Pearson Edexcel International Advanced Level

Monday 13 October 2025

Morning (Time: 1 hour 30 minutes)

Paper reference **WCH12/01A**

Chemistry

International Advanced Subsidiary/Advanced Level

UNIT 2: Energetics, Group Chemistry, Halogenoalkanes and Alcohols

Question Paper

You must have:
Scientific calculator, Data Booklet, ruler and Answer Book

Information

- A Periodic Table is printed on the back cover of this paper.

Turn over ▶

P87419A

M:1/1/1/1/1/1/

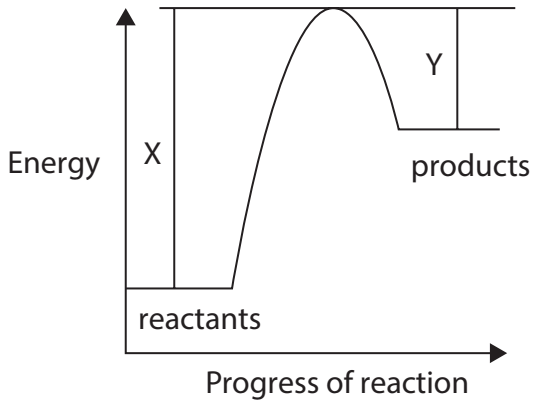
P 8 7 4 1 9 A

Pearson

SECTION A

Answer ALL the questions in this section in the Answer Booklet.

1 The reaction profile diagram 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 Magnesium reacts with hydrochloric acid.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

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 2 = 1 mark)

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

3 Barium chloride solution, $BaCl_2(aq)$, reacts with gallium sulfate solution, $Ga_2(SO_4)_3(aq)$, to form a precipitate of barium sulfate, $BaSO_4(s)$.

What is the **minimum** volume of 0.100 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 3 = 1 mark)

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4 Magnesium nitrate decomposes on heating.

$$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$$

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?

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

A 600 cm^3

B 300 cm^3

C 240 cm^3

D 120 cm^3

(Total for Question 4 = 1 mark)

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5 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 $BeCl_2$

