2017

**Question 39** **(25 marks)**

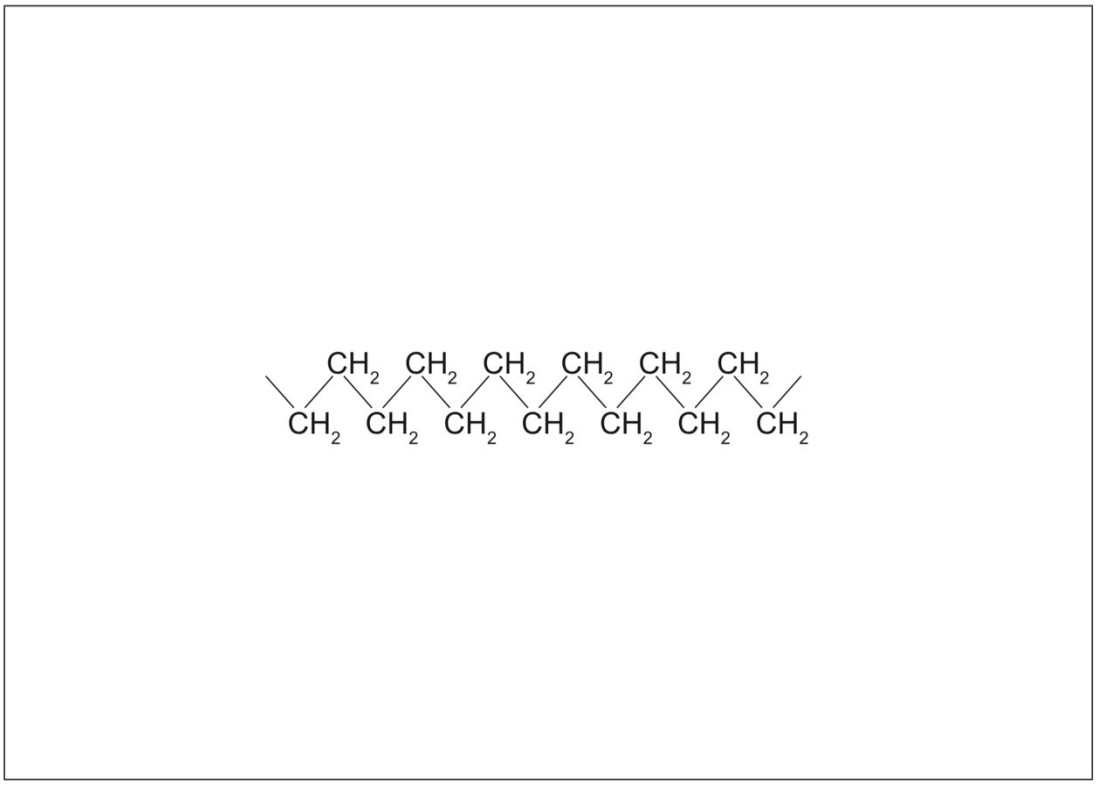
A cosmetic company advertises a range of 'inspiring quality organic, natural and essential personal care ingredients' in its skin care, hair care, aromatherapy and soaps products. It claims that the soaps it sells are made from different ingredients boasting 'an array of perfumes and cosmetic benefits'.

Soaps are a class of substances used to clean grease, dirt or oils from a surface such as skin. They do this because they are capable of dissolving in both aqueous and oily systems at the same time.

(a) (i) On the diagram below:

- complete the structure of a soap
- identify and label the key structural features of soap
- draw **two** molecules of water showing how they are orientated about soap.

(5 marks)



The process of dissolving is a consequence of attractive forces between solvent and solute. The different parts of soap are capable of producing different types of attractive forces.

(ii) Name and explain the origin of the predominant attractive force exhibited between the composite particles of soap and water. (3 marks)

(iii) Name and explain the origin of the predominant attractive force exhibited between the composite particles of soap and oil. (3 marks)

(b) Explain why soaps do **not** function very effectively in hard water. (2 marks)

**Question 39** (continued)

Fats and oils are essentially esters of fatty acids. These esters are called 'triglycerides' and are derived from glycerol and three fatty acids.

(c) (i) Name the functional group in glycerol. (1 mark)

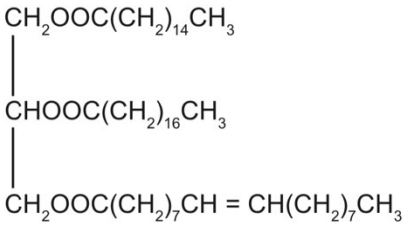
_____

(ii) State the **two** distinctive parts of a fatty acid used to make soap. (2 marks)

One: _____

Two: _____

Below is a typical animal fat (triglyceride).



To produce soap, the above fat can be hydrolysed with concentrated sodium hydroxide solution.

(d) Draw structural formulae of the **four** products from this saponification process. Names are **not** required. (4 marks)

| | |
|---|---|
| | |
| | |

(e) Why are soap solutions basic? (2 marks)

Under Australian law, any company wishing to make soap commercially using a saponification process must register with the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) administered by the Department of Health.

