

Please check the examination details below before entering your candidate information

Candidate surname		Other names	
Pearson Edexcel International Advanced Level	Centre Number		Candidate Number
Thursday 14 January 2021			
Afternoon (1 hour 30 minutes)		Paper Reference WCH12/01	
Chemistry International Advanced Subsidiary / Advanced Level Unit 2: Energetics, Group Chemistry, Halogenoalkanes and Alcohols			
You must have: Scientific calculator, Data booklet, Ruler			Total Marks

Instructions

- Use **black** ink or **black** 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.*
- Show all your working in calculations and include units where appropriate.

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.*
- In the question marked with an **asterisk (*)** marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.
- A Periodic Table is printed on the back cover of this paper.

Advice

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

Turn over ►

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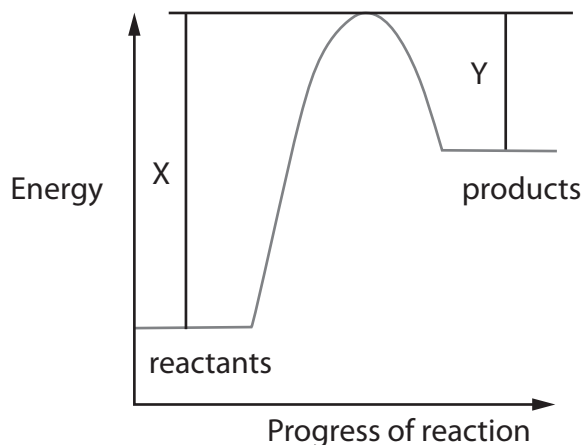
SECTION A

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 energy profile for a reaction is shown.



What is the minimum energy needed for this reaction to occur?

- ☐ A X
☐ B Y
☐ C $X - Y$
☐ D $X + Y$

(Total for Question 1 = 1 mark)

- 2 Which of these isomers with the formula C_8H_{18} has the lowest boiling temperature?

- ☐ A $CH_3CH(CH_3)CH_2CH_2CH(CH_3)CH_3$
☐ B $CH_3CH(CH_3)CH_2CH_2CH_2CH_2CH_3$
☐ C $CH_3C(CH_3)_2CH_2CH(CH_3)CH_3$
☐ D $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$

(Total for Question 2 = 1 mark)



3 Which of these pure compounds has hydrogen bonding in the liquid state?

- ☐ A 1,1,1-trichloroethane, CH_3CCl_3
- ☐ B trimethylamine, $(\text{CH}_3)_3\text{N}$
- ☐ C hydrogen fluoride, HF
- ☐ D hydrogen sulfide, H_2S

(Total for Question 3 = 1 mark)

4 The hydrogen ion, H^+ , bonds to a water molecule forming an H_3O^+ ion.

For H_3O^+ , what shape and H-O-H bond angle are predicted by the electron-pair repulsion theory?

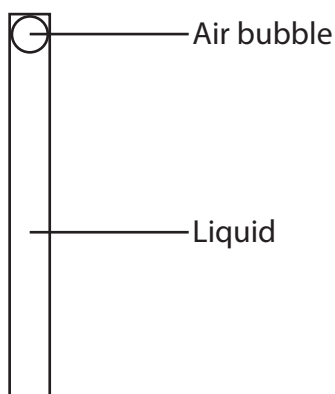
- ☐ A trigonal planar 120°
- ☐ B trigonal planar 117.5°
- ☐ C trigonal pyramidal 107°
- ☐ D trigonal pyramidal 104.5°

(Total for Question 4 = 1 mark)

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



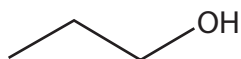
- 5 The viscosities of four liquid organic compounds are compared by placing the liquids in separate identical tubes, each with an air bubble at the top.



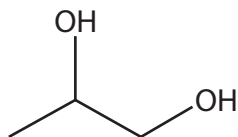
The tubes are inverted, and the times measured for the air bubble to travel the length of the tube.

For which compound does the air bubble take the longest time?

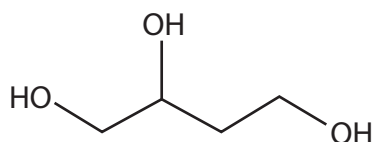
☐ A



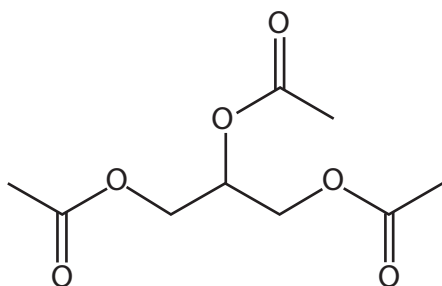
☐ B



☐ C



☐ D



(Total for Question 5 = 1 mark)

6 This question is about the reaction of potassium iodide with concentrated sulfuric acid.

(a) Which of these would **not** be seen?

