SUGGESTED ANSWERS	Teacher:

Level 3 Chemistry

91391 Demonstrate understanding of the properties of organic compounds

Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of the properties of organic compounds.	Demonstrate in-depth understanding of the properties of organic compounds.	Demonstrate comprehensive understanding of the properties of organic compounds.

You should attempt ALL the questions in this booklet.

A periodic table is provided in the Resource Sheet.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 1–11 in the correct order and that none of these pages is blank.

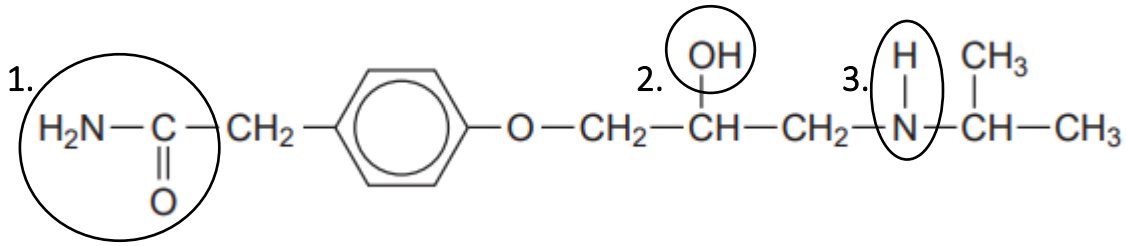
YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

TOTAL

ASSESSOR'S USE ONLY

QUESTION ONE

(a) (i) Atenolol is used mainly to lower high blood pressure. It can also be used to prevent chest pain (angina) or to treat an irregular heartbeat.
Identify the three circled functional groups.

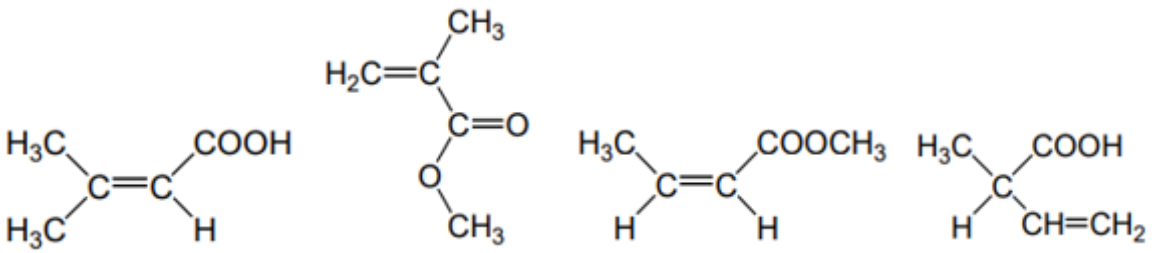


amide alcohol (2°) amine(2°)

(ii) The following isomers all have the formula $C_5H_8O_2$.

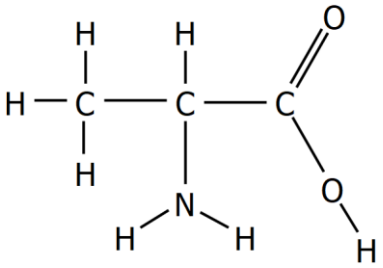
Label each structure with the correct letter A, B, C and D.

- A is an ester that shows geometrical isomerism.
- B is an optically active carboxylic acid.
- C is a carboxylic acid with a branched carbon chain and does not show stereoisomerism.
- D is methyl 2-methylpropenoate.

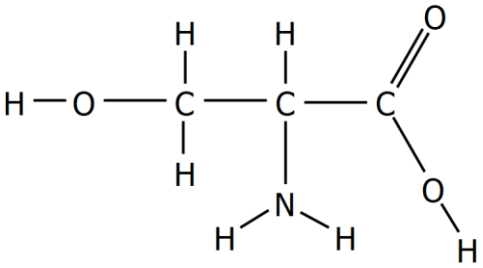


_C_ _D_ _A__ _B__

(b) Proteins contain sequences of amino acids joined by peptide links.



alanine



serine

(i) Give the IUPAC name for the amino acid alanine.

