

Pearson Edexcel International Advanced Level

Thursday 15 January 2026

Afternoon (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:

Answer Book (sent separately)

Scientific calculator, Data Booklet, ruler

Turn over ►

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SECTION A

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

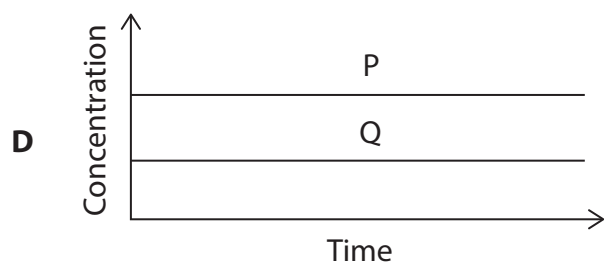
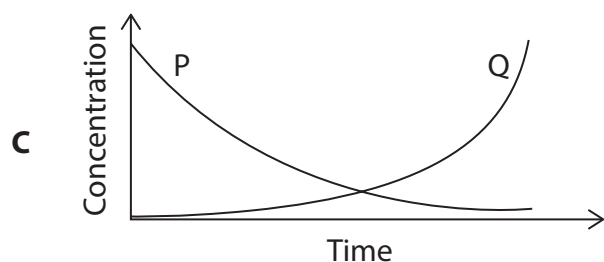
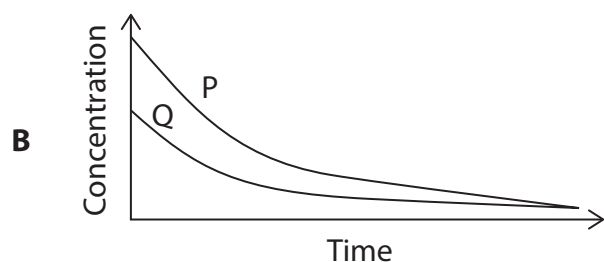
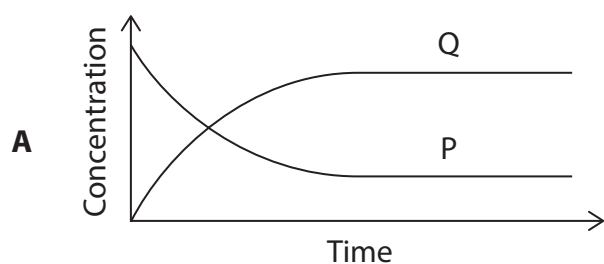
You should aim to spend no more than 20 minutes on this section.

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

- 1 A large amount of P is added to a small amount of Q. A reversible reaction occurs in which P reacts to form Q.



Which graph shows how the concentrations of P and Q change as the reaction reaches equilibrium?



(Total for Question 1 = 1 mark)

2 Which statement regarding a chemical reaction at equilibrium is **always** true?

- A The rates of the forward and backward reactions are equal
- B The concentrations of reactants and products are equal
- C The forward and backward reactions have stopped
- D The addition of a catalyst changes the position of equilibrium

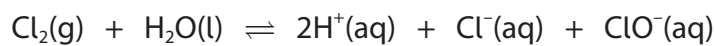
(Total for Question 2 = 1 mark)

3 Which equilibrium shifts to the right-hand side when the pressure in the system **decreases** at constant temperature?

- A $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
- B $\text{F}_2(\text{g}) + \text{H}_2(\text{g}) \rightleftharpoons 2\text{HF}(\text{g})$
- C $\text{C}_6\text{H}_6(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons \text{C}_6\text{H}_{12}(\text{g})$
- D $2\text{NOCl}(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) + \text{Cl}_2(\text{g})$

(Total for Question 3 = 1 mark)

4 The chlorate(I) ion, $\text{ClO}^-(\text{aq})$, is formed when chlorine gas dissolves in water.



The concentration of chlorate(I) ions could be increased by the addition of

- A solid potassium hydroxide
- B concentrated hydrochloric acid
- C solid sodium chloride
- D solid potassium sulfate

(Total for Question 4 = 1 mark)

5 A volume of 50.0cm^3 of a solution of 0.100mol dm^{-3} silver nitrate, $\text{AgNO}_3(\text{aq})$, is reacted completely with excess calcium chloride solution, $\text{CaCl}_2(\text{aq})$.

