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Level 3 Chemistry, 2016

91391 Demonstrate understanding of the properties of organic compounds

2.00 p.m. Monday 21 November 2016
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.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table is provided in the Resource Sheet L3–CHEMR.

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 2–12 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.

Excellence

TOTAL 24

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QUESTION ONE

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(a) Complete the table below by drawing the structural formula for the named compounds.

IUPAC systematic name	Structural Formula
butylethanoate	$CH_3-CH_2-CH_2-CH_2-O-\overset{\overset{O}{\|\|}}{C}-CH_3$
2-hydroxybutanal	$CH_3-CH_2-\underset{\underset{OH}{\|}}{CH}-\overset{\overset{O}{\|\|}}{C}-H$
ethanamide	$CH_3-\overset{\overset{O}{\|\|}}{C}-NH_2$

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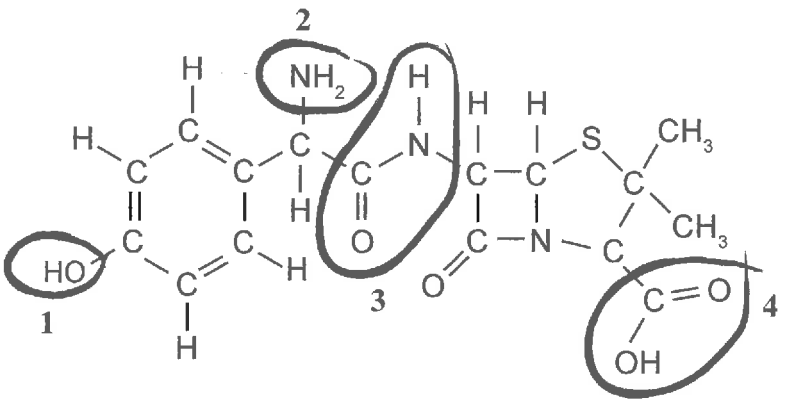
(b) The structure of amoxycillin is given below. It is an antibiotic used in the treatment of bacterial infections.



Name the four different functional groups circled within the amoxycillin molecule above.

1	alcohol
3	amide

2	amine
4	carboxylic acid

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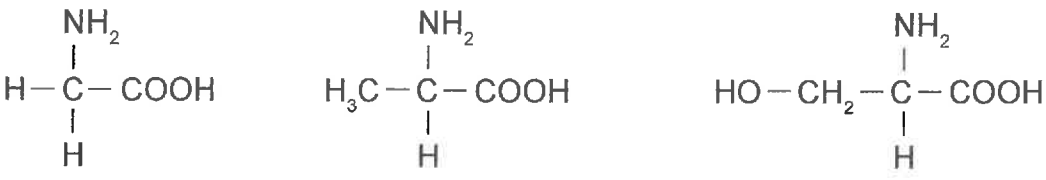
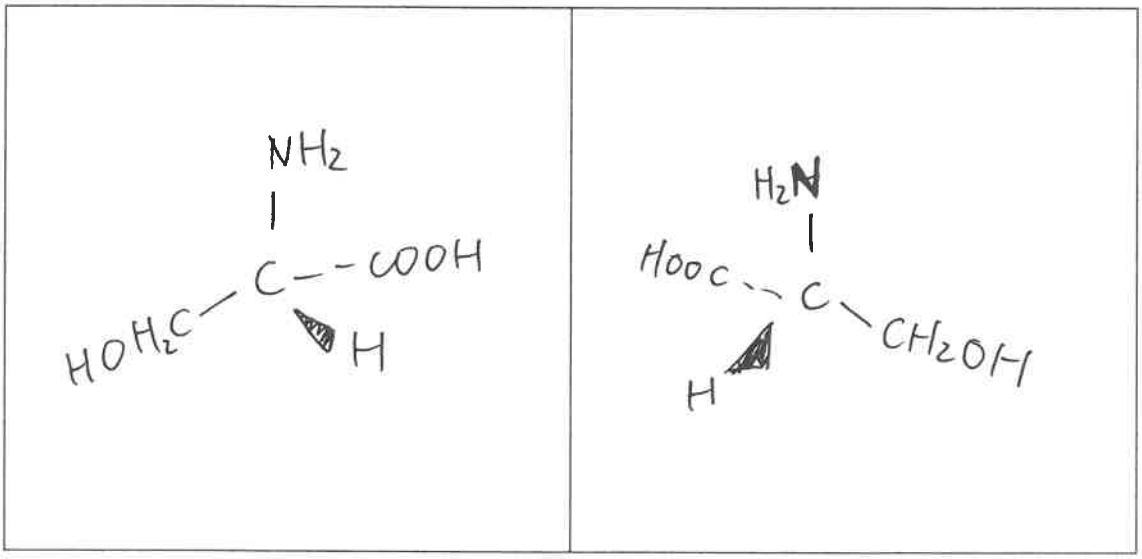
(c) Glycine, alanine, and serine are three amino acids shown below.



