OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

INTERNATIONAL A-LEVEL

CHEMISTRY (9620)

Unit 5: Practical and Synoptic

Tuesday 11 June 2019 07:00 GMT 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.
- All working must be shown.
- 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).
- 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	

Do not write outside the box

Section A

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

0 1 This question is about titrations.

25.0 cm^3 samples of barium hydroxide solution are titrated with 0.108 mol dm^{-3} hydrochloric acid using phenolphthalein as the indicator.

The results are shown in **Table 1.**

Table 1

	1	**2**	**3**
Final burette reading / cm^3	26.50	44.40	25.15
Initial burette reading / cm^3	4.20	22.30	3.15
Titre / cm^3	22.30	22.10	22.00

0 1 . 1 Calculate the mean titre.

[1 mark]

Mean titre _____ cm^3

0 1 . 2 Write an equation for the reaction between barium hydroxide solution and hydrochloric acid.

[1 mark]

_____

Do not write outside the box

0 1 . 3 Use your answers to question **01.1** and question **01.2** to calculate the concentration, in mol dm^{-3}, of the barium hydroxide solution.

Give your answer to 3 significant figures.

[3 marks]

Concentration _____ mol dm^{-3}

The inside of the conical flask is washed with deionised water during each titration.

0 1 . 4 State why this washing is done.

[1 mark]

_____

_____

0 1 . 5 Explain why the addition of water does not give an incorrect value for the titre.

[1 mark]

_____

_____

0 1 . 6 A student suggested universal indicator is used instead of phenolphthalein.

Give a reason why universal indicator is **not** a good choice for this titration.

[1 mark]

_____

_____

8

Do not write outside the box

0 2 This question is about propanal and propanoic acid.

Table 2 shows some data about propanal and propanoic acid.

Table 2

	Melting point / °C	Boiling point / °C
Propanal	–81	49
Propanoic acid	–21	141

Pure samples of propanal and of propanoic acid are made by oxidation of an alcohol using potassium dichromate(VI) and reagent **A**.

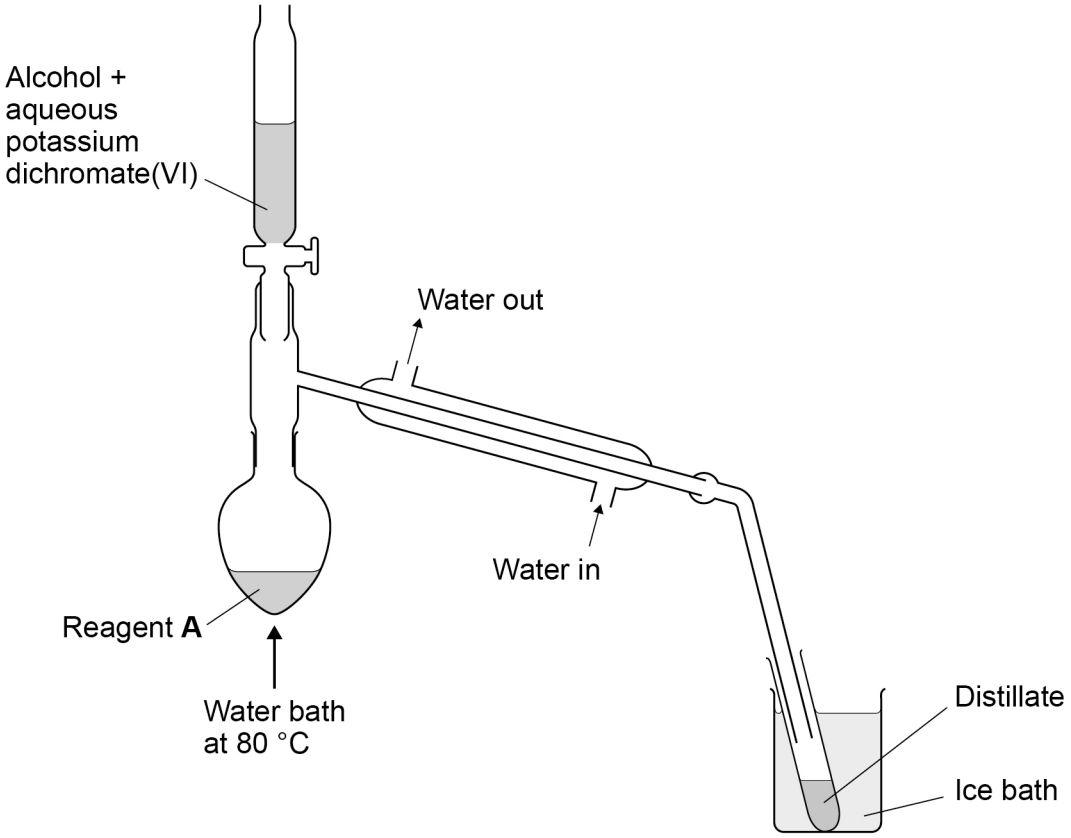
0 2 . 1 Use IUPAC rules to name the alcohol used to make propanal and propanoic acid.