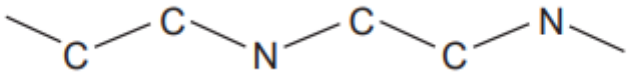
2-amino propanoic acid

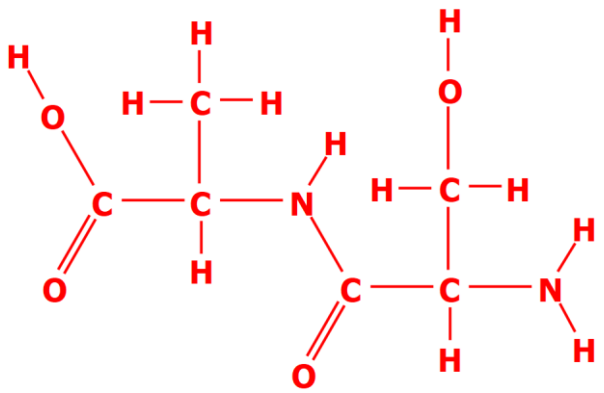
(ii) Draw the structure of the species formed by serine at low pH.

As above except -NH_2 becomes protonated and so is drawn as -NH_3^+

(iii) A section of a protein is formed from one molecule of each of the amino acids alanine and serine.

Add bonds and atoms to the diagram to complete a structural formula for this section of the protein.





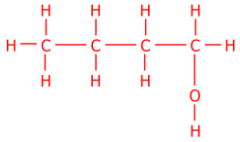
(c) Two reactions of organic compound E are shown below.
Compound **F** is a straight-chain hydrocarbon with the formula C_4H_8.

Discuss the reactions taking place. In your answer you should include

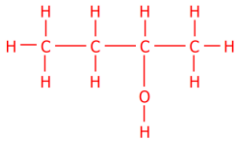
- The types of reaction taking place when E reacts to form F and G.
- Any colour changes that would be seen during the reaction(s).
- Structural formula of the possible isomers of E and how, if at all, this affects the products F and G.

E is an alcohol with 4 C atoms. It undergoes an elimination reaction with concentrated H_2SO_4 (losing an H and OH off adjacent C atoms). It cannot be 2-methyl propan-2-ol, $(CH_3)_3COH$ because this is a tertiary alcohol and would not be oxidised by acidified dichromate (no conversion of E to G would occur).

However, it could be butan-1-ol or butan-2-ol as butan-1-ol could be oxidised to butanal and then butanoic acid, and butan-2-ol to butanone, both oxidation reactions. In either case the colour of the orange dichromate solution would changes as it is reduced to green chromium(III) ion, Cr^{3+}.

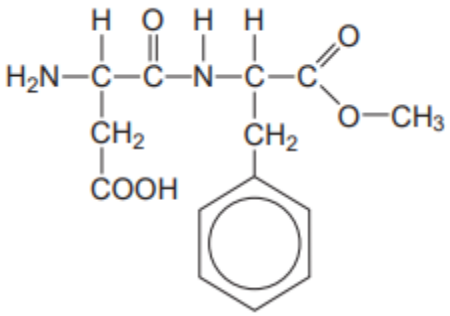


If butan-1-ol there would only be one product in the elimination reaction (but-1-ene), whereas butan-2-ol would form a minor product, but-1-ene and major product but-2-ene (which could exist as cis and trans isomers).

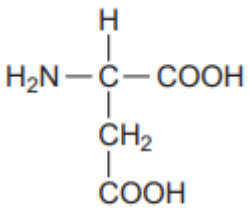


QUESTION TWO

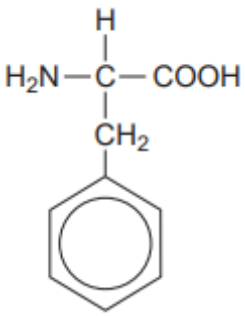
(a) Aspartame is a sweet tasting molecule that is the methyl ester of a compound formed by the condensation reaction between aspartic acid and phenylalanine. Neither aspartic acid nor phenylalanine taste sweet.



aspartame



aspartic acid



phenylalanine

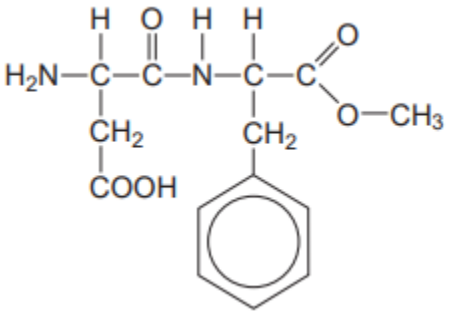
(i) What is meant by a condensation reaction?

a reaction in which two molecules combine to form a larger molecule, producing a small molecule such as H_2O (or HCl) as a by-product.

