

Please write clearly in block capitals.

Centre number

Candidate number

Surname

Forename(s)

Candidate signature

I declare this is my own work.

INTERNATIONAL A-LEVEL CHEMISTRY (9620)

Unit 5: Practical and synoptic

Friday 16 January 2026

07:00 UK Time

Time allowed: 1 hour 25 minutes

Materials

For this paper you must have:

- the Periodic Table/Data Sheet, provided as an insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.

For Examiner's Use	
Question	Mark
1	
2	
3	
4–33	
TOTAL	



There are no questions printed on this page

*Do not write
outside the
box*

**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**



Section A

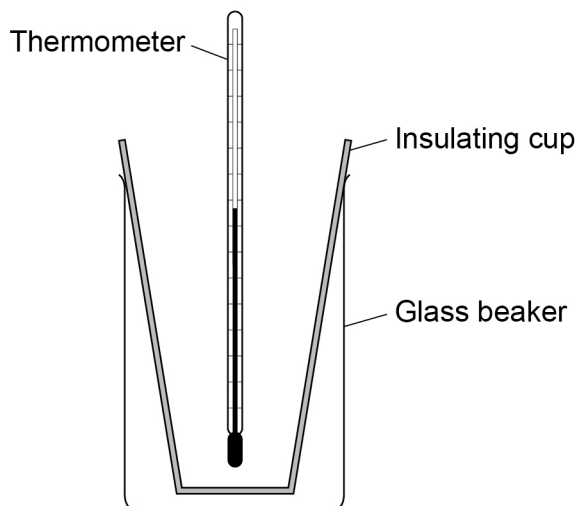
Answer **all** questions in the spaces provided.

0 1

A student investigates the enthalpy change when anhydrous magnesium chloride (MgCl_2) dissolves in water.

Figure 1 shows the equipment.

Figure 1



Method

- Step 1** 100 cm³ of water are added to an insulating cup.
The temperature of the water is measured every minute.
- Step 2** At the fourth minute, a known mass of anhydrous MgCl_2 is added to the water.
The mixture is stirred but the temperature is not measured.
- Step 3** The temperature of the mixture is then measured at the fifth minute and every minute for five more minutes.

0 1 . 1

Suggest why the mixture is stirred after the anhydrous MgCl_2 is added to the water.

[1 mark]

Question 1 continues on the next page

Turn over ►



Table 1 shows the student's results.

