Pearson Edexcel International Advanced Level

Wednesday 22 October 2025

Afternoon (Time: 1 hour 45 minutes)

Paper reference **WCH14/01A**

Chemistry

International Advanced Level

UNIT 4: Rates, Equilibria and Further Organic Chemistry
Question Paper

You must have:
Scientific calculator, Data Booklet, ruler
Answer Booklet (sent separately)

Correction to Answer Book

Question 19e is worth 3 marks **NOT** 2 marks.

Question 19 and Section C are worth a total of 21 marks.

Turn over ▶

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M:1/1/1/1/

P 8 7 4 2 1 A

Pearson

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 Which **continuous** monitoring method could be used to obtain rate data for the reaction shown?

$$C_4H_9Cl(l) + H_2O(l) \rightarrow C_4H_9OH(aq) + H^+(aq) + Cl^-(aq)$$

A colorimetry

B electrical conductivity

C mass change

D titration with alkali

(Total for Question 1 = 1 mark)

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2 The decomposition of ammonia is catalysed by tungsten metal.

$$2NH_3(g) \xrightarrow{\text{tungsten}} N_2(g) + 3H_2(g)$$

This reaction has zero order kinetics.

(a) What is the rate equation for this reaction?

(1)

A rate = k

B rate = $k[NH_3]$

C rate = $k[NH_3]^2$

D rate = $k[N_2][H_2]^3$

(b) What are the units of the rate constant, k, for this zero order reaction?

(1)

A no units

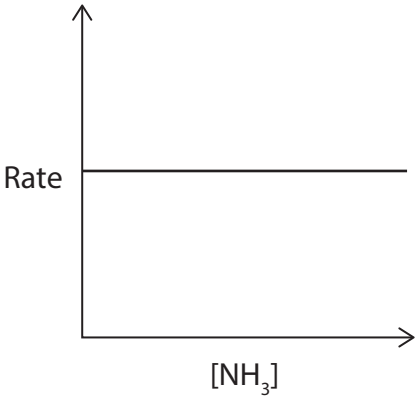
B s^{-1}

C $mol\,dm^{-3}\,s^{-1}$

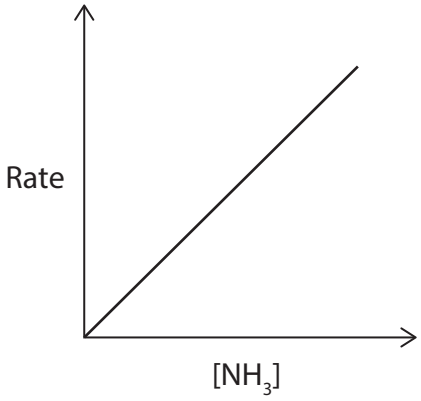
D $dm^3\,mol^{-1}\,s^{-1}$

(c) Which of these graphs represents this zero order reaction?

(1)



A



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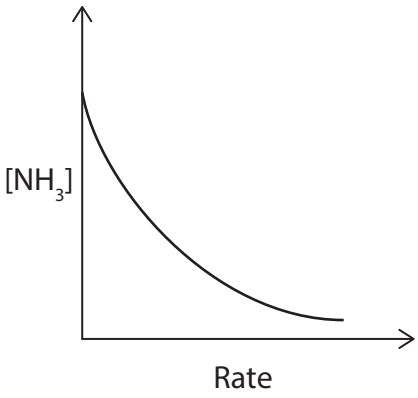
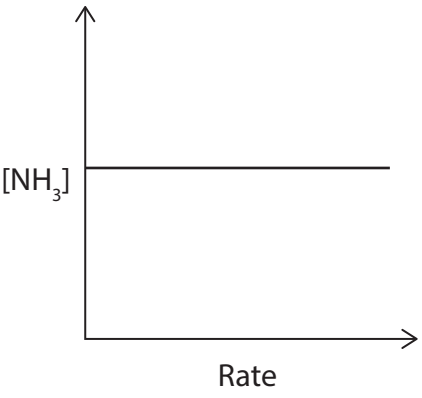


C



D

(Total for Question 2 = 3 marks)

3 The halogenoalkane 2-bromo-2-methylbutane was hydrolysed with sodium hydroxide solution, NaOH(aq).

Which suggestion about the mechanism of this reaction is correct?

