

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

Candidate Number

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Time 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 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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Pearson

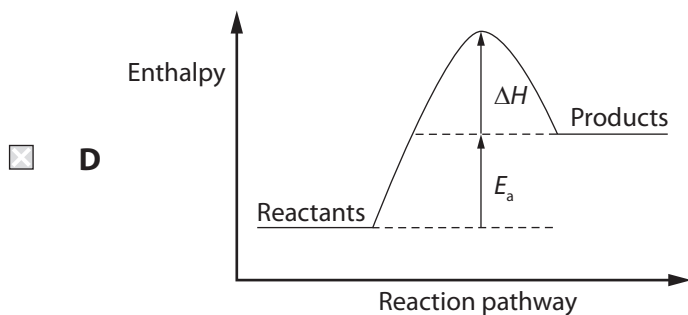
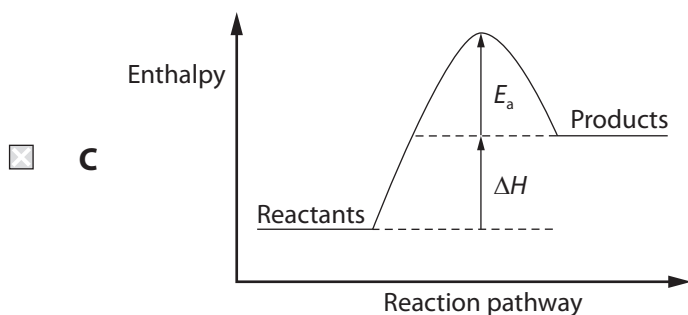
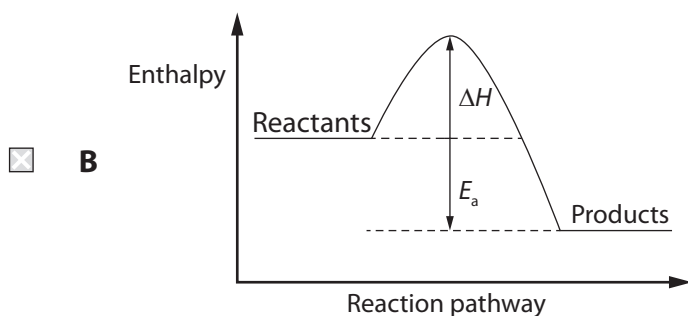
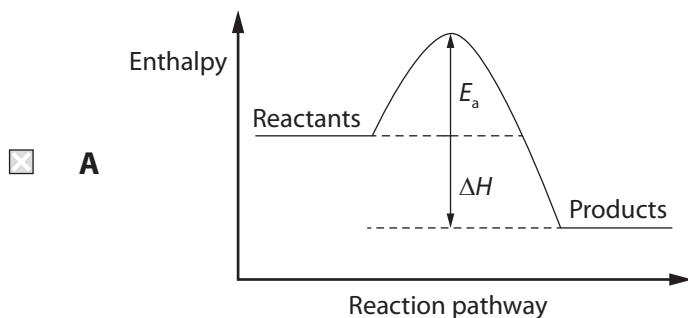
SECTION A

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 ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

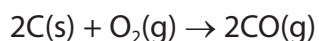
- 1 Which is the correctly labelled reaction profile for an exothermic reaction?



(Total for Question 1 = 1 mark)