(1)

- ☐ **A** misty fumes
- ☐ **B** black solid
- ☐ **C** yellow solid
- ☐ **D** dense white smoke

(b) One of the reaction products is the gas H_2S .

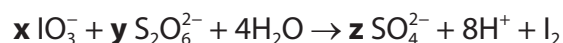
What is the **change** in oxidation number of sulfur as H_2S forms?

(1)

- ☐ **A** -8
- ☐ **B** -6
- ☐ **C** -2
- ☐ **D** +6

(Total for Question 6 = 2 marks)

7 Iodate(V) ions, IO_3^- , oxidise dithionate ions, $\text{S}_2\text{O}_6^{2-}$, according to the equation



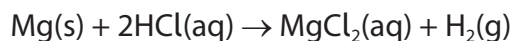
What are the balancing numbers **x**, **y** and **z**?

	x	y	z
☐ A	2	1	2
☐ B	2	2	4
☐ C	2	5	5
☐ D	2	5	10

(Total for Question 7 = 1 mark)



8 Magnesium reacts with hydrochloric acid.



Which statement about this reaction is correct?

- ☐ A magnesium atoms act as oxidising agents
- ☐ B hydrogen molecules act as reducing agents
- ☐ C hydrogen ions act as oxidising agents
- ☐ D chloride ions act as oxidising agents

(Total for Question 8 = 1 mark)

9 Which of these compounds does **not** produce a colour in a flame test, and produces an alkaline gas when warmed with sodium hydroxide solution?

- ☐ A Ca(OH)_2
- ☐ B Mg(OH)_2
- ☐ C NH_4Cl
- ☐ D BeCl_2

(Total for Question 9 = 1 mark)

10 Which of these **increases** as Group 7 is descended?

- ☐ A oxidising ability of the molecular halogens
- ☐ B reducing ability of the halide ions
- ☐ C electrostatic attraction between the nucleus and outer shell of electrons
- ☐ D electronegativity of the halogen atoms

(Total for Question 10 = 1 mark)

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- 11 The table shows the amount of energy released per gram when some alkanes are burned in excess oxygen under standard conditions.

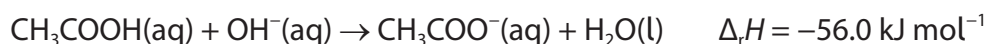
Alkane	Energy released / kJ g^{-1}
methane	55.6
ethane	52.0
propane	50.4
butane	49.6

Which alkane has a standard enthalpy change of combustion of $-2877 \text{ kJ mol}^{-1}$?

- ☐ A methane
- ☐ B ethane
- ☐ C propane
- ☐ D butane

(Total for Question 11 = 1 mark)

- 12 The enthalpy changes for two reactions are shown.



What is the enthalpy change for the dissociation of $\text{CH}_3\text{COOH}(\text{aq})$ into $\text{CH}_3\text{COO}^-(\text{aq})$ and $\text{H}^+(\text{aq})$ ions, in kJ mol^{-1} ?

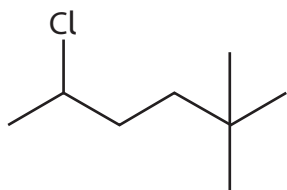
- ☐ A +113.2
- ☐ B +1.2
- ☐ C -1.2
- ☐ D -113.2

(Total for Question 12 = 1 mark)

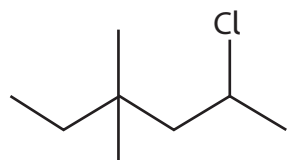


13 What is the skeletal formula of 2-chloro-4,4-dimethylhexane?

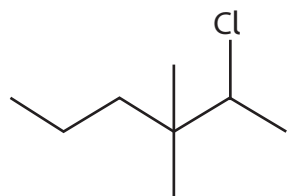
☐ A



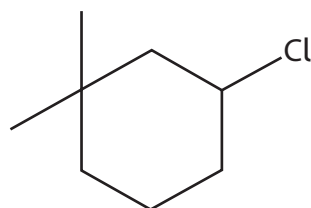
☐ B



☐ C



☐ D



(Total for Question 13 = 1 mark)

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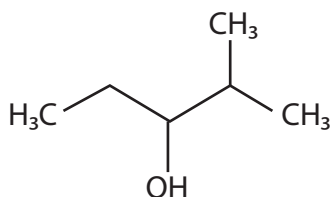


14 Some alcohols react with concentrated phosphoric(V) acid, H_3PO_4 , to form alkenes.

(a) What type of reaction occurs?