What is the maximum mass of precipitate, in g, that can form?

- A 0.410
- B 0.717
- C 0.894
- D 1.43

(Total for Question 5 = 1 mark)

6 What is the oxidation number of sulfur in the sulfate ion, SO_4^{2-} ?

- A -2
- B +4
- C +6
- D +8

(Total for Question 6 = 1 mark)

7 Which of these is a disproportionation reaction?

- A $2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$
- B $6\text{NaOH} + 3\text{Br}_2 \rightarrow 5\text{NaBr} + \text{NaBrO}_3 + 3\text{H}_2\text{O}$
- C $2\text{NaOH} + 2\text{Al} + 2\text{H}_2\text{O} \rightarrow 2\text{NaAlO}_2 + 3\text{H}_2$
- D $\text{NaOH} + \text{CO}_2 \rightarrow \text{NaHCO}_3$

(Total for Question 7 = 1 mark)

8 Which reaction is **not** a redox reaction?

- A $4\text{KClO}_3(\text{s}) \rightarrow 3\text{KClO}_4(\text{s}) + \text{KCl}(\text{s})$
- B $2\text{HCl}(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow \text{BaCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$
- C $\text{Zn}(\text{s}) + \text{CuSO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu}(\text{s})$
- D $\text{Cl}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{HCl}(\text{aq}) + \text{HClO}(\text{aq})$

(Total for Question 8 = 1 mark)

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



9 This question is about the reaction shown.



(a) What values of x, y and z are needed to balance the equation?

(1)

	x	y	z
A	5	6	8
B	10	3	4
C	5	3	8
D	10	6	4

(b) What is the reducing agent in the reaction?

(1)

- A H^+
- B $\text{C}_2\text{O}_4^{2-}$
- C MnO_4^-
- D SO_4^{2-}

(Total for Question 9 = 2 marks)

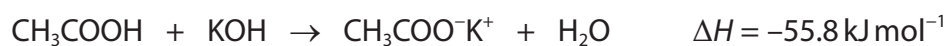
10 Hydrogen peroxide, H_2O_2 , breaks down into water and oxygen.

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

	Hydrogen	Oxygen
A	oxidised	reduced
B	oxidised and reduced	unchanged
C	reduced	oxidised
D	unchanged	oxidised and reduced

(Total for Question 10 = 1 mark)

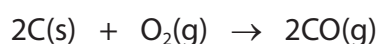
11 Which are correct for the reaction shown?



	Type of reaction	Type of enthalpy change
A	endothermic	formation
B	endothermic	neutralisation
C	exothermic	formation
D	exothermic	neutralisation

(Total for Question 11 = 1 mark)

12 The equation for a reaction is shown.



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 12 = 1 mark)

13 3.00 g of potassium hydrogencarbonate is added to an excess of acid.

The temperature decreases and the energy change is calculated to be 750 J.

What is the enthalpy change per mole of potassium hydrogencarbonate?

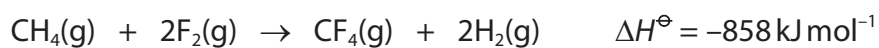
[Data: $M_{\text{r}} \text{KHCO}_3 = 100.1$]

- A $+25\,000 \text{ kJ mol}^{-1}$
- B $+250 \text{ kJ mol}^{-1}$
- C $+25.0 \text{ kJ mol}^{-1}$
- D $+2.50 \text{ kJ mol}^{-1}$

(Total for Question 13 = 1 mark)



14 Use the data shown.

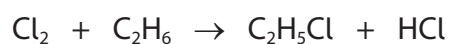


What is the standard enthalpy change of formation of methane, CH_4 , in kJ mol^{-1} ?

