

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

INTERNATIONAL A-LEVEL CHEMISTRY (9620)

Unit 5: Practical and synoptic

Monday 8 June 2026

08:00 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	



Section A

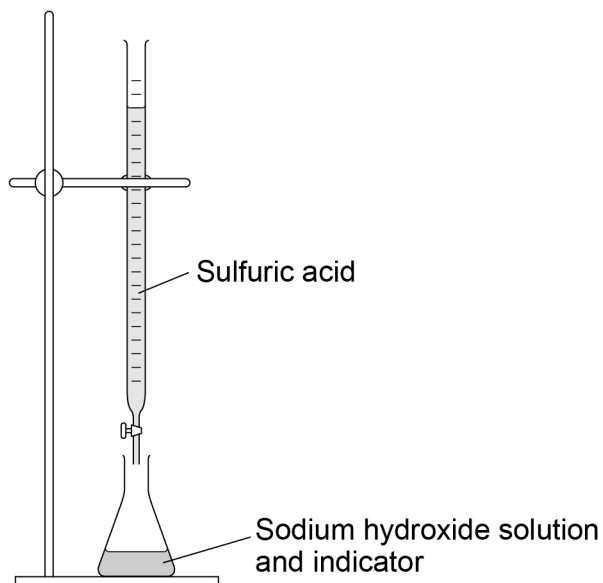
Answer **all** questions in the spaces provided.

0 1

The concentration of a solution of sodium hydroxide can be found by titration with dilute sulfuric acid using an indicator.

Figure 1 shows the equipment used.

Figure 1

**0 1****1**

The burette is filled using a filter funnel.

State why the filter funnel must be removed before starting the titration.

[1 mark]

0 1**2**

Explain why a conical flask is used in a titration instead of a beaker.

[1 mark]



0 1 . 3

The indicator used is a weak acid.

A student adds 2 cm^3 of the indicator to the conical flask instead of a few drops.

State the effect of this mistake on the titre value.

Explain your answer.

[2 marks]

Effect on titre value _____

Explanation _____

0 1 . 4

The student corrects the mistake with the indicator.

The student then does a rough titration and three further titrations.

Figure 2 shows part of the burette at the end of the rough titration.

Figure 2

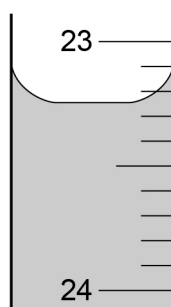


Table 1 shows some of the student's results.

Table 1

	Rough	1	2	3
Final volume / cm^3		32.85	22.85	45.40
Initial volume / cm^3	0.00	10.35	0.10	22.85
Titre / cm^3				

Use **Figure 2** and the student's other burette readings to complete **Table 1**.

Use appropriate data from the completed **Table 1** to calculate the mean titre.

[2 marks]

Mean titre _____ cm^3

Turn over ►



0	1	.	5
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A different student does a similar experiment but finds the mean titre to be 22.70 cm^3

The sulfuric acid has a concentration of $0.100 \text{ mol dm}^{-3}$

The volume of sodium hydroxide is 25.0 cm^3

Use this student's mean titre to calculate the concentration, in g dm^{-3} , of the sodium hydroxide solution.

[4 marks]

Concentration of NaOH _____ g dm^{-3}



0 1 . 6

Near the equivalence point of the titration, the student washes the inside of the conical flask with distilled water.

Give a reason for this washing.

[1 mark]

0 1 . 7

Which is the correct method to transfer a solution from a pipette to a conical flask?

Tick (✓) **one** box.

[1 mark]

Method to transfer solution	
Allow the solution to drain out of the pipette by gravity alone. Some solution remains in the pipette.	
Allow the solution to drain out of the pipette by gravity and then touch the surface of the solution in the flask. Some solution remains in the pipette.	
Use the pipette filler to force all of the solution out of the pipette. No solution remains in the pipette.	

