Write-on

Chemistry A
Unit H432

Practice Paper 2D

Name	

Time allowed
2 hours 15 minutes

Information
- The total marks available for this paper is 100. The number of marks available for each question is shown in brackets.
- Answer all questions and show all working

You will need:
An OCR A Chemistry data sheet

You may use:
- A scientific or graphical calculator
- A pencil for graphs and drawings
- A ruler

Question	Mark
MCQs	
16	
17	
18	
19	
20	
21	
Total	

Paper 2D

SECTION A

You should aim to finish this section within 20 minutes.

1 A student used Buchner apparatus to achieve purification of an organic compound. What is the purpose of Buchner apparatus?

A To determine a melting point

B Reduced pressure filtration

C To separate an organic layer and an aqueous layer

D To remove water from a liquid product

Your answer ☐

2 Ethyl iodide was made to undergo substitution by a hydroxide ion. State the observation if silver nitrate solution is added with a small amount of ethanol.

A Brown precipitate

B White precipitate

C Cream precipitate

D Yellow precipitate

Your answer ☐

3 Two ester hydrolysis experiments were carried out in two separate flasks by a student.

Flask 1: Ethyl ethanoate was hydrolysed with hot aqueous NaOH.

Flask 2: Ethyl ethanoate was hydrolysed with hot aqueous acid.

To both flasks an excess of ethanoic acid and ethanol was added, and the contents of the flask monitored using spectroscopic techniques.

Identify what would be observed using spectroscopic techniques.

A Ethyl ethanoate would start to reform in both flasks.

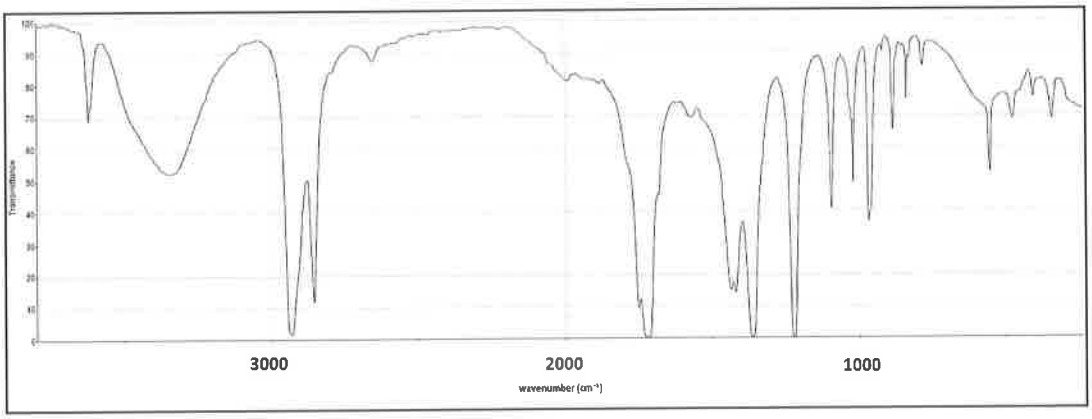
B Ethyl ethanoate would start to reform in flask 1, but not in flask 2.

C Ethyl ethanoate would start to reform in flask 2, but not in flask 1.

D Ethyl ethanoate would not start to reform in either flask.

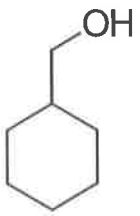
Your answer ☐

4



Which of the following molecules could give the above IR spectrum?

A



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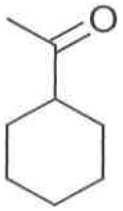
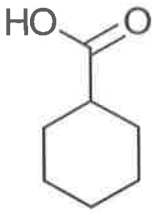
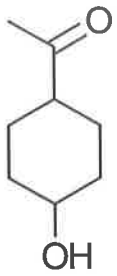


C



D



Your answer ☐

5 Lithium aluminium hydride, $LiAlH_4$ is an important reducing agent in chemistry. What is the oxidation state of each element in $LiAlH_4$?

A Li = +1 Al = +3 H = -1

B Li = -1 Al = -3 H = +1

C Li = +7 Al = +3 H= +1

D Li = +1 Al = -5 H= +1

Your answer ☐

6 A carboxylic acid with the formula $CH_3(CH_2)xCOOH$ is reacted with sodium hydroxide to give a salt that is 60 % carbon by mass. Give the value of X.