- ☐ **A** addition
- ☐ **B** elimination
- ☐ **C** hydrolysis
- ☐ **D** substitution

(b) The structure of 2-methylpentan-3-ol is shown.



This alcohol reacts with concentrated phosphoric(V) acid.

How many different alkenes can form?

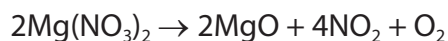
- ☐ **A** one
- ☐ **B** two
- ☐ **C** three
- ☐ **D** four

(Total for Question 14 = 2 marks)

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



15 Magnesium nitrate decomposes on heating.



What is the total volume of gas formed at room temperature and pressure (r.t.p.) when 0.005 mol of magnesium nitrate decomposes completely?

[Molar volume of a gas at r.t.p. = $24\,000\text{ cm}^3\text{ mol}^{-1}$]

- ☐ **A** 600 cm^3
- ☐ **B** 300 cm^3
- ☐ **C** 240 cm^3
- ☐ **D** 120 cm^3

(Total for Question 15 = 1 mark)

16 How many moles are there in 15.1 cm^3 of liquid propan-1-ol?

[Density of propan-1-ol = 0.80 g cm^{-3} M_r of propan-1-ol = 60]

- ☐ **A** $(0.80 \times 15.1) \div 60$
- ☐ **B** $0.80 \div (60 \times 15.1)$
- ☐ **C** $60 \div (0.80 \times 15.1)$
- ☐ **D** $(60 \times 15.1) \div 0.80$

(Total for Question 16 = 1 mark)

17 The oxidation of propan-1-ol by acidified potassium dichromate(VI) forms propanoic acid with a yield of 36 % by mass.

What mass of propan-1-ol is needed to form 37.0 g of propanoic acid in this reaction?

[M_r of propanoic acid = 74 M_r of propan-1-ol = 60]

- ☐ **A** 10.8 g
- ☐ **B** 36.0 g
- ☐ **C** 40.8 g
- ☐ **D** 83.3 g

(Total for Question 17 = 1 mark)



18 Barium chloride solution, $\text{BaCl}_2(\text{aq})$, reacts with gallium sulfate solution, $\text{Ga}_2(\text{SO}_4)_3(\text{aq})$ to form a precipitate of barium sulfate, $\text{BaSO}_4(\text{s})$.

What is the minimum volume of $0.100 \text{ mol dm}^{-3}$ barium chloride needed to precipitate **all** the sulfate ions in 200 cm^3 of 0.05 mol dm^{-3} gallium sulfate?

- ☐ **A** 100 cm^3
- ☐ **B** 200 cm^3
- ☐ **C** 300 cm^3
- ☐ **D** 400 cm^3

(Total for Question 18 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS



SECTION B

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

- 19** Ethanol can be made in industry by the reaction of ethene with steam, using a phosphoric(V) acid catalyst.



The reaction is carried out at 300°C and 60 atm. An initial yield of 5 % is achieved when the ethene and steam first pass through the reactor.

- *(a) Explain the chemical reasons for the conditions used and why such a low initial yield is acceptable in the industrial process.

(6)

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(b) The product of the reaction is a mixture of ethanol and water.

Explain why ethanol and water mix together fully.

You may find it helpful to draw a diagram.

(3)

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(c) Ethanol can be oxidised using a solution of acidified potassium dichromate(VI), $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$.

Ethanoic acid and another organic compound, **Y**, are both possible products.

(i) Draw the structure of **Y**.

(1)

(ii) State the conditions needed to maximise the yield of each product.

(2)

Conditions for maximum yield of **Y**

.....

.....

Conditions for maximum yield of ethanoic acid

.....