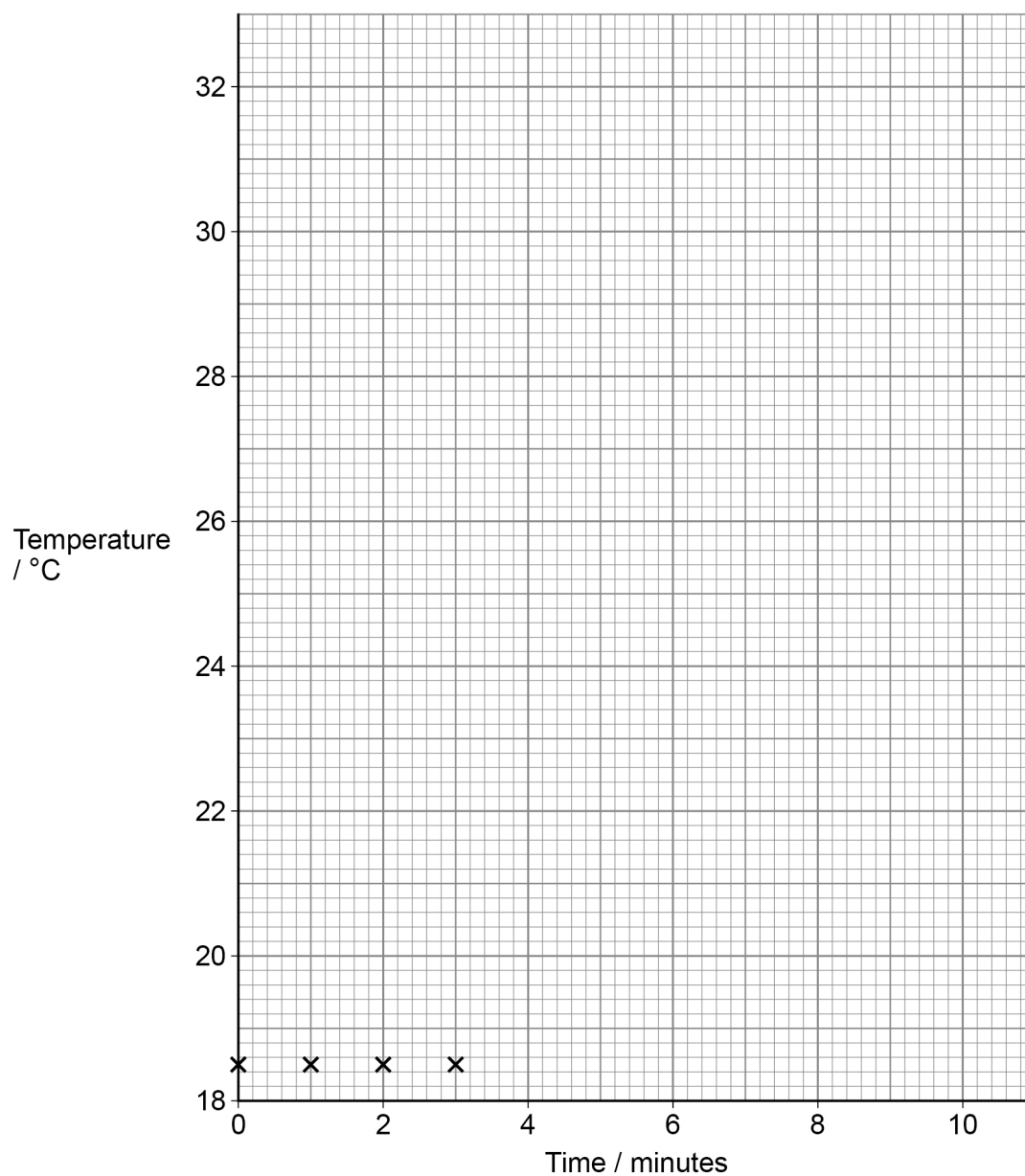
Table 1

Time / minutes	Temperature / °C
0	18.5
1	18.5
2	18.5
3	18.5
4	No measurement
5	24.0
6	26.4
7	26.8
8	26.3
9	25.7
10	25.2



Some of the student's results are plotted on **Figure 2**.

Figure 2



0 1 . 2 Plot the remaining points from **Table 1** onto **Figure 2**.

Draw **two** lines of best fit on the graph in **Figure 2**.

Use your lines to calculate the temperature rise at the fourth minute.

[3 marks]

Temperature rise _____ °C

Question 1 continues on the next page

Turn over ►



0 1 . 3

It is more accurate to determine the temperature rise by using the graph in **Figure 2** rather than by measuring the temperature rise at the fourth minute.

Suggest **two** reasons why.

[2 marks]

Reason 1 _____

Reason 2 _____

Another student does the same experiment.

Table 2 shows their results.

Table 2

Mass of anhydrous MgCl_2 / g	2.25
Volume of water / cm^3	100
Temperature rise / $^\circ\text{C}$	8.7

0 1 . 4

Use the values in **Table 2** to calculate $\Delta_{\text{solution}}H$, in kJ mol^{-1} , for MgCl_2

Assume the density of the solution = 1.00 g cm^{-3}

Specific heat capacity of the solution = $4.18 \text{ J K}^{-1} \text{ g}^{-1}$

[4 marks]

$\Delta_{\text{solution}}H$ _____ kJ mol^{-1}



0 1 . 5

This student repeats the experiment.

The student washes the insulating cup with water but does **not** dry it.

Suggest why this makes the experiment less accurate.

[1 mark]

0 1 . 6

The total uncertainty in measuring the mass of the anhydrous MgCl_2 is ± 0.01 g

Calculate the percentage uncertainty in the mass of anhydrous MgCl_2 used.

[1 mark]

Percentage uncertainty _____

0 1 . 7

Suggest why it is more accurate to use anhydrous MgCl_2 from a new, unopened container than from an opened container.

[1 mark]

13

Turn over for the next question

Turn over ►



0 2

This question is about electrochemical cells.

A student sets up the cell shown in **Figure 3**.

Figure 3

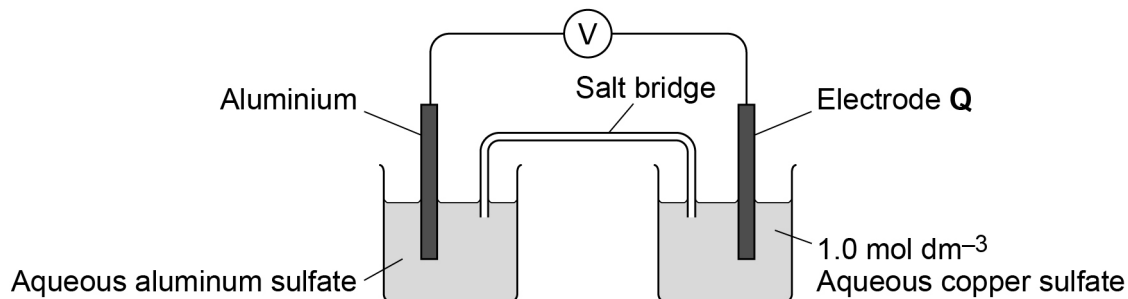


Table 3 shows some electrochemical data.

Table 3

Electrode half-equation	$E^\ominus / \text{V}$
$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$	+0.34
$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	To be calculated

0 2 . 1

Identify a suitable material for electrode **Q**.

The cell is run under standard conditions.

Give a suitable concentration, in mol dm^{-3} , for the aluminium sulfate solution.