A 7

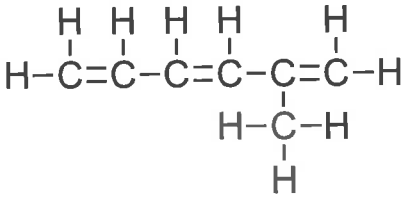
B 8

C 9

D 10

Your answer ☐

7 How many cis/trans isomers of the following molecule can exist?



A 0

B 2

C 4

D 6

Your answer ☐

8 Which of the following statements about alkanes is not true?

A The lack of polar bonds in alkanes helps make them unreactive.

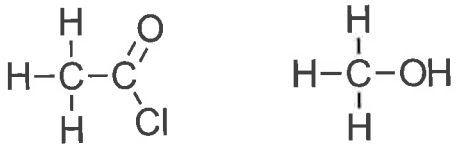
B The lack of polar bonds in alkanes means they do not dissolve well in water.

C The high bond enthalpy of alkanes helps make them unreactive.

D Alkanes do not form any stereoisomers because there is free rotation about the σ bonds.

Your answer ☐

9 The compounds below were reacted together to form an ester. What is the atom economy of this reaction?



A 67 %

B 68 %

C 80 %

D 81 %

Your answer ☐

10 Why is atom economy an important consideration for industrial chemists?

A A reaction with a high atom economy has a high yield of product.

B A reaction with a high atom economy has a high percentage conversion of starting materials.

C A reaction with a high atom economy wastes less material.

D A reaction with a high atom economy can be run at lower temperatures.

Your answer ☐

11 What is the correct order of these processes during recrystallisation of an organic product?

1. Filter to remove inorganic impurities
2. Cool and allow crystals to form
3. Dissolve in the minimum amount of hot solvent
4. Filter to remove organic impurities

A 3, 4, 1, 2

B 3, 1, 2, 4

C 1, 3, 2, 4

D 1, 3, 4, 2

Your answer ☐

12 What is the nitrogen-containing product if an excess of chloroethane is added to ammonia in ethanol?

A $CH_3CH_2NH_2$

B $(CH_3CH_2)_2NH$

C $(CH_3CH_2)_3N$

D $(CH_3CH_2)_4N^+$

Your answer ☐

13 Which of the following statements outlines the differences between distillation and reflux?

1. Reflux is only used in synthesis; distillation is only used in purification.
2. Reflux allows equilibrium to be reached, which cannot happen in distillation.
3. Distillation uses a condenser; reflux does not.

A 1 and 2 only

B 1 and 3 only

C 2 only

D 3 only

Your answer ☐

14 Which of the following are phenomena that arise due to differences in electronegativity in covalent bonds?

1. $CDCl_3$ being able to dissolve many carbonyl compounds for NMR
2. Alkenes being attractive to electrophiles
3. Ice being more dense than water

A 1 only

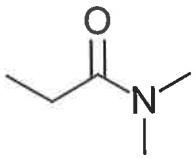
B 2 and 3 only

C 2 only

D 1, 2 and 3

Your answer ☐

15 Which of the statements about the molecule below are true?



1. It is a secondary amide.
2. Its name is N,N-dimethylethanamide.
3. One of its bonds is formed from the sideways overlap of p orbitals.

