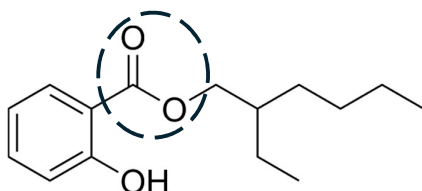


Topic 3: Organic and Biological Chemistry

TOTAL MARKS: 79

1. Octyl salicylate is a common organic ingredient used in commercial sunscreens.

The structural formula of octyl salicylate is shown below:



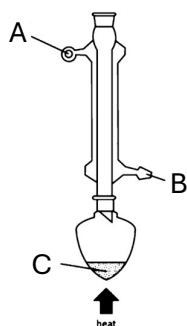
- (a) Write the molecular formula for octyl salicylate.

_____ (1 mark)

- (b) State the name of the functional group circled above.

_____ (1 mark)

- (c) An apparatus that can be used to synthesise octyl salicylate is shown below:



- (i) Name the apparatus above.

_____ (1 mark)

- (ii) Explain the purpose of the parts of the apparatus labelled A and B.

_____ (3 marks)

(iii) State the systematic name for one organic species present at C.

_____ (2 marks)

(iv) In industrial production of octyl salicylate, a more complex apparatus is used which removes water from the reaction mixture.

State the benefit of removing water from the reaction mixture.

_____ (1 mark)

2. The aromatic profile of fine wines can be substantially altered if some of the ethanol present is converted into ethanal.

(a) Name the action that converts ethanol into ethanal.

_____ (1 mark)

(b) State whether ethanol is classified as primary, secondary or tertiary.

_____ (1 mark)

(c) To test whether this conversion has taken place, a winemaker may analyse a sample of their wine with Tollen's reagent.

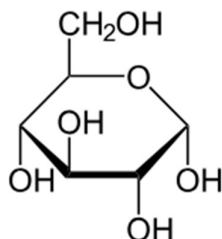
(i) Draw the structural formula of the organic product formed if ethanal is present.

(2 marks)

(ii) Explain why the winemaker could not use acidified dichromate for this test.

_____ (3 marks)

Sweet wines also contain high concentrations of carbohydrates such as glucose. One form of glucose is shown below:



- (iii) State whether glucose is a monosaccharide, a disaccharide, or a polysaccharide.

_____ (1 mark)

- (iv) State why ethanal is not classified as a carbohydrate.

_____ (1 mark)

- (v) Explain why the presence of glucose could interfere with a Tollen's reagent test for ethanal.

_____ (3 marks)

- (d) Other compounds such as 3,3-dimethyl butanoic acid and propyl propanoate can also contribute to aroma.

- (i) Draw the structural formula of 3,3-dimethyl butanoic acid.

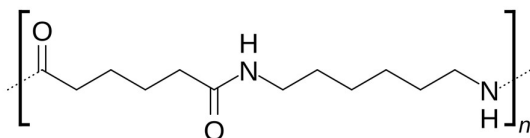
(2 marks)

- (ii) State which of 3,3-dimethyl butanoic acid and propyl propanoate has a higher boiling point.

_____ (1 mark)

3. Waste fibres produced by industrial processes can be broken down using enzymes.

The structural formula of one synthetic fibre is shown below:



(a) This synthetic fibre is formed from monomers by a condensation reaction.

(i) Define what is meant by *condensation reaction*.

_____ (2 marks)

(ii) Draw the structural formula of one monomer used to produce the fibre.

(2 marks)

(iii) State whether the monomer above is an amino acid.

_____ (1 mark)

(b) Under normal conditions, these synthetic fibres absorb moisture from the air without being broken down.

(i) Name the functional group in the fibre responsible for absorbing moisture.

_____ (1 mark)

(ii) Name the secondary interaction involved in absorbing moisture.

