Colloids answers

Q1 (a) This can be answered in 2 ways firstly from the spreading coefficient argument.

The spreading coefficient S is given by $S = \gamma_{AW} - (\gamma_{OA} + \gamma_{OW})$

So for Pentane S= 72.8-(15.5 + 48.7) = 8.6 mN.m^{-1}

And for dodecane S= 72.8-(25.4+ 52.9) = -5.5 mN. m^{-1}

Spreading occurs when S is so pentane spreads, dodecane does not

[5 marks]

From the Hamaker constants, the Hamaker constant of air is zero, so the net Hamaker constant is simply the Hamaker constant of the alkane minus the Hamaker constant of water

So for Pentane it's 3.75-4.00 = -0.25 (x10^{-20}) J

Dodecane it's 5.04-4.00 = 1.04 (x10^{-20}) J

So for Pentane Hamaker constant is –ve so the van der Waals interaction is positive, (repulsive) so pentane spreads on water, opposite is true for dodecane.

[5 marks]

b) using either or both of the above arguments, when water is the liquid spreading on the alkane situation is the same, so water spreads on dodecane but not on pentane, pentane does not?

[5 marks]

Q 2 This question has 7 parts some easy to explain some more difficult

i) bubbles are stabilised by a –ve surfactant SDS, so expect it to be –ve and that an edl will be set up, so that when measuring the zeta potential, the potential will be –ve. There is a spread of values due to the different nature of each bubble

ii) silica at pH 6 would be expected to be negative, due to the dissociations of Si-OH groups into Si-O⁻ groups. Again edl set up etc.

iii) Alumina is positively charged due to the formation of Al-OH⁺ surface groups.

iv) Bubbles plus alumina mix everything is –ve, no positive, so alumina has adsorbed onto the negative air bubbles, not a slight decrease in the zeta potential compared to the pure air bubbles indicating some neutralisation

v) Bubble silica mix, almost a merging of the bubble data and silica data indicating little interaction between the silica and bubbles as both are negative.

vi) Alumina and silica mix, very broad and complex, some silica particles with zeta potential of -40 mV seem similar to just silica, most of the very positive alumina +60 mV have been removed with a peak now around 20-40 mV some particles with -20 mV zeta potential.
To me it looks as though some alumina is adsorbing onto the silica, reducing the silica zeta potential and in many cases this dominates making the zeta potential dominate. Some silica seem to be unaffected, which is strange, this may be due to poor mixing actually

vii) Alumina particles picked up by the bubbles, whilst silica is not.

[5 marks each part]

Q 3

a)Three possible mechanisms

    i)   Polymer bridging where one molecule adsorbs simultaneously onto two particles

    ii)   Bare patch, where a positive region on one particle where the polymer is adsorbed attracts a negative part of another particle

    iii)   Charge neutralisation, where the zeta potential on the particles are reduced so that edl repulsion is minimal and van der Waals forces dominate

[3 marks each part]

b)

    i)   Inc polymer charge density would result in increasing attraction of polymer to surface, but somewhat counter intuitively probably less adsorption as every bit of polymer is attracted some polymer lies flat. If lower charged density polymer adsorb in loops (and trains) so more polymer could actually adsorb

    ii) Inc molecular weight would increase the thickness of polymer layer, but not that significantly increase the amount adsorbed which would only marginally increase

    iii) Inc surface charge density would attract more polymer to the surface

    iv) Inc ionic strength would screen edl of both particles and polyelectrolyte and decrease attraction of the particle to the polymer and so is likely to increase amount adsorbed.

[4 marks each part]

Q4

a) Cmc 8×10^{-4} M (accept between 7-10 $\times10^{-4}$)

[2 marks]

b) Use Gibbs Eqn

$$\Gamma = -\frac{1}{RT}\frac{d\gamma}{d\ln c}$$

= 4×10^{-2}/(2.303x 298x8.314) = **7 x 10-6M**

Slope at 3 X 10-4 and 8 x 10-4 the same therefore surface XS is the same, as it is at 3x 10-3 M above the cmc

[5 marks each part]

c) At 3 X 10 -4 molar, we are below the cms, surfactant will adsorb as a monolayer so the surface will be hydrophobic and so contact angle will be high, around 90.
At 3 X 10 -3 molar above cmc, surfactant adsorb more as micelles, and so present a hydrophilic surface so contact angle will be much lower (although perhaps initially it may be hydrophobic as monomers will diffuse to the surface first, then micelles will come and displace or form on the monolayer)

[4 marks each part]