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(Total for Question 19 = 12 marks)



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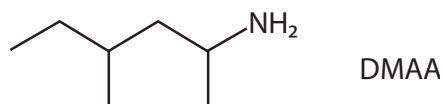
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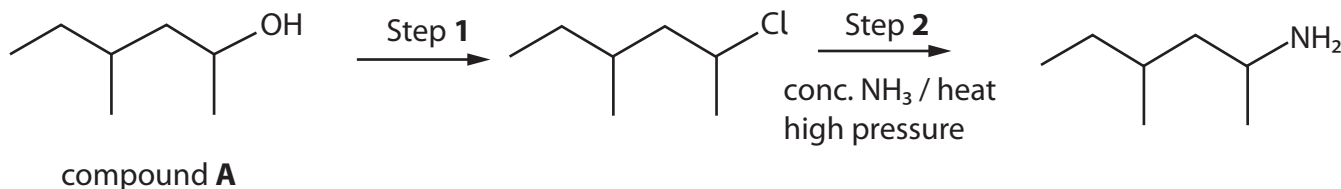
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20 The compound DMAA was originally synthesised as a decongestant.



A suggested synthetic route for DMAA is shown.



(a) (i) Give the systematic name of compound **A**.

(1)

(ii) Identify, by name or formula, a suitable reagent for Step 1.

(1)

(iii) Give the mechanism for the reaction in Step 2.
Include curly arrows, and any relevant dipoles and lone pairs.

(4)

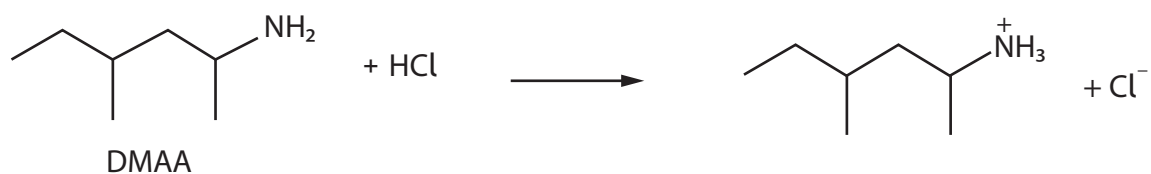
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- (b) DMAA is only slightly soluble in water but dissolves readily in hydrochloric acid to form an aqueous solution.

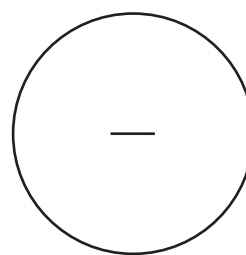
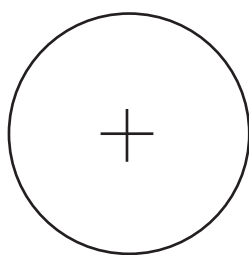


- (i) Explain the type of bonding that occurs between the nitrogen atom and the hydrogen ion, when the positive ion forms.

(3)

- (ii) Complete the diagrams to show how the ions formed in the reaction between DMAA and hydrochloric acid interact with water molecules.

(3)



(Total for Question 20 = 12 marks)



21 This question is about ethanoic acid and some related salts.

- (a) A test to confirm the presence of an aqueous acid is adding a small amount of solid sodium carbonate to the solution.

Describe **two** observations you would **see** in this test.

(2)

.....

.....

.....

.....

- (b) Sodium ethanoate is a component of reusable hand warmers.
In use, a supersaturated solution of sodium ethanoate recrystallises to form solid hydrated sodium ethanoate, releasing energy.



A hand warmer has a mass of 63.2 g and forms 20.1 g of hydrated sodium ethanoate on recrystallisation.

Calculate the maximum temperature reached by the hand warmer if its initial temperature is 5.0°C.

[Specific heat capacity of the hand warmer = 3.0 J °C⁻¹ g⁻¹]