_____ (1 mark)

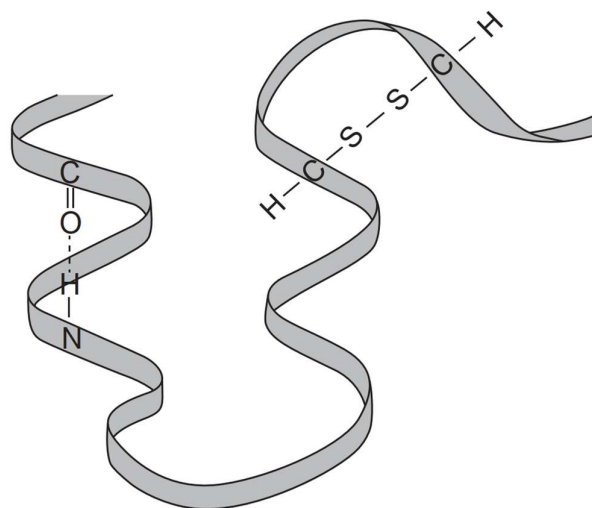
(iii) State the reason the fibres are not broken down without the enzyme present.

_____ (1 mark)

(iv) State the name of the reaction which breaks the fibres down.

_____ (1 mark)

(c) A section of one enzyme used to break down waste fibres is shown below:



The enzyme functions optimally at pH 7.

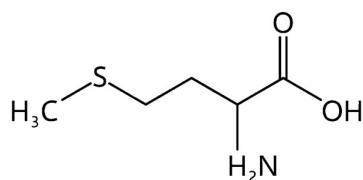
(i) Name the type of primary bond shown between the sulphur atoms.

_____ (1 mark)

(ii) Explain why this enzyme's biological function will be affected by low pH.

_____ (3 marks)

(iii) One of the amino acids in this enzyme is methionine, shown below:

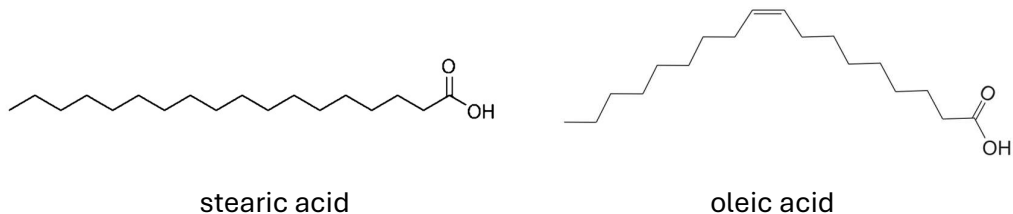


Draw the self-ionised form of methionine.

(2 marks)

4. Glyceryl stearate and glyceryl oleate are substances commonly used in cosmetics.

They can be produced by reacting glycerol with stearic or oleic acid, respectively:



(a) Draw the structural formula of a glyceryl molecule made from stearic acid.

(2 marks)

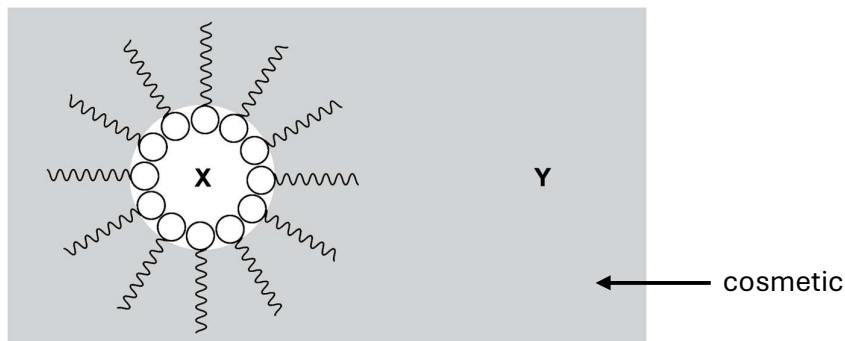
(b) Explain one difference in physical properties between the two glyceryls.

(3 marks)

(c) Describe a chemical test that could be used to distinguish whether a sample of a glyceryl is more likely to be glyceryl stearate or glyceryl oleate.