- A** -1791
- B** -75
- C** +75
- D** +1791

(Total for Question 14 = 1 mark)

15 Chlorine reacts with ethane to form chloroethane and hydrogen chloride.



Bond	Bond enthalpy / kJ mol^{-1}
C—Cl	346
C—H	413
Cl—Cl	243
H—Cl	432
C—C	347

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

- A** -1434
- B** -122
- C** +122
- D** +1434

(Total for Question 15 = 1 mark)

16 Which equation represents the standard enthalpy change of atomisation of bromine?

- A** $\text{Br}_2(\text{g}) \rightarrow 2\text{Br}(\text{g})$
- B** $\text{Br}_2(\text{l}) \rightarrow 2\text{Br}(\text{g})$
- C** $\frac{1}{2}\text{Br}_2(\text{l}) \rightarrow \text{Br}(\text{g})$
- D** $\frac{1}{2}\text{Br}_2(\text{g}) \rightarrow \text{Br}(\text{g})$

(Total for Question 16 = 1 mark)

17 In an experiment, 25.0 cm^3 of 1.0 mol dm^{-3} $\text{HCl}(\text{aq})$ reacts with 25.0 cm^3 of 1.0 mol dm^{-3} $\text{NaOH}(\text{aq})$.

The energy released = 1375 J .

The specific heat capacity of the mixture is $4.18\text{ J g}^{-1}\text{ }^\circ\text{C}^{-1}$

What temperature change occurs in the reaction?

- A** an increase of 6.6°C
- B** a decrease of 6.6°C
- C** an increase of 13.2°C
- D** a decrease of 13.2°C

(Total for Question 17 = 1 mark)

18 In a mass spectrum, the molecular ion is the ion which always has the

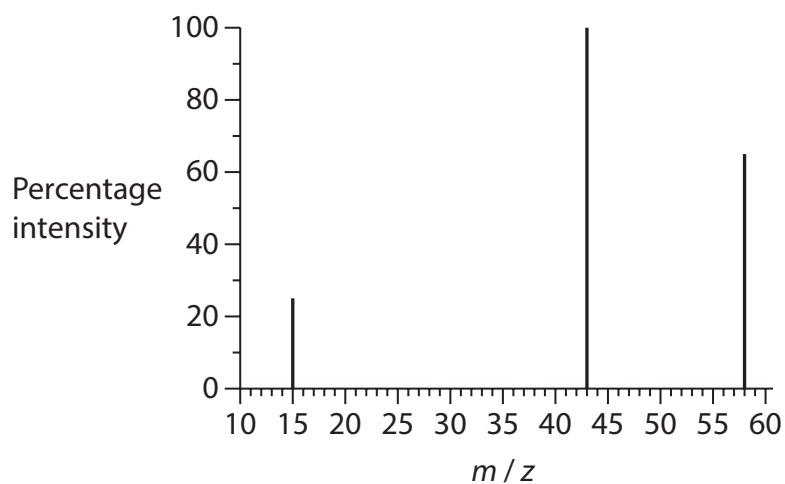
- A** greatest abundance
- B** greatest stability
- C** highest charge
- D** highest mass/charge ratio

(Total for Question 18 = 1 mark)

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



19 A simplified mass spectrum of an organic compound is shown.



Which of the following compounds produces this spectrum?

- A** propane
- B** propan-1-ol
- C** propan-2-ol
- D** propanone

(Total for Question 19 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

20 There are **four** isomeric alcohols with the molecular formula $C_4H_{10}O$.

(a) Two of these alcohols are butan-1-ol ($CH_3CH_2CH_2CH_2OH$) and butan-2-ol.
The other two isomers are alcohol **X** and alcohol **Y**.

(i) Draw the **displayed** formula for butan-2-ol, showing **all** the bonds. (1)

(ii) Alcohol **X** does not react with acidified potassium dichromate(VI) solution.
Give the structure of alcohol **X**. (1)

(iii) **Name** the fourth isomer, alcohol **Y**, using IUPAC rules. (1)

(b) Butan-1-ol reacts with acidified potassium dichromate(VI) solution to form two different organic products, depending on the reaction conditions.