B $Ca(OH)_2$

C $Mg(OH)_2$

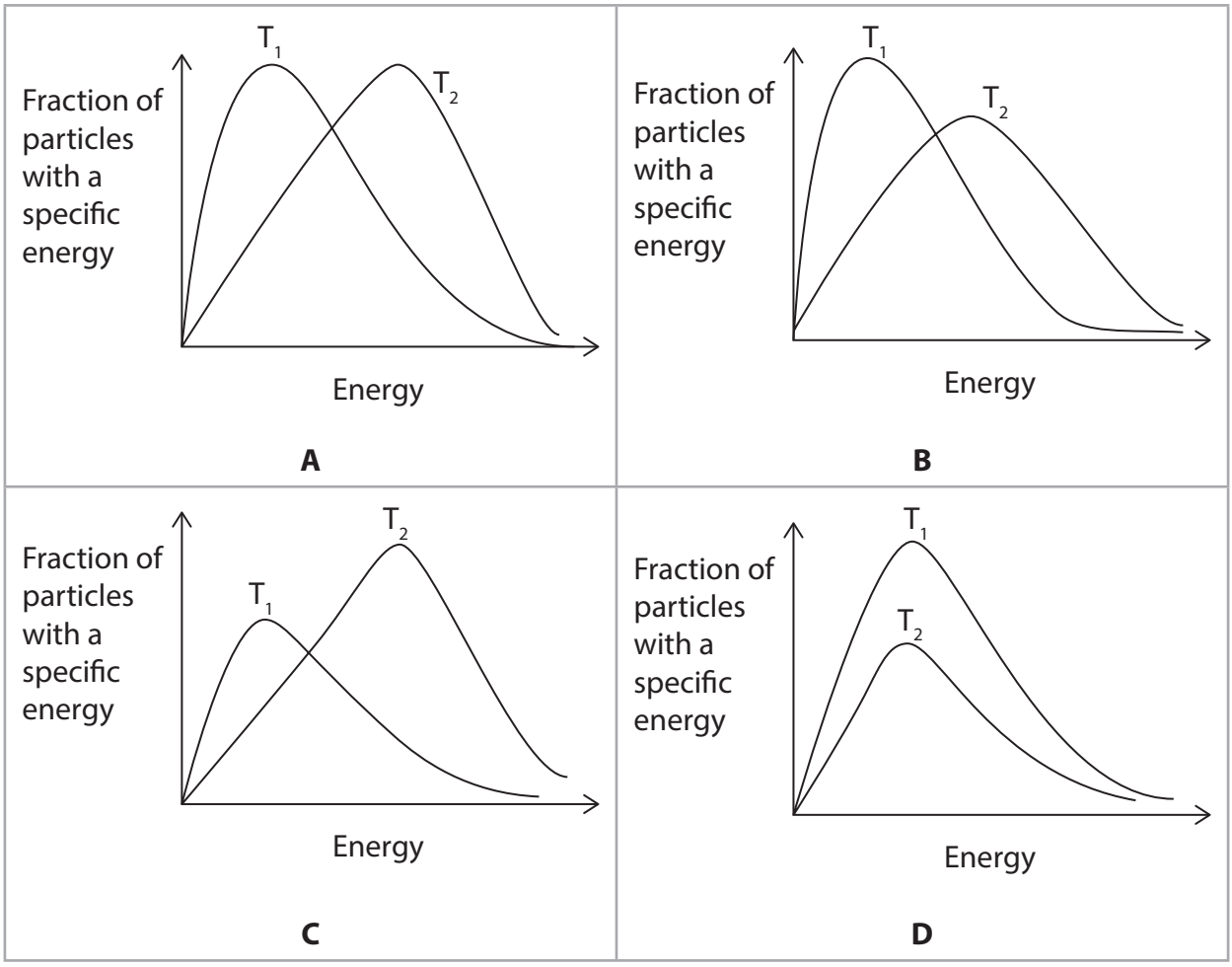
D NH_4Cl

(Total for Question 5 = 1 mark)

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

6 This question is about the Maxwell-Boltzmann energy distribution.

Which is the diagram for an increase in temperature from T_1 to T_2?



(Total for Question 6 = 1 mark)

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

7 The properties of Group 2 compounds change **down** the group from magnesium to barium.

Which statement is correct?

A thermal stability of Group 2 nitrates increases

B thermal stability of Group 2 carbonates decreases

C solubility of Group 2 sulfates increases

D solubility of Group 2 hydroxides increases

(Total for Question 7 = 1 mark)

8 Chlorine is added to 2 cm^3 of a dilute solution of potassium iodide.

The equation for the reaction between chlorine and iodide ions is shown.

$$Cl_2(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2Cl^-(aq)$$

(a) Which statement is correct?

A iodide ions oxidise chlorine

B iodide ions reduce chlorine

C chlorine reduces iodide ions

D chlorine is neither oxidised nor reduced

(b) When the reaction is complete, 10 cm^3 of cyclohexane (density = 0.79 g cm^{-3}) is added. The mixture is shaken and left to settle into two layers.

Which description of one of these layers is correct?

A the upper layer is purple

B the lower layer is purple

C the upper layer is brown

D the lower layer is brown

(Total for Question 8 = 2 marks)

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

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

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

A (0.80 × 15.1) ÷ 60

B 0.80 ÷ (60 x 15.1)

C 60 ÷ (0.80 x 15.1)

D (60 × 15.1) ÷ 0.80

(Total for Question 9 = 1 mark)

10 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?

[Data: 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 10 = 1 mark)

11 Which equation represents the standard enthalpy change of formation, $\Delta_f H^{\ominus}$, of hydrogen iodide?

A $H(g) + I(g) \rightarrow HI(g)$

B $H_2(g) + I_2(g) \rightarrow 2HI(g)$

C $\frac{1}{2}H_2(g) + \frac{1}{2}I_2(g) \rightarrow HI(g)$

D $\frac{1}{2}H_2(g) + \frac{1}{2}I_2(s) \rightarrow HI(g)$

(Total for Question 11 = 1 mark)

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

12 The equation for a reversible reaction is shown.

$$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g) \qquad \Delta H = -88\,kJ\,mol^{-1}$$

What effect will each change have on the rate of reaction and the equilibrium yield of phosphorus(V) chloride?

(a) Increasing the temperature at constant pressure.

	Effect on rate of reaction	Effect on yield of $PCl_5(g)$
A	increase	decrease
B	decrease	decrease
C	increase	increase
D	decrease	increase

(b) Increasing the pressure at constant temperature.

