Topic 4 Bubbles

1. The interactions of liquid molecules with other liquid molecules give rise to cohesive forces. The interactions of liquid molecules with molecules of another substance are called adhesive forces. In the case of water and glass the adhesive glass/water forces are stronger than the cohesive water/water forces and water is pulled up the sides of a glass container giving a concave meniscus. In the case of mercury and glass the mercury/mercury cohesive forces are stronger so the mercury sticks more strongly to itself than to the glass giving a convex meniscus.

2. Capillary forces are the adhesive forces between water and glass. The adhesive forces will pull water upwards in a glass tube until they are exactly balanced by the gravitational forces pulling water downwards. In a narrow tube the weight of water is less so the water can rise higher before gravity balances the adhesive force.

3. Surface tension arises because there are net sideways forces on the surface of a liquid (making the surface a bit like cling film). Water has very strong sideways forces because it can hydrogen bond. When a surfactant is added to water the surfactant molecules arrange themselves on the surface. The interaction between surfactant molecules is not as strong as the interaction between water molecules so the surface force (the surface tension) is reduced.

4. Detergents can dissolve in water because, although they have tails that are hydrophobic (don't like water), their hydrophilic head groups interact strongly with water (often the head groups are charged). The tail groups can, however, interact with grease (like dissolves like). What happens when you wash clothes or dishes is that the agitation in the tub or sink encourages the tail groups to surround the grease (making micelles – little globs of grease) which can then float to the surface of the water and be rinsed off.

5. 'Hard' water contains metal salts (like calcium and magnesium salt) which can interact with the soap (often causing it to precipitate – fall to the bottom - or form a scum) which prevents the soap from being able to clean.

6. Surfactants or detergents have 3 roles in making bubbles: 1. They lower the surface tension of the water so the water film in the bubble is not pulled back into the liquid water; 2. They increase the elasticity of the film so that it doesn't break so easily; and 3. They coat the water film and reduce evaporation so the bubble lasts longer.

7. Glycerin is thick and viscous. It is added in a bubble recipe to make it harder for the water to flow, that is it is harder for the water to move under gravity and the top of the bubble thin and the bottom of the bubble thick (as the film gets too thin it will break).

8. Bubbles last longer on a rainy day because the high humidity in the air when it's raining slows the evaporation of water from the bubble film.

9. Bubbles are spherical because, for a given amount of soap film, the bubble that forms has the smallest possible surface area (ie the thickest possible film). The minimal surface is a sphere, ie for a given volume of air a sphere is the shape with the smallest possible surface area.

10. Bubbles will pop on a dry finger (or dry clothing or dry ground…) because the film wants to 'wet' the surface, ie it wants to spread out and coat your finger because the adhesive interactions with your finger are bigger than the adhesive interactions with the air. If your finger is already wet, however, the soap film on your finger and in the bubble can coexist.