12

Turn over for the next question

Turn over ►

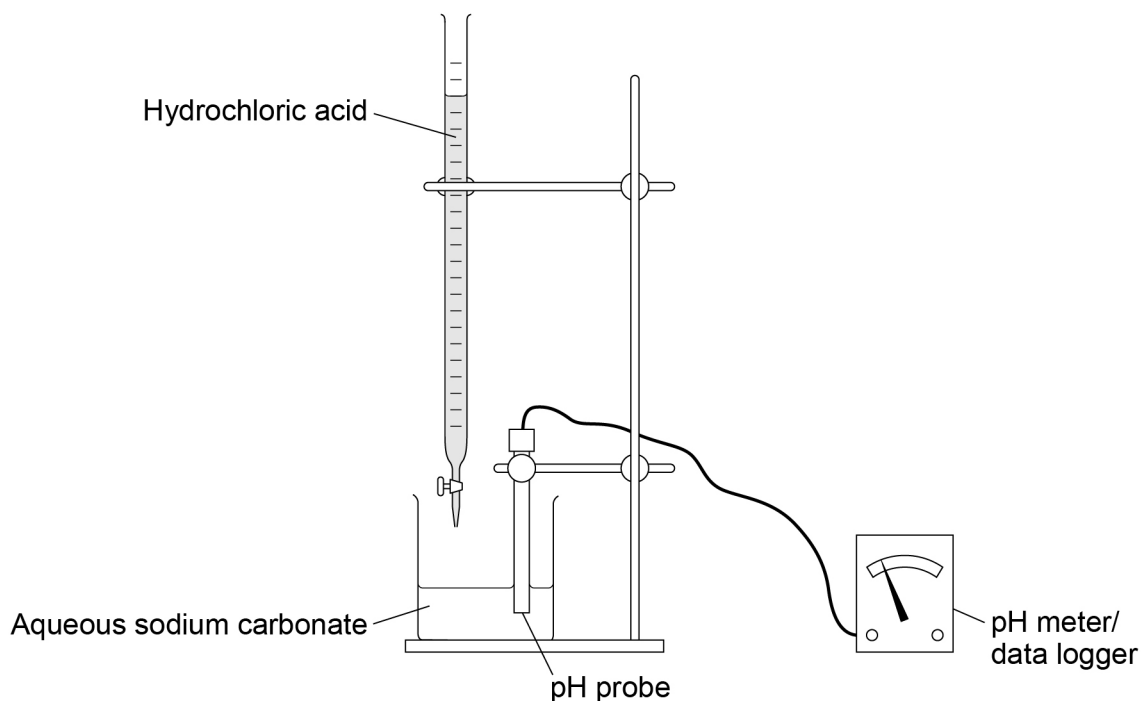


0 2

This question is about the changes in pH during the titration of aqueous sodium carbonate, $\text{Na}_2\text{CO}_3(\text{aq})$, with hydrochloric acid.

Figure 3 shows the equipment used to measure the pH in this titration.

Figure 3



0 2 . 1

The pH meter is calibrated with three buffer solutions that have different pH values.

Method

Step 1 Wash the pH probe with distilled water.

Step 2 Wash the pH probe with a small volume of a buffer solution.

Step 3 Measure the pH of the buffer solution.

Step 4 Repeat **Steps 1** to **3** with the other buffer solutions.

The pH probe must be washed with a small volume of the buffer solution before the pH of that buffer solution is measured.

Suggest why.

[1 mark]



The equipment is set up as shown in **Figure 3**.

The pH probe is washed with a little aqueous sodium carbonate.
It is then placed in the beaker of aqueous sodium carbonate.

The initial pH is measured.

0 2 . 2

A small volume of hydrochloric acid is added from the burette.
The pH is measured.

Suggest **one** practical step that should be done between adding the acid and measuring the pH

[1 mark]

0 2 . 3

Hydrochloric acid is added gradually to the aqueous sodium carbonate until the acid is in excess.

The pH is measured after each addition.

Suggest why the pH probe should **not** be washed with water after each addition of hydrochloric acid.

[1 mark]

0 2 . 4

The hydrochloric acid has a concentration of $0.200 \text{ mol dm}^{-3}$

Give an expression for pH

Calculate the pH of this acid.

Give your answer to **two** decimal places.