	Effect on rate of reaction	Effect on yield of $PCl_5(g)$
A	increase	decrease
B	decrease	decrease
C	increase	increase
D	decrease	increase

(Total for Question 12 = 2 marks)

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

13 Consider the bond enthalpy values given in the table.

Bond	Bond enthalpy / kJ mol^{-1}
N≡N	+945
H—H	+436
N—H	+391

The equation for the reaction between nitrogen and hydrogen is shown.

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

What is the enthalpy change, in kJ mol^{-1}, for this reaction?

A +1080

B +852

C −93

D −529

(Total for Question 13 = 1 mark)

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14 The enthalpy change of combustion of ethanol was determined by using a spirit burner containing ethanol to heat 250 cm^3 of water in a copper calorimeter. The experimental value obtained was less exothermic than the Data Booklet value.

Which is the **least** likely reason for this difference in the enthalpy values?

A heat loss from the copper calorimeter

B incomplete combustion of the ethanol

C loss of ethanol by evaporation

D use of non-standard conditions

(Total for Question 14 = 1 mark)

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15 What is the most significant factor determining the trend in the rate of hydrolysis of halogenoalkanes?

A the electronegativity of the halogen

B the magnitude of the halogen ionisation energy

C the oxidising ability of the halogen

D the carbon-halogen bond strength

(Total for Question 15 = 1 mark)

16 Propanal, CH_3CH_2CHO, and propanone, CH_3COCH_3, are isomers.

(a) Which *m* / *z* peak would **not** be expected in the mass spectrum of propanone?

(1)

A 15

B 29

C 43

D 58

(b) Propanal and propanone can be distinguished by chemical tests.

Which pair of observations is correct?

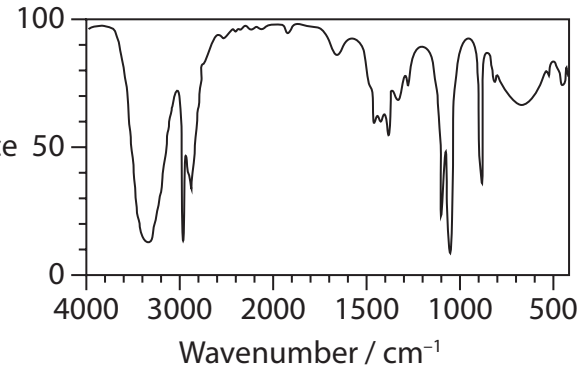
(1)

	Test	Observation with propanal	Observation with propanone
A	warm with Fehling's solution	no change	red precipitate
B	add solid phosphorus(V) chloride	no change	misty fumes
C	warm with acidified potassium dichromate(VI)	turns green	no change
D	add sodium hydrogencarbonate	fizzes	no change

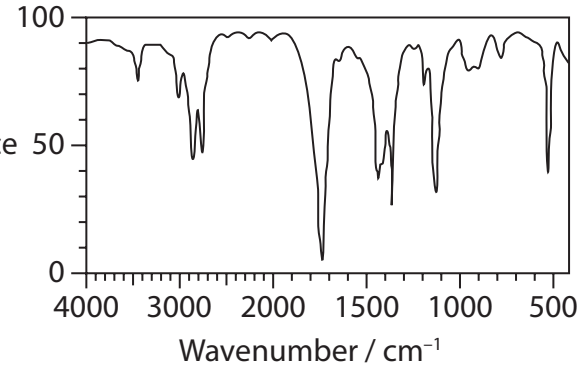
(Total for Question 16 = 2 marks)

17 Which could be the infrared spectrum of $CH_2{=}CHCH_2OH$?

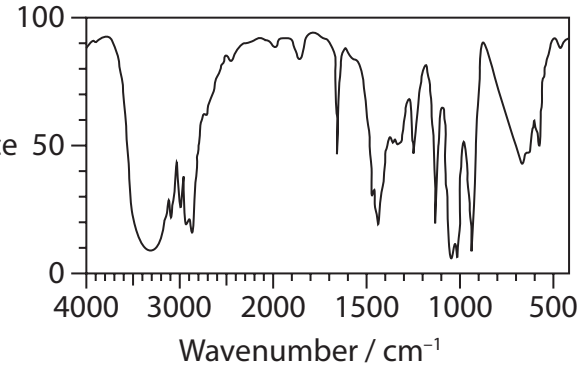
A



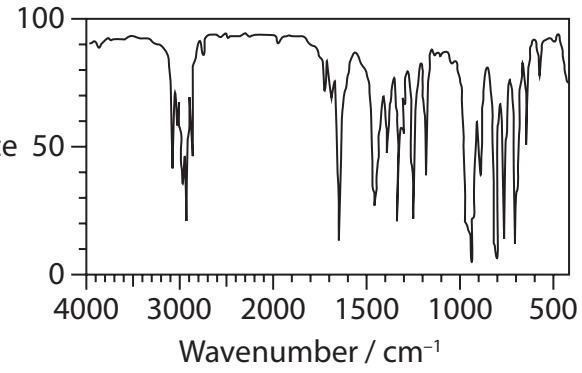
B



C



D



(Total for Question 17 = 1 mark)