(2 marks)

- (d) Glyceryl stearate helps aqueous components stay mixed in cosmetics by forming micelles. A diagram of a micelle in a cosmetic is shown below:

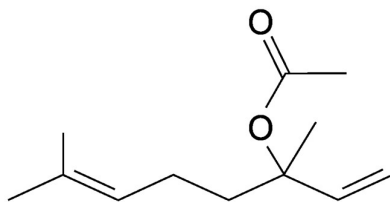


Identify the region (**X** or **Y**) that is more polar.

_____ (1 mark)

- (e) Fragrant compounds from plants such as lavender may be added to cosmetics.

The structural formula of a compound found in lavender is shown below:



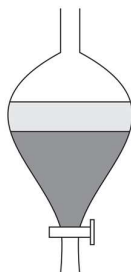
- (i) State the number of carbon atoms in this molecule that are bonded to three other atoms.

_____ (1 mark)

- (ii) Explain whether or not the compound above is likely to dissolve in water.

_____ (3 marks)

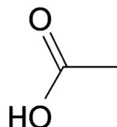
- (iii) One step in the production of lavender fragrance involves the separation of the compound from water using a separating funnel, shown below.



Suggest one practical method of determining which of the two layers is the aqueous layer.

(2 marks)

- (iv) One of reactants used in production of lavender fragrance is shown below.



- (A) State the systematic name of this reactant.

(1 mark)

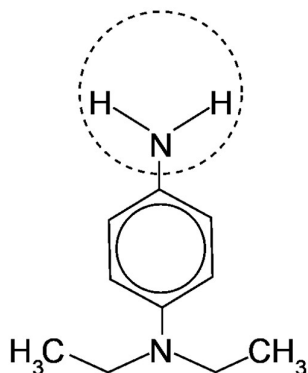
- (B) Write an equation for the reaction between this reactant and sodium carbonate.

(2 marks)

- (C) State what would be observed during the reaction in (B).

(1 mark)

5. Diethyl-phenylenediamine (DPD) can be used to measure free chlorine concentration in water. The structural formula of DPD is shown below:



- (a) State whether the amine group circled on the structural formula above is a primary, secondary or tertiary amine.
- _____ (1 mark)
- (b) DPD reacts with acid to form a new product.
- (i) Draw the structural formula of the product formed when DPD reacts with excess acid.

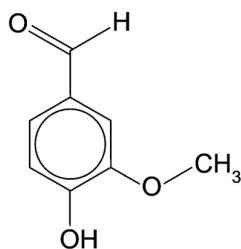
(2 marks)

- (ii) Explain whether this product is more or less soluble in water than DPD.

_____ (4 marks)

6. Vanilla flavouring may contain synthetic vanillin.

The structural formula of vanillin is shown below.



(a) On the structural formula above, circle the aldehyde group. (1 mark)

(b) Vanillin can be produced by reaction of a compound with acidified dichromate.

(i) Draw the structural formula of the organic reactant.

(2 marks)

(ii) State the colour change that would be observed during this reaction.

_____ (2 marks)

(iii) State why it is necessary to boil off the vanillin as it forms.

_____ (1 mark)

(iv) Describe how Tollens' reagent can be used to distinguish a sample of vanillin from a sample of the organic reactant referred to in part (i).

_____ (2 marks)

7. Food spreads can be produced from natural oils such as canola oil.

(a) State the class of chemical compound to which canola oil belongs.

_____ (1 mark)

(b) Write the chemical formula for the reactant that is used to convert canola oil into canola spread.

_____ (1 mark)

(c) Name the reaction in part (b).

_____ (1 mark)

(d) Name the functional group in canola oil affected during the reaction in part (b).

_____ (1 mark)

(e) The reaction in part (b) takes place at high temperature and in the presence of a catalyst.

State another reaction condition.

_____ (1 mark)

(f) Canola oil can also be used to produce soap by reaction with sodium hydroxide.

Draw the structural formula of the organic compound (other than soap) formed during reaction between canola oil and sodium hydroxide.

(2 marks)