[2 marks]

pH _____

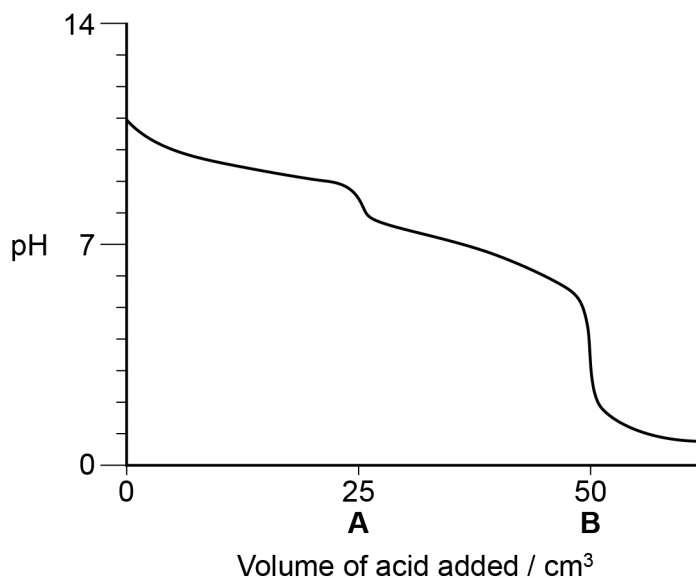
Question 2 continues on the next page

Turn over ►



Figure 4 shows a graph of the pH against the volume of acid added.

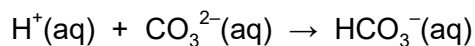
Figure 4



The reaction occurs in two stages.

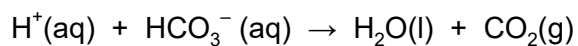
Each stage involves a reaction between a monoprotic acid and a base. Each stage has its own equivalence point.

Stage 1 Carbonate ions react to form hydrogencarbonate ions.



Stage 1 is complete at equivalence point **A**.

Stage 2 Hydrogencarbonate ions react to form carbon dioxide.



Stage 2 is complete at equivalence point **B**.

0 2 . 5

State **one** observation that would be seen **after** 25 cm³ of hydrochloric acid have been added.

[1 mark]

0 2 . 6

Suggest why equivalence point **A** would be difficult to determine accurately using an indicator.

[1 mark]

0 2 . 7

An indicator is added after equivalence point **A**.

Table 2 shows the pH range of some indicators.

Identify the most suitable indicator for equivalence point **B**. Tick (✓) **one** box.

[1 mark]

Table 2

Indicator	pH range of indicator	
Phenol red	6.8 – 8.4	
Bromothymol blue	6.0 – 7.6	
Bromophenol blue	3.0 – 4.6	
Thymol blue	1.2 – 2.8	

0 2 . 8

The experiment is repeated with a small amount of solid sodium hydrogencarbonate added to the initial sodium carbonate solution.

Use **Figure 4** and the equations for **Stage 1** and **Stage 2** to deduce how this addition changes the volumes of acid added for equivalence point **A** and for equivalence point **B**.

Which row is correct? Tick (✓) **one** box.

[1 mark]

Change to volume for equivalence point A	Change to volume for equivalence point B	
No change	No change	
No change	Increase	
Increase	No change	
Increase	Increase	



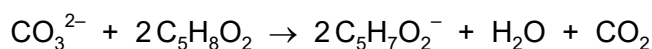
0 3

This question is about the purification of a solid inorganic complex.
The technique is the same as that used in the purification of organic solids.

Cobalt(II) carbonate (CoCO_3) reacts with a compound $\text{C}_5\text{H}_8\text{O}_2$ and
hydrogen peroxide (H_2O_2) to form the octahedral cobalt(III) complex, $\text{Co}(\text{C}_5\text{H}_7\text{O}_2)_3$

This reaction happens in two stages.

Stage 1 $\text{C}_5\text{H}_8\text{O}_2$ reacts with CoCO_3 to form an anionic ligand and two other
substances.



Stage 2 Co^{2+} reacts with H_2O_2 and this ligand to form $\text{Co}(\text{C}_5\text{H}_7\text{O}_2)_3$

0 3 . 1

State the role of $\text{C}_5\text{H}_8\text{O}_2$ in **Stage 1**.

[1 mark]

0 3 . 2

Deduce the role of H_2O_2 in **Stage 2**.

State the type of anionic ligand in $\text{Co}(\text{C}_5\text{H}_7\text{O}_2)_3$

[2 marks]

Role of H_2O_2 _____

Type of ligand _____

0 3 . 3

Once the reaction is complete and crystals begin to form, the mixture is placed in
an ice bath.

Suggest why the mixture is placed in an ice bath.