(i) Draw the 3-D structures of the enantiomers (optical isomers) of **serine** in the boxes below.



(ii) Circle the amino acid below which does NOT display optical isomerism:

glycine **alanine** **serine**

Explain your answer.

Glycine does not have a chiral carbon - a carbon atom with 4 different groups attached to it. The only carbon with 4 groups attached in glycine has two -H groups attached (so the 4 groups are not different), so glycine does not fulfill the requirements of optical isomerism, which is a carbon with 4 different groups attached.

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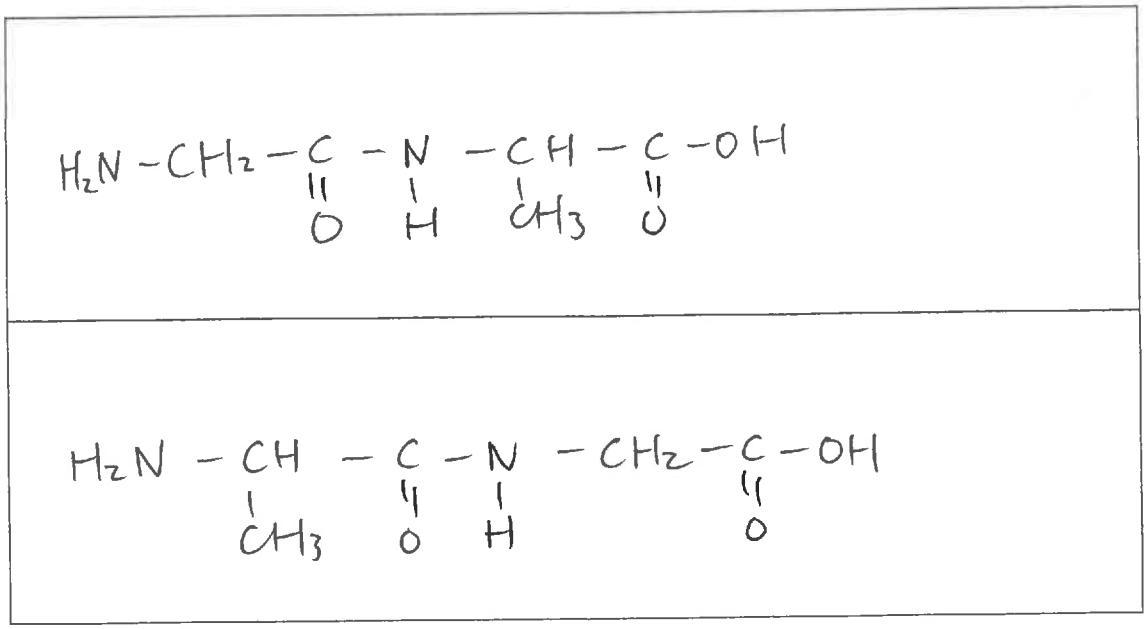
(iii) Draw the two possible dipeptides formed from the amino acids **glycine** and **alanine**.



(iv) Name the type of reaction that occurred when the dipeptides formed in (iii) above.

