Question 1 **[35marks]**

a) Because the lowest energy state will minimise the surface area of any drops as this lowers the total surface energy. The lowest energy state corresponds to all the droplets coalescing so that eventually the two phases separate. However, the interactions between the two drops in a "stable emulsion" are going to be repulsive, if this energy barrier is high then the two drops will not be able to get close enough to coalesce. Could show a diagram to show this here.

10 Marks

b) Its unstable because the particles are too hydrophilic and do not go to the interface and so no stable emulsion, so the particles need to be made more hydrophobic, ideally this would give a contact angle of 90 degrees.

5 Marks

c) Simply lowering the interfacial tension will not give rise to a stable emulsion, its necessary to ensure there is a repulsion between the drops. SDS has sulfate groups which are charged and repel each other through electrical double layer interaction

5 Marks

d) Its due to the packing fraction, i.e relative size of the head group to the tail, in water there is a repulsion between the head groups on the surface of the micelle, so the head group is large in area than the tail group so packing as a sphere is favoured. Adding salt screens the range of the repulsion between the head groups making the effective surface area less encouraging packing in rods, or as in the case of CTAB large wormlike micelles

5 marks

e) It's a problem because the water containing the pesticide droplet runs off the leaves so it's no use as a fungicide as that needs to stay on the leaf. The contact angle of the droplet needs to be reduced to at least below 90, preferably to zero. This can be achieved by adding a surfactant, which will adsorb on the hydrophobic leaves making the nsurface hydrophilic

A picture would help here

10 Marks

<u>Question 2</u> **[40 marks]**

a)

i) The electrical double layer interaction dominates over the van der Waals attraction, so even though if the spheres were pressed very hard together the attraction would become larger than the edl repulsion, they have not been pressed that hard

3 marks

ii) Due to screening of the edl, which is larger at higher salt concentrations

3 marks

iii) The edl forces have been reduced so much that the interaction is totally dominated by van der Waals forces now hence no repulsion

3 marks

iv) In this case there is a delicate balance between edl and vdw, hence the presence of a maximum

5 marks

v) 50 nm, or thereabouts as its 10x the value at 100mM, edl length scales with log concentration so edl 10x value at for every 2 orders of magnitude reduction of electrolyte concentration

5 marks

b)

i) Interaction due to edl, force decays exponentially with electrolyte concentration hence linear on log axes

3 marks

ii) edl forces and this decay length (thickness of edl) corresponds to about 10-3 molar electrolyte, however the pH is 3 which corresponds to an electrolyte (H+) ion conc of 10-3

5 marks

iii) Essentially its depletion, the nanoparticles are non-adsorbing and their interaction causes an attraction if they are not in the gap between the particles

5 marks

iv) The presence of particles causes layering of particles close to the surface, so there is a repulsion initially, this layer of particles then gets pushed out giving a depleted layer and a consequential attraction

8 marks

Question 3 **[25 marks]**

a) Needs to be shear thinning, low viscosity at high shear so drilling is not hindered and high viscosity at low shear to prevent particle settling

3 marks

b) It doesn't form a filter cake in permeable regions so drilling fluid could penetrate such permeable areas

3 marks

c) Some particles of an appropriate size which would plug the pores

3 marks

d) The interaction between the plates in sea water would be much shorter ranged and attractive due to double layer, in water long ranged repulsion. This would give rise to a more gel like property and probably would give rise to better rheology from a drilling fluid viewpoint than in sea water, where the attraction would give better rheology but at a higher particle volume fraction

6 marks

e) Firstly need to grind particles to less than a mm. Then need to ensure on of the particles becomes hydrophobic. Better to make to CuO hydrophobic as that will need less collector (surfactant). Therefore, add an anionic collector, surfactant at a pH less than the iep of the CuO say pH 4-5. This will make the particles hydrophobic as the surfactant will adsorb onto the +ve particles. The CuO particles will the be hydrophobic and air bubbles from the flotation cell will attach, floating those particles leaving the quartz in the tailings of the cell. Likely to need to use about 20 flotation cells to get optimum separation of the two minerals

10 marks