Please check the examination detai	ils below before ente	ring your candidate information
Candidate surname		Other names
Pearson Edexcel International Advanced Level	Centre Number	Candidate Number
Time 1 hour 30 minutes	Paper reference	WCH12/01
Chemistry		
International Advanced UNIT 2: Energetics, Great Halogenoalkanes and A	oup Chemis	′
You must have: Scientific calculator, Data Booklet	t, ruler	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.
- 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.
- Good luck with your examination.

Turn over ▶



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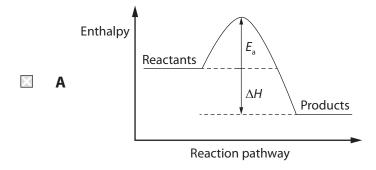
SECTION A

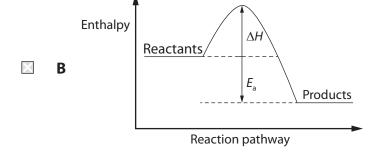
Answer ALL questions. Write your answers in the spaces provided.

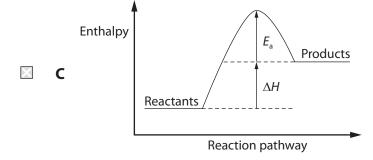
You should aim to spend no more than 20 minutes on this section.

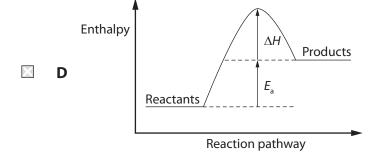
For each question, select one answer from A to D and put a cross in the box \boxtimes . If you change your mind, put a line through the box \boxtimes and then mark your new answer with a cross \boxtimes .

1 Which is the correctly labelled reaction profile for an exothermic reaction?









(Total for Question 1 = 1 mark)

2 The equation for a reaction is

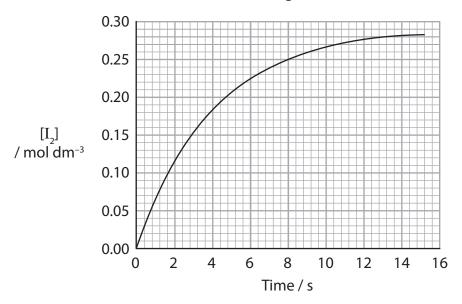
$$2C(s) + O_2(g) \rightarrow 2CO(g)$$

Which is the correct symbol for the enthalpy change for this reaction?

- \triangle **A** $\triangle_{at}H$
- \square **B** $\triangle_{c}H$
- \square C $\triangle_f H$
- \square **D** $\triangle_r H$

(Total for Question 2 = 1 mark)

3 The graph shows how the concentration of iodine changes with time in a reaction.



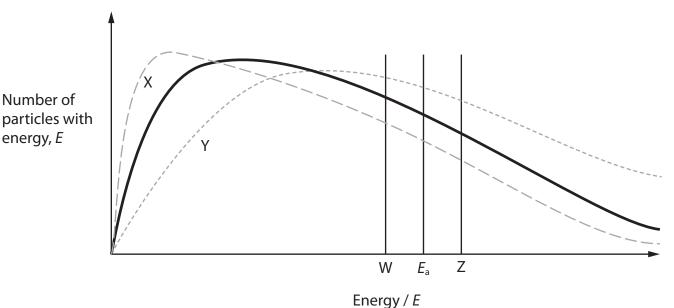
What is the value for the rate of reaction, in mol dm⁻³ s⁻¹, at 8 seconds?

- **△ A** 0.01
- **■ B** 0.02
- **C** 0.03
- **□ D** 0.25

(Total for Question 3 = 1 mark)

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

4 The solid line on the graph below shows the Maxwell–Boltzmann distribution for an uncatalysed reaction. E_a is the activation energy of this reaction.



Which row shows the correct Maxwell–Boltzmann curve and activation energy for the reaction at a higher temperature with a catalyst?