A 1 only

B 1 and 2 only

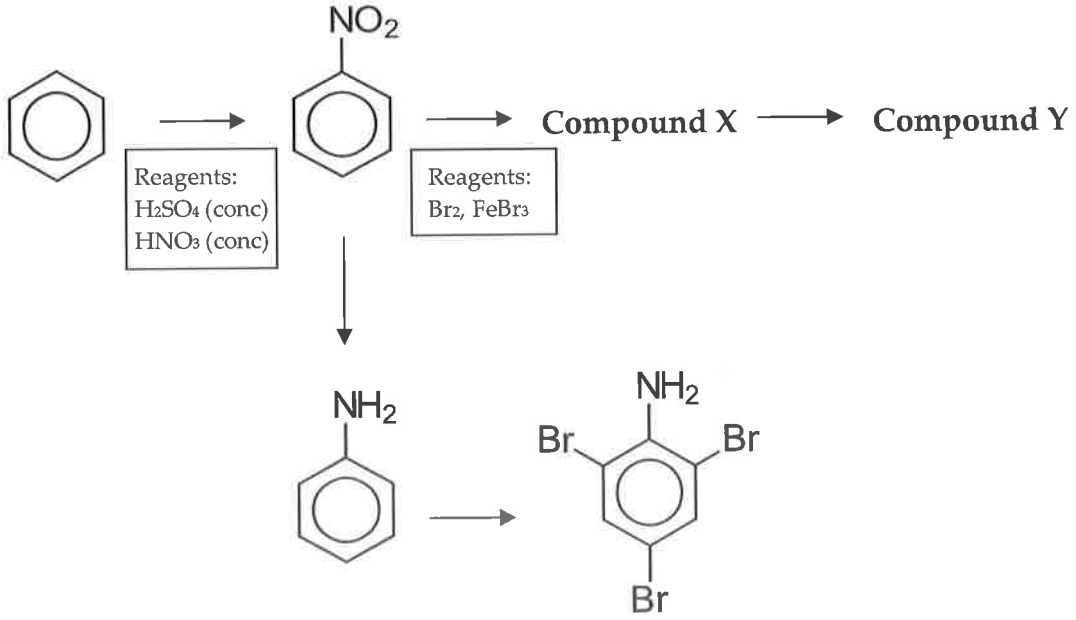
C 2 and 3 only

D 3 only

Your answer ☐

SECTION B

16. The introduction of functional groups to benzene revolves around a few key reactions, but these can be done in different orders to achieve different results.



Compound Z

a) Explain how the delocalised ring in benzene is formed.

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(2)

b) Describe, using a mechanism, how benzene can be converted into nitrobenzene. You should include equations in your answer to show the role of the catalyst.

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(5)

c) Nitrobenzene can be converted to compound X as shown above. Compound X is then converted to compound Y by reducing the nitro group.

Draw the structures of compound X and compound Y.

(2)

d) i) Name compound Z.

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(1)

ii) Explain why a halogen carrier is not needed to form compound Z.

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(3)