	Type of mechanism	Number of steps in mechanism
A	S_N2	one
B	S_N2	two
C	S_N1	one
D	S_N1	two

(Total for Question 3 = 1 mark)

4 The water gas reaction is used in the manufacture of hydrogen.

$$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g) \qquad \Delta H^{\ominus} = +131.2\,kJ\,mol^{-1}$$

What is the equilibrium constant, K_c, expression for this reaction?

A $K_c = [CO][H_2]$

B $K_c = \dfrac{[CO][H_2]}{[C]}$

C $K_c = \dfrac{[CO][H_2]}{[H_2O]}$

D $K_c = \dfrac{[CO][H_2]}{[H_2O][C]}$

(Total for Question 4 = 1 mark)

5 When ethanoic acid and chloroethanoic acid are mixed, an equilibrium is set up.

$$CH_3COOH + CH_2ClCOOH \rightleftharpoons CH_3COOH_2^+ + CH_2ClCOO^-$$

The Brønsted-Lowry acids in this equilibrium are

A CH_3COOH and $CH_2ClCOOH$

B CH_3COOH and $CH_3COOH_2^+$

C $CH_2ClCOOH$ and $CH_3COOH_2^+$

D $CH_3COOH_2^+$ and CH_2ClCOO^-

(Total for Question 5 = 1 mark)

6 What is the pH of a 0.05 mol dm^{-3} solution of barium hydroxide?

A 13.3

B 13.0

C 12.7

D 12.4

(Total for Question 6 = 1 mark)

7 What is the pH of a solution containing 0.100 mol dm^{-3} CH_3COOH and 0.200 mol dm^{-3} CH_3COONa?

[Data: pK_a CH_3COOH = 4.76]

A 5.06

B 4.76

C 4.46

D 2.88

(Total for Question 7 = 1 mark)

8 Which of these indicators is **most** suitable for the titration of ammonia solution with hydrochloric acid?

A methyl violet (pK_{in} = 0.8)

B bromocresol green (pK_{in} = 4.7)

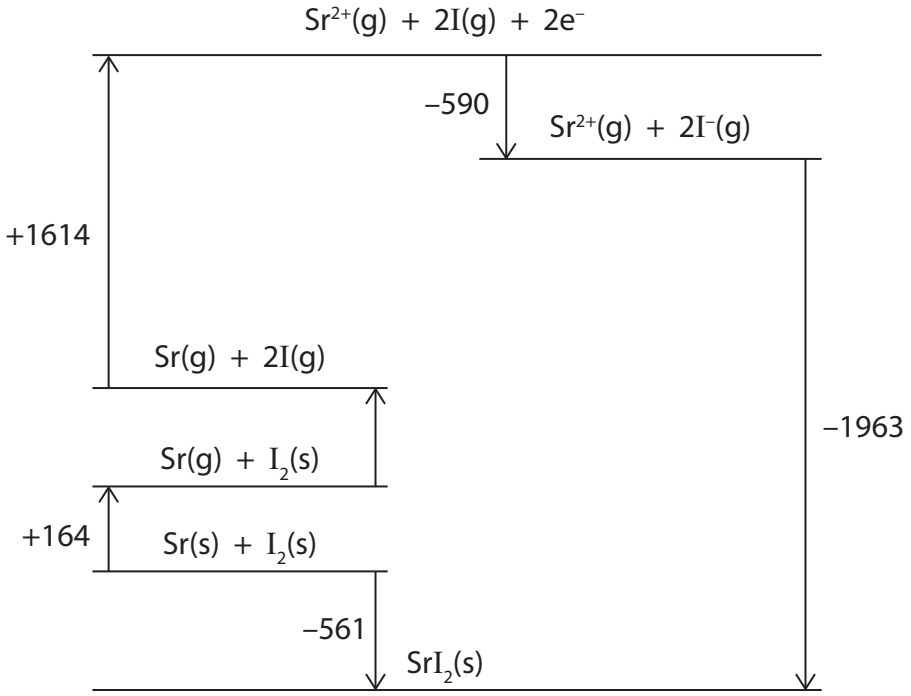
C thymol blue (pK_{in} = 8.9)

D alizarin yellow (pK_{in} = 12.5)

(Total for Question 8 = 1 mark)

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

9 The Born-Haber cycle for strontium iodide, SrI_2, is shown.
All values are in kJ mol^{-1}. The cycle is not to scale.



(a) Which of the following statements is **not** true?