2 The equation for a reaction is

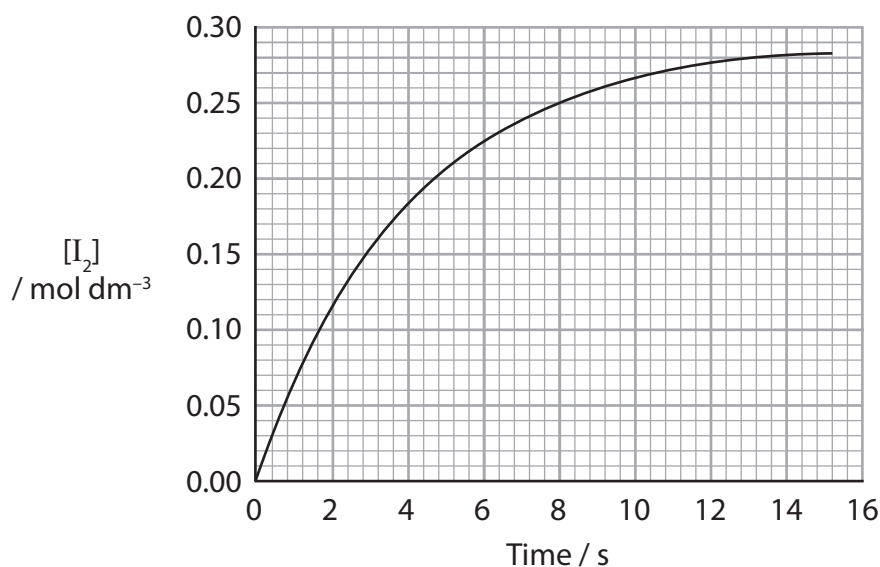


Which is the correct symbol for the enthalpy change for this reaction?

- A $\Delta_{\text{at}}H$
- B $\Delta_{\text{c}}H$
- C $\Delta_{\text{f}}H$
- D $\Delta_{\text{r}}H$

(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?

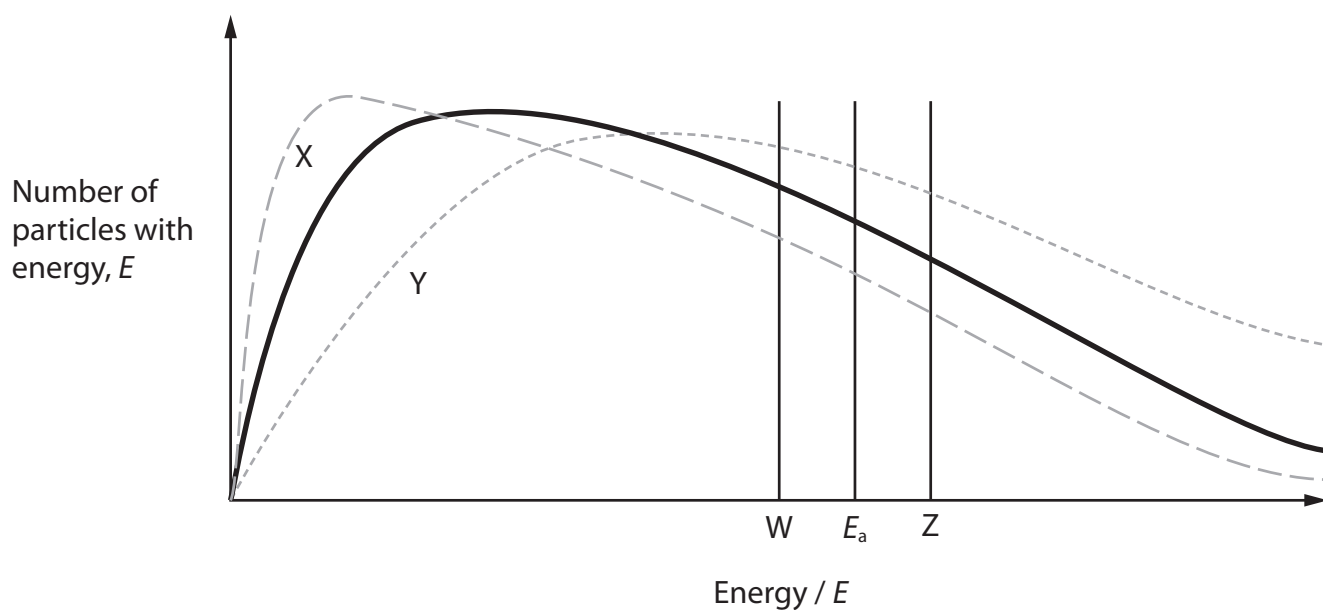
- A 0.01
- B 0.02
- C 0.03
- D 0.25

(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
<input type="checkbox"/> A	X	W
<input type="checkbox"/> B	X	Z
<input type="checkbox"/> C	Y	W
<input type="checkbox"/> D	Y	Z

(Total for Question 4 = 1 mark)

- 5 What is the oxidation number of chromium in $\text{Na}_2\text{Cr}_2\text{O}_7$?