(i) Give the classification of the alcohol butan-1-ol. (1)

(ii) Draw the **structural** formula of the organic product formed when butan-1-ol is heated under reflux with acidified potassium dichromate(VI) solution. (1)

(iii) Draw the **displayed** formula of the organic product formed when butan-1-ol is gently heated with acidified potassium dichromate(VI) solution and the product distilled off as it is formed. (1)

(Total for Question 20 = 6 marks)

21 This question is about halogenoalkanes.

- (a) The rates of hydrolysis of 1-chloropropane, 1-bromopropane and 1-iodopropane in reactions with aqueous silver nitrate solution were compared.

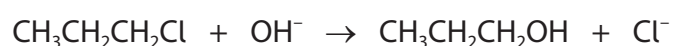
(i) State what would be measured in the experiment to compare the rates of hydrolysis.

(1)

(ii) State which of these halogenoalkanes would hydrolyse the fastest. Justify your answer.

(2)

- (b) The equation for the hydrolysis of 1-chloropropane by aqueous hydroxide ions is shown.



Draw the mechanism for this hydrolysis.

Include curly arrows, and relevant dipoles and lone pairs.

(2)

- (c) In another experiment, 2-bromobutane is heated with ethanolic potassium hydroxide and an elimination reaction occurs.

Draw the **skeletal** formulae of the three possible organic products, giving their names.

(3)

(Total for Question 21 = 8 marks)

22 This question is about the carbonates and nitrates of elements in Group 1 and Group 2 of the Periodic Table.

(a) Many of the metal ions of Group 1 and Group 2 can be identified using flame tests.

(i) State the colour given to a flame by barium nitrate.

(1)

(ii) Explain the origin of the flame colour.

(3)

(b) Sodium nitrate and magnesium nitrate decompose when heated.

Write equations to show the thermal decomposition of each of these nitrates. State symbols are not required.

(i) Sodium nitrate

(1)

(ii) Magnesium nitrate

(1)

(c) Magnesium carbonate decomposes readily when heated but sodium carbonate does not.

Explain this observation by including reference to the charge and size of the cations.

(4)



(d) Hydrated sodium carbonate has the formula $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$.

A student determined the value of x in the formula of a sample of hydrated sodium carbonate using the procedure shown.

Procedure

Step 1 Use 1.00 g of hydrated sodium carbonate to prepare 250 cm^3 of solution.

Step 2 Use a pipette to transfer 25.0 cm^3 of the sodium carbonate solution to a conical flask.

Step 3 Add a few drops of methyl orange indicator to the conical flask.

Step 4 Titrate the solution with 0.150 mol dm^{-3} hydrochloric acid until concordant results are obtained.

The student's mean titre was 10.75 cm^3 .

The equation for the reaction is



(i) Calculate the amount, in moles, of sodium carbonate, Na_2CO_3 , in the 250 cm^3 of solution in the volumetric flask.

(3)

(ii) Calculate the molar mass of $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$ and hence the value of x .

(2)

(iii) Another student carried out the same experiment but obtained a different answer. The method this student used for preparing the sodium carbonate solution is shown.

I weighed 1.00 g of hydrated sodium carbonate in a weighing bottle and then tipped the solid into a 250 cm^3 volumetric flask.

I dissolved the solid in a small amount of deionised water and then added deionised water up to the mark.

I then carried out a series of titrations.

Identify **two** errors that the student made in preparing this solution. Include the effect these errors will have on the titration volumes, with a reason.

(4)

(Total for Question 22 = 19 marks)

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

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

Molecule	M_r	Boiling temperature / K
Fluorine	38.0	85
Hydrogen sulfide	34.1	212
Methanol	32.0	338

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

Detailed descriptions of the forces involved are not required.

(6)

(b) Magnesium chloride is soluble in water.

Complete the diagram in the Answer Book to show how water molecules interact with each ion.

