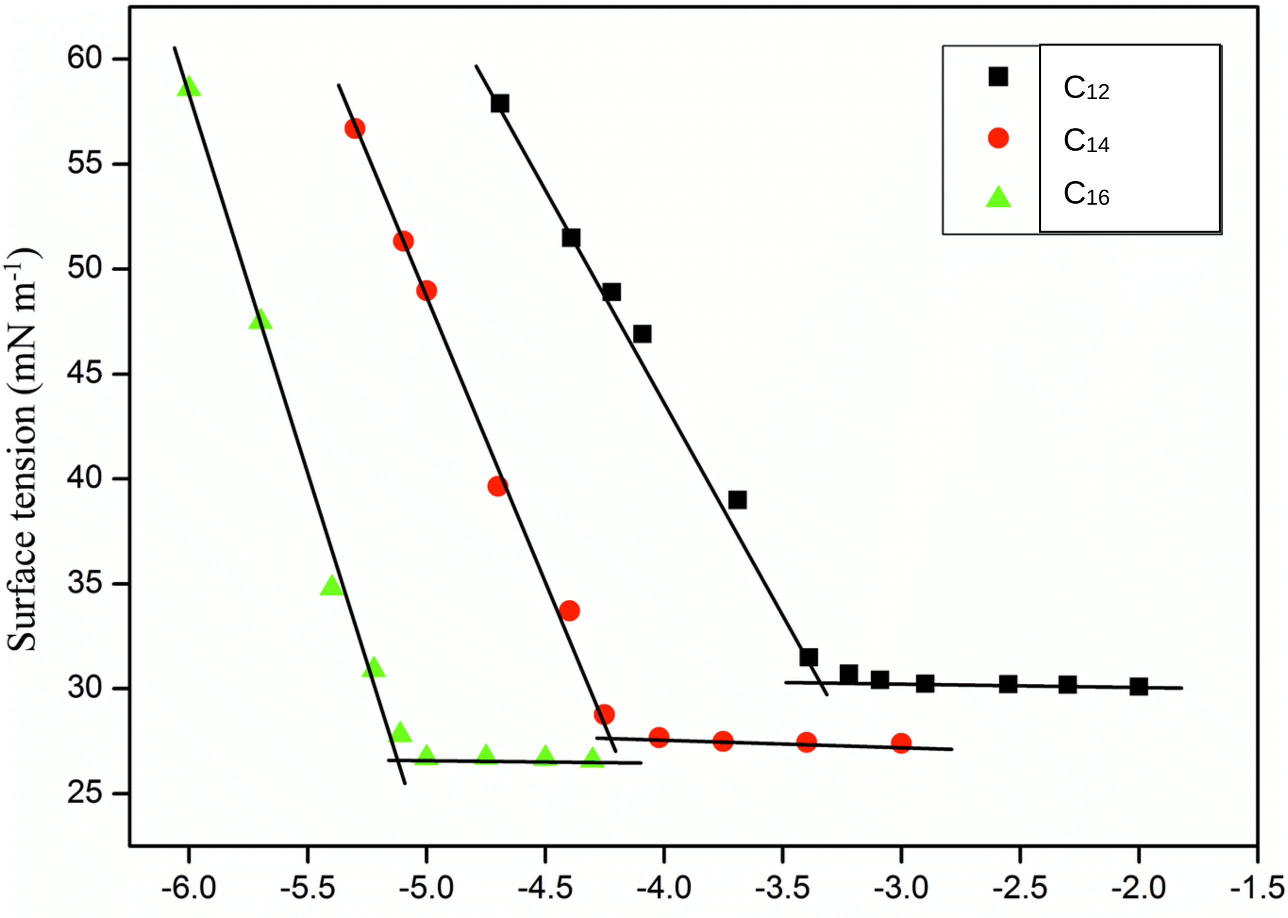
Question 1 **30 marks**



Log$_{(10)}$ concentration (mol.l^{-1})

Figure 1 Surface tension as a function of log(10) concentration for three cationic surfactants with the same head group but varying hydrocarbon tail groups

Figure 1 above shows surface tension against $\log_{10}$ concentration for a cationic surfactant series in 0.1 mol.L^{-1} sodium chloride solution. The surfactants all have the same head-group but have different length hydrocarbon tail groups, which are linear alkyl chains, namely C_{12}, C_{14} and C_{16}. The data were taken at 300 K

a) What are the critical micelle concentrations, cmc's, for these three surfactants? **6 marks**

b) Why are they different for different hydrocarbon chain lengths? **4 marks**

c) What is the surface excess for the three surfactants at a surface tension of 45 mN.m^{-1}? **10 marks**

d) Ionic surfactants of this type generally form oil in water emulsions, how would you go about modifying the system so that a water in oil emulsion would form. You cannot change the surfactant type. **5 marks**

e) Non-ionic ethoxylated surfactants of the form $C_x(CH_2CH_2O)_y$ can also form both types of emulsions, in this case how does the nature of the hydrophilic group change to enable this to occur? **5 marks**