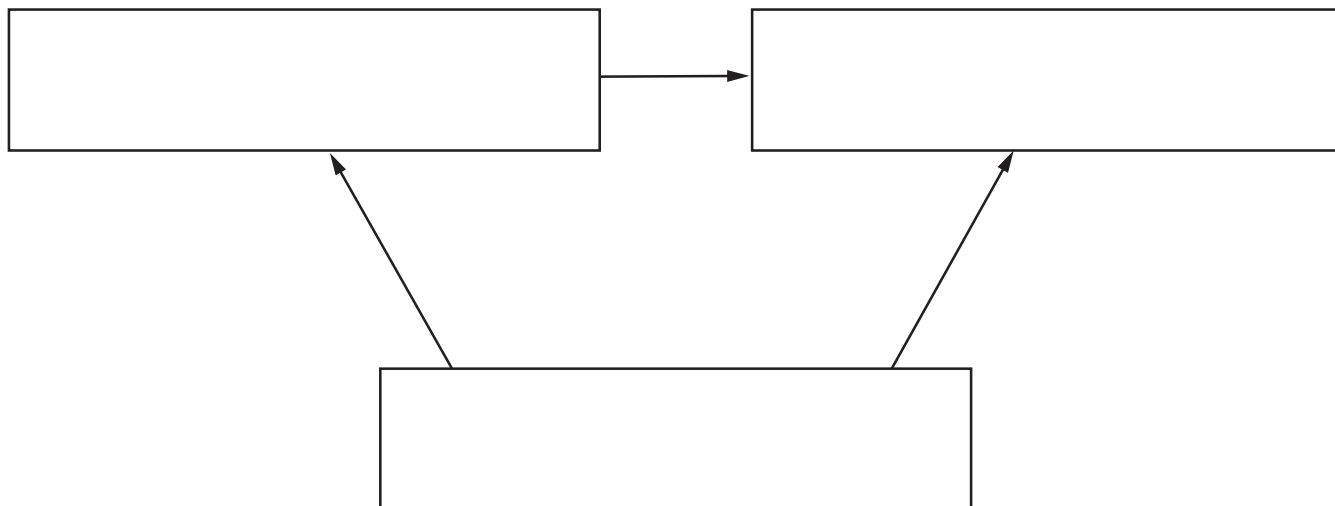
(5)



- (c) Ammonium ethanoate, $\text{CH}_3\text{COONH}_4(\text{s})$, is used to control the pH of foods. It can be formed by the reaction of pure ethanoic acid, $\text{CH}_3\text{COOH}(\text{l})$, with ammonium carbonate, $(\text{NH}_4)_2\text{CO}_3(\text{s})$.

Calculate the standard enthalpy change for this reaction by completing the Hess cycle and using the data shown.

(5)



Compound	Enthalpy change of formation / kJ mol^{-1}
$\text{CH}_3\text{COOH}(\text{l})$	-484.5
$(\text{NH}_4)_2\text{CO}_3(\text{s})$	-939.9
$\text{CH}_3\text{COONH}_4(\text{s})$	-586.3
$\text{CO}_2(\text{g})$	-393.5
$\text{H}_2\text{O}(\text{l})$	-285.8



- (d) Ammonium carbonate, $(\text{NH}_4)_2\text{CO}_3$, is an ingredient in cleaning solutions for camera lenses.

These are aqueous solutions which contain no more than 1.8 g of ammonium carbonate in 100 cm^3 of solution.

Calculate the maximum concentration, in mol dm^{-3} , of ammonium carbonate in such a solution.

(2)

(Total for Question 21 = 14 marks)

TOTAL FOR SECTION B = 38 MARKS



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SECTION C

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

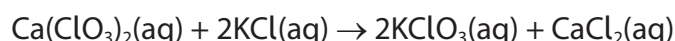
22 Potassium chlorate(V), KClO_3 , is a crystalline solid used in fireworks.

It is produced by the Liebig Process in two stages.

Stage **1** Chlorine gas is passed through hot calcium hydroxide solution forming calcium chlorate(V), $\text{Ca}(\text{ClO}_3)_2$.



Stage **2** Potassium chloride solution is then added to form potassium chlorate(V).



The solution is heated to reduce its volume and then allowed to crystallise.

The crystals are filtered off.

The remaining filtrate is evaporated further to obtain more crystals.

- (a) (i) Write the **overall** equation for the Liebig Process.
State symbols are not required.

(1)

- (ii) Calculate the **overall** atom economy by mass for the production of potassium chlorate(V), KClO_3 , using your equation in (a)(i).

(3)

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- (b) Explain the type of reaction that takes place in Stage 1 of the Liebig Process, using oxidation numbers.



(3)

- (c) The crystals of potassium chlorate(V) formed also contain some halide ion impurities.

- (i) Describe a chemical test on a solution of these crystals to **confirm** that the impurities present are chloride ions rather than bromide ions. Include the expected results.

(3)



- (ii) 1.52 g of impure potassium chlorate(V), formed in the Liebig Process, was heated until the mass of solid remaining was constant at 1.02 g.

The reaction that occurred was



The impurities present did not decompose on heating.

Calculate the percentage purity of the sample.

Give your answer to an appropriate number of significant figures.

(5)



- (d) In fireworks, potassium chlorate(V) decomposes. This thermal decomposition takes place in two stages with a solid catalyst.



- (i) Give the systematic name of KClO_4 .

(1)

- (ii) A student investigated the role of the catalyst in this reaction.

Procedure

Step 1 Heat a sample of KClO_3 , in a test tube, with a known mass of insoluble catalyst until the mass remains constant.

Step 2 Mix the contents of the test tube with water.