[1 mark]



0 3 . 4

The crude solid product is purified by recrystallisation.

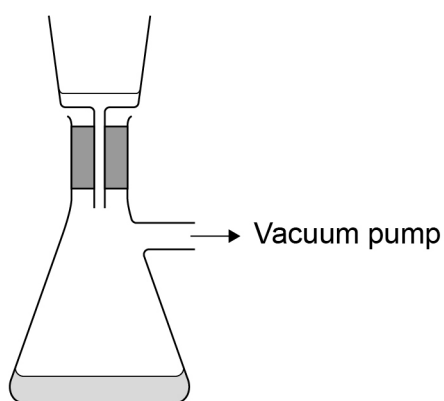
Describe the property of a solvent that makes it suitable for the recrystallisation of a solid.

[1 mark]

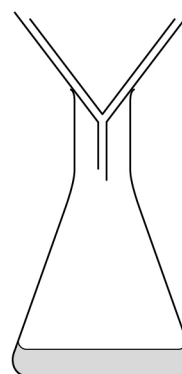
0 3 . 5

Figure 5 shows two methods of filtration that can be used to collect the crystals after recrystallisation.

Figure 5



Method A



Method B

Give two advantages of **Method A**.

[2 marks]

Advantage 1 _____

Advantage 2 _____

Question 3 continues on the next page

Turn over ►



A student makes a different cobalt complex.
Part of the process involves boiling a solution that contains concentrated ammonia.

0	3
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6

 Other than safety goggles, suggest **one** important safety device that should be used. **[1 mark]**

0	3
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7

 The mixture containing the different cobalt(III) complex is filtered while it is still hot.
Suggest **one** reason why the mixture is filtered while it is still hot. **[1 mark]**

9



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 The table gives information about some of the fundamental particles in two ions.

Ion	Number of neutrons	Number of electrons
$^{79}\text{Se}^{2-}$	X	36
$^{52}\text{Cr}^{3+}$	28	Y

Which row shows the values of **X** and **Y**?

[1 mark]

	X	Y
A	43	25
B	45	21
C	43	31
D	45	27

☐
☐
☐
☐


0 5 Consider the **second** ionisation energies of the Period 3 elements Na, Mg and Al

Which shows them in the correct order?

[1 mark]

A Na > Al > Mg ☐

B Na > Mg > Al ☐

C Mg > Al > Na ☐

D Mg > Na > Al ☐

0 6 A student heats a 7.80 g sample of hydrated magnesium sulfate, $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$, until all the water of crystallisation is removed.

The mass of solid remaining is 3.83 g

What is the value of x in $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$?

M_r of $\text{MgSO}_4 = 120.4$

[1 mark]

A 3 ☐

B 4 ☐

C 6 ☐

D 7 ☐

0 7 The concentration of a sodium hydroxide solution is determined by titration against an acid of known concentration. The acid is in the burette.

Which decreases the percentage uncertainty in the burette reading?

[1 mark]

A Adding water to the conical flask during the titration ☐

B Drying the flask after washing between each titration ☐

C Using a smaller pipette ☐

D Using an acid of lower concentration ☐



0 8

^{31}P is the only stable isotope of phosphorus.

One form of phosphorus has the formula P_4

What is the mass, in kg, of a single molecule of P_4 ?

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

[1 mark]

A 2.06×10^{-22}

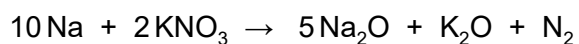
B 5.15×10^{-23}

C 2.06×10^{-25}

D 5.15×10^{-26}

0 9

Which is the percentage atom economy for the formation of sodium oxide in this reaction?

**[1 mark]**

A 14.3%

B 21.8%

C 48.1%

D 71.7%

Turn over for the next question

Turn over ►

1 0Which property can be used to explain why iodine has a **higher** melting point than ice?**[1 mark]**

- A** Size of molecule ☐
- B** Strength of covalent bonds ☐
- C** Polarity of the molecule ☐
- D** Type of crystal structure ☐

1 1

Which of these molecules has a permanent dipole?

[1 mark]

- A** BeCl_2 ☐
- B** BCl_3 ☐
- C** CCl_4 ☐
- D** PCl_3 ☐

1 2

Which is a correct definition for the standard enthalpy of combustion of a substance?