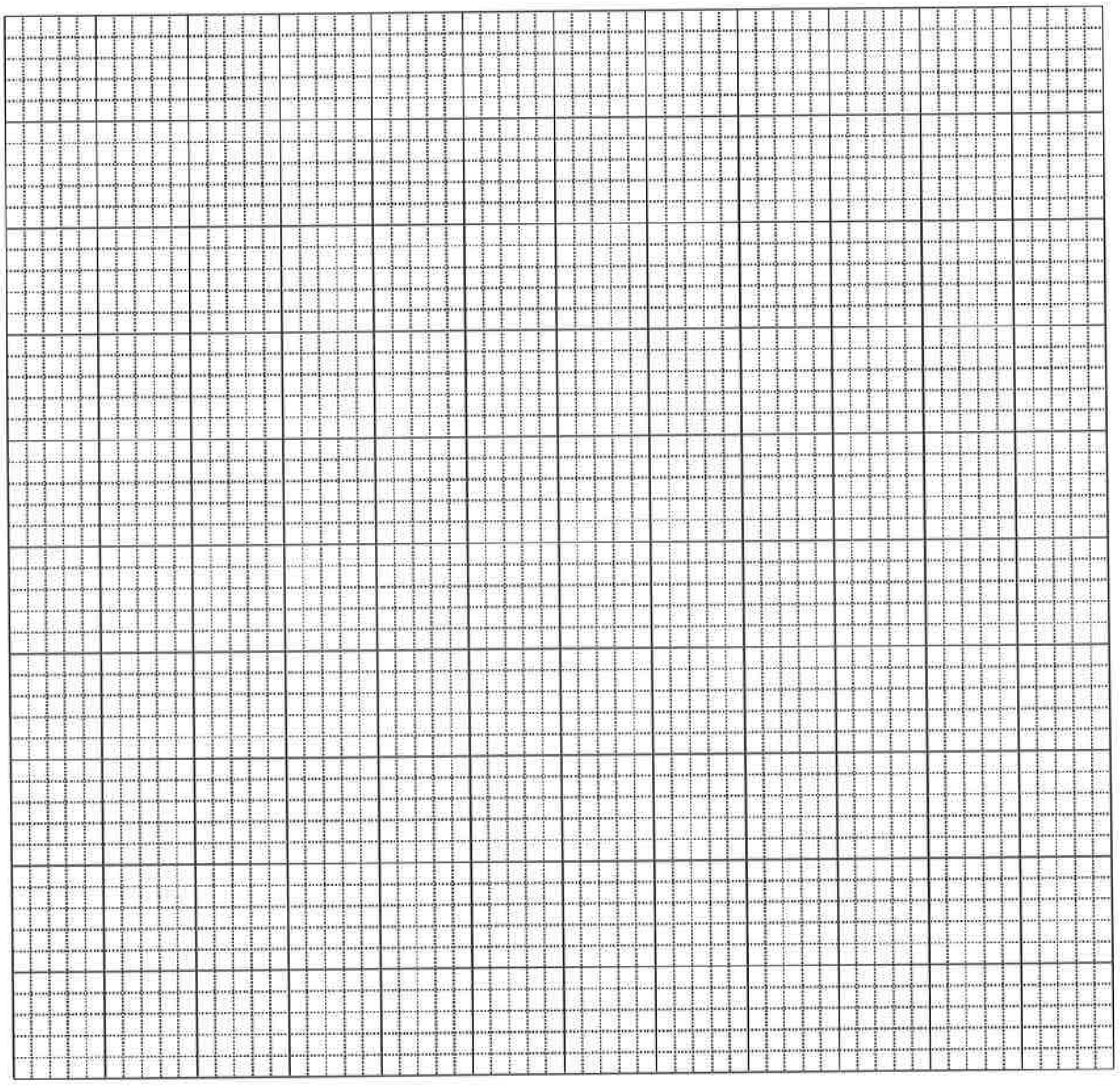
QUESTION TOTAL: 13 MARKS

17 A student measured the melting point of some linear (straight chain) carboxylic acids, to investigate how melting point varies with chain length. The student obtained the following data.

Upon analysing them, the student realised that the data contained an anomaly.

Chain Length of Carboxylic Acid	Melting Point (°C)
10	31
12	45
14	55
16	59
18	69
20	75

a) i) Draw a graph of these results including a line or curve of best fit, labelling the anomaly.



(3)

ii) Use your graph to suggest a correct value for the anomalous experimental reading. Ensure your working is clear on the graph.

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(1)

b) i) The thermometer used has 2 °C divisions. The student wants to repeat the experiment for any results with a percentage uncertainty of greater than 2 %. Which experiments need to be repeated? Show your working.

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(2)

ii) Identify a piece of apparatus that could be used to measure temperature more accurately.

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(1)

c) Explain the pattern shown in the results at the start of the question.

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(3)

d) The chemist synthesised a branched chain carboxylic acid. Explain what steps the chemist could take to identify it without the use of spectroscopy or spectrometry.

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(3)

e) Following this investigation, the student decided to investigate the trend in water solubility of the carboxylic acids with increasing chain length. Predict and explain the trend the chemist will observe.

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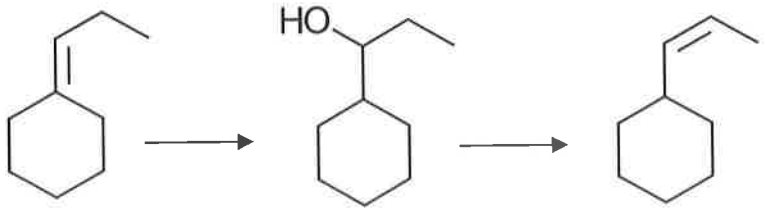
(4)

QUESTION TOTAL: 17 MARKS

18 Isomerisation reactions are integral to many natural processes, and often involve the conversion of one structural isomer to another.

Nature often achieves these processes using enzymes with highly specific active sites. The sequence below represents an example of the sort of isomerisation that can be achieved.



J **K** **L**

a) Explain why compound J and compound L are structural isomers.

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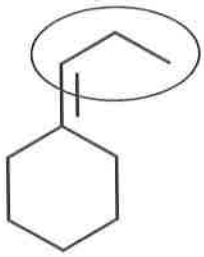
(1)

b) The three carbons attached to the cyclohexane ring in J (circled below) do not all have the same bond angles. Suggest and explain values for these bond angles.



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(3)

c) One of the compounds above, J, K or L, can exist as a pair of E/Z isomers. Draw the structure of the E and Z isomers and label the two structures as E and Z.

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(2)

d) One of the compounds above, J, K or L, contains a chiral carbon.

i) Define the term 'chiral carbon'.