[2 marks]

Electrode material _____

Concentration of aluminium sulfate solution _____ mol dm^{-3}

0 2 . 2

State why the pressure for this cell does **not** need to be controlled.

[1 mark]



0 2 . 3 State the purpose of the salt bridge.

Explain why potassium hydroxide is **not** a suitable substance for the salt bridge in this cell.

[2 marks]

Purpose _____

Reason potassium hydroxide is **not** suitable _____

0 2 . 4 Explain why it is necessary to rub the surface of the aluminium electrode with sandpaper before use.

[1 mark]

0 2 . 5 The Al^{3+}/Al electrode is connected to the positive terminal of the voltmeter and the Cu^{2+}/Cu electrode is connected to the negative terminal.
The voltmeter gives a reading of -1.98 V

State how the equipment should be changed to give a positive reading.

Give the conventional representation for the cell with $\text{EMF} = +1.98\text{ V}$

[2 marks]

Change needed _____

Cell representation _____

0 2 . 6 Calculate the electrode potential for the Al^{3+}/Al electrode when the cell $\text{EMF} = +1.98\text{ V}$

[1 mark]

Electrode potential _____ V

Turn over ►



0 2 . 7 The aluminium electrode is replaced with a larger piece of aluminium.

Which is the effect on the EMF of the cell?

[1 mark]

Tick (✓) **one** box.

Increases

☐

Stays the same

☐

Decreases

☐

0 2 . 8 The voltmeter is replaced with a bulb.

Give an equation for the overall reaction that occurs when the cell is operating.

[1 mark]

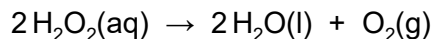


0 3

This question is about the rate of a reaction.

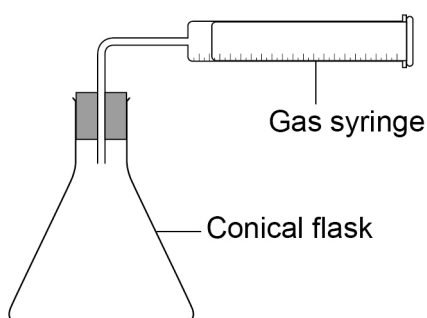
Figure 4 shows the equipment used to measure the initial rate of decomposition of hydrogen peroxide, $\text{H}_2\text{O}_2(\text{aq})$

Potassium iodide, $\text{KI}(\text{aq})$, is added as a catalyst for the decomposition.



Two students are working together to measure the initial rate of the reaction.

Figure 4



Method

Step 1 100 cm³ of a known concentration of $\text{H}_2\text{O}_2(\text{aq})$ are added to the conical flask.

Step 2 5 cm³ of $\text{KI}(\text{aq})$ are added to the flask and the bung is immediately inserted. The clock is started and the initial reading on the gas syringe is measured.

Step 3 The time is measured for the volume of gas in the gas syringe to increase by 50 cm³

Step 4 The experiment is repeated for other concentrations of $\text{H}_2\text{O}_2(\text{aq})$

0 3 . 1

Suggest **one** reason why it is helpful to have two students working together in **Step 2** of the method.

[1 mark]

0 3 . 2

Explain why it is more accurate to use the method in **Step 3** rather than measure the time taken to reach the 50 cm³ mark on the gas syringe.

[1 mark]

Turn over ►



5 cm³ of KI(aq) are used in every experiment.

Table 4 shows the results of the experiments.

Table 4

Experiment	Volume of H ₂ O ₂ (aq) / cm ³	Volume of water / cm ³	Initial [H ₂ O ₂ (aq)] / mol dm ⁻³	Initial rate of reaction / mol dm ⁻³ s ⁻¹
1	100	0	0.952	0.00467
2	80	20	0.762	0.00371
3	60	40	To be calculated	0.00272
4	40	60	0.381	0.00194
5	20	80	0.190	0.00108

0 3 . 3 Calculate the initial [H₂O₂(aq)], in mol dm⁻³, of the reaction mixture used in **Experiment 3**.

[1 mark]

Initial [H₂O₂(aq)] _____ mol dm⁻³



0 3 . 4 The decomposition of $\text{H}_2\text{O}_2(\text{aq})$ is exothermic.

Explain why this could cause inaccuracy.

Suggest **one** improvement that could be made to the experiment to increase the accuracy.

[2 marks]

Explanation _____

Improvement _____

0 3 . 5 The students did further experiments and determined that the rate equation was

$$\text{Rate} = k[\text{H}_2\text{O}_2][\text{I}^-]$$

Deduce the units of the rate constant, k

[1 mark]

6

Turn over for the next section

Turn over ►



Section B

Each question is followed by four responses, **A**, **B**, **C** and **D**.

For each question select the best response.

Only **one** answer per question is allowed.

For each question completely fill in the circle alongside the appropriate answer.