Step 3 Filter the mixture and rinse with deionised water.

Step 4 Dry the remaining solid.

Step 5 Measure the mass of the dry solid.

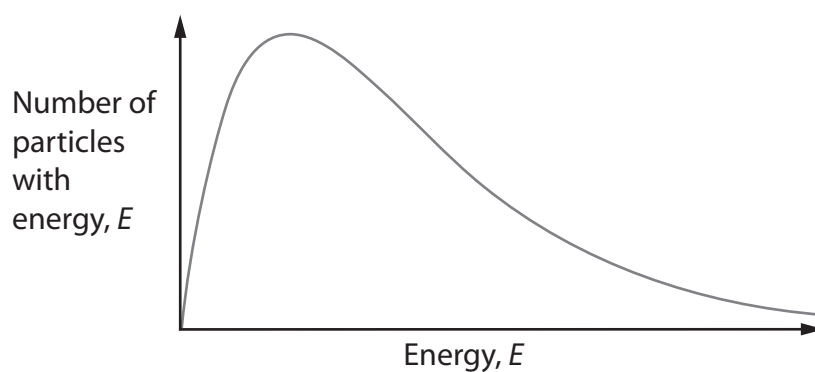
Explain how each of the steps in this procedure is needed to show that the catalyst is **not** used up in this reaction.

(4)



(e) Explain, using the diagram, how a catalyst speeds up a chemical reaction.

(2)



(Total for Question 22 = 22 marks)

TOTAL FOR SECTION C = 22 MARKS
TOTAL FOR PAPER = 80 MARKS



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The Periodic Table of Elements