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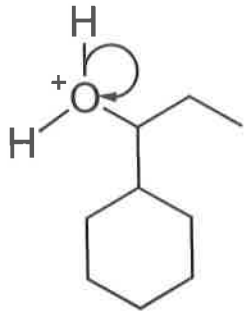
(1)

ii) Draw either J, K or L below, with the chiral carbon labelled with a star (*).

(1)

e) The conversion of J to K is electrophilic addition, which has three stages in the mechanism. The final stage is shown below.



i) State the conditions needed for this electrophilic addition reaction.

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(1)

ii) Define the term 'electrophile'.

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(1)

iii) Draw the mechanism for the first two stages in the electrophilic addition mechanism to form this intermediate from J, using H^+ as an electrophile.

(3)

f) The reaction of J to form K only gives a low yield of 40 %.

i) Identify the main reason for this low yield.

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(2)

ii) If the conversion of K to L then proceeds with a yield of 65 %, identify the mass of J required to form 5.00 g of L.

(2)

g) The structural isomers J and L can be separated using thin layer chromatography with a silica plate stationary phase.

i) Explain what is meant by 'stationary phase' in TLC and explain how TLC separates these compounds.

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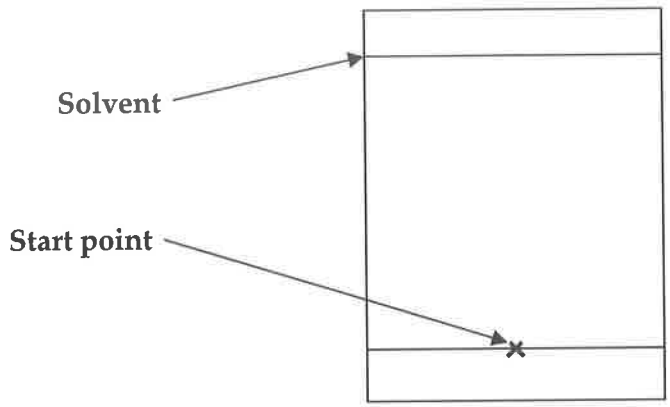
(3)

ii) A TLC plate that has been used to carry out chromatography in a carefully chosen solvent is shown below. If the R_f of J is 0.38, draw where you would expect the spot to be, showing your working.



(1)

h) The mass spectrum of a sample of either J or L contained a peak at 95.

Draw the species responsible for this peak, and explain why this can identify whether the sample is J or L.

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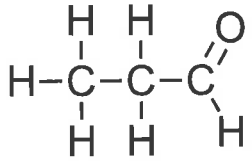
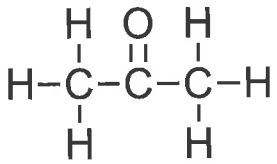
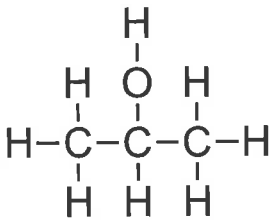
(2)

QUESTION TOTAL: 23 MARKS

19 The structures shown below represent some of the simplest members of their functional groups.







a) Describe how the functional groups in these three structures can be confirmed using chemical tests.

You should include:

- reagents required
- expected observations and conclusions
- how you would ensure safety

You do not need to include equations.

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(6)

b) i) Explain whether infrared spectroscopy could be used to distinguish the compounds above.

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(2)

ii) Explain the suspected link between infrared radiation and the compounds associated with global warming, and how this has prompted a shift towards renewable energy.

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c) Another simple compound, propene, can be identified by its reaction with bromine. Explain whether or not this is a redox reaction.