CORRECT METHOD 

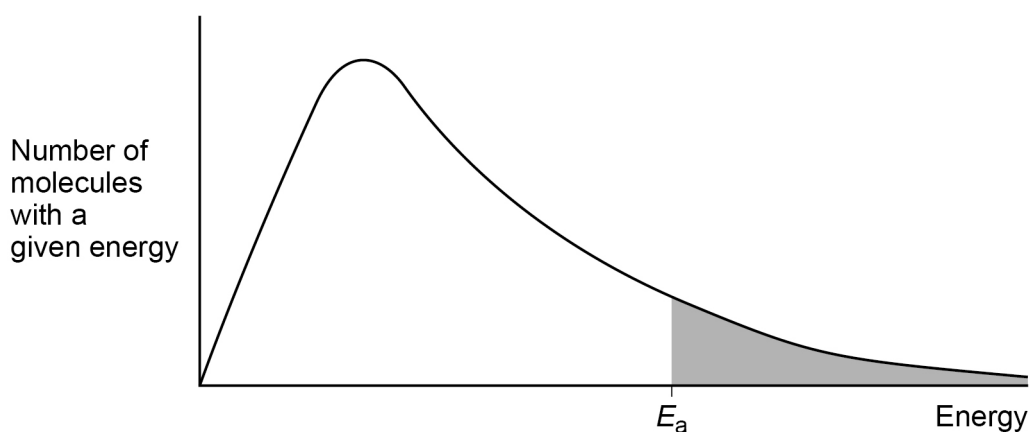
WRONG METHODS    

If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

You may do your working in the blank space around each question but this will not be marked.

- 0 4** A Maxwell–Boltzmann curve for a mixture of reacting gases at a given temperature is shown.



Which statement best explains why a small increase in temperature causes a large increase in rate?

[1 mark]

- A** A small increase in temperature causes a large increase in the collision rate between reacting particles. 
- B** A small increase in temperature causes a large increase in the shaded area under the curve. 
- C** A small increase in temperature causes a large increase in the total area under the curve. 
- D** A small increase in temperature moves the activation energy needed for a reaction to occur to the left. 



0 5 0.698 g of a metal **M** reacts with 0.0127 mol of oxygen gas to form a compound MO_2

Which is metal **M**?

[1 mark]

A Aluminium ☐

B Chromium ☐

C Manganese ☐

D Zirconium ☐

0 6 Which reaction produces the largest atom economy of CaCl_2 ?

[1 mark]

A $\text{CaO} + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O}$ ☐

B $\text{Ca(OH)}_2 + 2\text{HCl} \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O}$ ☐

C $\text{Ca} + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2$ ☐

D $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$ ☐

0 7 Which comparison is correct and explained by hydrogen bonding?

[1 mark]

A Liquid H_2O has a lower M_r than liquid H_2S ☐

B Liquid H_2O has a higher boiling point than liquid H_2S ☐

C Solid H_2O has a higher density than liquid H_2O ☐

D The bonds are more polar in a molecule of H_2S than in a molecule of H_2O ☐

Turn over ►



0 8 MnO_4^{2-} reacts with H^+ to form MnO_2 and MnO_4^-

Which is the correct ratio of the products $\text{MnO}_2 : \text{MnO}_4^-$?

[1 mark]

A 1:1 ☐

B 1:2 ☐

C 1:3 ☐

D 1:4 ☐

0 9 Bromine exists as two isotopes, ^{79}Br and ^{81}Br , in approximately a 1:1 ratio. A sample of $\text{C}_2\text{H}_4\text{Br}_2$ is analysed by time of flight mass spectrometry.

Which statement is correct?

[1 mark]

A The $\text{C}_2\text{H}_4\text{Br}_2^+$ ion is formed from $\text{C}_2\text{H}_4\text{Br}_2$ by electrospray ionisation. ☐

B The $\text{C}_2\text{H}_4(^{81}\text{Br})_2^+$ ion will reach the detector before the $\text{C}_2\text{H}_4(^{79}\text{Br})_2^+$ ion. ☐

C All peaks in the spectrum are of equal size. ☐

D There are three molecular ion peaks in the spectrum. ☐

1 0

A student prepares a solution.

Method

Step 1 Pipette 15.0 cm^3 of $0.250 \text{ mol dm}^{-3}$ sulfuric acid into a 100 cm^3 volumetric flask.**Step 2** Make the solution up to the mark using distilled water.**Step 3** Insert a stopper into the flask and shake the flask.

Assume that the acid is fully dissociated.

Which is the pH of the solution formed?

[1 mark]**A** 0.60 ☐**B** 1.12 ☐**C** 1.43 ☐**D** 1.73 ☐**1 1**A $0.150 \text{ mol dm}^{-3}$ solution of a weak acid (HA) has a pH of 4.50Which is the value of K_a in mol dm^{-3} ?**[1 mark]****A** 1.50×10^{-10} ☐**B** 6.67×10^{-9} ☐**C** 4.74×10^{-6} ☐**D** 2.11×10^{-4} ☐**1 2**Which will **decrease** the value of K_p for this gaseous equilibrium?**[1 mark]****A** Decrease the temperature at constant pressure. ☐**B** Increase the pressure at constant temperature. ☐**C** Use a catalyst. ☐**D** Use a larger container. ☐**Turn over ►**

1 3 Which statement is correct?