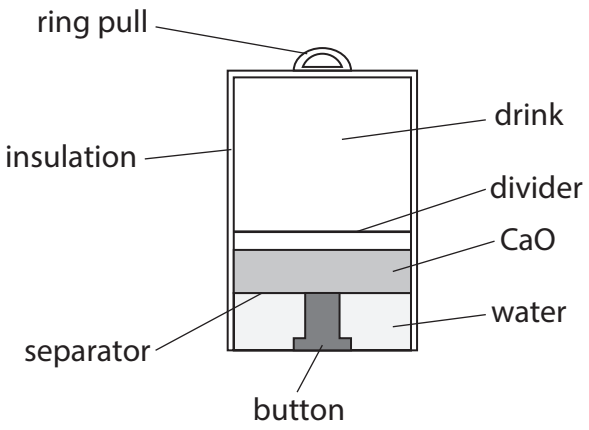
TOTAL FOR SECTION A = 20 MARKS

SECTION B

Answer ALL the questions in the Answer Booklet.

18 Salts have many uses.

(a) The reaction between calcium oxide and water to produce calcium hydroxide solution is exothermic, and is used to warm canned drinks.
A typical arrangement is shown.



The enthalpy change of reaction is $-65.1\ kJ\ mol^{-1}$.

(i) Calculate the mass of calcium oxide that would be required to raise the temperature of 200 cm^3 of drink by 40 °C.

[Data: Assume the specific heat capacity of the solution = $4.18\ J\ g^{-1}\ °C^{-1}$
density of solution = $1.00\ g\ cm^{-3}$]

(3)

(ii) Suggest **two** reasons why the can is insulated.

(2)

(b) Ammonium ethanoate, $CH_3COONH_4(s)$, is used to control the pH of foods. It can be formed by reaction of pure ethanoic acid, $CH_3COOH(l)$, with ammonium carbonate, $(NH_4)_2CO_3(s)$.

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

(5)

Compound	Enthalpy change of formation / kJ mol^{-1}
$CH_3COOH(l)$	−484.5
$(NH_4)_2CO_3(s)$	−939.9
$CH_3COONH_4(s)$	−586.3
$CO_2(g)$	−393.5
$H_2O(l)$	−285.8

(c) Ammonium carbonate, $(NH_4)_2CO_3$, is an ingredient in cleaning solutions for camera lenses.
These are aqueous solutions which contain no more than 3.60 g of ammonium carbonate in 200 cm^3 of solution.

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

(2)

(Total for Question 18 = 12 marks)