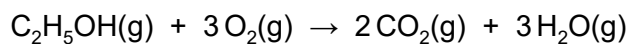
[1 mark]

- A** The enthalpy change when a substance is completely burned in oxygen under standard conditions with all reactants and products in their standard states. ☐
- B** The heat energy change when one mole of substance is completely burned in excess oxygen at 100 kPa and 298 K with all reactants and products in their standard states. ☐
- C** The enthalpy change when one mole of substance is burned in oxygen at 100 kPa and 298 K with all reactants and products in their standard states. ☐
- D** The heat energy change when one mole of substance is completely burned in oxygen with all reactants and products in their standard states. ☐



1 3

Which is the enthalpy change, in kJ mol^{-1} , for the combustion of 1 mol of gaseous ethanol?



	C–C	C–H	C–O	O–H	C=O	O=O
Bond enthalpy / kJ mol^{-1}	348	412	360	463	803	496

[1 mark]

A +1271 ☐

B +1631 ☐

C –1631 ☐

D –1271 ☐

1 4

The enthalpy of hydration of calcium ions = $-1650 \text{ kJ mol}^{-1}$
The enthalpy of hydration of chloride ions = -364 kJ mol^{-1}

The enthalpy of lattice formation of calcium chloride = $-2237 \text{ kJ mol}^{-1}$

Which is the enthalpy of solution of calcium chloride?

[1 mark]

A 223 kJ mol^{-1} ☐

B 141 kJ mol^{-1} ☐

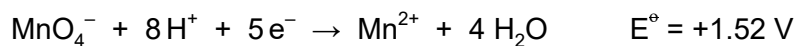
C -141 kJ mol^{-1} ☐

D -223 kJ mol^{-1} ☐

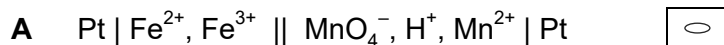
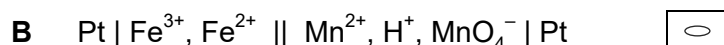
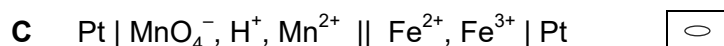
Turn over ►

1 5

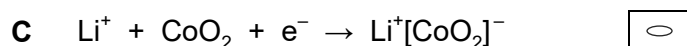
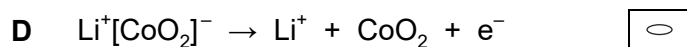
An electrochemical cell is set up to measure the EMF of the redox reaction between MnO_4^- and Fe^{2+}



Which is the correct conventional cell representation when the EMF = +0.75 V?

[1 mark]**1 6**

Which equation shows the process occurring at the negative electrode when a lithium ion cell is being used?

[1 mark]

1 7

Four samples are known to be the elements aluminium, silicon, phosphorus (white) and sulfur. The melting points of these samples are measured.

The table shows the melting points.

Sample	Melting Point / K
W	386
X	317
Y	1687
Z	933

Which shows the elements in the order **W, X, Y, Z**?

[1 mark]

- A** Phosphorus, sulfur, aluminium, silicon ☐
- B** Phosphorus, sulfur, silicon, aluminium ☐
- C** Sulfur, phosphorus, aluminium, silicon ☐
- D** Sulfur, phosphorus, silicon, aluminium ☐