[1 mark]

_____

Figure 1 shows the apparatus used to make propanal.

Figure 1



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0 2 . 2 Identify reagent **A.**

[1 mark]

0 2 . 3 Suggest a reason why a water bath is used instead of a Bunsen burner.

[1 mark]

0 2 . 4 Explain, in terms of structure and bonding, why propanal, instead of propanoic acid, is collected in the test tube.

[3 marks]

0 2 . 5 State how the apparatus in **Figure 1** can be changed to give a high yield of propanoic acid.

[1 mark]

Question 2 continues on the next page

Do not write outside the box

0 2 . 6 Give a reagent and the expected observation for a simple test-tube reaction that can be used to identify the functional group in each of propanal and propanoic acid.

[4 marks]

Propanal

Reagent _____

Observation _____

_____

Propanoic acid

Reagent _____

Observation _____

_____

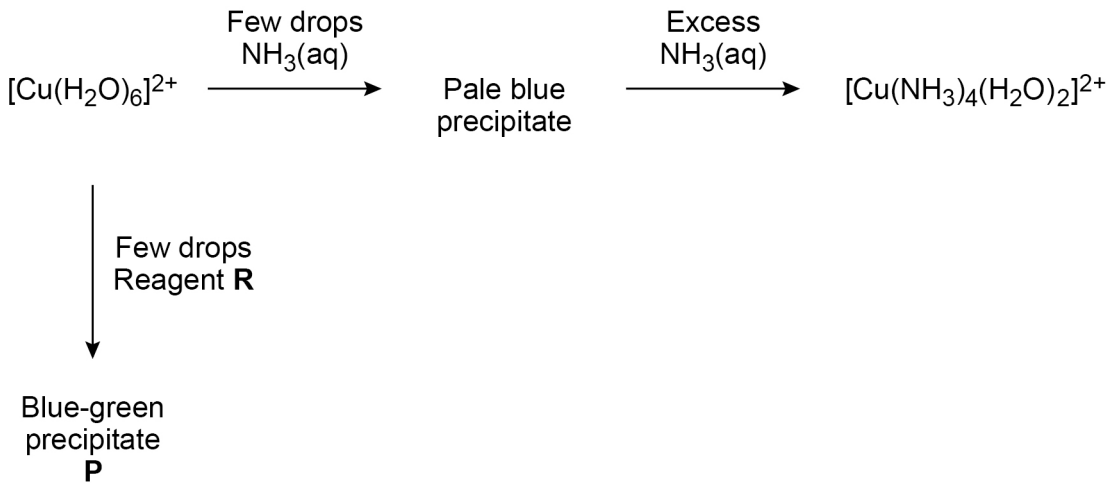
11

Do not write outside the box

0 3 A student investigates the reactions of some aqueous metal ions.

Figure 2 shows some reactions of aqueous copper(II) ions.

Figure 2



0 3 . 1 Deduce the formula of **P** and the formula of **Q**.

Identify reagent **R**.

State the colour of the solution that contains $[Cu(NH_3)_4(H_2O)_2]^{2+}$ ions.

[4 marks]

Formula of **P** _____

Formula of **Q** _____

Identity of reagent **R** _____

Colour _____

Question 3 continues on the next page

Do not write outside the box

Table 3 shows the results of tests on an aqueous solution containing $[Fe(H_2O)_6]^{3+}$ ions.