- A +1
- 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?

- A N_2O
 B N_2O_3
 C N_2O_4
 D N_2O_5

(Total for Question 6 = 1 mark)

7 Hydrogen peroxide, H_2O_2 , breaks down into water and oxygen.

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

	Hydrogen	Oxygen
<input type="checkbox"/> A	oxidised	reduced
<input type="checkbox"/> B	oxidised and reduced	unchanged
<input type="checkbox"/> C	reduced	oxidised
<input type="checkbox"/> 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 I and II
 B II and III
 C III and IV
 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 $\text{CH}_3\text{CHICH}_3$
 B $\text{CH}_3\text{CHBrCH}_3$
 C $\text{CH}_3\text{CHClCH}_3$
 D $\text{CH}_3\text{CHFCH}_3$

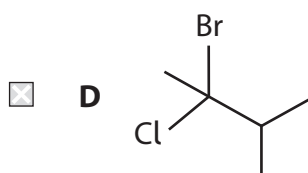
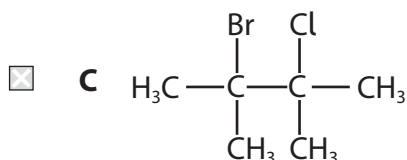
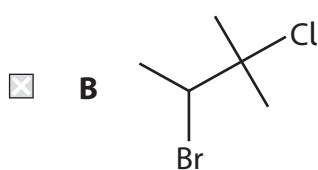
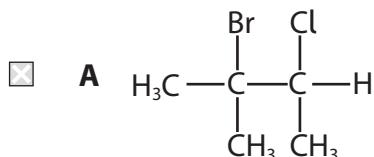
(b) Which of these halogenoalkanes reacts the **fastest**?

(1)

- A $\text{CH}_3\text{CHBrCH}(\text{CH}_3)\text{CH}_3$
 B $\text{CH}_3\text{CH}_2\text{CBr}(\text{CH}_3)\text{CH}_3$
 C $\text{CH}_3\text{CH}(\text{CH}_2\text{Br})\text{CH}_2\text{CH}_3$
 D $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$

(Total for Question 9 = 2 marks)

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



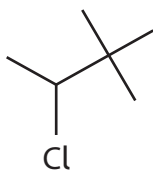
(Total for Question 10 = 1 mark)



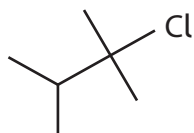
11 Which structure represents a primary halogenoalkane?



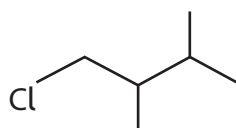
A



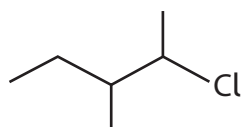
B



C



D



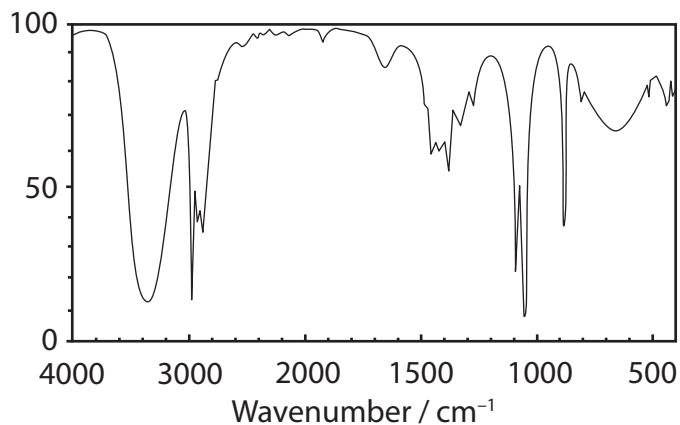
(Total for Question 11 = 1 mark)