		Maxwell-Boltzmann curve	Activation energy
X	Α	X	W
X	В	X	Z
X	C	Υ	W
X	D	Υ	Z

(Total for Question 4 = 1 mark)

- What is the oxidation number of chromium in Na₂Cr₂O₇?
 - A +1
 - \blacksquare **B** +2
 - **C** +3
 - **□ D** +6

(Total for Question 5 = 1 mark)

6 In an oxide of nitrogen, the oxidation number of nitrogen is +4.

Which is the formula of the oxide?

- \triangle A N_2O
- \blacksquare **B** N_2O_3
- \square C N_2O_4
- \square **D** N_2O_5

(Total for Question 6 = 1 mark)

7 Hydrogen peroxide, H₂O₂, breaks down into water and oxygen.

In terms of oxidation and reduction, how do hydrogen and oxygen change in this reaction?

		Hydrogen	Oxygen
×	Α	oxidised	reduced
X	В	oxidised and reduced	unchanged
X	c	reduced	oxidised
×	D	unchanged	oxidised and reduced

(Total for Question 7 = 1 mark)

- **8** Several factors may affect ionisation energies:
 - I) the number of protons increases
 - II) the outer electron is further from the nucleus
 - III) the amount of shielding increases
 - IV) the number of unpaired outer electrons increases

Which factors explain the **decrease** in ionisation energy as Group 1 is descended?

- A Land II
- B II and III
- D I, II, III and IV

(Total for Question 8 = 1 mark)

- **9** Separate samples of some halogenoalkanes were dissolved in ethanol and a few drops of silver nitrate solution added. The faster the reaction of the halogenoalkane, the quicker a precipitate forms.
 - (a) Which of these halogenoalkanes reacts the **fastest**?

(1)

- A CH₃CHICH₃
- B CH₃CHBrCH₃
- C CH₃CHClCH₃
- □ CH₃CHFCH₃
- (b) Which of these halogenoalkanes reacts the **fastest**?

(1)

- A CH₃CHBrCH(CH₃)CH₃
- B CH₃CH₂CBr(CH₃)CH₃
- C CH₃CH(CH₂Br)CH₂CH₃
- □ CH₃CH₂CH₂CH₂CH₂Br

(Total for Question 9 = 2 marks)

10 What is the structure of 2-bromo-3-chloro-2-methylbutane?

(Total for Question 10 = 1 mark)

11 Which structure represents a primary halogenoalkane?

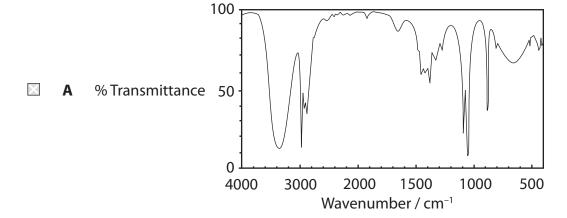
- □ A CI
- B
- C CI
- □ D CI

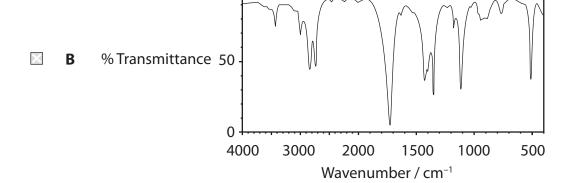
(Total for Question 11 = 1 mark)

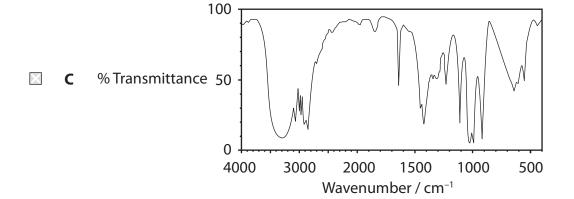
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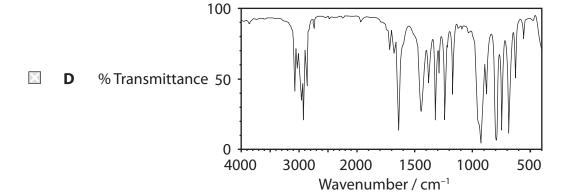
12 Which could be the infrared spectrum of CH₂=CHCH₂OH?

