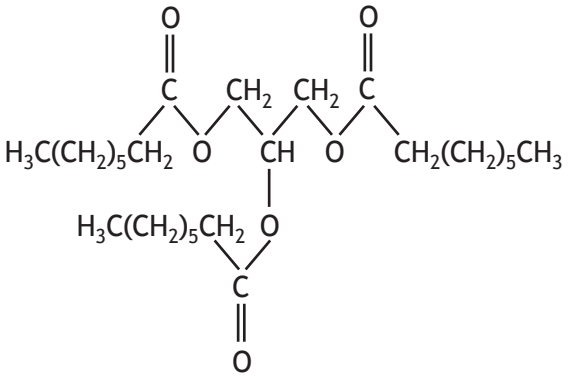
3. Cheese is a complex substance containing a wide variety of chemicals.

(a) The structure of a fat found in cheese is shown below.



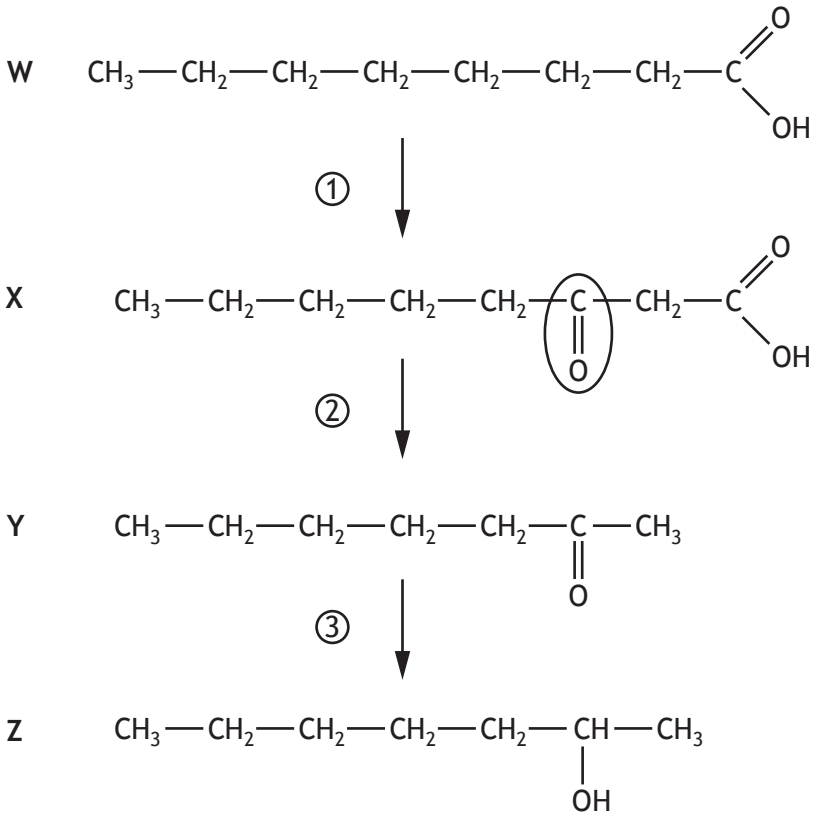
(i) (A) The alcohol needed to form fat molecules is glycerol.

State the systematic name for glycerol. **1**

(B) Name the type of reaction used to form fat molecules from fatty acids and glycerol. **1**

3. (a) (continued)

(ii) Fatty acid **W** reacts as shown.



(A) Identify the functional group circled in molecule **X**. **1**

(B) Name molecule **Y**. **1**

(C) Identify the type of reaction used to convert molecule **Y** into molecule **Z**. **1**

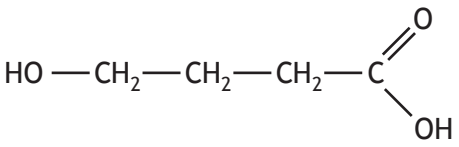
(D) State which of the reactions, ①, ② or ③, results in an increase in the oxygen to hydrogen ratio. **1**

[Turn over

3. (a) (continued)

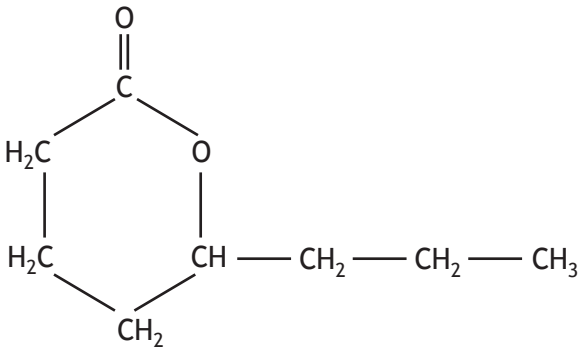
(iii) Fatty acids can be converted into hydroxycarboxylic acids.