(1)

A the lattice energy of strontium iodide is exothermic

B the first electron affinity of iodine is −295 kJ mol^{-1}

C the second ionisation energy of strontium is +1614 kJ mol^{-1}

D the standard enthalpy change of atomisation of strontium is +164 kJ mol^{-1}

(b) Using the Born-Haber cycle, it can be calculated that the standard atomisation of iodine, in kJ mol^{-1}, is

(1)

A +542

B +271

C +214

D +107

(Total for Question 9 = 2 marks)

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

10 This question is about chromatography.

(a) In gas chromatography, the time taken for the substance to travel from the input to the detector is called the

(1)

A reference time

B retention time

C separation time

D travelling time

(b) Which of the following would be the most suitable carrier gas in gas chromatography?

(1)

A argon

B hydrogen

C methane

D oxygen

(c) A spot caused by an amino acid has moved 52 mm from the baseline of a paper chromatogram.
The R_f value for the amino acid under these conditions is 0.62.

What is the distance moved by the solvent?

(1)

A 840 mm

B 84 mm

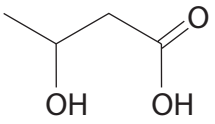
C 52 mm

D 32 mm

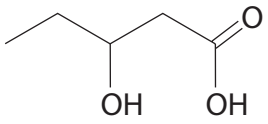
(Total for Question 10 = 3 marks)

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

11 The substance known as PHBV is a biodegradable polymer formed from 3-hydroxybutanoic acid and 3-hydroxypentanoic acid.



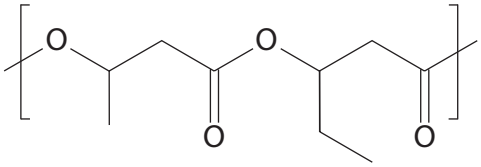
3-hydroxybutanoic acid



3-hydroxypentanoic acid

Which of these is the repeat unit of the polymer?

A



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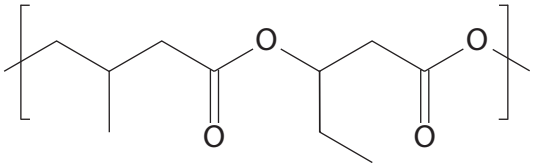

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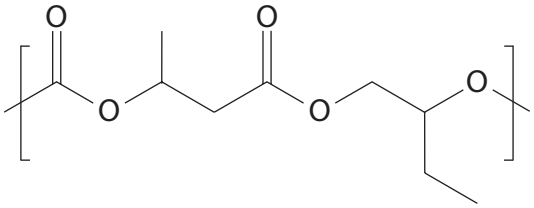
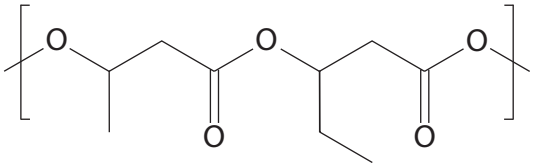


D



(Total for Question 11 = 1 mark)

12 Which reagent reacts at room temperature with methylamine, CH_3NH_2, to form the compound N-methylethanamide?

A CH_3COCH_3

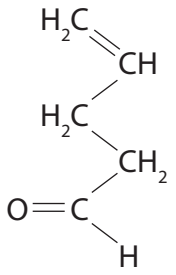
B CH_3COOH

C CH_3COOCH_3

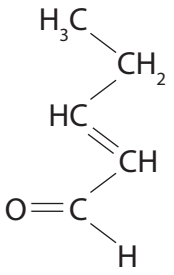
D CH_3COCl

(Total for Question 12 = 1 mark)

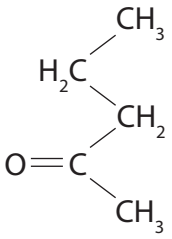
13 This question refers to the following molecules, all of which have a carbonyl group.