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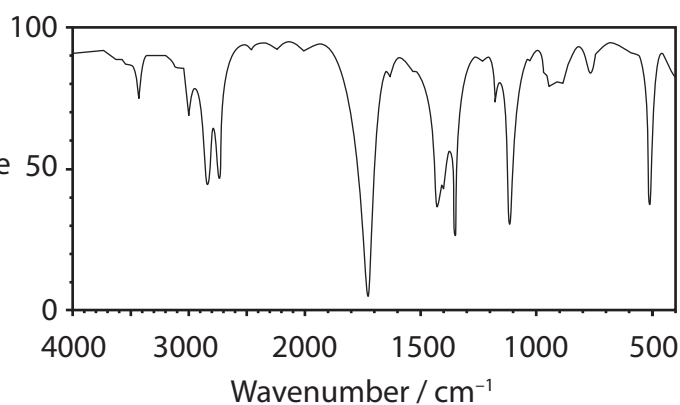


12 Which could be the infrared spectrum of $\text{CH}_2=\text{CHCH}_2\text{OH}$?

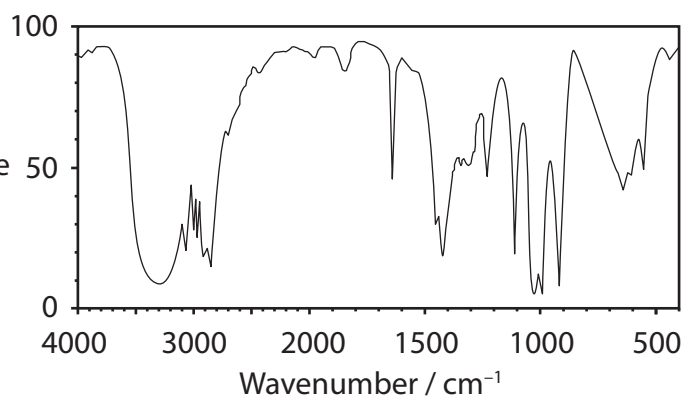
A % Transmittance



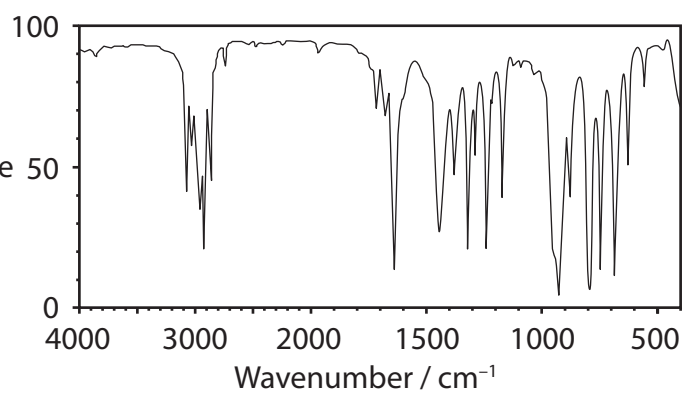
B % Transmittance



C % Transmittance



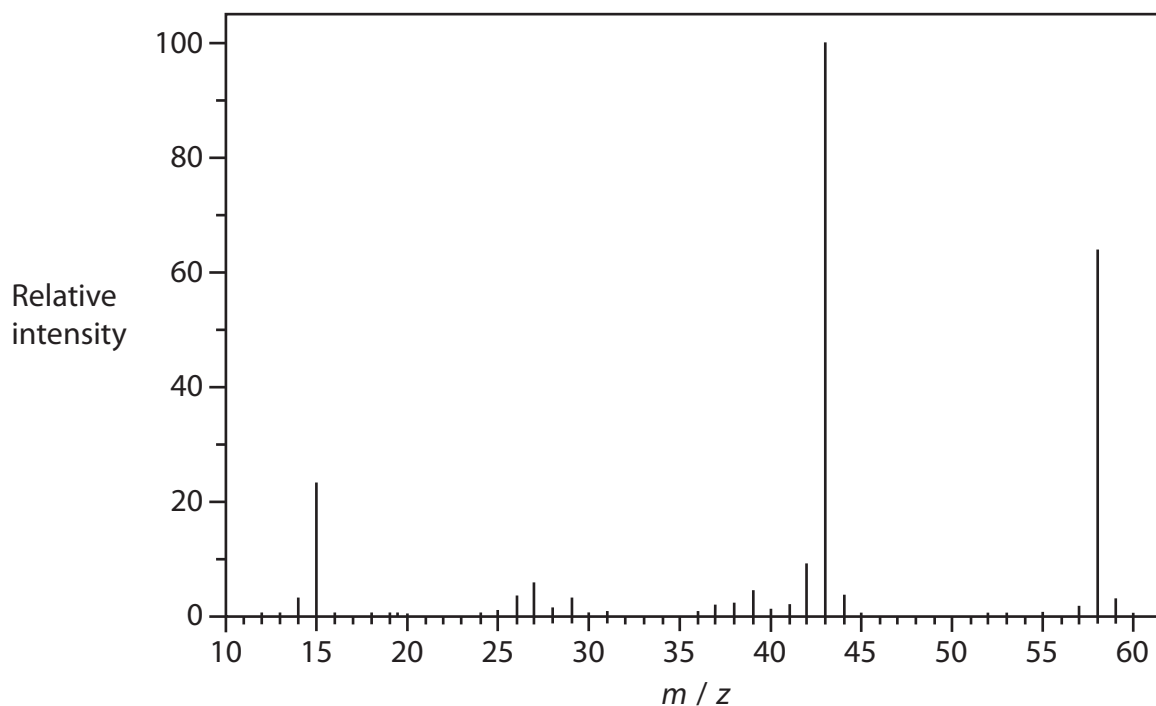
D % Transmittance



(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 $\text{CH}_3\text{CH}_2\text{CH}_2^+$
- B CH_3CO^+
- C CH_2CHO^+
- D CHCH_2O^+

(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 cm^3 of 0.35 mol dm^{-3} solution of the acid?

- A 13.1 cm^3
- B 52.5 cm^3
- C 97.5 cm^3
- D 136.9 cm^3

(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.