(ii) Hydrolysis of aspartame produces methanol initially. After a longer time, free amino acids are formed when the amide (peptide) link breaks.

What is meant by hydrolysis. Use aspartame to illustrate your answer .

Hydrolysis is the reaction with water; the C-N bond of the amide (peptide link) would break, reforming the -COOH group of aspartame and the $-NH_2$ group of phenylalanine. (If acid hydrolysis will get -COOH and $-NH_3^+$, if basic hydrolysis with get $-COO^-$ and $-NH_2$)



(iii) Discuss a reason why aspartame is unsuitable for use as a sweetener in foods that are being cooked.

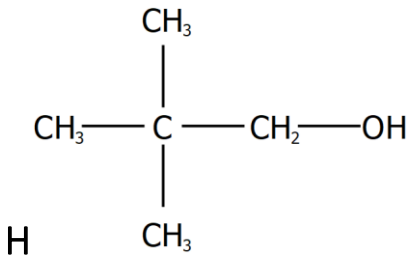
Hydrolysis is the reaction with water and is likely to occur (faster) during the cooking process; once the ester was hydrolysed it would lose its sweet flavour (rather defeating its purpose as a sweetener!)

(b) Describe how you could distinguish between the compounds in the following pairs using one simple test-tube reaction in each case.
For each pair,

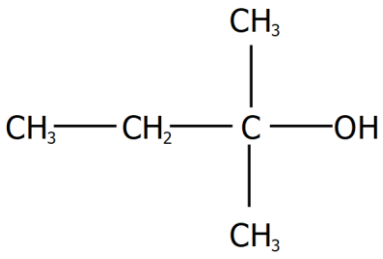
- identify a reagent and
- state what you would observe

when both compounds are tested separately with this reagent.

(i)



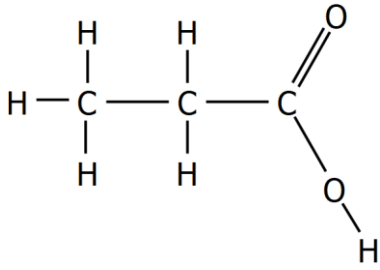
H



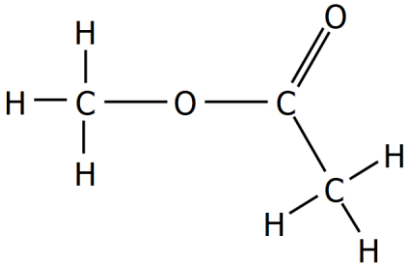
I

Heat a sample of each with acidified dichromate, $H^+/Cr_2O_7^{2-}$. H would be oxidised (to aldehyde or carboxylic acid) and the dichromate reduced to green Cr^{3+}. On the other hand there would be no colour change with I (since it is a tertiary alcohol)

(ii)



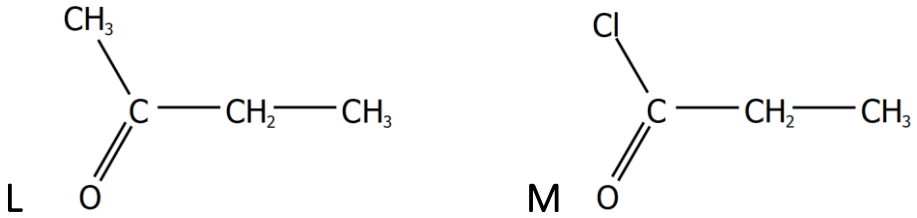
J



K

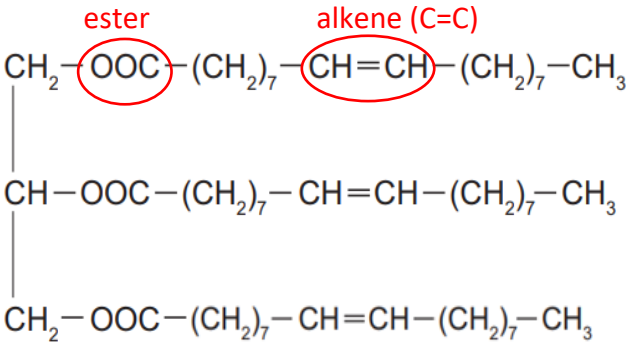
Test J and K with a little Universal indicator; the indicator would turn orange with J (as it is a weak acid) but there would be no colour change with K (a virtually insoluble neutral ester).
NOTE: You could also use blue litmus paper or add a reactive metal e.g. Mg or a carbonate to both; would see litmus turn red or effervescence due to the production of H_2 or CO_2 gas.