100



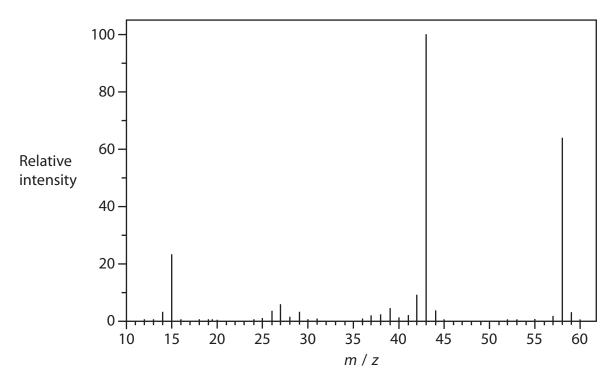






(Total for Question 12 = 1 mark)

13 The mass spectrum of propanone is shown.



Which fragment is most likely to produce the peak at m/z = 43?

- A CH₃CH₂CH₂⁺
- B CH₃CO⁺
- C CH₂CHO⁺
- ☑ D CHCH₂O⁺

(Total for Question 13 = 1 mark)

14 A 4.00 mol dm⁻³ solution of an acid is used to prepare dilute solutions of the acid.

What volume of water is required to make up 150 cm³ of 0.35 mol dm⁻³ solution of the acid?

- \triangle **A** 13.1 cm³
- 52.5 cm³
- **C** 97.5 cm³

(Total for Question 14 = 1 mark)

15 (a) A pellet of sodium hydroxide has a mass of 0.700 g.

Some pellets were dissolved to make 350 cm³ of 0.25 mol dm⁻³ solution.

 $[M_r \text{ value: NaOH} = 40]$

How many pellets were dissolved?

(1)

- **■ B** 5

- (b) 25.0 cm³ of the sodium hydroxide solution prepared in (a) was placed in a conical flask and titrated with sulfuric acid.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the number of moles of sulfuric acid that reacted.

(1)

- **■ B** 0.0063
- **C** 0.013
- **D** 0.044
- (c) Phenolphthalein indicator was used for the titration in (b).

What was the colour change at the endpoint?

(1)

- \square A colourless \rightarrow pink
- \square **B** pink \rightarrow colourless
- \square **C** orange \rightarrow yellow
- \square **D** yellow \rightarrow orange

(Total for Question 15 = 3 marks)

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

- 16 Which silver halides are soluble in **concentrated** aqueous ammonia?
 - A AgBr and AgI
 - B AgCl and AgI
 - C AgCl and AgBr
 - D AgCl only

(Total for Question 16 = 1 mark)

17 What volume, in dm³, of hydrogen gas will be produced when 3.00 g of lithium is reacted with water at room temperature and pressure (r.t.p.)?

$$2Li + 2H_2O \rightarrow 2LiOH + H_2$$

[Molar volume of gas at r.t.p. = $24.0 \text{ dm}^3 \text{ mol}^{-1}$]

- **A** 0.217
- **■ B** 0.435
- **C** 5.22
- **■ D** 10.4

(Total for Question 17 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

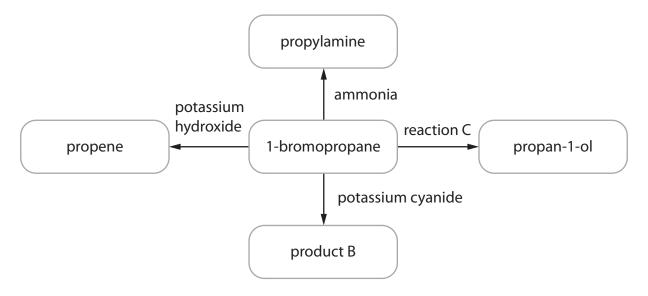
Answer ALL questions.