Table 3

Test	Reagent	Observation
1	a few drops of NaOH(aq)	brown precipitate
2	an excess of concentrated HCl(aq)	yellow solution

0 3 . 2 Write an equation for the reaction that occurs in **Test 1.**

[1 mark]

0 3 . 3 Give the ionic equation for the reaction that occurs in **Test 2**.

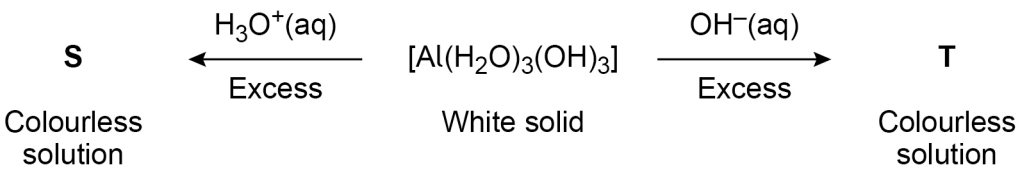
[1 mark]

Do not write outside the box

Two tests are done on $Al(H_2O)_3(OH)_3$

Figure 3 shows the tests and the results.

Figure 3



0 3 . 4 Give the co-ordination number of Al in $Al(H_2O)_3(OH)_3$

Name the shape of this complex.

[2 marks]

Co-ordination number _____

Name of shape _____

0 3 . 5 State the property of $Al(H_2O)_3(OH)_3$ shown by the tests in **Figure 3**.

[1 mark]

_____

0 3 . 6 Give the formula for the aluminium species **S**.

Write an equation for the reaction of $[Al(H_2O)_3(OH)_3]$ to form **T**.

[2 marks]

Formula of **S** _____

Equation to form **T**

_____

11

Turn over for Section B

Do not write outside the box

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 answer 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 What is the mass number of an atom?

[1 mark]

A The mass of the nucleus of an atom. ⬭

B The mean mass of an atom compared with $\frac{1}{12}$ of the mass of an atom of ^{12}C ⬭

C The number of protons in the nucleus of an atom. ⬭

D The number of protons plus neutrons in the nucleus of an atom. ⬭

0 5 What is the electron configuration of the Cr^{2+} ion in the ground state?

[1 mark]

A $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2$ ⬭

B $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4$ ⬭

C $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$ ⬭

D $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$ ⬭

Do not write outside the box

0 6 Which element has the highest **third** ionisation energy?

[1 mark]

A Al

B Mg

C Ne

D Na

0 7 Which molecule has a permanent dipole?

[1 mark]

A BF_3

B NF_3

C CF_4

D PF_5

0 8 Which statement is correct for both the standard enthalpy of formation **and** the standard enthalpy of combustion?

[1 mark]

A They both need one mole of reactants.

B They both need one mole of products.

C They both need products in the gaseous state.

D They both need a specified temperature.

Turn over for the next question

Do not write outside the box

0 9 A 2.0 g sample of an alcohol was completely burned in a spirit burner.
The heat energy released increased the temperature of 100 cm^3 of water by 23 °C.

What is the enthalpy of combustion, in kJ g^{-1}, of the alcohol?

The specific heat capacity of water is 4.2 J g^{-1} K^{-1}.

[1 mark]

A 0.19 ⬭

B 4.8 ⬭

C 9.7 ⬭

D 62 ⬭

1 0 Nitrogen reacts with fluorine to form nitrogen trifluoride.

$$N_2(g) + 3F_2(g) \rightarrow 2NF_3(g)$$

Bond	N≡N	F–F	N–F
Bond enthalpy / kJ mol^{-1}	941	158	272

What is the enthalpy of formation, in kJ mol^{-1}, for nitrogen trifluoride?

[1 mark]

A –217 ⬭

B –108.5 ⬭

C +108.5 ⬭

D +217 ⬭

Do not write outside the box

1 1 The equation for a reaction is shown.

$$A(s) + B(aq) \rightarrow C(aq) + D(l) + E(g)$$

Which change can be used to monitor the rate of this reaction in a conical flask?