(2)

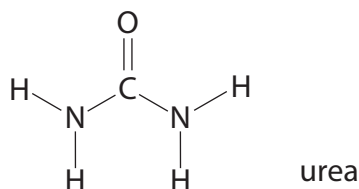
(Total for Question 23 = 8 marks)

TOTAL FOR SECTION B = 41 MARKS

SECTION C

Answer ALL the questions in the Answer Book.

- 24** Some diesel cars contain an extra catalytic converter for the reduction of nitrogen oxides (NO_x) in exhaust gases.
A solution of urea is used for this process.



- (a) Predict the bond angle and shape about the carbon in a molecule of urea.

Indicate this angle clearly on the diagram in the Answer Book.

(2)

- (b) A saturated solution of urea has a concentration of 18.0 mol dm^{-3} at 20°C .

Calculate the mass of urea in 125 cm^3 of a saturated solution.

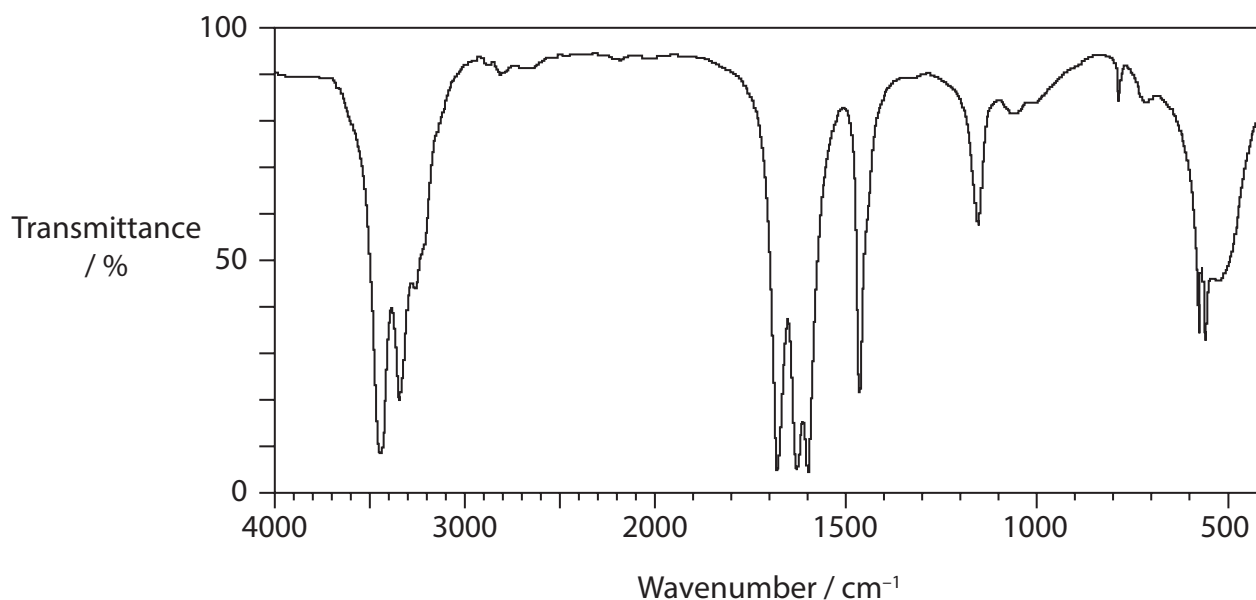
(2)

- (c) State why NO_x emissions are harmful to the environment.

(1)

- (d) An infrared spectrum of urea is shown.

Refer to your Data Booklet.



- (i) Draw a cross (x) on an absorption in the spectrum that could be due to the stretching of the $\text{N}-\text{H}$ bond.

(1)

- (ii) Identify the bond responsible for the absorption at 1683 cm^{-1} .

(1)

(e) In a diesel car exhaust system, the urea reacts with water to form ammonia and carbon dioxide. The enthalpy change for this reaction is $+133 \text{ kJ mol}^{-1}$.

