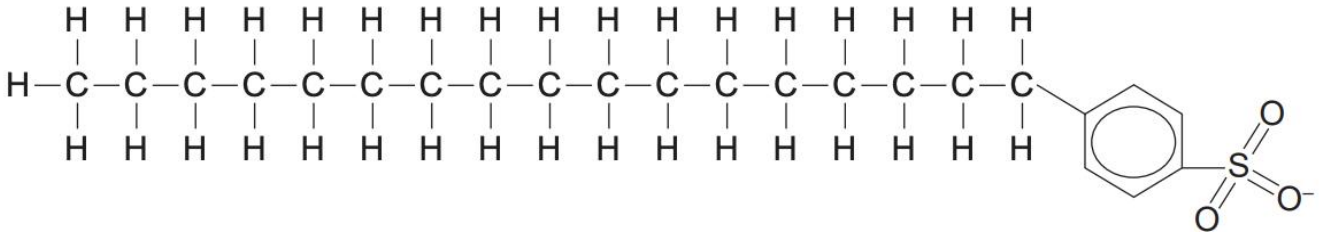
Question 37 **(24 marks)**

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.

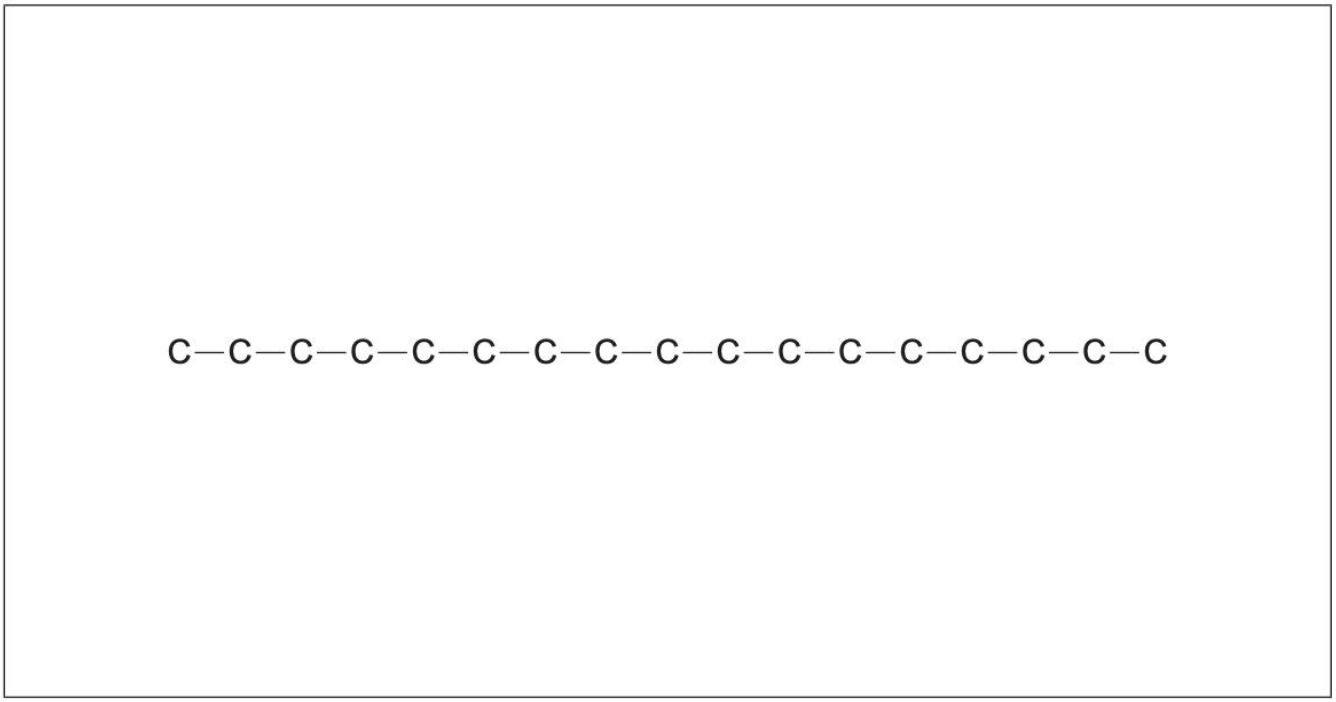
(7 marks)

Detergents are considered to be more versatile cleaners than soap.

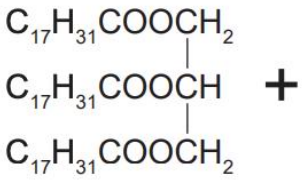
(b) Explain why soaps are generally less effective than detergents as cleaning agents in hard water. Include a relevant equation in your answer. (4 marks)

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)