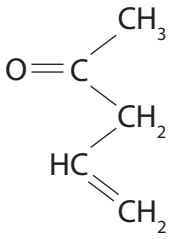
W



X



Y



Z

(a) A pale yellow precipitate is formed when iodine in alkali reacts with

(1)

A **W** and **X** only

B **Y** only

C **Y** and **Z** only

D **Z** only

(b) A brick red precipitate is formed on warming blue Benedict's or Fehling's solution with

(1)

A **W** only

B **X** only

C **W** and **X** only

D **Y** and **Z** only

(c) A mass spectrum fragment with a *m* / *z* value of 29 would be expected for

(1)

A **W** and **X** only

B **X** and **Y** only

C **Y** and **Z** only

D **W**, **X** and **Y** only

(Total for Question 13 = 3 marks)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

14 Ethanol may be produced by the hydration of ethene.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H = -45.3\ kJ\ mol^{-1}$$

(a) In a laboratory investigation of this reaction, 1.00 mol of ethene was mixed with 1.00 mol of steam at 160 °C. At equilibrium, when the total pressure of the steam was 50.0 atm, 0.430 mol of ethanol had formed.

(i) Give the expression for the equilibrium constant, K_p, for the reaction.

(1)

(ii) Calculate the equilibrium constant, K_p, for the hydration of ethene at 160 °C.
Include units in your answer.
You **must** show your working.

(5)

(b) The manufacture of ethanol is carried out at 230 °C and 70 atm, with an overall conversion into ethanol of 95%.

Comment on these conditions in relation to their effect on the equilibrium and the overall yield of ethanol.

(3)

(Total for Question 14 = 9 marks)

15 Butanedione, $CH_3COCOCH_3$, has two carbonyl groups. It is a volatile yellow-green liquid and its colour is due to electron delocalisation.

Butanedione can be reduced to butane-2,3-diol, which does not have this electron delocalisation.

(a) Complete the equation in the Answer Book for this reduction of butanedione.

(2)

(b) Suggest what you would see when this reaction occurs.

(1)

(c) A mixture of butanedione and butane-2,3-diol can be separated by distillation.

Explain which compound has the higher boiling temperature.

(2)

(d) Butane-2,3-diol shows a type of stereoisomerism that butanedione does not.

Explain this type of stereoisomerism shown.

(2)

(e) Butane-2,3-diol can be esterified using propanoyl chloride or propanoic acid.

(i) Identify three differences in the esterification reaction when propanoyl chloride is used instead of propanoic acid.

(3)

(ii) Draw the **skeletal** formula of the ester produced when butane-2,3-diol reacts with **excess** propanoic acid.

(2)

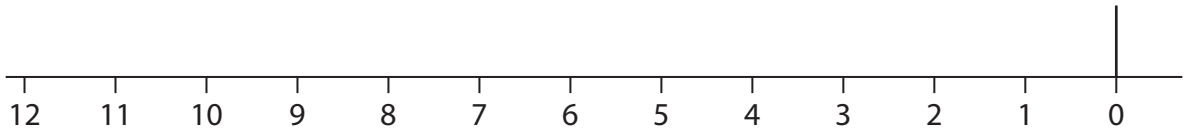
(f) Give **two** differences between the infrared spectra of butanedione and butane-2,3-diol. Include wavenumbers and the bonds responsible. Use your Data Booklet.

(2)

(g) Complete both the high resolution ^{1}H spectrum **and** the ^{13}C NMR spectrum for butanedione.
Include the relevant hydrogen atoms and carbon atoms responsible for the peaks.
Use your Data Booklet.