[1 mark]

- A** When iodine is added to a solution of potassium bromide, bromide ions are oxidised. ☐
- B** When chlorine is bubbled through cold water, some chlorine atoms are oxidised. ☐
- C** When magnesium reacts with titanium(IV) chloride, magnesium atoms are reduced. ☐
- D** When chlorine reacts with cold, dilute, aqueous sodium hydroxide, sodium ions are reduced. ☐

1 4 Which produces the most stable complex?

[1 mark]

- A** Adding an excess of ammonia to $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ ☐
- B** Adding an excess of $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$ to $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ ☐
- C** Adding an excess of hydrochloric acid to $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ ☐
- D** Adding an excess of $\text{Na}_4(\text{EDTA})$ to $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ ☐

1 5 An aqueous solution of a transition metal absorbs visible light at a wavelength of 470 nm

What is the energy gap (ΔE), in J, when a d electron is excited in this complex?

You should assume that all the light absorbed is used for d–d transitions.

Speed of light, $c = 3.00 \times 10^8 \text{ m s}^{-1}$

Planck constant, $h = 6.63 \times 10^{-34} \text{ J s}$

[1 mark]

- A** $9.35 \times 10^{-32} \text{ J}$ ☐
- B** $4.23 \times 10^{-28} \text{ J}$ ☐
- C** $9.35 \times 10^{-23} \text{ J}$ ☐
- D** $4.23 \times 10^{-19} \text{ J}$ ☐



- 1 6** Which explains why the value of the acid dissociation constant, K_a , for $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ is **greater** than the value of K_a for $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$?

[1 mark]

- A** 1 mol of $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ reacts with more alkali than 1 mol of $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ ☐
- B** Fe^{3+} has a larger charge density than Fe^{2+} ☐
- C** Fe^{3+} has a larger ionic radius than Fe^{2+} ☐
- D** A solution containing $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ ions has a higher pH than a solution of the same concentration containing $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ ☐

- 1 7** Which shows both optical and *E-Z* stereoisomerism?

[1 mark]

- A**
$$\begin{array}{c} \text{CH}_2\text{CH}_3 \\ | \\ \text{HO}-\text{C}-\text{CH}=\text{CH}_2 \\ | \\ \text{CH}_3 \end{array}$$
 ☐
- B**
$$\begin{array}{c} \text{CH}_2\text{CH}_3 \\ | \\ \text{H}_3\text{C}-\text{C}-\text{CH}=\text{CHCH}_3 \\ | \\ \text{CH}_3 \end{array}$$
 ☐
- C**
$$\begin{array}{c} \text{CH}_2\text{CH}_3 \\ | \\ \text{H}_3\text{C}-\text{C}-\text{CH}=\text{CH}_2 \\ | \\ \text{CH}_3 \end{array}$$
 ☐
- D**
$$\begin{array}{c} \text{CH}_2\text{CH}_3 \\ | \\ \text{HO}-\text{C}-\text{CH}=\text{CHCH}_3 \\ | \\ \text{CH}_3 \end{array}$$
 ☐

Turn over ►



1 8 Which statement about SO_2 is correct?

[1 mark]

- A** SO_2 dissolves in water to form H_2SO_4 ☐
- B** SO_2 has a bond angle of 180° ☐
- C** SO_2 is oxidised in the Contact process using a Fe catalyst. ☐
- D** SO_2 is removed from flue gases using CaO ☐

1 9 1-Bromopropane reacts with aqueous sodium hydroxide to give propan-1-ol.
Which is correct?

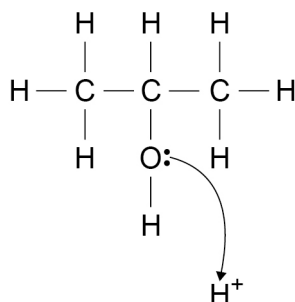
[1 mark]

- A** The addition of silver nitrate and an excess of nitric acid to the products gives a white precipitate. ☐
- B** The mechanism of the reaction is electrophilic addition. ☐
- C** 1-Chloropropane reacts faster than 1-bromopropane with aqueous sodium hydroxide because the C–Cl bond is more polar than the C–Br bond. ☐
- D** 1-Iodopropane reacts faster than 1-bromopropane with aqueous sodium hydroxide because the C–I bond is weaker than the C–Br bond. ☐