[1 mark]

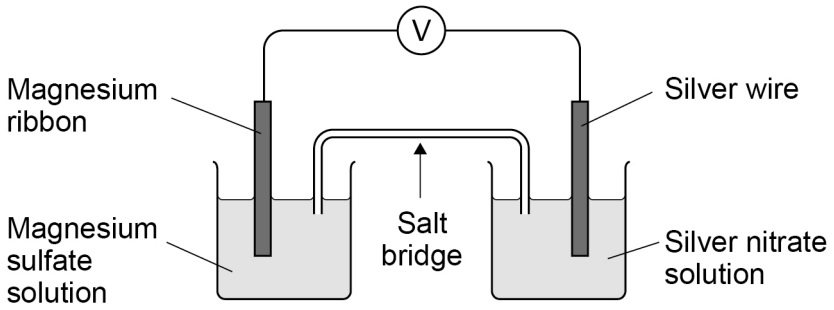
A A decrease in the mass of the flask and its contents. ⬭

B A decrease in the volume of the solution in the flask. ⬭

C A decrease in the concentration of C. ⬭

D A decrease in the partial pressure of E. ⬭

1 2 A student sets up a cell as shown.



Which of these will decrease the accuracy of the measurement of the EMF?

[1 mark]

A Clean the magnesium ribbon before the experiment. ⬭

B Clean the silver wire with propanone. ⬭

C Use a larger piece of magnesium ribbon. ⬭

D Use sodium chloride solution in the salt bridge. ⬭

Turn over for the next question

Do not write outside the box

1 3 The electrode reactions in an alkaline hydrogen fuel cell are shown

$H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(l) + 2e^-$ $E^\ominus = -0.83$ V

$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$ $E^\ominus = +0.40$ V

Which shows the overall equation and EMF for this fuel cell?

[1 mark]

	Overall equation	EMF / V
A	$H_2(g) + ½O_2(g) \rightarrow H_2O(l)$	+1.23
B	$H_2O(l) \rightarrow H_2(g) + ½O_2(g)$	+1.23
C	$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$	–1.23
D	$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$	–1.23

1 4 Which pair of aqueous reagents can be mixed to form a basic buffer solution?

[1 mark]

A Ammonia and ammonium chloride

B Ammonia and sodium chloride

C Ethanoic acid and sodium chloride

D Ethanoic acid and sodium ethanoate

Do not write outside the box

1 5 Which combination of acid and indicator is suitable to determine the concentration of ammonia solution by titration?

Indicator	pH range
methyl orange	3.1 — 4.4
phenolphthalein	8.3 — 10.0

[1 mark]

A Ethanoic acid and phenolphthalein ⬭

B Ethanoic acid and methyl orange ⬭

C Hydrochloric acid and phenolphthalein ⬭

D Hydrochloric acid and methyl orange ⬭

1 6 Which pair of reagents do not form a racemic mixture when they react?

[1 mark]

A $CH_3CH{=}CH_2$ + Br_2 ⬭

B $CH_3CH{=}CHCH_3$ + HBr ⬭

C CH_3CH_2CHO + $NaBH_4$ ⬭

D $CH_3CH_2COCH_3$ + HCN ⬭

Turn over for the next question

Do not write outside the box

1 7 A transition metal ion absorbs energy of 4.24×10^{-19} J when one of its d electrons moves from the ground state to the excited state.

What is the frequency, in Hz, of the light absorbed?

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

[1 mark]

A 2.81×10^{-52} ⬭

B 1.56×10^{-15} ⬭

C 6.40×10^{14} ⬭

D 3.85×10^{38} ⬭

1 8 A colorimeter can be used to determine the concentration of transition metal ions in solution.

What quantities are plotted on the calibration graph?

[1 mark]

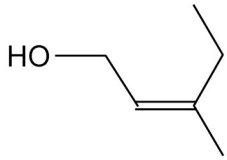
	x-axis	**y-axis**	
A	concentration	absorbance	⬭
B	frequency	absorbance	⬭
C	wavelength	concentration	⬭
D	absorbance	wavelength	⬭

Do not write outside the box

1 9 What is the skeletal formula of *Z*-3-methylpent-2-en-1-ol?

[1 mark]

A



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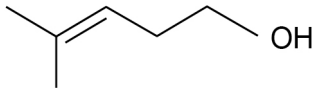

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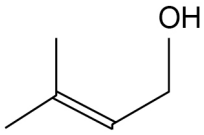

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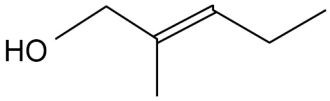


2 0 What is the mechanism for the reaction between an alkane and a halogen?