Write your answers in the spaces provided.

- **18** 1-bromopropane is used for spot removal when 'dry cleaning' clothes.
 - (a) 1-bromopropane does not occur naturally but can be made from propan-1-ol. Identify the reagent or reagents you would use to make 1-bromopropane from propan-1-ol.

(1)

(b) Some reactions of 1-bromopropane are shown.



(i) Give the conditions for the formation of propene.

(1)

(ii) Give the **molecular** formula of product B.

(1)

(iii) Name the type and mechanism of the reaction taking place in reaction C.

(2)



(iv) Complete the mechanism for the reaction that occurs between ammonia and 1-bromopropane to form propylamine, $CH_3CH_2CH_2NH_2$.

Include curly arrows, and relevant lone pairs and dipoles.

(4)

(Total for Question 18 = 9 marks)



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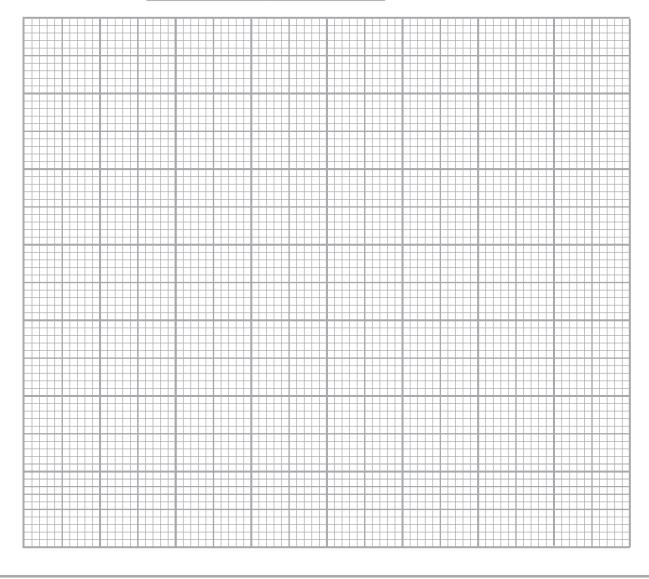
(a) Write an e	reacts with sulfuric acid in an exoth equation for the reaction. tate symbols in your answer.	nermic reaction.	(2)
the reacti A sample 25 cm³ of Calculate	et carried out an experiment to deterion. The of 0.50 g of magnesium powder we followed the following the following the following the following the number of moles of magnesium answer.	vas added to	

(c) (i) The results obtained are given in the table.

Plot the results on the grid.

(2)

Time / minutes	Temperature /°C	
0	22.2	
1	22.0	
2	22.0	← Mg added
3	39.6	
4	41.8	
5	40.8	
6	40.2	
7	39.4	
8	38.6	



(ii) Use your graph to determine the maximum change in temperature.

You **must** show your working on the graph.

(2)

 $\Delta T = \dots$

(d) Calculate the standard molar enthalpy change for the reaction, using your answers to (b) and (c)(ii).

Include a sign and units in your answer.

[Specific heat capacity of solution =
$$4.18 \text{ J g}^{-1} \,^{\circ}\text{C}^{-1}$$
]

(4)

(Total for Question 19 = 13 marks)

20 This question is about the forces between molecules and ions.

*(a) Some data for three small molecules are shown.

Molecule	$M_{\rm r}$	Boiling temperature /°C			
Fluorine	38.0	-188			
Hydrogen chloride	36.5	-85			
Methanol	32.0	65			

Explain the large variation in boiling temperatures, given the small range in M_r values.

Detailed descriptions of the forces involved are not requ	uired.	6)



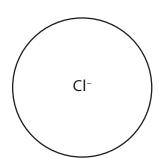
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(b) Calcium chloride is soluble in water.

Complete the diagram to show how water molecules interact with each ion. You may use ____ to represent a water molecule.

(2)





(c) Explain why bromine is a liquid but iodine is a solid at room temperature.

Detailed explanations of the forces involved are not required.