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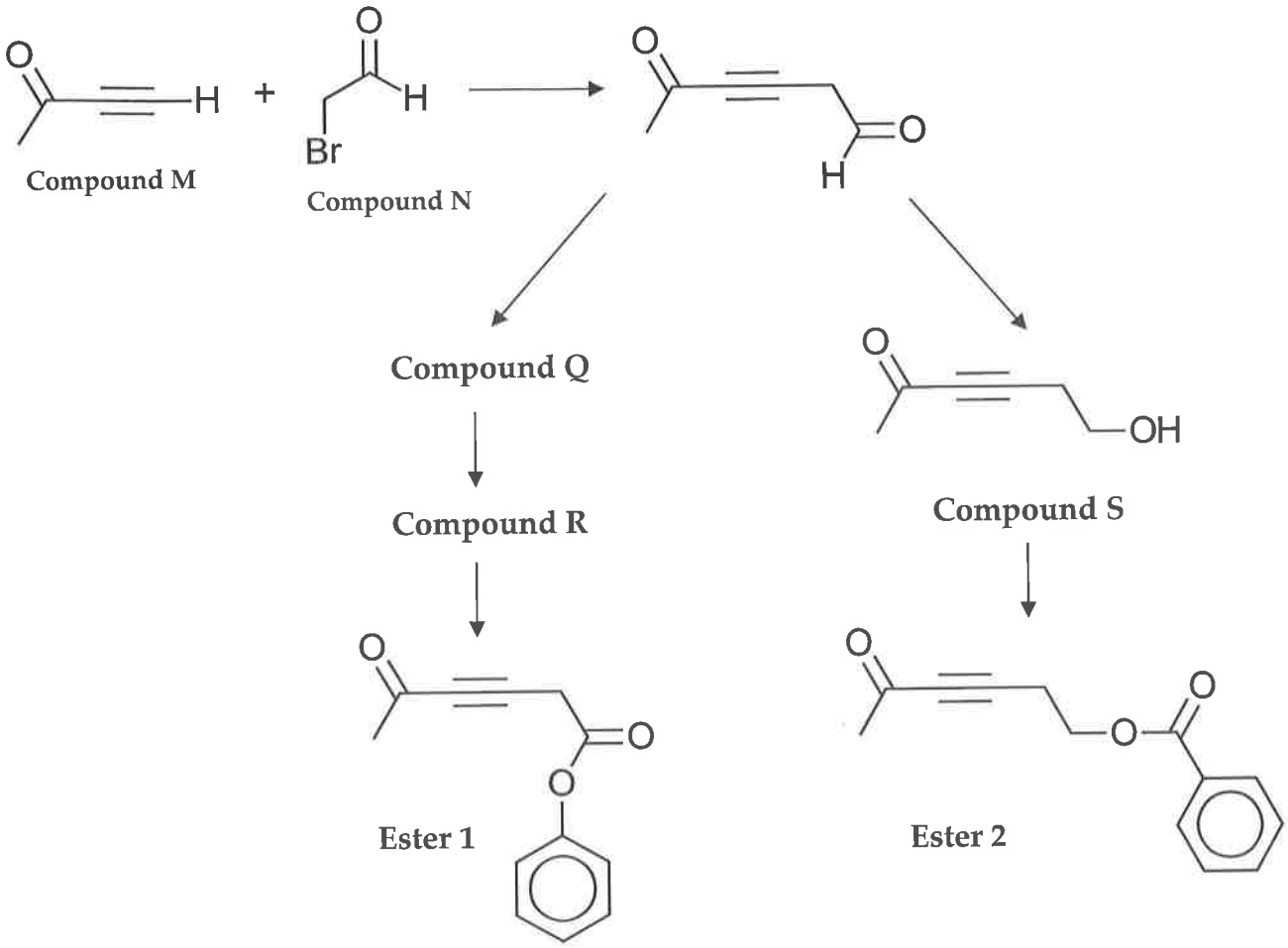
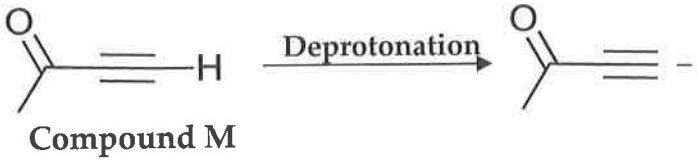
(1)

QUESTION TOTAL: 12 MARKS

20 A number of compounds containing triple bonds have been shown to be exceptionally powerful antiviral drugs and incorporation of triple bonds into structures is, therefore, a line of investigation for synthetic chemists. The scheme below shows two different routes to achieve this in related compounds.



a) In the first step, compound M is deprotonated by a base to give the ion shown below, which reacts via nucleophilic substitution with compound N.



Draw a mechanism for the nucleophilic substitution of compound N by the ion shown.

(2)

b) State the reagents necessary to form ester 1 from P, by converting P to compound Q, then compound R, then finally ester 1, and draw the structure of intermediates Q and R.

Reagents for P to Q:

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Reagents for Q to R:

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Reagents for R to Ester 1:

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Compound Q **Compound R**

(5)

c) The formation of S from P can be achieved under carefully controlled conditions to ensure the ketone does not react. Write an equation, using structural formulae, for the formation of S from P.