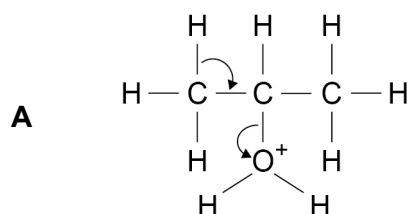
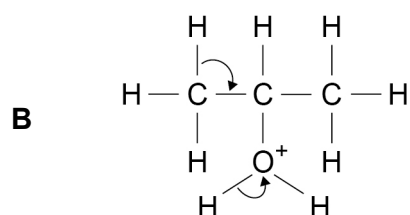
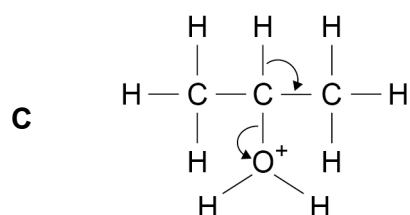
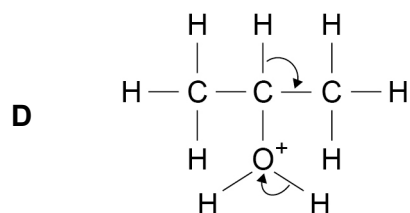
2 0 Propan-2-ol can be dehydrated.

The first step of the mechanism is shown.



Which shows the correct curly arrows for the second step in the mechanism?

[1 mark]



Turn over ►



2 1

An unknown gas is analysed using high resolution mass spectrometry. The precise M_r is found to be 44.0132

The table shows some precise relative atomic mass values.

Element	Precise relative atomic mass
Hydrogen	1.0079
Carbon	12.0107
Nitrogen	14.0069
Oxygen	15.9994

Which is a possible identity for the gas?

[1 mark]

- A** A gas produced by oxidation of nitrogen, which has nitrogen with an oxidation state of +1 in the compound.
- B** A gas produced from the partial oxidation of ethene with a silver catalyst.
- C** A gas produced from the reaction of propanoic acid with potassium carbonate.
- D** A gas produced when 1 mole of pentane is cracked to produce 1 mole of ethene and 1 mole of this gas.

☐☐☐☐**2 2**

Some compounds with molecular formula C_4H_8O can be reduced by $NaBH_4(aq)$

Which could **not** be formed by this reaction?

[1 mark]

- A** Butan-1-ol

☐

- B** Butan-2-ol

☐

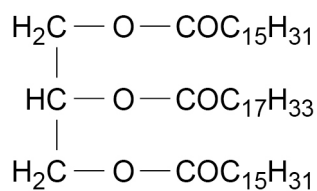
- C** Methylpropan-1-ol

☐

- D** Methylpropan-2-ol

☐

2 3 A compound found in a vegetable oil is shown.



Which statement is correct?

[1 mark]

- A** Heating the compound with aqueous sodium hydroxide gives a mixture used as biodiesel.
- B** Heating the compound with methanol in the presence of a catalyst gives $\text{C}_{15}\text{H}_{31}\text{COOCH}_3$ as one product.
- C** Heating the compound with methanol in the presence of a catalyst gives $\text{C}_{17}\text{H}_{33}\text{COOH}$ as one product.
- D** The hydrocarbon chains in the compound are all saturated.

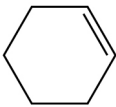
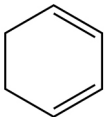
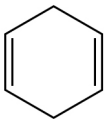
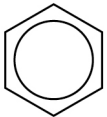
☐
☐
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☐

Turn over for the next question

Turn over ►



2 4The table contains information on the reactions of compounds **E**, **F**, **G** and **H**.

Compound	Structure	Observation when bromine water is added	Enthalpy of hydrogenation / kJ mol^{-1}
E		Orange to colourless	-120
F		Orange to colourless	-230
G		Orange to colourless	-240
H		Remains orange	-208

Which statement is correct?

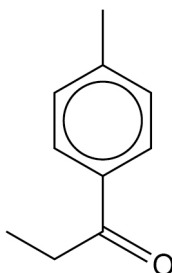
[1 mark]

- A** Only compounds **E**, **F** and **G** can react with electrophiles.
- B** Compound **F** has a more stable bonding arrangement than compound **G**.
- C** Compounds **F** and **G** will form the same organic product in the reaction with bromine water.
- D** The enthalpy of hydrogenation for compound **H** is more exothermic than that predicted for the theoretical compound cyclohexa-1,3,5-triene.

☐☐☐☐

2 5

In the presence of an AlCl_3 catalyst, methylbenzene reacts with a compound to form



Which is the type of mechanism and type of reaction?

[1 mark]

	Type of mechanism	Type of reaction
A	Electrophilic substitution	Acylation
B	Electrophilic substitution	Alkylation
C	Nucleophilic substitution	Acylation
D	Nucleophilic substitution	Alkylation

☐
☐
☐
☐
2 6

Which is the correct order of decreasing base strength?