(2)

(Total for Question 20 = 10 marks)

21	Magnesium oxalate, MgC ₂ O ₄ , decomposes on heating to form magnesium carbonate
	and carbon monoxide.

$$MgC_2O_4(s) \rightarrow MgCO_3(s) + CO(g)$$

(a) A 6.0 g sample of magnesium oxalate was heated for three minutes but the decomposition was only 70 % complete.

Calculate the total mass of solid that remains.

(4)

(b) In practice, magnesium carbonate also decomposes on stronger heating.

Describe and explain the trend in the thermal decomposition of Group 2 carbonates.

(3)

(Total for Question 21 = 8 ma	
the decomposition of magnesium oxalate even if the sample is heated for longer.	(1)
(c) Suggest why a pure sample of magnesium carbonate will not be produced from	

TOTAL FOR SECTION B = 40 MARKS

SECTION C

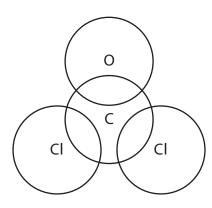
Answer all the questions. Write your answers in the spaces provided.

22 Phosgene (COCl₂) is a colourless gas used in the pharmaceutical industry.

Phosgene has a boiling temperature of 8 °C and is extremely toxic.

(a) Complete the dot-and-cross diagram to show the bonding in phosgene.

(2)



(b) Phosgene can be formed from carbon monoxide and chlorine, using a catalyst of activated carbon.

$$CO(g) + CI_2(g) \Rightarrow COCI_2(g)$$

$$\Delta_{\rm r} H = -107.6 \text{ kJ mol}^{-1}$$

(i) State and explain how the reaction conditions could be changed to maximise the **equilibrium** yield of phosgene in this reaction.

	-	ъ
1	71	п
v.	4	J

(4)

(ii) The standard enthalpy change of formation for phosgene is $\Delta_f H = -220.1 \text{ kJ mol}^{-1}$.

Complete the Hess cycle and determine the standard enthalpy change of formation for carbon monoxide. Use the data from (b)(i).

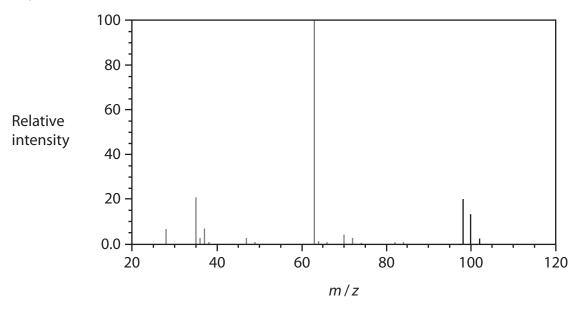
Include state symbols in your cycle.

CO(g) + $CI_2(g)$ \longrightarrow $COCI_2(g)$



(c) The mass spectrum of a sample of phosgene is shown.

The peak at m/z = 65 has been omitted.



(i) Give the reason for the **ratio** of peak heights at m/z values of 102, 100 and 98.

(2)

(ii) Suggest an identity for the peak at m/z = 63.

(1)

(iii) The peak at m/z = 65 has been omitted.

Draw **on the mass spectrum** the peak at m / z = 65, showing its relative intensity.

(1)

(d) Use your Data Booklet to suggest the wavenumber of a strong absorbance you would expect to see in the infrared spectrum for phosgene. Justify your answer.

(2)



(e)	In UV light, trichloromethane (CHCl ₃ , boiling temperature 61°C) reacts with
	oxygen to form phosgene and hydrogen chloride.

(i)	Write an equation for this reaction.
	State symbols are not required.

(1)

(ii) In a closed bottle, the rate of this reaction decreases with time.

Give a reason for this.

(1)

(iii) Suggest a precaution that should be taken when opening a bottle of trichloromethane.

(1)

(iv) Trichloromethane can be used as an anaesthetic.

Suggest whether an old bottle of trichloromethane can still be used for medical treatment, giving a reason for your answer.