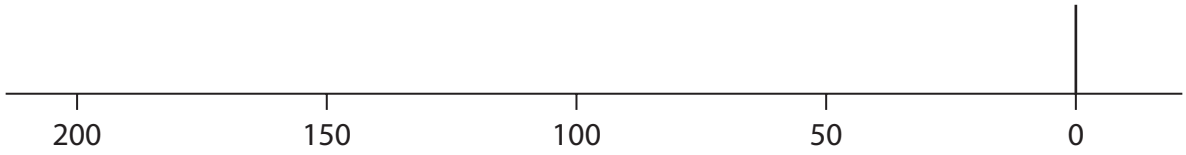
(3)

^{1}H spectrum



Chemical shift, δ / ppm

^{13}C spectrum



Chemical shift, δ / ppm

(Total for Question 15 = 17 marks)

***16** The table shows the theoretical and experimental (Born-Haber) lattice energy data for two metal halide compounds, potassium chloride and calcium iodide.

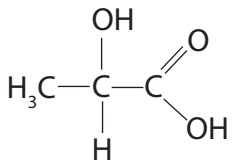
	Lattice energy / kJ mol^{-1}	
Metal halide	Theoretical	Experimental (Born-Haber)
Potassium chloride	−702	−711
Calcium iodide	−1905	−2074

Using the data, compare and contrast the type and strength of bonding in these compounds.
Include reasons for your answers.

(6)

(Total for Question 16 = 6 marks)

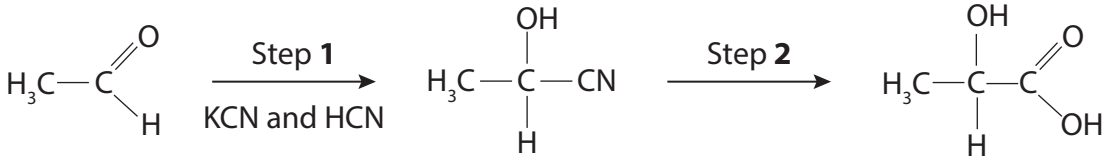
17 Lactic acid has the structure shown.



(a) Give the IUPAC name of lactic acid.

(1)

(b) Lactic acid can be synthesised from ethanal in two steps.



(i) Draw the mechanism for Step **1**.
Include curly arrows and relevant lone pairs and dipoles.

(4)

(ii) State the reaction type for Step **2**.

(1)

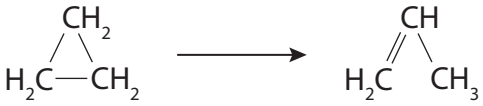
(c) Sodium hydrogencarbonate, $NaHCO_3$, has been used to prevent lactic acid causing muscle pain during exercise.

Write an equation for the reaction between sodium hydrogencarbonate and lactic acid.

(1)

(Total for Question 17 = 7 marks)

18 The rate constant for the reaction to convert cyclopropane to propene was determined at five different temperatures.



The results are shown in the table.

Temperature, T / K	$1 \div T$ / K^{-1}	Rate constant, k / s^{-1}	ln k
714	1.40×10^{-3}	1.67×10^{-5}	−11.00
746	1.34×10^{-3}	1.23×10^{-4}	−9.00
791		1.66×10^{-3}	−6.40
833	1.20×10^{-3}	1.23×10^{-2}	
893	1.12×10^{-3}	1.65×10^{-1}	−1.80

(a) (i) Complete the table.

(1)

(ii) Plot a graph of ln k against $1 \div T$.

(3)

(iii) Determine the activation energy, E_a, in kJ mol^{-1} using your graph.

You should include the value and units of the gradient of the line.

The Arrhenius equation is

$$\ln k = -\frac{E_a}{R} \times \frac{1}{T} + \text{constant}$$

(3)

(b) Explain the trend in the value of the rate constant k as the temperature increases.

(3)

(Total for Question 18 = 10 marks)

TOTAL FOR SECTION B = 49 MARKS

SECTION C

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

19 Endothermic changes can be thermodynamically feasible.

(a) One example of an endothermic reaction is between the solids hydrated barium hydroxide and ammonium chloride.
The equation for this reaction is shown.

$$Ba(OH)_2{\bullet}8H_2O(s) + 2NH_4Cl(s) \rightarrow BaCl_2(s) + 10H_2O(l) + 2NH_3(g)$$

(i) Suggest **two** experimental observations that you would expect to make when carrying out this reaction without additional chemical tests.

(2)

(ii) Predict the sign of the standard entropy change of the system ($\Delta S^{\ominus}_{system}$) for this reaction. Justify your choice with **two** reasons.