An example of a hydroxycarboxylic acid is shown.



The two functional groups in a hydroxycarboxylic acid react together to form a cyclic ester.

An example of a cyclic ester is shown.



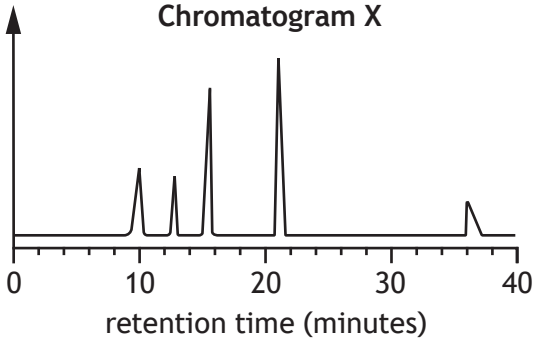
Draw a structural formula for the hydroxycarboxylic acid that can be used to produce this cyclic ester. **1**

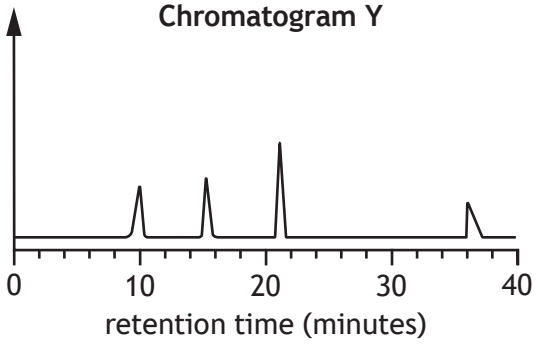
3. (a) (continued)

(iv) The flavour of cheese changes over time as the concentrations of flavour molecules change.

Gas chromatography can be used to analyse the concentrations of flavour molecules.

(A) Chromatograms for two samples of cheese are shown below.



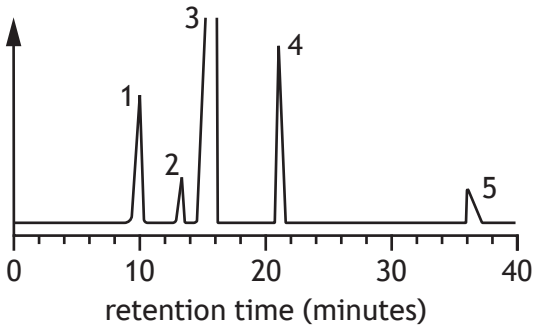


Determine the retention time, in minutes, of the peak in **Chromatogram X** that is missing in **Chromatogram Y**. **1**

[Turn over

3. (a) (iv) (continued)

(B) The following chromatogram was obtained from another sample of cheese. The concentration of a flavour molecule in cheese can be determined by calculating the area under the peak that corresponds to that molecule.



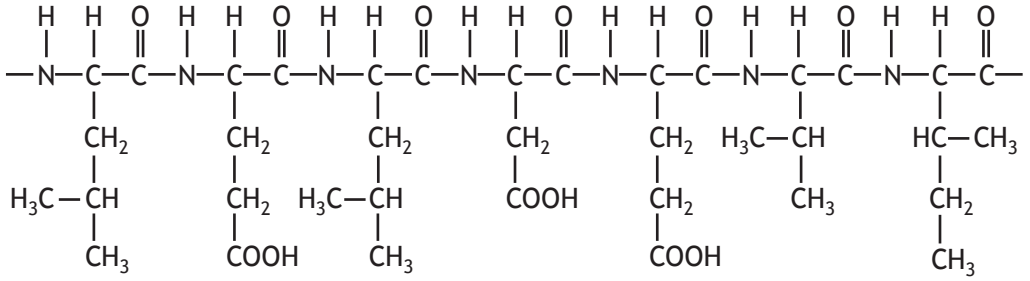
The concentration of flavour molecule 3 cannot be determined from this chromatogram.

Suggest what would need to be done to the sample to allow the concentration of flavour molecule 3 to be determined. **1**

MARKS

(b) The main protein in cheese is called casein.

The diagram shows part of the structure of a casein molecule.



The table shows the relative proportions of the amino acids found in this section of protein.

Amino acid	Relative proportion
Aspartic acid	1
Glutamic acid	2
Isoleucine	1
Leucine	2
Valine	1

(i) Leucine and valine are amino acids that must be obtained through the diet.

State the term for this type of amino acid. **1**

(ii) Using information from the diagram and the table, draw a structural formula for glutamic acid. **1**

[Turn over