(1)

(Total for Question 22 = 20 marks)

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



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0 (8)	(18) 4.0 He hetium 2	Ne neon 10	39.9 Ar argon 18	83.8 Kr krypton 36	Xe xenon 54	[222] Rn radon 86	ported	- E	
7	(17)	19.0 F fluorine 9	35.5 Cl chlorine 17	79.9 Br bromine 35	126.9 I iodine 53	[210] At astatine 85	been re	175 Lu lutetium 71	[257] Lr
9	(16)	16.0 O oxygen 8	32.1 Sulfur 16	79.0 Selenium 34	127.6 Te tellurium 52	[209] Po potonium 84	-116 have	173 Yb ytterbium 70	[254] No
Ŋ	(15)	14.0 N nitrogen 7	31.0 P phosphorus 15	74.9 As arsenic 33	Sb antimony 51	209.0 Bi bismuth 83	tomic numbers 112-116 hav but not fully authenticated	169 Tm thulium 69	PW [356]
4	(14)	12.0 C carbon 6	Si Sificon 14	72.6 Ge germanium 32	118.7 Sn tin 50	207.2 Pb tead 82	atomic nu but not f	167 Er erbíum 68	[253] Fm
m	(13)	10.8 B boron 5	27.0 Al aluminium 13	69.7 Ga gallium 31	Indium 199	204.4 TI thallium 81	Elements with atomic numbers 112-116 have been reported but not fully authenticated	165 Ho hotmium 67	[251] [254] Cf Es
	(12)		65.4 Zn zinc 30	112.4 Cd cadmium 48	200.6 Hg mercury 80	Elem	163 Dy dysprosium 66	[251] Cf	
	(9) (11)			63.5 Cu copper 29	Ag silver 47	197.0 Au gold 79	Rg roentgenium 111	159 Tb terbium 65	[245] BK
				58.7 Ni micket 28	106.4 Pd palladium 46	195.1 Pt platinum 78	[271] Ds damstadtium 110	157 Gd gadolinium 64	[247] Cm
				58.9 Co cobalt 27	Rh rhodium 45	192.2 Ir iridium 77	[268] Mt metroenum 109	152 Eu europíum 63	[243] Am
	1.0 1 hydrogen		(8)	55.8 Fe iron 26	Ru Ru ruthenium 44	190.2 Os osmium 76	[277] Hs hassium 108	150 Sm samarium 62	[242] Pu
	· · ·			Mn Manganese 25	[98] Tc technetium 43	Re rhenium 75	[264] Bh bohrium 107		[237] [242] Np Pu
		mass ool umber	(9)	52.0 54.9 Cr Mn chromium manganese 24 25	95.9 [98] Mo Tc molybdenum technetium 42 43	183.8 W tungsten 74	Sg seaborgium 106	Nd neodymium 60	238 U
	Key	relative atomic mass atomic symbol name atomic (proton) number	(5)	50.9 V vanadium 23	92.9 Nb niobium r 41	180.9 Ta tantalum 73	[262] Db dubnium s 105	141 144 [147] Pr Nd Pm praecodymium neodymium promethium 59 60 61	[231] Pa
		relatí ato atomic	(4)	47.9 Ti titanium 22	91.2 Zr Zr zirconium 40	178.5 Hf hafnium 72	[261] Rf rutherfordium 104	Ce ceríum 58	232 Th
			(3)	Sc scandium 21	88.9 4 yttrium 39	138.9 La* lanthanum 57	[227] Ac* actinium 89	xì	
7	(2)	9.0 Be beryllium 4	24.3 Mg magnesium 12	Ca catcium 20	87.6 Sr strontium 38	137.3 Ba barium 56	[226] Ra radium 88	* Lanthanide series * Actinide series	
-	ε	6.9 Li lithium 3	Na Sodium	39.1 K potassium 19	85.5 Rb rubidium 37	132.9 Cs caesium 55	[223] Fr Fr francium 87	* Lanth	

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