19 This is a question about alcohols.

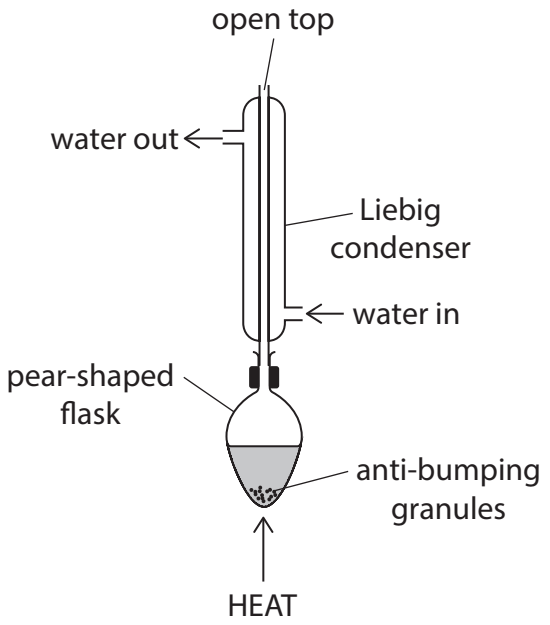
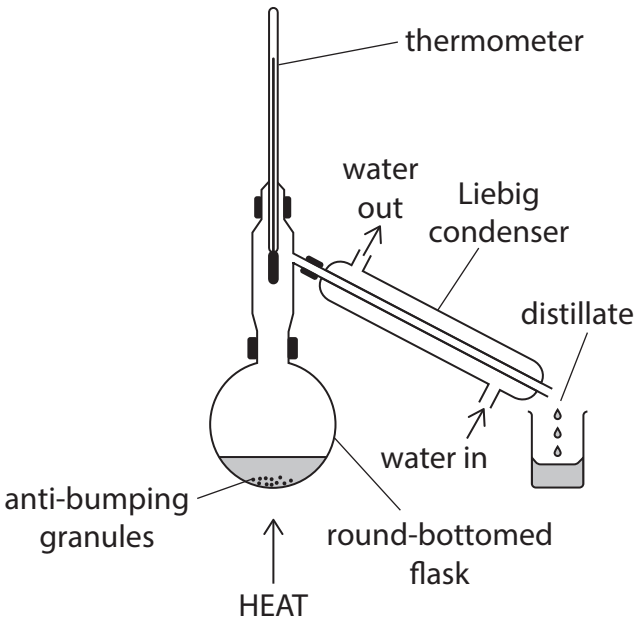
(a) There are two alcohol structural isomers with the molecular formula, C_3H_8O.

Complete the table with the **skeletal** formula of these isomers, their IUPAC names and the classification of the type of alcohol in each case.

(3)

Skeletal formula	Name	Classification

(b) Ethanol can be oxidised by acidified sodium dichromate(VI) to ethanal and then to ethanoic acid. The apparatus may be set up in two ways.

Reflux apparatus	Distillation apparatus
	

(i) Complete the ionic half-equation for the reduction of the dichromate(VI) ions to chromium(III) ions.
State symbols are not required.

(2)

$Cr_2O_7^{2-}$ + ... H^+ + ... → ..... + ...

(ii) Describe how the reflux apparatus ensures that any ethanal initially produced is further oxidised to ethanoic acid.

(1)

(iii) The distillation apparatus effectively separates ethanal from ethanol because of the large difference in boiling temperatures, which is a result of the hydrogen bonding between the molecules in ethanol.

Compound	Boiling temperature / °C
Ethanol, CH_3CH_2OH	79
Ethanal, CH_3CHO	21

Draw a labelled diagram showing a hydrogen bond between two ethanol molecules.
Clearly indicate any relevant dipoles, lone pairs of electrons and relevant bond angles involved.

(3)

(iv) State the reason why hydrogen bonds do **not** form between ethanal molecules.

(1)

(c) Alcohols can be converted into halogenoalkanes.

(i) Write the equation for the reaction between methanol, CH_3OH, and phosphorus(V) chloride, PCl_5.

(1)

(ii) State the observation that would be made from this reaction.

(1)

(d) Alcohols can be produced from the reaction of halogenoalkanes with aqueous alkali.

(i) Draw the mechanism for this reaction with 1-bromopropane.
Include curly arrows, and relevant dipoles and lone pairs.

(3)

(ii) The reaction of 1-bromopropane with concentrated alcoholic alkali forms a different organic product.
Give the name of this type of reaction and the **displayed formula** of the organic product.

(2)

(Total for Question 19 = 17 marks)

20 This question is about trends in the Periodic Table.

*(a) The boiling temperatures of some isoelectronic hydrides are shown.

Hydride	CH_4	NH_3	H_2O	HF
Boiling temperature / °C	–161	–33	100	20

Explain the differences in these boiling temperatures by considering all the intermolecular forces involved.
Detailed descriptions of the intermolecular forces involved are not required.

(6)

(b) Compare and contrast the reactions of concentrated sulfuric acid with solid sodium chloride and with solid sodium bromide.

(4)

(Total for Question 20 = 10 marks)

TOTAL FOR SECTION B = 39 MARKS

SECTION C

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

21 Major volcanic eruptions, such as the one in Indonesia in 1815, eject large amounts of ash and gases into the atmosphere. The gases include carbon dioxide, water vapour, hydrogen chloride and sulfur dioxide.

(a) (i) Complete the dot-and-cross diagram to show a possible arrangement of the outer shell electrons in a molecule of sulfur dioxide.
Use dots (●) for the sulfur electrons and crosses (✖) for the oxygen electrons.

(2)

(ii) Suggest a value for the bond angle.