- (i) Complete the equation for this **reversible** reaction in the Answer Book.
State symbols are not required.

(1)

- (ii) Sketch the reaction profile for the forward reaction on the axes provided in the Answer Book.

Include labels for ΔH and the activation energy (E_a).

(3)

(f) The catalytic converter contains metal oxides. When the exhaust gases pass through the catalytic converter, ammonia reacts with NO_x gases to form nitrogen and water.

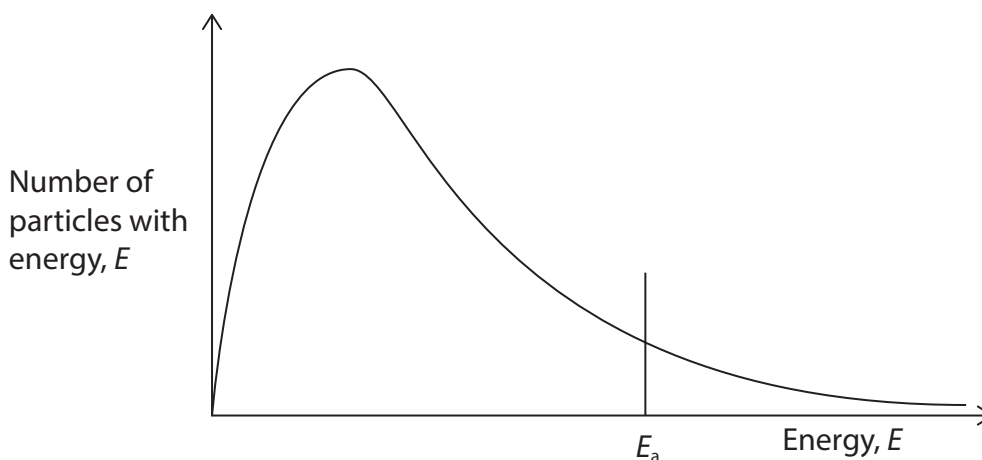
- (i) Give the reason why it is **not** correct to state that urea is acting as a catalyst in the reaction.

(1)

- (ii) Explain how a catalyst increases the rate of a chemical reaction.

Use the Maxwell-Boltzmann distribution shown and refer to the collision theory.

(3)



(g) The catalytic converter works best at a temperature of around 400°C.

(i) Suggest how the catalytic converter reaches this temperature.

(1)

(ii) The chemical reactions in the exhaust system of a diesel car, using a catalytic converter, form 90.0 m³ of nitrogen per hour.

Calculate the number of **molecules** of nitrogen formed per hour.

[Data: Molar volume at 400°C = 55.2 dm³ mol⁻¹

Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$]

(3)

(Total for Question 24 = 19 marks)

TOTAL FOR SECTION C = 19 MARKS
TOTAL FOR PAPER = 80 MARKS

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Please check the examination details below before entering your candidate information

Candidate surname		Other names	
Centre Number		Candidate Number	

Pearson Edexcel International Advanced Level

Thursday 15 January 2026

Afternoon (Time: 1 hour 30 minutes)

Paper reference **WCH12/01A**

Chemistry

International Advanced Subsidiary/Advanced Level

UNIT 2: Energetics, Group Chemistry, Halogenoalkanes and Alcohols

Answer Book

You must have:
Question Paper, 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.*
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).

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.
- There is a Periodic Table 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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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)

3

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 3 = 1 mark)

4

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 4 = 1 mark)

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DO NOT WRITE IN THIS AREA



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)

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



9 (a)

(1)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(b)

(1)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 9 = 2 marks)

10

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 10 = 1 mark)

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



11

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 11 = 1 mark)

12

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 12 = 1 mark)

13

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 13 = 1 mark)

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



14

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 14 = 1 mark)

15

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 15 = 1 mark)

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16

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 16 = 1 mark)

17

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 17 = 1 mark)

18

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 18 = 1 mark)

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



19

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 19 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS



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SECTION B

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

20 (a) (i)

(1)

(ii)

(1)

(iii)

(1)

.....