[1 mark]

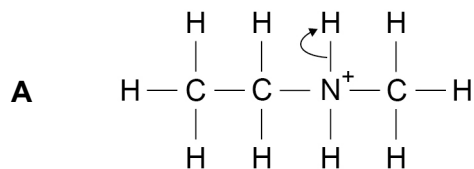
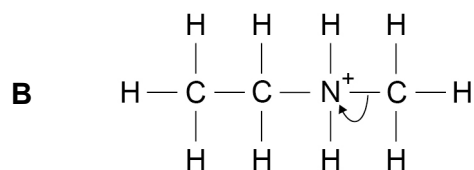
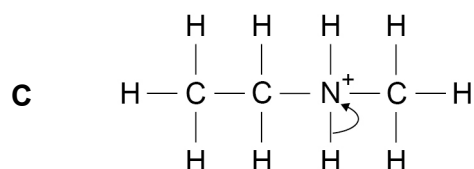
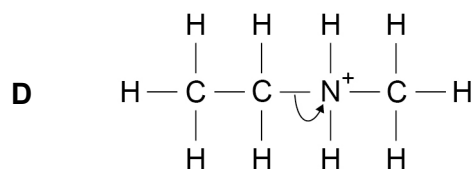
	strongest		weakest
A	CH_3NH_2	NH_3	$\text{C}_6\text{H}_5\text{NH}_2$
B	$\text{C}_6\text{H}_5\text{NH}_2$	NH_3	CH_3NH_2
C	NH_3	CH_3NH_2	$\text{C}_6\text{H}_5\text{NH}_2$
D	$\text{C}_6\text{H}_5\text{NH}_2$	CH_3NH_2	NH_3

☐
☐
☐
☐


2 7

Bromoethane reacts with methylamine to produce a secondary amine.

Which shows the correct curly arrow on the intermediate in this reaction?

[1 mark]
☐

☐

☐

☐
2 8

Condensation polymers can be hydrolysed, but addition polymers cannot be hydrolysed.

Which best describes why poly(alkenes) cannot be hydrolysed?

[1 mark]

A The C=C bonds repel nucleophiles.

☐

B The forces between polymer chains are too strong.

☐

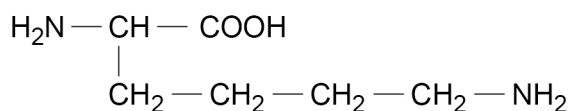
C The bonds in the main chain are non-polar.

☐

D The relative molecular mass is too high.

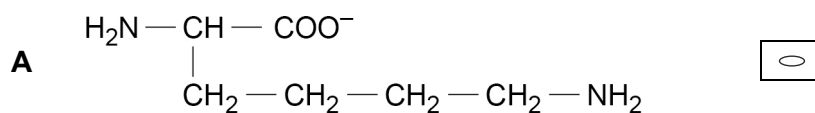
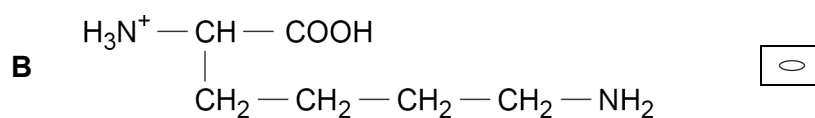
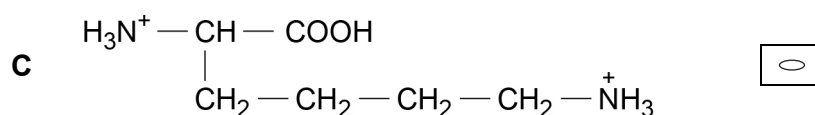
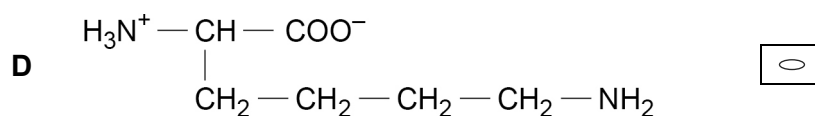
☐


2 9 The amino acid lysine is shown.



Which is the structure of lysine in a solution at pH = 3?

[1 mark]



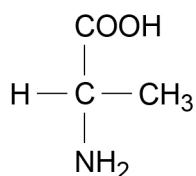
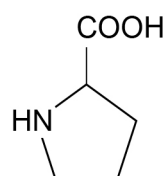
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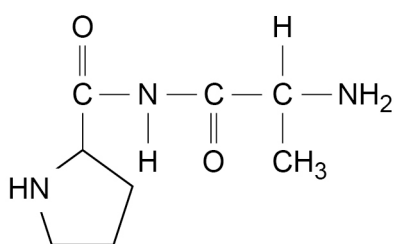
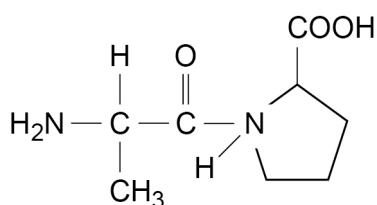
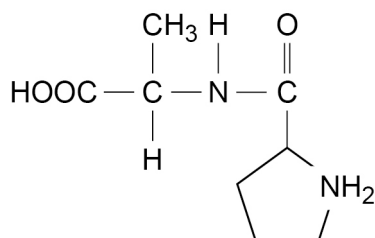
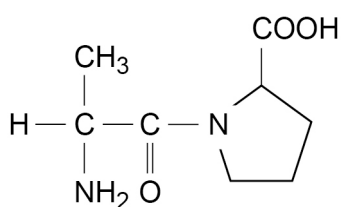


3 0

A dipeptide is hydrolysed.
The products of this hydrolysis are shown.