(1)

(b) The levels of sulfur dioxide in the atmosphere can be measured by collection and titration with sodium hydroxide solution.

One possible method is:

- air containing sulfur dioxide is bubbled through hydrogen peroxide solution
- all the sulfur dioxide reacts to form 40.0 cm^3 of dilute sulfuric acid, solution **Z**

$$SO_2(g) + H_2O_2(aq) \rightarrow H_2SO_4(aq)$$

- a pipette is used to remove 10.0 cm^3 portions of solution **Z**
- each portion is titrated with 0.00400 mol dm^{-3} sodium hydroxide

The results are shown in the table.

Titration	1	2	3
Final volume / cm^3	22.55	44.70	22.05
Initial volume / cm^3	0.00	22.55	0.00
Titre / cm^3	22.55	22.15	22.05

The mean titre is 22.10 cm^3.

(i) Give a reason why a further titration was not carried out.

(1)

(ii) Calculate the number of moles of sulfuric acid in the 40.0 cm^3 of solution **Z**.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

(3)

(iii) Deduce the number of moles of sulfur dioxide bubbled through the hydrogen peroxide solution, using your answer from (b)(ii) and the equation shown.

$$SO_2(g) + H_2O_2(aq) \rightarrow H_2SO_4(aq)$$

(1)

(iv) The air containing sulfur dioxide was bubbled through the hydrogen peroxide solution at a rate of 15 $dm^3\,min^{-1}$ for 20 minutes.

Calculate the concentration of sulfur dioxide in the air in parts per million (ppm) by volume.

[Data: Molar volume of a gas at room temperature and pressure = 24 $dm^3\,mol^{-1}$]

(3)

(c) (i) During a volcanic eruption, hydrogen chloride gas is also released into the upper atmosphere. This produces some chlorine free radicals that react with ozone as shown.

$$Cl\bullet + O_3 \rightarrow ClO\bullet + O_2$$

$$ClO\bullet + O_3 \rightarrow Cl\bullet + 2O_2$$

Deduce the overall equation for this reaction of ozone.
State symbols are not required.

(1)

(ii) Give two reasons why the presence of a small number of chlorine free radicals in the upper atmosphere causes a large decrease in the amount of ozone.

(2)

(d) (i) Sulfur dioxide is converted into sulfur trioxide in the upper atmosphere in the presence of ultraviolet radiation.

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

Show, by use of all the relevant oxidation numbers, that this is a redox reaction.

(2)

(ii) Sulfur trioxide reacts with water to form sulfuric acid.

$$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq) \qquad \Delta_r H = -200\,kJ\,mol^{-1}$$

Draw an enthalpy level diagram to show the enthalpy change for this reaction.

(2)

(iii) Droplets of sulfuric acid are formed when sulfur trioxide reacts with water in the upper atmosphere. These droplets reflect ultraviolet radiation from the Sun back into space.

In the volcanic eruption in Indonesia in 1815, large amounts of both carbon dioxide and sulfur dioxide were released.
During the following year, there were global low temperatures.

Explain the relative effect of both gases on global temperatures after the volcanic eruption.

(3)

(Total for Question 21 = 21 marks)

TOTAL FOR SECTION C = 21 MARKS
TOTAL FOR PAPER = 80 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									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							

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

* Lanthanide series

* Actinide 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
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

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Monday 13 October 2025

Morning (Time: 1 hour 30 minutes)

Paper reference **WCH12/01A**

Chemistry

International Advanced Subsidiary/Advanced Level

UNIT 2: Energetics, Group Chemistry, Halogenoalkanes and Alcohols

Answer Booklet

You must have:
Scientific calculator, Data Booklet, ruler and Question paper

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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.*
- 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.
- Show all your working in calculations and include units where appropriate.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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M:1/1/1/1/

P 8 7 4 7 5 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

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 1 = 1 mark)

2

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 2 = 1 mark)

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

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

3

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

Total for Question 3 = 1 mark)

4

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

Total for Question 4 = 1 mark)

5

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 5 = 1 mark)

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

6

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 6 = 1 mark)

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

7

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 7 = 1 mark)

8 (a)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(b)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 8 = 2 marks)

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

9

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 9 = 1 mark)

10

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 10 = 1 mark)

11

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 11 = 1 mark)

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

12 (a)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(b)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 12 = 2 marks)

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

13

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 13 = 1 mark)

14

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 14 = 1 mark)

15

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 15 = 1 mark)

16 (a)

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(b)

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 16 = 2 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

17

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 17 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

18 (a) (i)

(3)

(ii)

(2)

.....