(2)

(b) Another example of a reaction between two solids involves anhydrous barium hydroxide and ammonium nitrate.
The equation for this reaction is shown.

$$Ba(OH)_2(s) + 2NH_4NO_3(s) \rightarrow Ba(NO_3)_2(s) + 2H_2O(l) + 2NH_3(g)$$

Compound	Standard molar entropy, $S^{\ominus}$ / $J\,K^{-1}\,mol^{-1}$	Standard enthalpy change of formation, $\Delta_f H^{\ominus}$ / $kJ\,mol^{-1}$
$Ba(OH)_2(s)$	99.7	−944.7
$NH_4NO_3(s)$	151.1	−365.6
$Ba(NO_3)_2(s)$	213.8	−992.1
$H_2O(l)$	69.9	−285.8
$NH_3(g)$	192.3	−46.1

(i) Calculate the standard molar entropy change of the system, $\Delta S^{\ominus}_{system}$, for this reaction at 298 K.
Use the data in the table.

(3)

(ii) Calculate the standard molar enthalpy change of this reaction at 298 K.

(2)

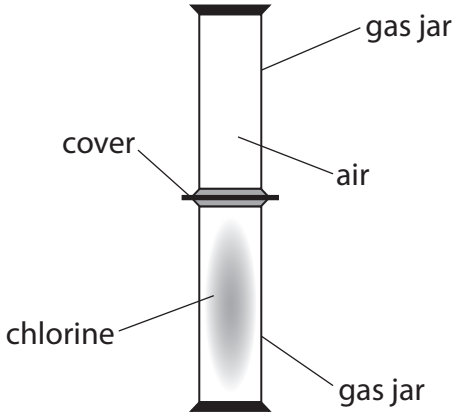
(iii) Calculate the total entropy change for this reaction, $\Delta S^{\ominus}_{total}$, at 298 K using your answers to (b)(i) and (b)(ii).
Include a sign and units in your answer.

(3)

(c) The feasibility of chemical changes can be related to entropy in terms of the dispersal of molecules and of energy quanta between molecules.

(i) Explain, in terms of entropy, what happens to the chlorine gas when the cover between the gas jars is removed.

(2)



(ii) Complete the table to show the five different ways that **four** energy quanta can be shared between two molecules.

(1)

Molecule A	Molecule B
2	2
3	1

(d) Draw a sketch of entropy against temperature for water to illustrate the changes in entropy as the temperature changes.
On your sketch indicate where water changes state.

A scale is not required for the vertical axis.

(3)

(e) Explain why the entropy change of the system increases when sodium chloride dissolves.

(3)

(Total for Question 19 = 21 marks)

TOTAL FOR SECTION C = 21 MARKS
TOTAL FOR PAPER = 90 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										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

Wednesday 22 October 2025

Afternoon (Time: 1 hour 45 minutes)

Paper reference **WCH14/01A**

Chemistry

International Advanced Level

UNIT 4: Rates, Equilibria and Further Organic Chemistry

Answer Book

You must have:
Question paper (sent separately), Scientific calculator, Data Booklet, ruler

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 90.
- 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 ▶

P87482A

M:1/1/

P 8 7 4 8 2 A 0 1 2 4

Pearson

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)

(1)

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

(b)

(1)

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

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c)

(1)

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

(Total for Question 2 = 3 marks)

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)

6

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

(Total for Question 6 = 1 mark)

7

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

(Total for Question 7 = 1 mark)

8

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

(Total for Question 8 = 1 mark)

9

(a)

(1)

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

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(b)

(1)

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

(Total for Question 9 = 2 marks)

10

(a)

(1)

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

(b)

(1)

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

(c)

(1)

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

(Total for Question 10 = 3 marks)

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

11

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

(Total for Question 11 = 1 mark)

12

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

(Total for Question 12 = 1 mark)

13

(a)

(1)

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

(b)

(1)

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

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c)

(1)

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

(Total for Question 13 = 3 marks)

TOTAL FOR SECTION A = 20 MARKS

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

SECTION B

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

14

(a)

(i)

(1)

(ii)

(5)

(b)

(3)

(Total for Question 14 = 9 marks)

15

(a)

(2)

$CH_3COCOCH_3$ + …….[H] →

(b)

(1)

(c)

(2)

(d)

(2)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(e)

(i)

(3)

(ii)

(2)

(f)

(2)

.....