Which is the correct structure of the dipeptide?

[1 mark]**A****B****C****D**

3 1

The ^1H NMR spectrum of a compound with molecular formula $\text{C}_5\text{H}_{10}\text{O}_2$ has only four peaks.

Data for these peaks are shown.

Peaks centred on chemical shift value δ / ppm	Splitting pattern	Integration ratio
1.1	triplet	3
1.2	triplet	3
2.3	quartet	2
4.1	quartet	2

Which is the compound?

[1 mark]

- A** Butyl methanoate ☐
- B** Propyl ethanoate ☐
- C** Ethyl propanoate ☐
- D** Methyl butanoate ☐

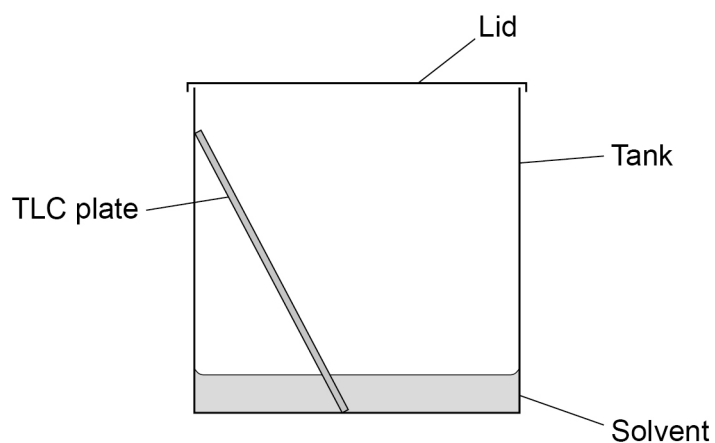
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3 2

A thin layer chromatography (TLC) plate is placed in a developing tank containing a little solvent as shown.



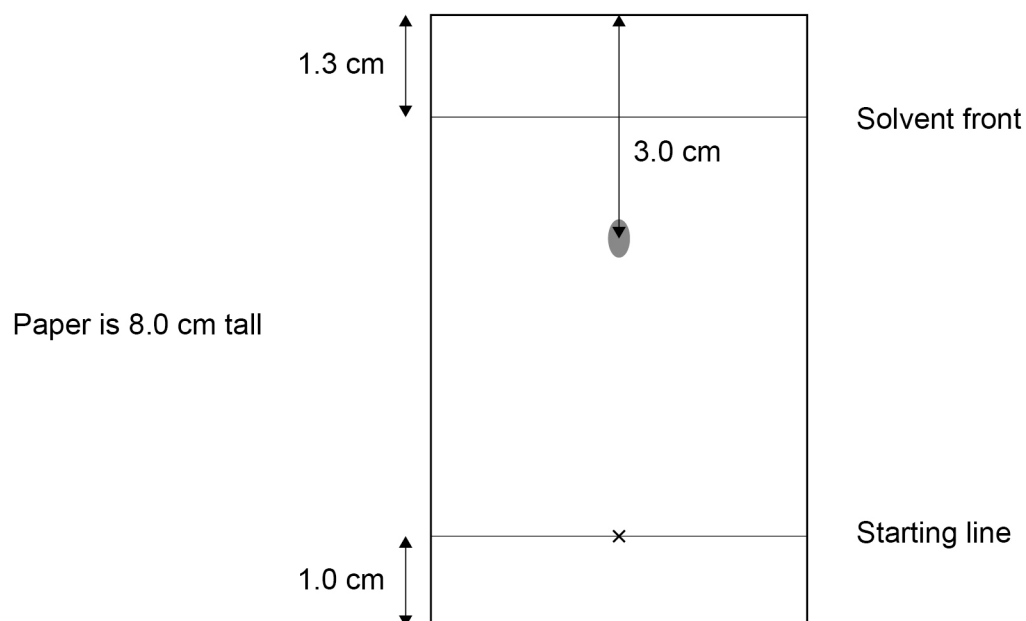
Which change improves the accuracy of the chromatogram obtained?

[1 mark]

- A** Use a larger developing tank. ☐
- B** Use a longer TLC plate. ☐
- C** Use more solvent. ☐
- D** Use paper rather than a TLC plate. ☐

3 3

A student developed the paper chromatogram shown.
(The diagram is **not** to scale.)



Which is the R_f value for the spot that is shown?

[1 mark]

- A** 0.45 ☐
- B** 0.70 ☐
- C** 0.75 ☐
- D** 1.43 ☐

30

END OF QUESTIONS



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3 6



2 6 1 X C H 0 5

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