(iii)



Add a little water to both. Vigorous production of hydrogen chloride fumes would be seen with M (an acid chloride) while there would be no reaction with L (the ketone).

(c) The triglyceride shown below occurs in vegetable oils.



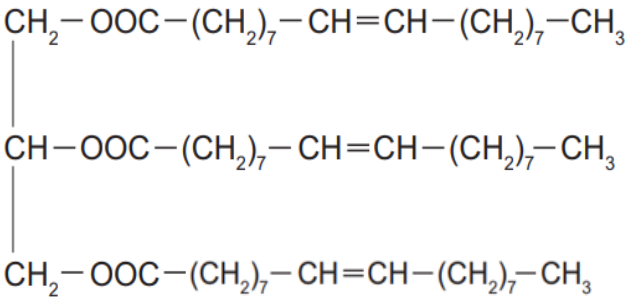
(i) Circle two different functional groups and name them on the diagram above.

(ii) Describe a chemical test that can be used to show that the molecule is unsaturated. Give any observations and state the type of reaction occurring.

It would rapidly decolourise orange-brown bromine water in an addition reaction.

(ii) Compare and contrast the reaction of the above triglyceride when it undergoes both acidic and basic hydrolysis. In your answer you should include:

- drawings of condensed structures of the organic products
- any reagents and conditions required for the reaction to proceed.



Acid hydrolysis, H^+/H_2O and heat: Would get hydrolysis of the ester bond and would produce propane-1,2,3-triol $CH_2OHCH(OH)CH_2OH$ and

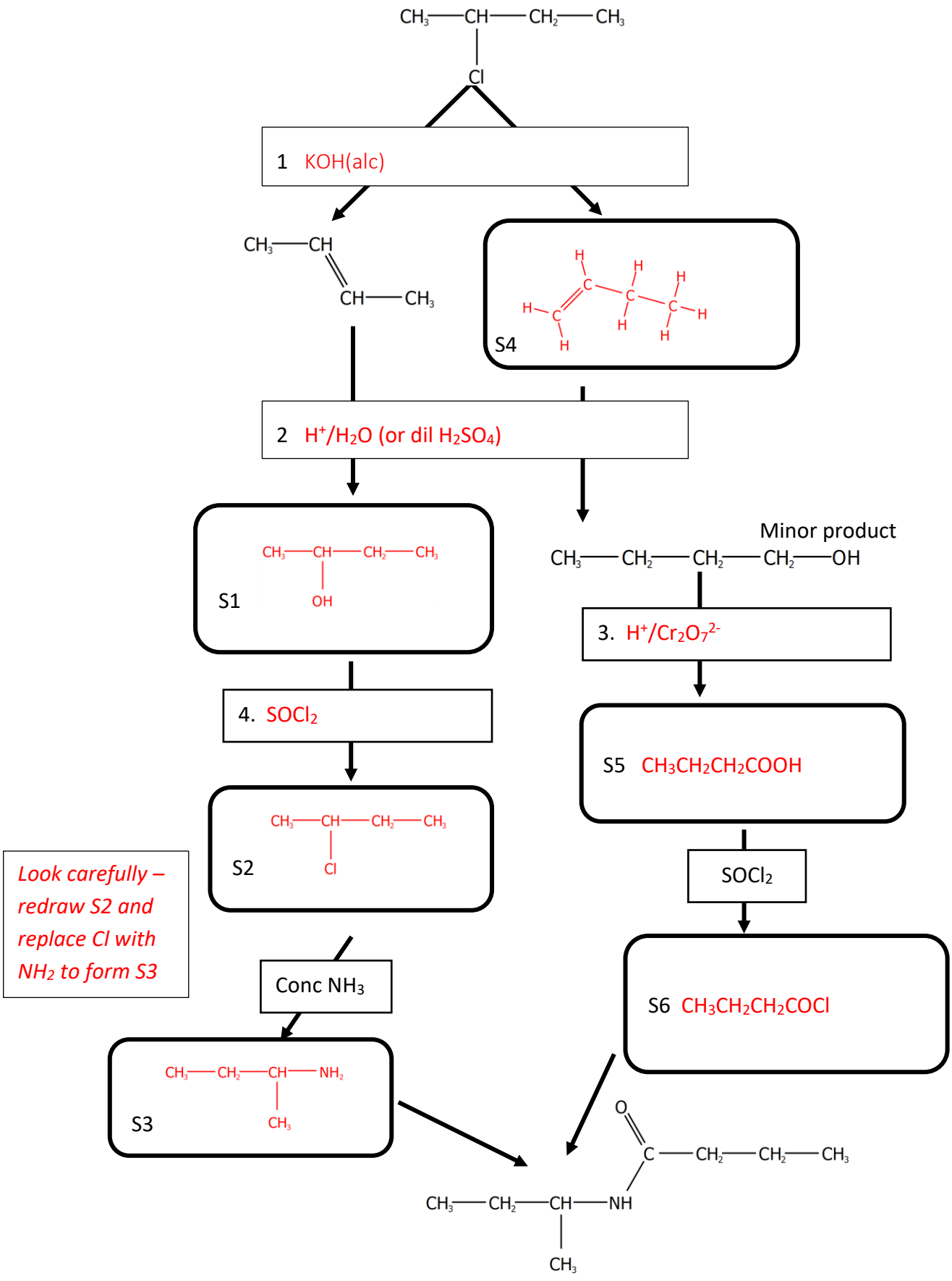
3 x molecules of CH_3-$(CH_2)_7$-CH=CH-$(CH_2)_7COOH$