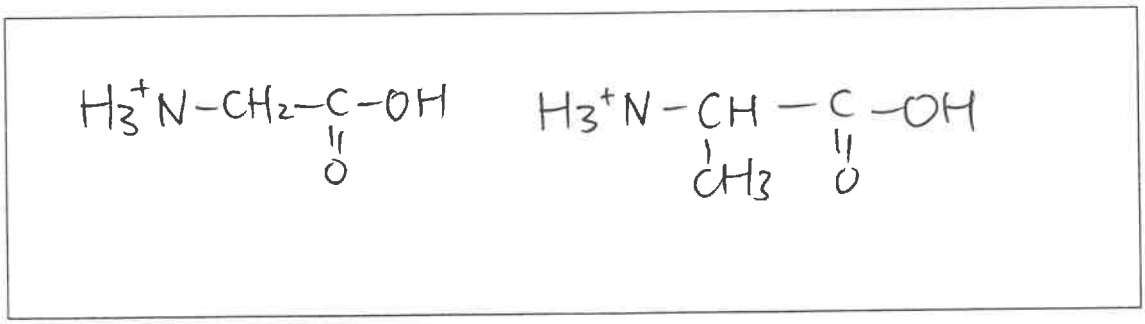
Condensation ~~polymerisation~~

Explain your choice.

Two smaller molecules, glycine and alanine, are joined together to form 1 larger molecule, with the elimination of a small H_2O molecule at the joining site. -H is removed from the $-NH_2$ group and -OH is removed from the $-\overset{\overset{O}{\|}}{C}-OH$ group.

(v) Draw the products of an acidic hydrolysis for ONE of the dipeptides from (iii) above.

Explain why these products are formed.



In hydrolysis, water is used to split the molecule, with -H joining onto one part of the molecule (-NH-) and -OH joining onto the other ($-\overset{\overset{O}{\|}}{C}-$) part of the molecule. In acidic conditions the basic $-NH_2$ group will then accept an H^+ from water to become NH_3^+.

QUESTION TWO

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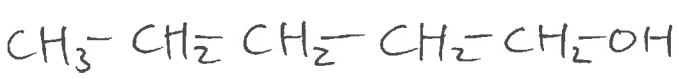
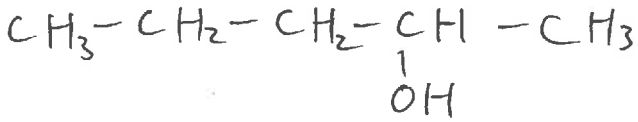
(a) (i) What reagent can be used to reduce aldehydes and ketones?

$NaBH_4$

(ii) For the **reduction** of pentanal and pentan-2-one, draw the structure of the organic product formed in each case.

Identify the functional group of each product formed.

pentanal	Structure of the product:  Functional group: alcohol (primary)
pentan-2-one	Structure of the product:  Functional group: alcohol (secondary)

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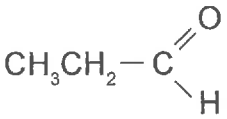
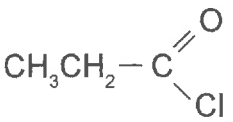
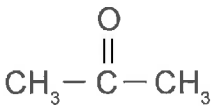
(b) The structures of four different organic substances are shown in the table below.

(i) Name the organic substances **A** to **D**.

Letter	Structure	Name
A	$CH_3CH_2CH_2-NH_2$	1-amino propane
B		propanal
C		propanoyl chloride
D		propanone

4

(ii) Explain how you would identify each of the organic substances, **A** to **D**, from the table in (b)(i), using only moist litmus paper, water, and Benedict's solution.

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In your answer, you should include:

- a description of any tests carried out and any observations you would make
- equations to show the organic products formed, if applicable.

Add water to samples of each substance. C, propanoyl chloride, will react vigourously with water in a hydrolysis reaction.

$CH_3-CH_2-C(=O)-Cl + H_2O \longrightarrow CH_3-CH_2-C(=O)-OH + HCl$

(This can be used to confirm C)

Moist blue litmus will then turn red in the same sample of C as the products of hydrolysis donate an H^+ to water, forming H_3O^+: $CH_3-CH_2-C(=O)-OH + H_2O \rightleftharpoons CH_3-CH_2-C(=O)-O^- + H_3O^+$

and $HCl + H_2O \longrightarrow H_3O^+ + Cl^-$

The other three substances will not react with water. Add moist red litmus to samples of remaining 3 compounds. Red litmus will turn blue in A, 1-amino propane, which accepts H^+ from water to form OH^-: $CH_3-CH_2-CH_2-NH_2 + H_2O \rightleftharpoons CH_3-CH_2-CH_2-NH_3^+ + OH^-$

The other 2 substances will not change the colour of moist red litmus. Add Benedict's solution to new samples of the remaining 2 substances, and warm. In B, propanal, the blue colour of the solution will change to form a brick red precipitate as a redox reaction occurs. C

continued at back.