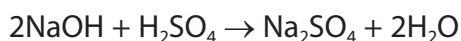
[M_r value: NaOH = 40]

How many pellets were dissolved?

(1)

- A 4
- B 5
- C 8
- D 125

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



Calculate the number of moles of sulfuric acid that reacted.

(1)

- A 0.0031
- 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)

- A colourless → pink
- B pink → colourless
- C orange → yellow
- D yellow → 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 dm^3 , of hydrogen gas will be produced when 3.00 g of lithium is reacted with water at room temperature and pressure (r.t.p.)?



[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.

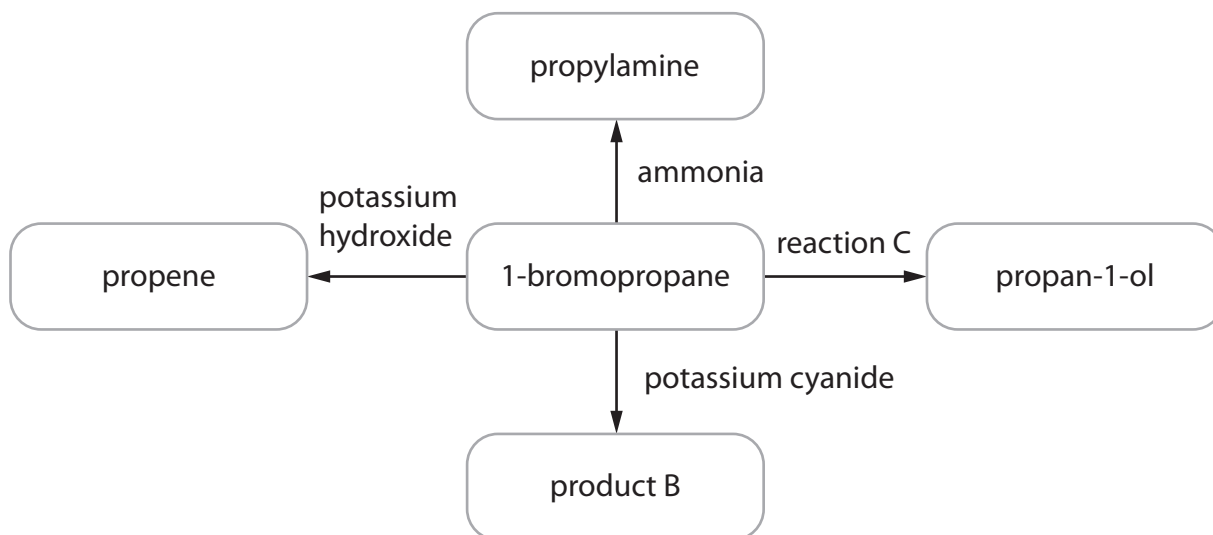
18 1-bromopropane is used for spot removal when 'dry cleaning' clothes.