1	2	3	4	5	6	7	0 (8)
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	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	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	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	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	200.6 Hg mercury 80	201.0 Tl thallium 81	204.4 Pb lead 82	208.98 Po polonium 84	210 At astatine 85	222 Rn radon 86
Elements with atomic numbers 112-116 have been reported but not fully authenticated							
112 Cn copernicium 112	113 Nh nihonium 113	114 Fl flerovium 114	115 Mc moscovium 115	116 Lv livermorium 116	117 Ts tennessine 117	118 Og oganesson 118	119 Uue unbinilium 119
120 Uub unbinilium 120	121 Uut untrium 121	122 Uuq unquadium 122	123 Uuh unhexium 123	124 Uuq unquadium 124	125 Uuh unhexium 125	126 Uuq unquadium 126	127 Uuh unhexium 127
128 Uuo ununoctium 128	129 Uuq unquadium 129	130 Uuh unhexium 130	131 Uuq unquadium 131	132 Uuh unhexium 132	133 Uuq unquadium 133	134 Uuh unhexium 134	135 Uuq unquadium 135
136 Uuo ununoctium 136	137 Uuq unquadium 137	138 Uuh unhexium 138	139 Uuq unquadium 139	140 Uuh unhexium 140	141 Uuq unquadium 141	142 Uuh unhexium 142	143 Uuq unquadium 143
144 Uuo ununoctium 144	145 Uuq unquadium 145	146 Uuh unhexium 146	147 Uuq unquadium 147	148 Uuh unhexium 148	149 Uuq unquadium 149	150 Uuh unhexium 150	151 Uuq unquadium 151
152 Uuo ununoctium 152	153 Uuq unquadium 153	154 Uuh unhexium 154	155 Uuq unquadium 155	156 Uuh unhexium 156	157 Uuq unquadium 157	158 Uuh unhexium 158	159 Uuq unquadium 159
160 Uuo ununoctium 160	161 Uuq unquadium 161	162 Uuh unhexium 162	163 Uuq unquadium 163	164 Uuh unhexium 164	165 Uuq unquadium 165	166 Uuh unhexium 166	167 Uuq unquadium 167
168 Uuo ununoctium 168	169 Uuq unquadium 169	170 Uuh unhexium 170	171 Uuq unquadium 171	172 Uuh unhexium 172	173 Uuq unquadium 173	174 Uuh unhexium 174	175 Uuq unquadium 175
176 Uuo ununoctium 176	177 Uuq unquadium 177	178 Uuh unhexium 178	179 Uuq unquadium 179	180 Uuh unhexium 180	181 Uuq unquadium 181	182 Uuh unhexium 182	183 Uuq unquadium 183
184 Uuo ununoctium 184	185 Uuq unquadium 185	186 Uuh unhexium 186	187 Uuq unquadium 187	188 Uuh unhexium 188	189 Uuq unquadium 189	190 Uuh unhexium 190	191 Uuq unquadium 191
192 Uuo ununoctium 192	193 Uuq unquadium 193	194 Uuh unhexium 194	195 Uuq unquadium 195	196 Uuh unhexium 196	197 Uuq unquadium 197	198 Uuh unhexium 198	199 Uuq unquadium 199
200 Uuo ununoctium 200	201 Uuq unquadium 201	202 Uuh unhexium 202	203 Uuq unquadium 203	204 Uuh unhexium 204	205 Uuq unquadium 205	206 Uuh unhexium 206	207 Uuq unquadium 207
208 Uuo ununoctium 208	209 Uuq unquadium 209	210 Uuh unhexium 210	211 Uuq unquadium 211	212 Uuh unhexium 212	213 Uuq unquadium 213	214 Uuh unhexium 214	215 Uuq unquadium 215
216 Uuo ununoctium 216	217 Uuq unquadium 217	218 Uuh unhexium 218	219 Uuq unquadium 219	220 Uuh unhexium 220	221 Uuq unquadium 221	222 Uuh unhexium 222	223 Uuq unquadium 223
224 Uuo ununoctium 224	225 Uuq unquadium 225	226 Uuh unhexium 226	227 Uuq unquadium 227	228 Uuh unhexium 228	229 Uuq unquadium 229	230 Uuh unhexium 230	231 Uuq unquadium 231
232 Th thorium 90	231 Pa protactinium 91	238 U uranium 92	237 Np neptunium 93	242 Pu plutonium 94	244 Am americium 95	247 Cm curium 96	250 Bk berkelium 97
251 Cf californium 98	252 Es einsteinium 99	257 Fm fermium 100	258 Md mendelevium 101	261 No nobelium 102	265 Lr lawrencium 103	267 Rf rutherfordium 104	269 Db dubnium 105
271 Hs hassium 108	272 Hs hassium 108	273 Hs hassium 108	274 Hs hassium 108	275 Hs hassium 108	276 Hs hassium 108	277 Hs hassium 108	278 Hs hassium 108
279 Hs hassium 108	280 Hs hassium 108	281 Hs hassium 108	282 Hs hassium 108	283 Hs hassium 108	284 Hs hassium 108	285 Hs hassium 108	286 Hs hassium 108
287 Hs hassium 108	288 Hs hassium 108	289 Hs hassium 108	290 Hs hassium 108	291 Hs hassium 108	292 Hs hassium 108	293 Hs hassium 108	294 Hs hassium 108
295 Hs hassium 108	296 Hs hassium 108	297 Hs hassium 108	298 Hs hassium 108	299 Hs hassium 108	300 Hs hassium 108	301 Hs hassium 108	302 Hs hassium 108
303 Hs hassium 108	304 Hs hassium 108	305 Hs hassium 108	306 Hs hassium 108	307 Hs hassium 108	308 Hs hassium 108	309 Hs hassium 108	310 Hs hassium 108