[1 mark]

A Nucleophilic substitution

B Free-radical substitution

C Electrophilic addition

D Elimination

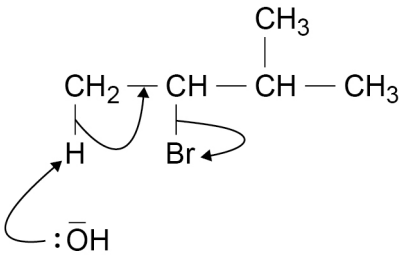
Turn over for the next question

Do not write outside the box

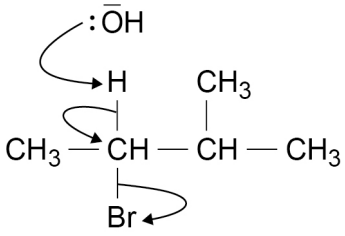
2 1 Which diagram shows an **incorrect** mechanism?

[1 mark]

A



B



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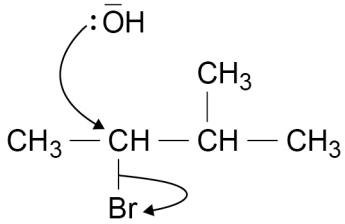

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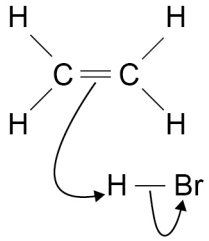

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2 2 Which equation represents a Brønsted-Lowry acid-base equilibrium?

[1 mark]

A $[Cu(H_2O)_6]^{2+} + CO_3^{2-} \rightleftharpoons CuCO_3 + 6H_2O$

B $[Cu(H_2O)_6]^{2+} + 4NH_3 \rightleftharpoons [Cu(H_2O)_2(NH_3)_4]^{2+} + 4H_2O$

C $Cl_2 + 2NaOH \rightleftharpoons NaCl + NaOCl + H_2O$

D $Ca(OH)_2 + 2NH_4Cl \rightleftharpoons CaCl_2 + 2H_2O + 2NH_3$

2 3 Ethylamine can be made by reacting bromoethane with ammonia as shown.

$$CH_3CH_2Br + 2NH_3 \rightarrow CH_3CH_2NH_2 + NH_4Br$$

What is the percentage atom economy for the formation of ethylamine in this reaction?

[1 mark]

A 31.5 %

B 35.7 %

C 41.3 %

D 68.5 %

2 4 Which reagent can be used to convert ethanenitrile to ethylamine?

[1 mark]

A Ammonia

B Hydrogen and nickel

C Potassium dichromate(VI) and sulfuric acid

D Sodium hydroxide

Turn over for the next question

Do not write outside the box

2 5 What is the starting material and the catalyst for the production of epoxyethane?

[1 mark]

A Ethane-1,2-diol and nickel

B Ethane-1,2-diol and silver

C Ethene and nickel

D Ethene and silver

2 6 Methanol and ethanoic acid react to form methyl ethanoate.

Which range of infrared absorptions can be used to check that the product is **not** contaminated with methanol?

[1 mark]

A 3230 – 3550 cm^{-1}

B 2500 – 3000 cm^{-1}

C 1680 – 1750 cm^{-1}

D 1000 – 1300 cm^{-1}

2 7 Which statement about benzene is **not** correct?

[1 mark]

A The benzene molecule has 12 atoms that are all in the same plane.

B The carbon-carbon bond length in benzene is shorter than the carbon-carbon bond length in ethene.

C Benzene is more stable than expected due to the delocalisation of p electrons.

D Benzene undergoes substitution reactions with electrophiles.

Do not write outside the box

2 8 Propyl ethanoate can be hydrolysed by aqueous sodium hydroxide and by dilute hydrochloric acid.

Which compound is **not** formed in either of these hydrolysis reactions?

[1 mark]

A Sodium ethanoate ⬭

B Ethanoic acid ⬭

C Ethanol ⬭

D Propan-1-ol ⬭

2 9 Which statement is correct about chlorine free-radicals?