Basic hydrolysis, NaOH(aq) and heat: Would still get propane-1,2,3-triol but this time the sodium salt of the fatty acid would be formed,

CH_3-$(CH_2)_7$-CH=CH-$(CH_2)_7COO^-$ Na^+

QUESTION THREE

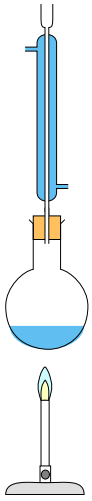
(a) Complete the following reaction scheme by drawing organic structures for S1 to S5 and identifying reagents 1 to 4.



(b) The boiling points of ethanol, ethanal and ethanoic acid are given in the table below.

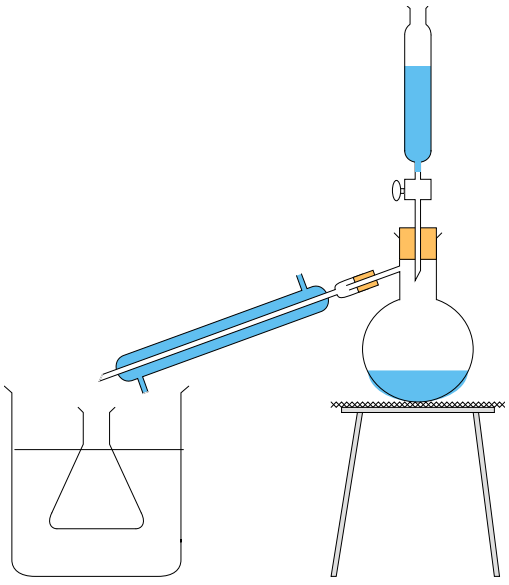
	CH_3CH_2OH	CH_3CHO	CH_3COOH
Boiling point(°C)	78	21	118

(i) Why is the organic product likely to be ethanoic acid if the apparatus below is used? The flask contains ethanol and acidified potassium dichromate solution.



The primary alcohol will be oxidised to ethanal which will vaporise immediately given it's very low boiling point of 21°C. The condenser in the reflux position will condense the ethanal vapour bringing it back into the flask into contact with more / unreacted oxidising agent (the acidified dichromate). and so the aldehyde, ethanal, will inevitably be further oxidised to the carboxylic acid.

(ii) Explain how the apparatus below can be used to produce a sample of ethanal.
The dropping funnel contains potassium dichromate solution and ethanol. The round bottomed flask contains dilute sulfuric acid that has been gently warmed to about 25°C. The conical flask is stood in a beaker of iced water.
The dichromate will not oxidise the ethanol in the dropping funnel as it is not acidified. As soon as the ethanol and dichromate are dripped into the warm acid, oxidation occurs and the ethanal that is formed vaporises (since it has a boiling point of only 21°C) and distills off and is condensed by the condenser and the flask in iced water and liquid ethanal is collected. Since the aldehyde distills off immediately it is formed (as flask contents are about 25°C) it is no longer in contact with oxidising agent and will not be further oxidised to ethanoic acid.



Extra paper if required.

Write the question number(s) if applicable