.....

.....

.....

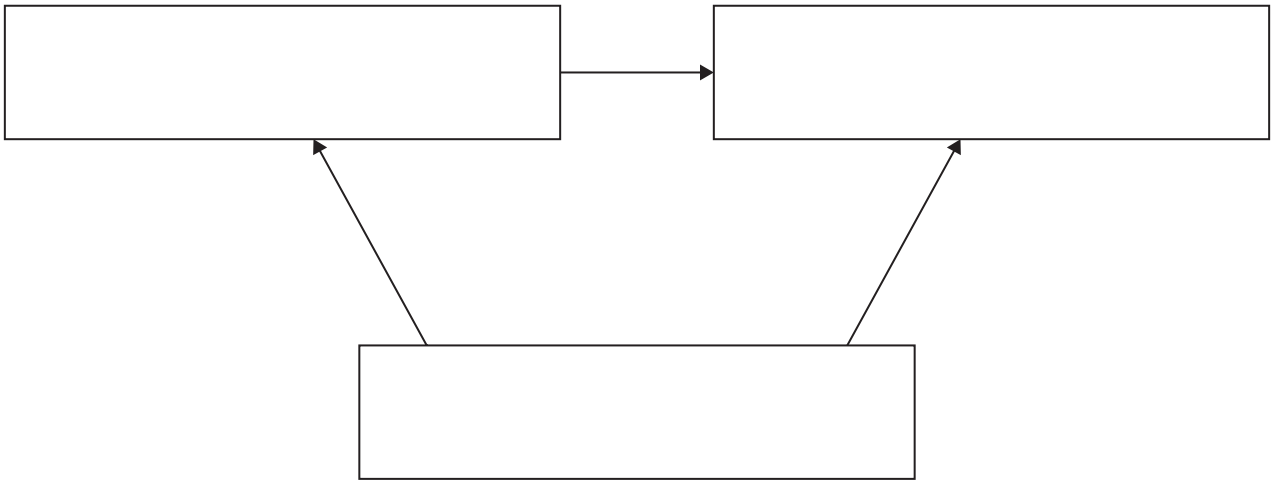
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(b)

(5)



(c)

(2)

(Total for Question 18 = 12 marks)

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DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

19 (a)

(3)

Skeletal formula	Name	Classification

(b) (i)

(2)

+ ..... H^+ + ... → ..... + ...

(ii)

(1)

.....

.....

.....

(iii)

(3)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(iv)

(1)

.....

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.....

.....

(c)

(i)

(1)

(ii)

(1)

.....

(d) (i)

(3)

(ii)

(2)

Name of type of reaction .....

.....

(Total for Question 19 = 17 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

20

*(a)

(6)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 20(a) continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(b)

(4)

(Total for Question 20 = 10 marks)

TOTAL FOR SECTION B = 39 MARKS

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DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

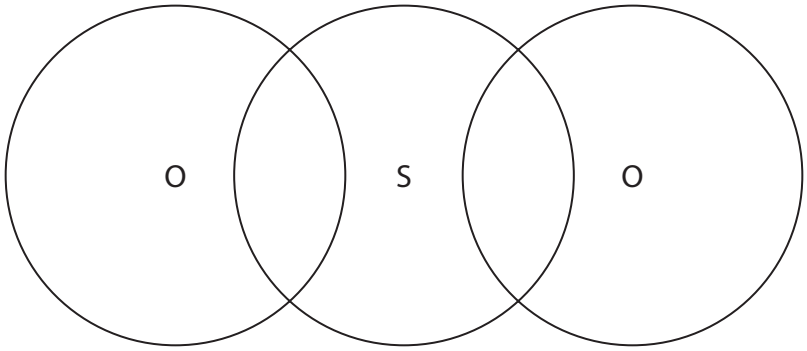
SECTION C

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

21

(a) (i)

(2)



(ii)

(1)

(b)

(i)

(1)

.....

.....

(ii)

(3)

(iii)

(1)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(iv)

(3)

(c) (i)

(1)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(ii)

(2)

(d) (i)

(2)

(ii)

(2)

(iii)

(3)

.....

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(Total for Question 21 = 21 marks)

TOTAL FOR SECTION C = 21 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)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									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							

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

* Lanthanide series

* Actinide 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
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