End of Question 1

Question 2 **30 marks**

(a)

i) The generation of foam by many cosmetic formulations containing surfactants provide both aesthetic and functional benefits. Describe the conditions that must be met in order for the formation of a foam to take place. **5 marks**

ii) Describe with the aid of a diagram how the foam structure changes over time after formation. **5 marks**

iii) Why is any foam thermodynamically unstable? **4 marks**

iv) Suggest three ways that will prolong the lifetime of a foam **6 marks**

b) An electrostatic barrier with its characteristic double layer can prevent coagulation of an aqueous dispersion of colloidal particles.

i) Sketch a typical electrostatic potential versus distance plot for a flat object with protonated tertiary amine surface groups, when placed in tap water. **4 marks**

ii) Give TWO different ways to lower the zeta potential of this surface, and sketch on the plot from (question bi above) the effect of each of these on the electrostatic potential as a function of distance. **6 marks**

End of Question 3

Question 3 **20 marks**

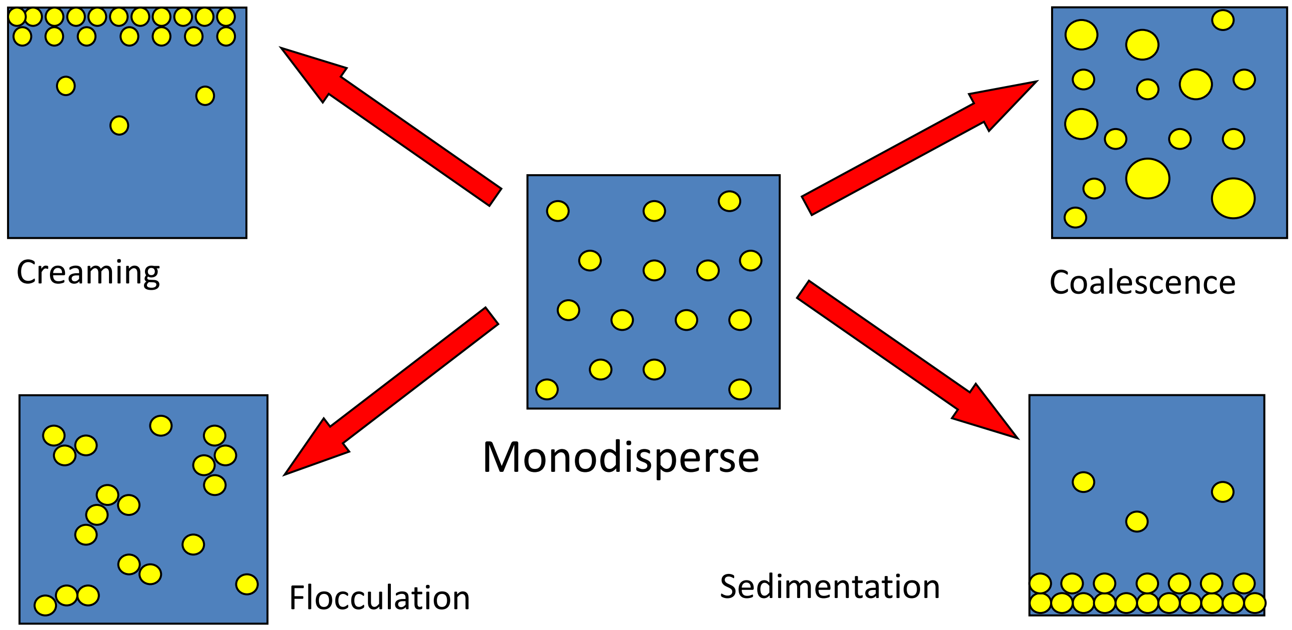


Figure 2 Four ways in which a monodisperse emulsion can become destabilised

a) In Figure 2 above four mechanisms which can change the state of a stable **monodisperse** emulsion are shown. For each mechanism, describe the forces which bring about the change. **15 Marks**

b) For a **polydisperse** emulsion a further mechanism can also change the nature of the emulsion, what mechanism is this and how does it bring about a change. **5 Marks**

End of Question 3

Question 4 **20 marks**

Sodium montmorillonite is an anionic hydrophilic clay. You wish to make the clay hydrophobic by adsorbing a monolayer of a cationic surfactant (molecular weight 300 $g.mole^{-1}$), which adsorbs on the clay at a level of 0.5 mg/m^2. The thickness of a sodium montmorillonite plate (montmorillonite is a clay) is 0.97 nm and the density of sodium montmorillonite is 2800 $kg.m^{-3}$

a) Calculate the maximum amount of surfactant required per gram of sodium montmorillonite stating any assumptions which you make.

10 marks

b) On average how far apart would these surfactant molecules be? (Note that the counterion has **not** been included in the quoted molecular weight of the surfactant).

10 marks

End of Paper