FX

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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2b(ii)

Propanal gains oxygen, and is oxidised to propanoic acid. Blue Cu^{2+} in Benedict's solution is reduced to Cu_2O, which forms as the brick red precipitate.

The blue colour of Benedict's solution will remain in D, propanone, which cannot be oxidised. Cu^{2+} in Benedict's solution is thus not reduced, so the blue colour of the solution remains in D.

QUESTION THREE

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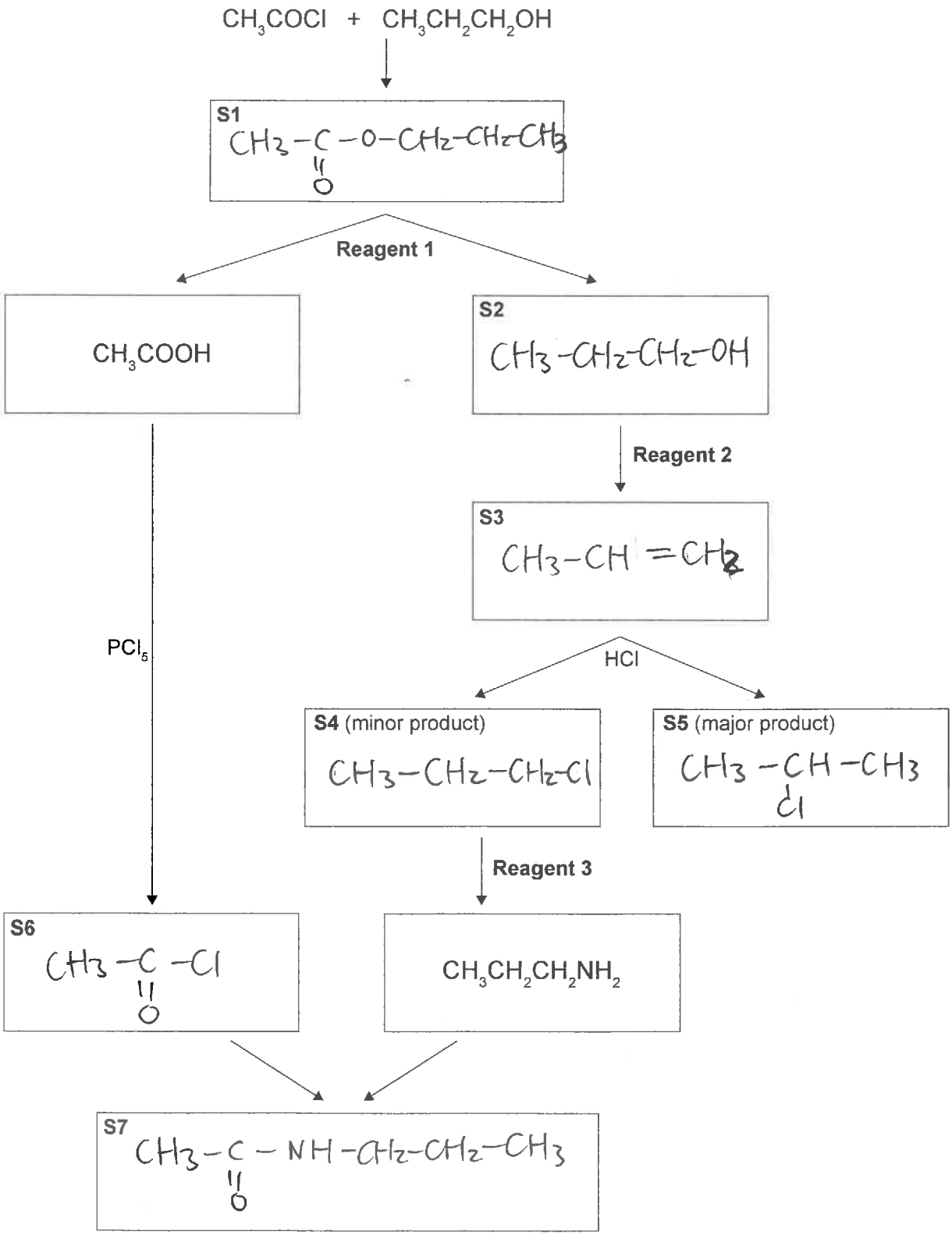
(a) Complete the following reaction scheme by drawing organic structures for **S1** to **S7**, and identifying reagents **1** to **3**.



