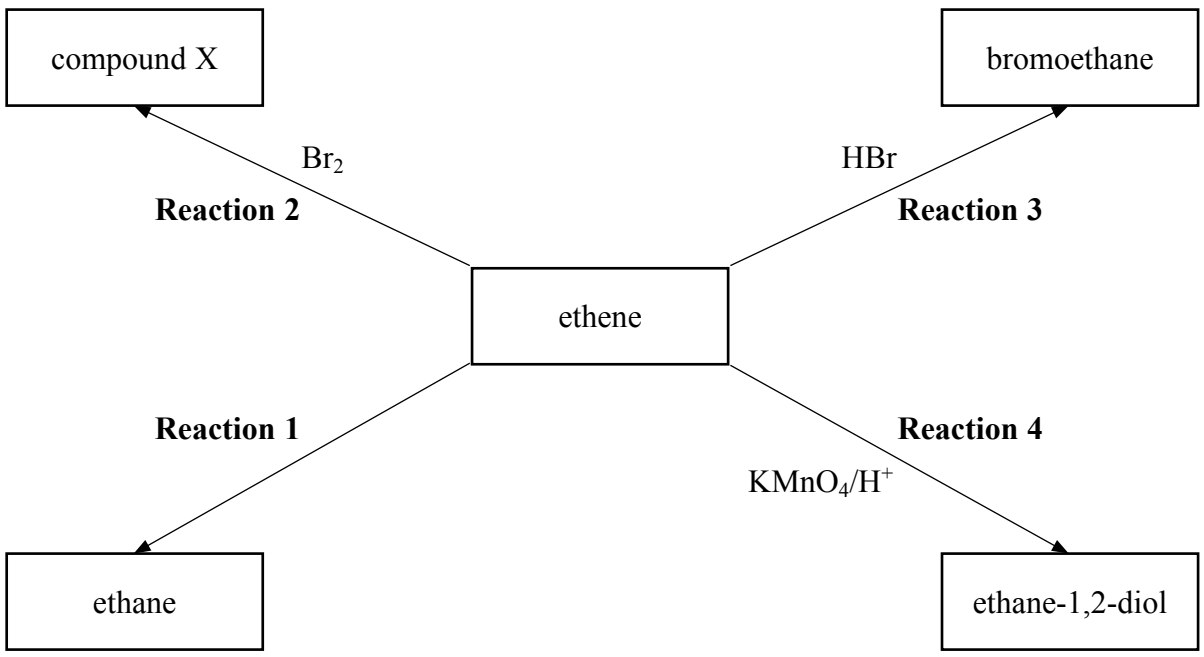
(iii) It was proposed to set up the apparatus below on a laboratory bench, in order to crack paraffin.



State TWO of the **risks** of using the apparatus in this way and suggest how you would amend the set-up to minimise each risk.

(4)

(b) Study the reaction scheme below and then answer the questions that follow.



(i) Name the reagent and catalyst needed for **Reaction 1**.

(2)

Reagent.....

Catalyst.....

(ii) Give the name and displayed formula of **compound X**.

(2)

Name.....

Displayed formula

(iii) Describe what colour change you would see during **Reaction 4** if a small amount of acidified $KMnO_4(aq)$ was shaken with ethene.

(1)

From..... **to**.....

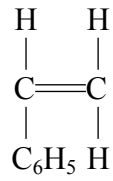
(c) (i) Use displayed formulae to show the mechanism for **Reaction 3**.

(3)

(ii) Explain why the alkene, propene, could form two products when it reacts with hydrogen bromide in a similar way.

(1)

(d) The formula of the alkene phenylethene, often called styrene, is shown below. It can be used to make the polymer poly(styrene).



phenylethene

Draw a section of the poly(styrene) polymer chain formed from **two** monomer units.

(2)

(e) The table below shows some data used in a life cycle analysis of polystyrene and paper drinking cups.

	Paper Cup	Polystyrene Cup
Raw Materials (per cup)		
Wood or bark	26 g	0 g
Petroleum fractions	2.2 g	3.4 g
Energy used (per tonne of material made)	980 kWh	280 kWh
Water released into environment (per tonne of material made)	120 m^3	2.5 m^3
Air emissions (per tonne of material made)		
Chlorine / chlorine dioxide	0.4 kg	0 kg
Sulfides / sulfur dioxide	11 kg	3.5 kg
Hydrocarbons	0 kg	40 kg

(i) Some people argue that using a polystyrene cup has less environmental impact than using a paper cup.

Choose TWO pieces of data to support this argument, explaining your choices.

(2)

(ii) Suggest TWO further pieces of information, not given in the table, regarding the life cycle of the cups that would make any assessment of the environmental impact more reliable.

(2)

.....

.....

.....

.....

.....

(Total for Question 18 = 22 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 MARKS

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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