(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.

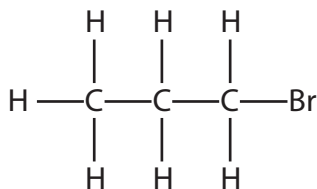
(2)



(iv) Complete the mechanism for the reaction that occurs between ammonia and 1-bromopropane to form propylamine, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$.

Include curly arrows, and relevant lone pairs and dipoles.

(4)



(Total for Question 18 = 9 marks)



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19 Magnesium reacts with sulfuric acid in an exothermic reaction.

- (a) Write an equation for the reaction.
Include state symbols in your answer.

(2)

- (b) A student carried out an experiment to determine the enthalpy change of the reaction.

A sample of 0.50 g of magnesium powder was added to 25 cm³ of 0.20 mol dm⁻³ sulfuric acid.

Calculate the number of moles of magnesium and of sulfuric acid that **reacted**.
Justify your answer.

(3)

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(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
3	39.6
4	41.8
5	40.8
6	40.2
7	39.4
8	38.6

← Mg added



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

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

(2)

$$\Delta T = \dots\dots\dots$$

(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 = $4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$]

(4)

(Total for Question 19 = 13 marks)

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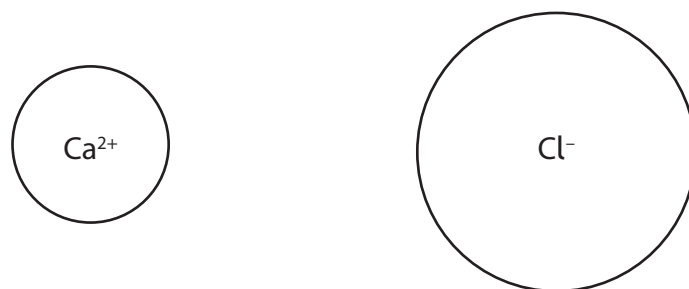
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(b) Calcium chloride is soluble in water.

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)

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(Total for Question 20 = 10 marks)



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21 Magnesium oxalate, MgC_2O_4 , decomposes on heating to form magnesium carbonate and carbon monoxide.



(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)

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(c) Suggest why a pure sample of magnesium carbonate will **not** be produced from the decomposition of magnesium oxalate even if the sample is heated for longer.

(1)

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(Total for Question 21 = 8 marks)

TOTAL FOR SECTION B = 40 MARKS



SECTION C

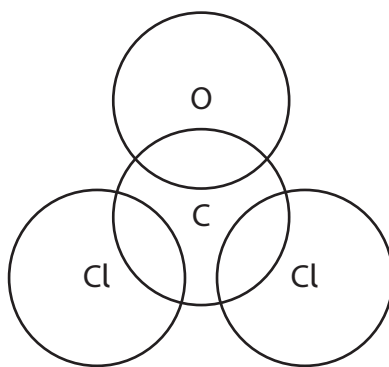
Answer all the questions. Write your answers in the spaces provided.

22 Phosgene (COCl_2) 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.



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

(4)

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- (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.