Reagent 1 is: H_2O / H^+, heat

Reagent 2 is: conc. H_2SO_4, heat

Reagent 3 is: NH_3 conc.

C

(b) Draw a reaction scheme to show the conversion of **butan-1-ol** to **butan-2-one**.

You should include any relevant reagents, conditions required, and the structures of all organic substances involved.

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butan-1-ol

$CH_3-CH_2-CH_2-CH_2-OH$ + conc H_2SO_4 / heat →

$CH_3-CH_2-CH=CH_2$

but-1-ene

$CH_3-CH_2-CH=CH_2 + H_2O/H^+ \rightarrow$

$CH_3-CH_2-CH(OH)-CH_3$ + $CH_3-CH_2-CH_2-CH_2(OH)$

butan-2-ol (major) butan-1-ol (minor)

$CH_3-CH_2-CH(OH)-CH_3 + Cr_2O_7^{2-}/H^+ \rightarrow$ heat

$CH_3-CH_2-C(=O)-CH_3$

butan-2-one

C

Question Three continues on the following page.

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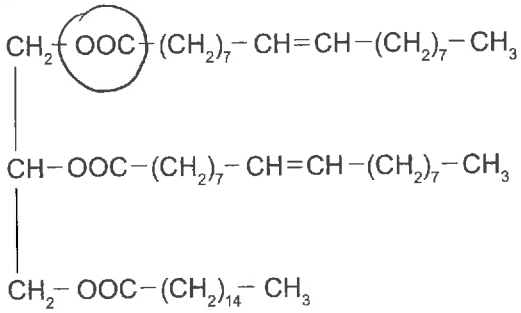
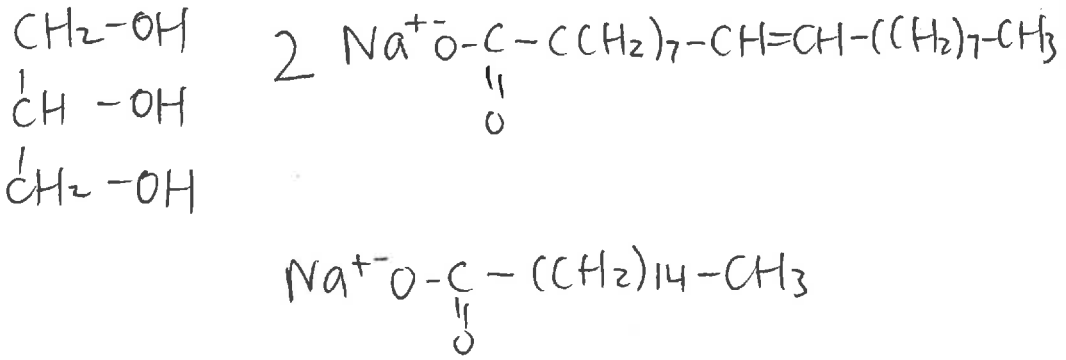
(c) A triglyceride found in olive oil has the following structure:



(i) Put a **circle** around one of the ester groups in the triglyceride molecule shown above.

(ii) Draw the structural formulae of the products produced by the hydrolysis of this triglyceride in basic conditions, using aqueous sodium hydroxide, NaOH.



Excellence exemplar 2016

Subject:	Chemistry	Standard:	91391	Total score:	24

Q	Grade score	Annotation
1	E8	All aspects of parts (a) and (b) are correct. Every aspect of part (c) is correctly answered, for example: Correct 3D diagrams in part (i), correctly explains the requirements for optical isomerism in part (ii), both dipeptides correctly drawn in part (iii), correct reaction type and explanation (polymerisation has been crossed out) in part (iv), and correctly draws both products with the amine group protonated and explains how this comes about in part (v).
2	E8	All aspects of parts (a) and (b) are correctly answered, for example: Correct reagent plus structures and classification of each alcohol in part (a), all names correct and a comprehensive explanation of appropriate tests with relevant observations, including equations showing the organic products, is given in part (b).
3	E8	All aspects of parts (a) to (c) are correct, including: All structures, reagents, and conditions in part (a), a valid reaction scheme with correct structures, reagents and conditions outlined in part (b), all aspects about the ester functional group and the hydrolysis of the triglyceride are correct.