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(b) (i)

(1)

(ii)

(1)

(iii)

(1)

(Total for Question 20 = 6 marks)



DO NOT WRITE IN THIS AREA

(1)

(2)

(2)



(c)

(3)

Skeletal formula	Name

(Total for Question 21 = 8 marks)



22 (a) (i)

(1)

(ii)

(3)

(b) (i)

(1)

(ii)

(1)



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(c)

(4)

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(d) (i)

(3)

(ii)

(2)



(iii)

(4)

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(Total for Question 22 = 19 marks)



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23

*(a)

(6)

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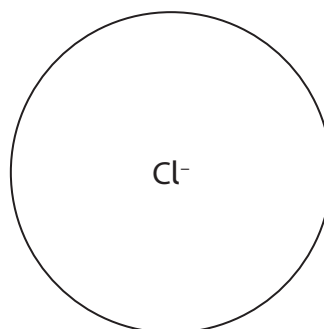
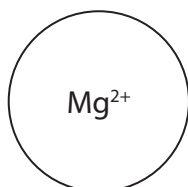
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(b)

(2)



(Total for Question 23 = 8 marks)

TOTAL FOR SECTION B = 41 MARKS

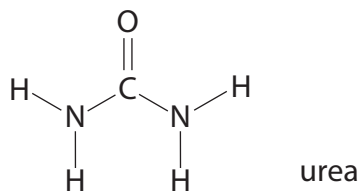


SECTION C

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

24 (a)

(2)



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(b)

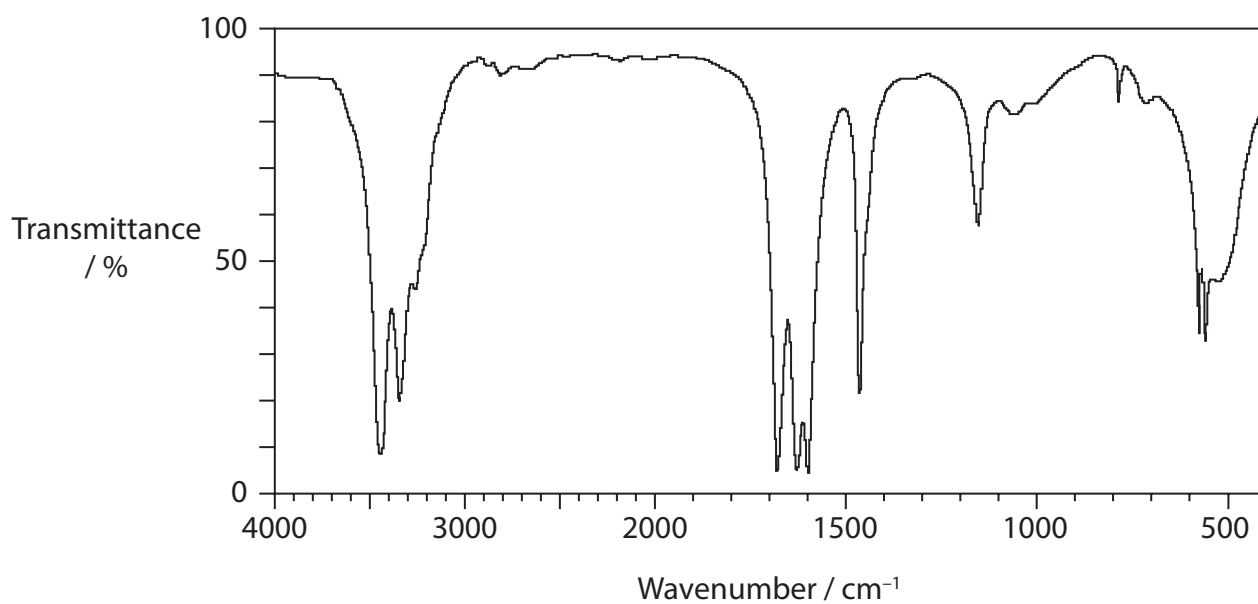
(2)