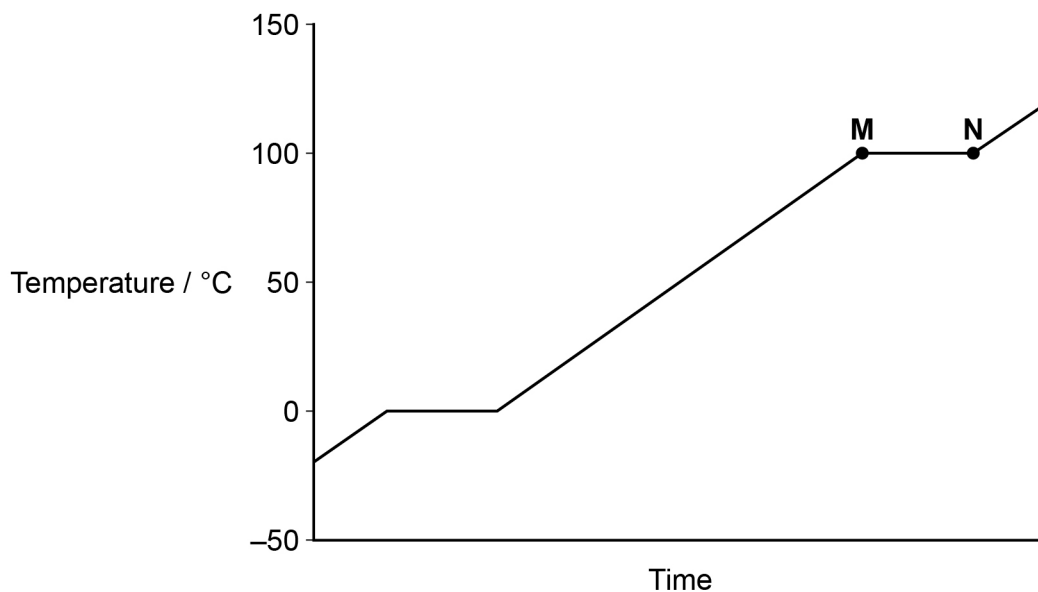
Turn over for the next question

Turn over ►



1 8 A sample of $\text{H}_2\text{O}(\text{s})$ is heated from $-20\text{ }^\circ\text{C}$ to $120\text{ }^\circ\text{C}$

The graph shows the temperature of the H_2O sample over time.



Which statement is correct about the change from point **M** to point **N**?

[1 mark]

- A** It is an endothermic process;
the entropy of the H_2O sample increases. ☐
- B** It is an endothermic process;
the entropy of the H_2O sample decreases. ☐
- C** It is an exothermic process;
the entropy of the H_2O sample increases. ☐
- D** It is an exothermic process;
the entropy of the H_2O sample decreases. ☐



1 9 **A** and **B** react in the presence of an acid catalyst, H^+



For this reaction

- the unit of the rate constant k is $\text{mol}^{-3} \text{dm}^9 \text{s}^{-1}$
- when both the concentration of **A** is doubled and the concentration of **B** is reduced by half, the rate of reaction reduces by half.

Which is the correct rate equation for the reaction?

[1 mark]

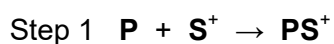
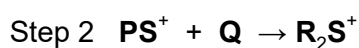
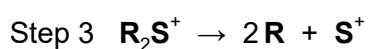
A Rate = $k[\text{A}][\text{B}][\text{H}^+]$ ☐

B Rate = $k[\text{A}]^2[\text{B}][\text{H}^+]$ ☐

C Rate = $k[\text{A}][\text{B}]^2[\text{H}^+]$ ☐

D Rate = $k[\text{A}][\text{B}]^2[\text{H}^+]^2$ ☐

2 0 Substances **P** and **Q** react in the presence of a catalyst to form **R**.
The mechanism of the reaction has three steps.



The second step is the rate determining step in the mechanism.

Which is the rate equation for the reaction?

[1 mark]

A Rate = $k[\text{P}][\text{S}^+]$ ☐

B Rate = $k[\text{P}][\text{S}^+][\text{Q}]$ ☐

C Rate = $k[\text{P}][\text{S}^+][\text{PS}^+][\text{Q}]$ ☐

D Rate = $k[\text{PS}^+][\text{Q}]$ ☐

Turn over ►



2 1

Which statement about Group 2 hydroxides is correct?

[1 mark]

- A** Barium hydroxide is less soluble in water than strontium hydroxide.
- B** Barium hydroxide is used in medicine to produce X-rays.
- C** Magnesium hydroxide is a product of the reaction of magnesium with steam.
- D** Magnesium hydroxide is used in medicine to treat indigestion.

☐☐☐☐**2 2**A student does three separate tests on a solution of compound **M**.

The observations from these tests are recorded in the table.