.....

.....

.....

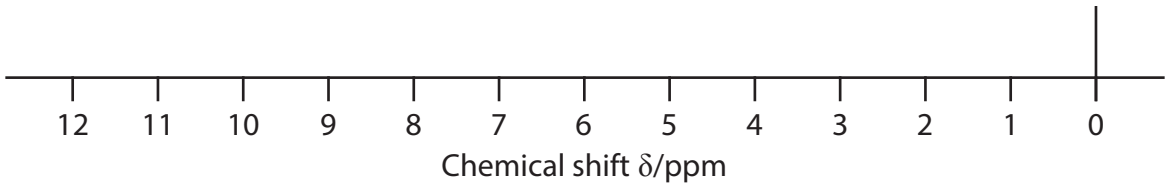
.....

.....

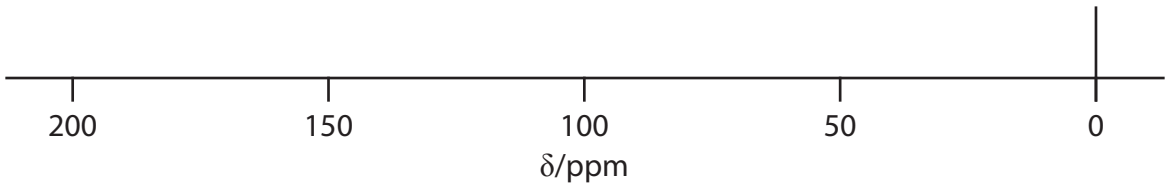
(g)

(3)

^{1}H spectrum



^{13}C spectrum



(Total for Question 15 = 17 marks)

***16**

(6)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(Total for Question 16 = 6 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

17

(a)

(1)

(b)

(i)

(4)

(ii)

(1)

(c)

(1)

(Total for Question 17 = 7 marks)

18

(a)

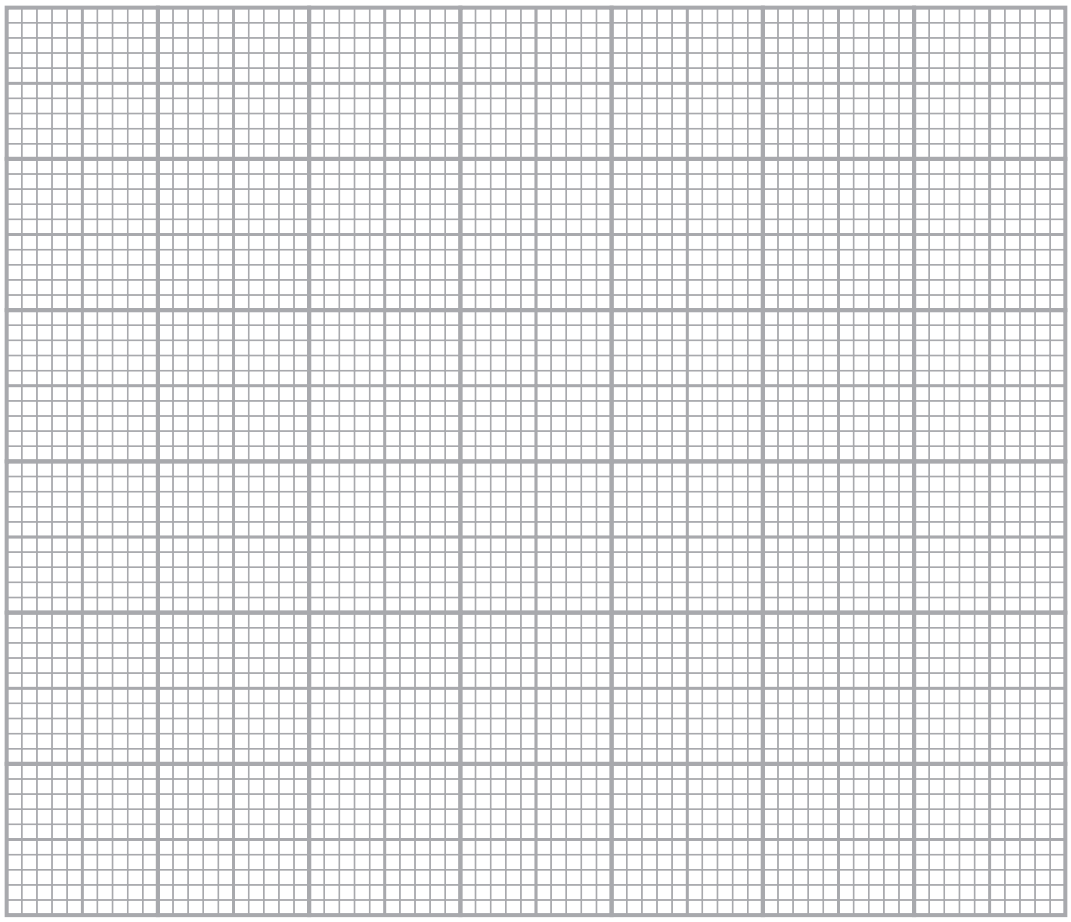
(i)