(f) State **one** health risk caused by chemicals used in the saponification process that would require careful monitoring by NICNAS. (1 mark)

The following table claims to list soaps in increasing order of cleaning effectiveness.

**Soaps and their chemical structure**

| Common name | Chemical structure |
|---|---|
| Sodium caprylate | $CH_3(CH_2)_6COONa$ |
| Sodium caprate | $CH_3(CH_2)_8COONa$ |
| Sodium laurate | $CH_3(CH_2)_{10}COONa$ |
| Sodium myristate | $CH_3(CH_2)_{12}COONa$ |
| Sodium palmitate | $CH_3(CH_2)_{14}COONa$ |
| Sodium stearate | $CH_3(CH_2)_{16}COONa$ |
| Sodium arachidate | $CH_3(CH_2)_{18}COONa$ |
| Sodium behenate | $CH_3(CH_2)_{20}COONa$ |
| Sodium lignocerate | $CH_3(CH_2)_{22}COONa$ |
| Sodium cerotic | $CH_3(CH_2)_{24}COONa$ |

least effective

↓

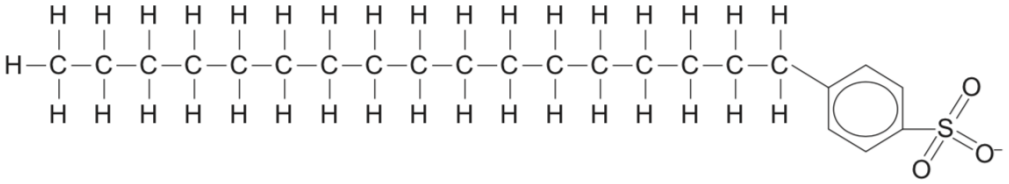
most effective

(g) Use the information in the table to write an **hypothesis** that could be used to investigate cleaning effectiveness. (2 marks)

2019

**Question 37** **(24 marks)**

Detergents and soaps are both used as cleaning agents. The general structure of a detergent is given below.



(a) Explain how detergents are able to remove grease from a surface by referring to the intermolecular forces present. Include a labelled diagram to illustrate your answer.

(7 marks)

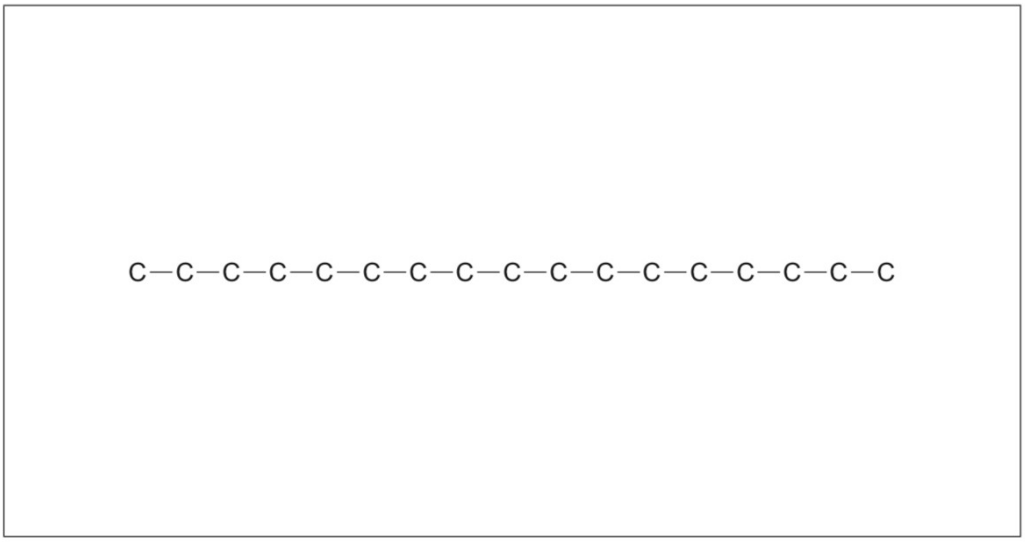
Detergents are considered to be more versatile cleaners than soap.

(b) Explain why soaps are generally less effective than detergents as cleaning agents in hard water. Include a relevant equation in your answer. (4 marks)

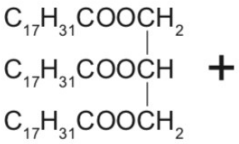
**Question 37** (continued)

Alkenes can also form soaps.

(c) Draw a structural diagram for the soap ion, $C_{17}H_{31}CO_2^-$ using the incomplete structure below. Show **all** atoms and bonds. (2 marks)



(d) Write an equation showing the formation of this soap from the fat (triglyceride) shown below. (3 marks)



The formation of soap is both an endothermic and equilibrium reaction.

(e) Predict and explain the conditions that would result in the highest yield of soap in the shortest amount of time. (8 marks)