(c)

(1)



(d)



(i)

(1)

(ii)

(1)

(e) (i)

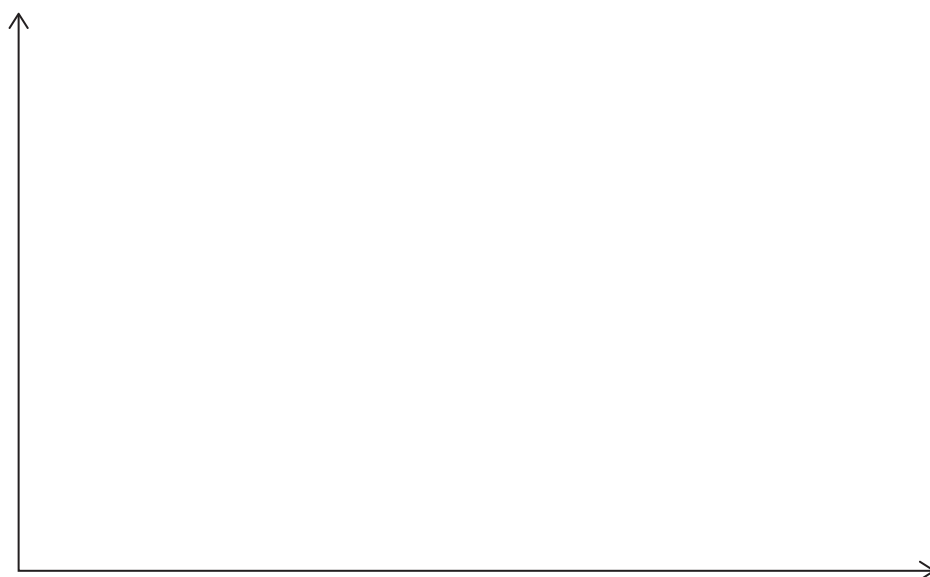
(1)



(ii)

(3)

Energy



Reaction progress

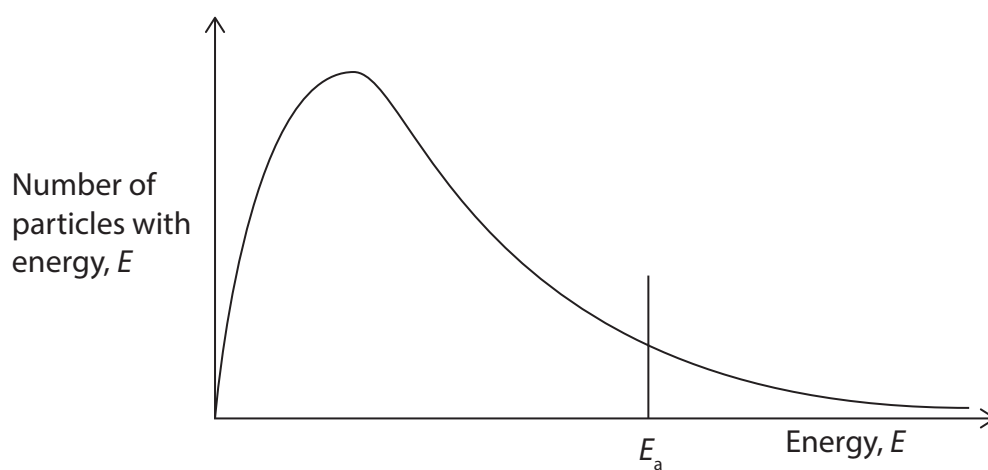
(f) (i)

(1)



(ii)

(3)



(g) (i)

(1)



(ii)

(3)

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(Total for Question 24 = 19 marks)

TOTAL FOR SECTION C = 19 MARKS
TOTAL FOR PAPER = 80 MARKS



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28

P 8 7 6 3 3 A 0 2 8 2 8

* 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	mercurium	101	[254]	No	nobelium	102	[257]	Lr	lawrencium	103

DO NOT WRITE IN THIS AREA