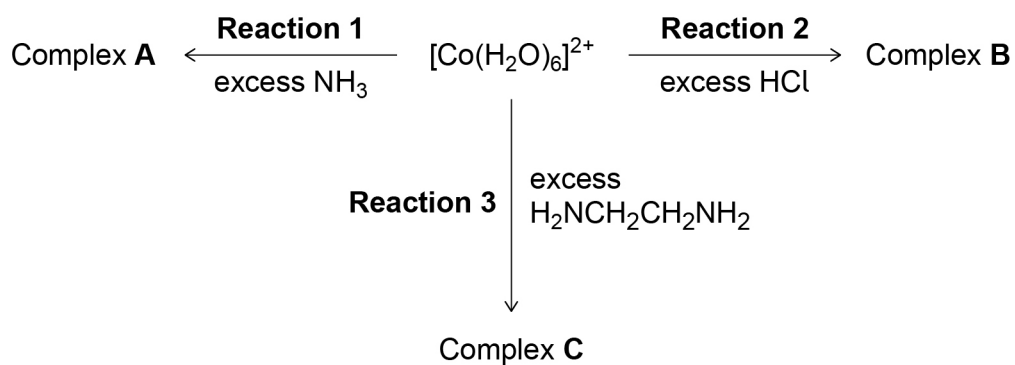
Test	Add dilute H_2SO_4	Add $\text{Na}_2\text{CO}_3(\text{aq})$	Add $\text{AgNO}_3(\text{aq})$
Observation	White precipitate	White precipitate	White precipitate

Which is compound **M**?**[1 mark]**

- A** Barium chloride
- B** Barium nitrate
- C** Magnesium chloride
- D** Magnesium nitrate

☐☐☐☐

2 3 Some reactions of $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ are shown.



Which is correct?

[1 mark]

- A** The energy gap between the d-orbitals is the same in Complex **A** and $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$
- B** **Reaction 2** has a negative entropy change.
- C** Complex **B** has a lower ligand-metal-ligand bond angle than $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$
- D** **Reaction 3** produces a pair of isomers.

☐
☐
☐
☐

Turn over for the next question

Turn over ►



2 4

A student investigates the oxidation states of vanadium using the method shown.

Method

- Pour some acidified ammonium vanadate(V) solution into a conical flask.
- Add powdered zinc.
- Put a piece of cotton wool into the neck of the conical flask.
- Swirl the conical flask then leave the contents to react.

Which statement is correct?

[1 mark]

- A** Zinc acts as an oxidising agent.
- B** The correct order of vanadium species formed from the ammonium vanadate(V) solution is V^{3+} then VO^{2+} then V^{2+} .
- C** The cotton wool helps to prevent air from entering the conical flask, to make sure that V^{2+} is obtained.
- D** Bubbles are observed as vanadium reacts with the acid.

☐☐☐☐

2 5

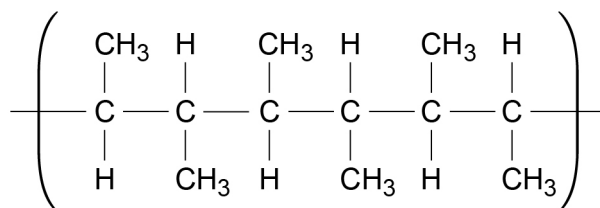
Which is the correct structural formula for 2-methylbutyl ethanoate?

[1 mark]**A** $\text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_3$ ☐**B** $\text{CH}_3\text{COOCH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$ ☐**C** $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{COOCH}_2\text{CH}_3$ ☐**D** $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{COOCH}_2\text{CH}_3$ ☐**2 6**

How many isomeric alkenes, in total, are formed when 3-iodo-2-methylpentane reacts with ethanolic potassium hydroxide?

[1 mark]**A** 2 ☐**B** 3 ☐**C** 4 ☐**D** 5 ☐**Turn over for the next question****Turn over ►**

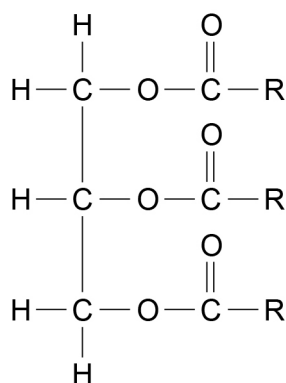
- 2 7** A section of a polymer is shown. Which statement is correct?



[1 mark]

- A** It is a condensation polymer. ☐
- B** The section of the polymer has six repeating units. ☐
- C** The polymer can be made from but-2-ene. ☐
- D** The polymer is biodegradable. ☐

- 2 8** A student tested both products of the acidic hydrolysis of a triglyceride ester in separate test tubes.



Triglyceride ester

Which reagents will identify the functional groups in the two products of this hydrolysis?