(1)

	_____		
			_____

(ii)

(3)



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(iii)

(3)

(b)

(3)

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(Total for Question 18 = 10 marks)

TOTAL FOR SECTION B = 49 MARKS

DO NOT WRITE IN THIS AREA

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.

19

(a)

(i)

(2)

(ii)

(2)

(b)

(i)

(3)

(ii)

(2)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(iii)

(3)

(c)

(i)

(2)

(ii)

(1)

2	2
3	1

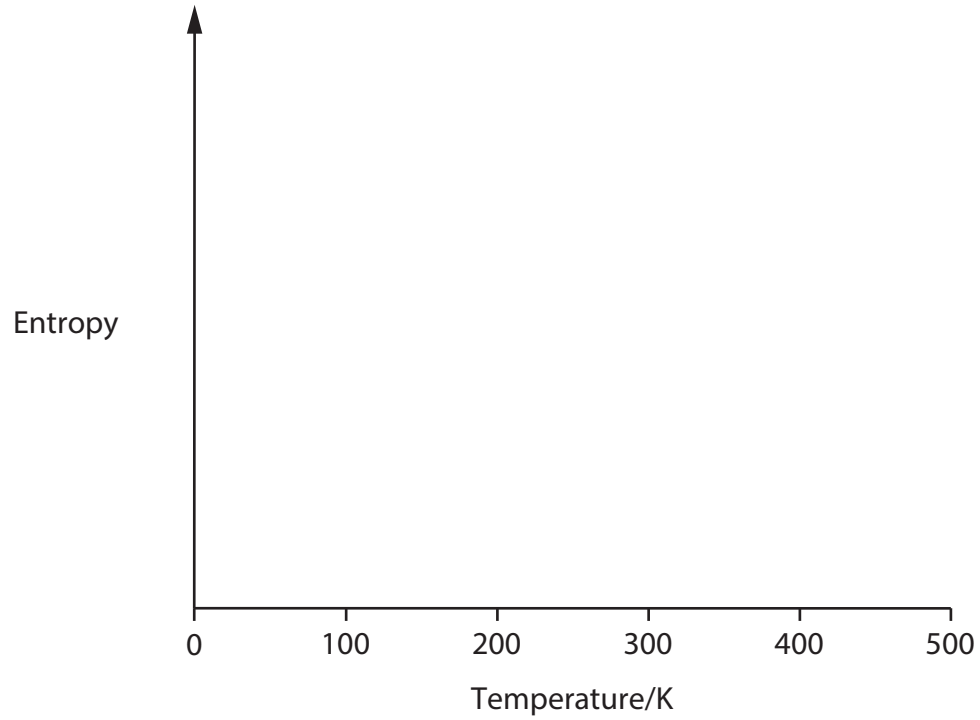
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(d)

(3)



(e)

(2)

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(Total for Question 19 = 21 marks)

TOTAL FOR SECTION C = 20 MARKS
TOTAL FOR PAPER = 90 MARKS

BLANK PAGE

BLANK PAGE

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
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