(4)



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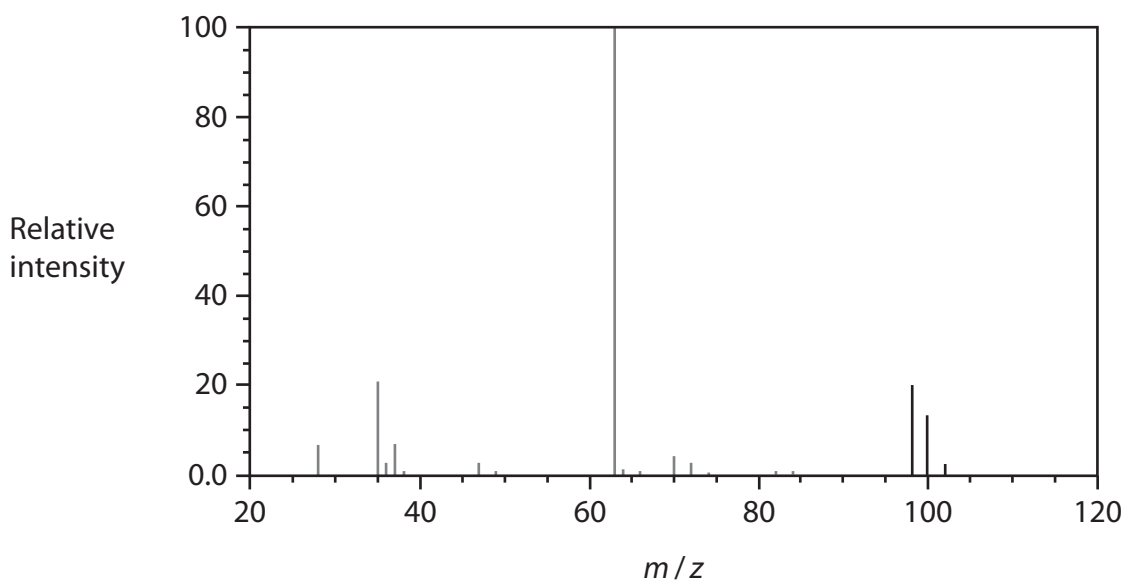
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(c) The mass spectrum of a sample of phosgene is shown.

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)



P 6 4 6 2 4 A 0 2 5 2 8

(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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The Periodic Table of Elements

1 2 3 4 5 6 7 0 (8)
(18)

1.0	H	hydrogen	1
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Key

relative atomic mass
atomic symbol
name
atomic (proton) number

(1) (2)

6.9	Li	lithium	3
9.0	Be	beryllium	4
23.0	Na	sodium	11
24.3	Mg	magnesium	12

	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	
39.1	40.1	45.0	47.9	50.9	52.0	54.9	55.8	58.9	58.7	63.5	65.4	69.7	72.6	74.9	79.0	79.9	83.8
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
potassium	calcium	scandium	titanium	vanadium	chromium	manganese	iron	cobalt	nickel	copper	zinc	gallium	germanium	arsenic	selenium	bromine	krypton
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
85.5	87.6	88.9	91.2	92.9	95.9	[98]	101.1	102.9	106.4	107.9	112.4	114.8	118.7	121.8	127.6	126.9	131.3
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
rubidium	strontium	yttrium	zirconium	niobium	molybdenum	technetium	ruthenium	rhodium	palladium	silver	cadmium	indium	tin	antimony	tellurium	iodine	xenon
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
132.9	137.3	138.9	178.5	180.9	183.8	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209.0	[209]	[210]	[222]
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
caesium	barium	lanthanum	hafnium	tantalum	tungsten	rhenium	osmium	iridium	platinum	gold	mercury	thallium	lead	bismuth	polonium	astatine	radon
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
[223]	[226]	[227]	[261]	[262]	[266]	[264]	[277]	[268]	[271]	[272]							
Fr	Ra	Ac*	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg							
francium	radium	actinium	rutherfordium	dubnium	seaborgium	bohrium	hassium	meitnerium	darmstadtium	roentgenium							
87	88	89	104	105	106	107	108	109	110	111							

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

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

* Lanthanide series

* Actinide series