311 Hs hassium 108	312 Hs hassium 108	313 Hs hassium 108	314 Hs hassium 108	315 Hs hassium 108	316 Hs hassium 108	317 Hs hassium 108	318 Hs hassium 108
319 Hs hassium 108	320 Hs hassium 108	321 Hs hassium 108	322 Hs hassium 108	323 Hs hassium 108	324 Hs hassium 108	325 Hs hassium 108	326 Hs hassium 108
327 Hs hassium 108	328 Hs hassium 108	329 Hs hassium 108	330 Hs hassium 108	331 Hs hassium 108	332 Hs hassium 108	333 Hs hassium 108	334 Hs hassium 108
335 Hs hassium 108	336 Hs hassium 108	337 Hs hassium 108	338 Hs hassium 108	339 Hs hassium 108	340 Hs hassium 108	341 Hs hassium 108	342 Hs hassium 108
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351 Hs hassium 108	352 Hs hassium 108	353 Hs hassium 108	354 Hs hassium 108	355 Hs hassium 108	356 Hs hassium 108	357 Hs hassium 108	358 Hs hassium 108
359 Hs hassium 108	360 Hs hassium 108	361 Hs hassium 108	362 Hs hassium 108	363 Hs hassium 108	364 Hs hassium 108	365 Hs hassium 108	366 Hs hassium 108
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375 Hs hassium 108	376 Hs hassium 108	377 Hs hassium 108	378 Hs hassium 108	379 Hs hassium 108	380 Hs hassium 108	381 Hs hassium 108	382 Hs hassium 108
383 Hs hassium 108	384 Hs hassium 108	385 Hs hassium 108	386 Hs hassium 108	387 Hs hassium 108	388 Hs hassium 108	389 Hs hassium 108	390 Hs hassium 108
391 Hs hassium 108	392 Hs hassium 108	393 Hs hassium 108	394 Hs hassium 108	395 Hs hassium 108	396 Hs hassium 108	397 Hs hassium 108	398 Hs hassium 108
399 Hs hassium 108	400 Hs hassium 108	401 Hs hassium 108	402 Hs hassium 108	403 Hs hassium 108	404 Hs hassium 108	405 Hs hassium 108	406 Hs hassium 108
407 Hs hassium 108	408 Hs hassium 108	409 Hs hassium 108	410 Hs hassium 108	411 Hs hassium 108	412 Hs hassium 108	413 Hs hassium 108	414 Hs hassium 108
415 Hs hassium 108	416 Hs hassium 108	417 Hs hassium 108	418 Hs hassium 108	419 Hs hassium 108	420 Hs hassium 108	421 Hs hassium 108	422 Hs hassium 108
423 Hs hassium 108	424 Hs hassium 108	425 Hs hassium 108	426 Hs hassium 108	427 Hs hassium 108	428 Hs hassium 108	429 Hs hassium 108	430 Hs hassium 108
431 Hs hassium 108	432 Hs hassium 108	433 Hs hassium 108	434 Hs hassium 108	435 Hs hassium 108	436 Hs hassium 108	437 Hs hassium 108	438 Hs hassium 108
439 Hs hassium 108	440 Hs hassium 108	441 Hs hassium 108	442 Hs hassium 108	443 Hs hassium 108	444 Hs hassium 108	445 Hs hassium 108	446 Hs hassium 108
447 Hs hassium 108	448 Hs hassium 108	449 Hs hassium 108	450 Hs hassium 108	451 Hs hassium 108	452 Hs hassium 108	453 Hs hassium 108	454 Hs hassium 108
455 Hs hassium 108	456 Hs hassium 108	457 Hs hassium 108	458 Hs hassium 108	459 Hs hassium 108	460 Hs hassium 108	461 Hs hassium 108	462 Hs hassium 108
463 Hs hassium 108	464 Hs hassium 108	465 Hs hassium 108	466 Hs hassium 108	467 Hs hassium 108	468 Hs hassium 108	469 Hs hassium 108	470 Hs hassium 108
471 Hs hassium 108	472 Hs hassium 108	473 Hs hassium 108	474 Hs hassium 108	475 Hs hassium 108	476 Hs hassium 108	477 Hs hassium 108	478 Hs hassium 108
479 Hs hassium 108	480 Hs hassium 108	481 Hs hassium 108	482 Hs hassium 108	483 Hs hassium 108	484 Hs hassium 108	485 Hs hassium 108	486 Hs hassium 108
487 Hs hassium 108	488 Hs hassium 108	489 Hs hassium 108	490 Hs hassium 108	491 Hs hassium 108	492 Hs hassium 108	493 Hs hassium 108	494 Hs hassium 108
495 Hs hassium 108	496 Hs hassium 108	497 Hs hassium 108	498 Hs hassium 108	499 Hs hassium 108	500 Hs hassium 108	501 Hs hassium 108	502 Hs hassium 108
503 Hs hassium 108	504 Hs hassium 108	505 Hs hassium 108	506 Hs hassium 108	507 Hs hassium 108	508 Hs hassium 108	509 Hs hassium 108	510 Hs hassium 108
511 Hs hassium 108	512 Hs hassium 108	513 Hs hassium 108	514 Hs hassium 108	515 Hs hassium 108	516 Hs hassium 108	517 Hs hassium 108	518 Hs hassium 108
519 Hs hassium 108	520 Hs hassium 108	521 Hs hassium 108	522 Hs hassium 108	523 Hs hassium 108	524 Hs hassium 108	525 Hs hassium 108	526 Hs hassium 108
527 Hs hassium 108	528 Hs hassium 108	529 Hs hassium 108	530 Hs hassium 108	531 Hs hassium 108	532 Hs hassium 108	533 Hs hassium 108	534 Hs hassium 108
535 Hs hassium 108	536 Hs hassium 108	537 Hs hassium 108	538 Hs hassium 108	539 Hs hassium 108	540 Hs hassium 108	541 Hs hassium 108	542 Hs hassium 108
543 Hs hassium 108	544 Hs hassium 108	545 Hs hassium 108	546 Hs hassium 108	547			