[1 mark]

	Reagent 1	Reagent 2	
A	Tollens' reagent	$\text{K}_2\text{Cr}_2\text{O}_7$ and H_2SO_4	☐
B	NaHCO_3	blue litmus indicator	☐
C	NaHCO_3	$\text{K}_2\text{Cr}_2\text{O}_7$ and H_2SO_4	☐
D	Tollens' reagent	blue litmus indicator	☐



2 9

A student uses gas chromatography (GC) to analyse a mixture of pentane, ethyl ethanoate, and butanoic acid.

The stationary phase is very polar. Nitrogen is the carrier gas.

Which row shows the order of increasing retention times?

[1 mark]

	Shortest retention time	Intermediate retention time	Longest retention time
A	pentane	ethyl ethanoate	butanoic acid
B	ethyl ethanoate	butanoic acid	pentane
C	ethyl ethanoate	pentane	butanoic acid
D	butanoic acid	ethyl ethanoate	pentane

☐☐☐☐

Turn over for the next question

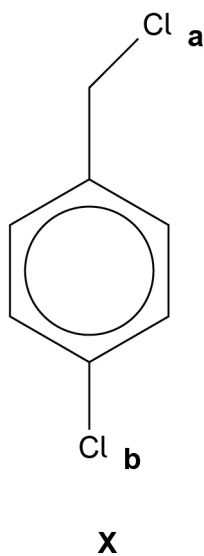
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3	0
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 Which statement about compound **X** is correct?

The chlorine atoms are labelled.



[1 mark]

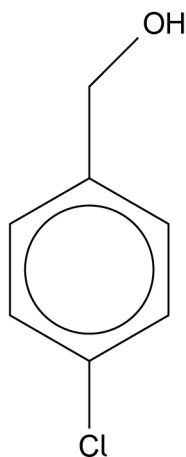
A The chlorine atom labelled **a** can be introduced into the molecule by reacting methylbenzene with chlorine in an electrophilic substitution reaction.

☐

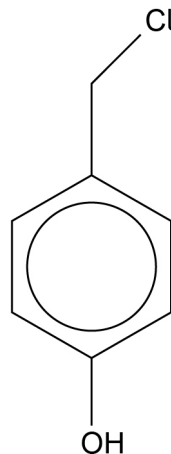
B The chlorine atom labelled **b** can be introduced into the molecule by reacting benzene with chlorine in a nucleophilic substitution reaction.

☐

C Reaction of **X** with aqueous NaOH makes

☐

D Reaction of **X** with aqueous NaOH makes

☐

Turn over for the next question

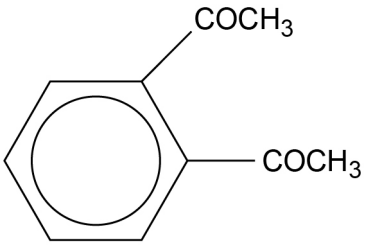
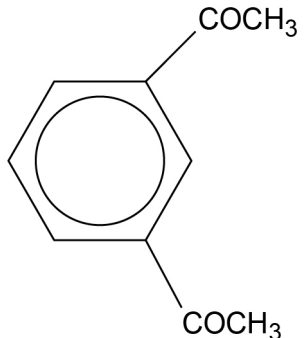
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3 1A student prepares a sample for ^1H NMR spectroscopy.

Which is used to compare the chemical shift data with standard values?

[1 mark]**A** CCl_4 ☐**B** CDCl_3 ☐**C** $\text{Si}(\text{CH}_3)_4$ ☐**D** $\text{C}_2\text{H}_5\text{OH}$ ☐**3 2**Which row shows the number of peaks in the ^{13}C NMR spectrum of these two compounds?**[1 mark]**

			
A	5	4	☐
B	5	6	☐
C	6	5	☐
D	6	6	☐



3 3

An amine contains 49.0% carbon and 13.5% hydrogen by mass.

Which is its empirical formula?

[1 mark]**A** CH_5N ☐**B** $\text{C}_2\text{H}_5\text{N}$ ☐**C** $\text{C}_3\text{H}_{10}\text{N}_2$ ☐**D** $\text{C}_4\text{H}_{10}\text{N}_2$ ☐**30****END OF QUESTIONS**

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3 6



2 6 6 X C H 0 5

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