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(2)

d) Ester 2 is formed from the reaction of S with an acid anhydride.

i) Draw the structure of the acid anhydride.

(1)

ii) Draw the structure of the side product formed in this reaction.

(1)

e) State the stages required to purify a liquid ester from aqueous products.

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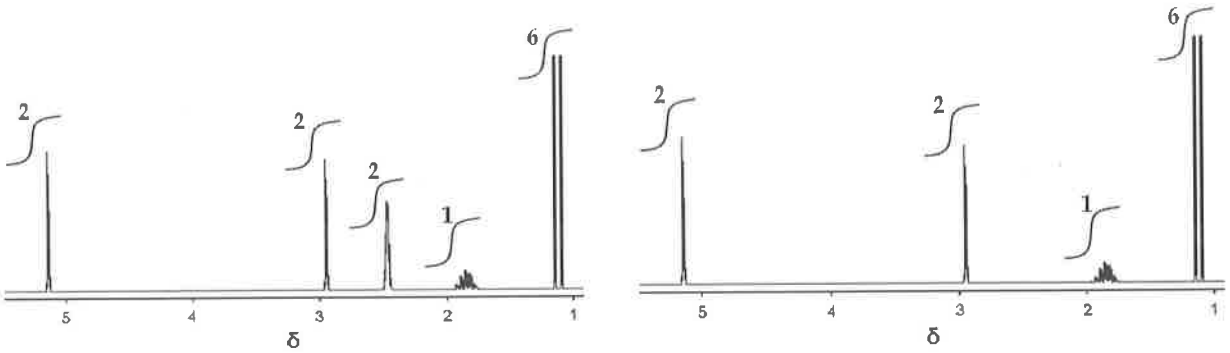
(3)

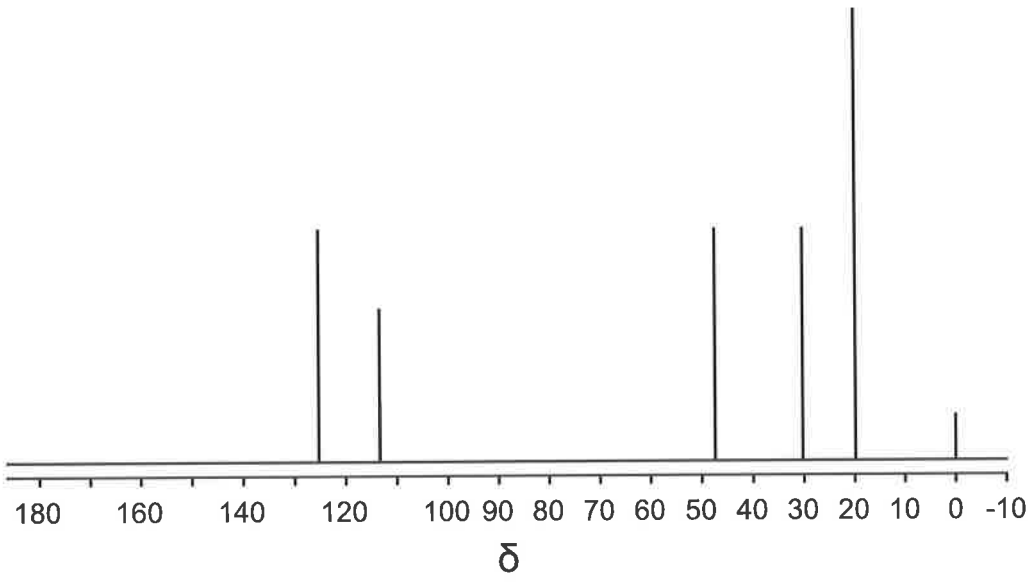
QUESTION TOTAL: 14 MARKS

21* A scientist used a series of analytical techniques to analyse an unknown compound.

- The mass spectrum showed a molecular ion peak at 99.
- A section of a ^{1}H NMR spectrum for a compound is shown below. The spectrum on the left shows the spectrum without D_2O and the spectrum on the right shows it with D_2O. These sections contains all the peaks for the compound.



The ^{13}C spectrum is shown below.



Use the above information to deduce the structure of the compound.

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(6)

QUESTION TOTAL: 6 MARKS