[1 mark]

A They react with benzene in a substitution reaction involving the ring. ⬭

B They react with methylbenzene in a substitution reaction involving the ring. ⬭

C They react with methylbenzene in an addition reaction in the side chain. ⬭

D They react with benzene in an addition reaction involving the ring. ⬭

3 0 What type of interaction occurs in the formation of the secondary structure of a protein?

[1 mark]

A The formation of an α-helix. ⬭

B The formation of induced dipole-dipole forces. ⬭

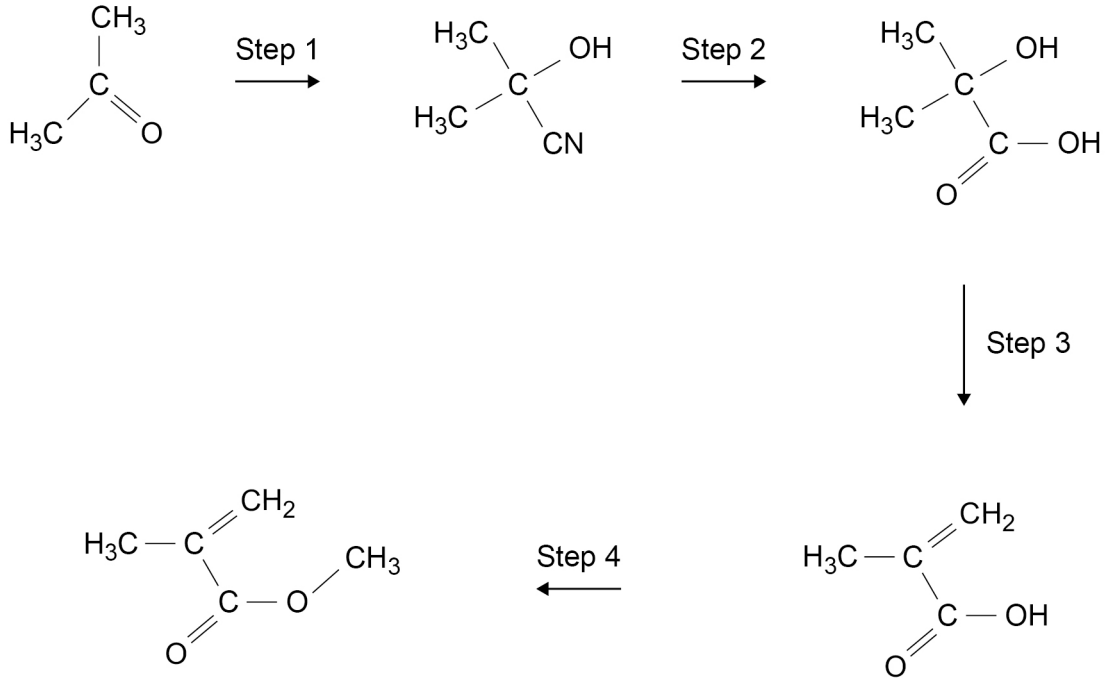
C The formation of S–S bonds. ⬭

D The formation of a peptide link. ⬭

Turn over for the next question

Do not write outside the box

3 1 A four-step synthesis starting from propanone is shown.



Which type of reaction does **not** occur in this synthesis?

[1 mark]

A Addition

B Elimination

C Hydrolysis

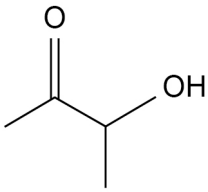
D Substitution

Do not write outside the box

3 2 Which compound has a triplet peak in its ^{1}H NMR spectrum?

[1 mark]

A



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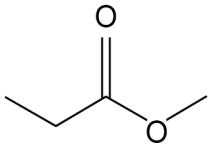

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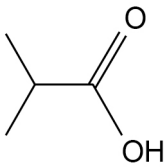

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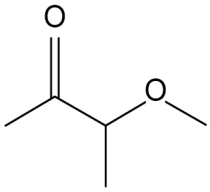

3 3 Which solvent should be used when obtaining the ^{1}H NMR spectrum of an amino acid?

[1 mark]

A CCl_4

B CD_4

C D_2O

D H_2O

30

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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