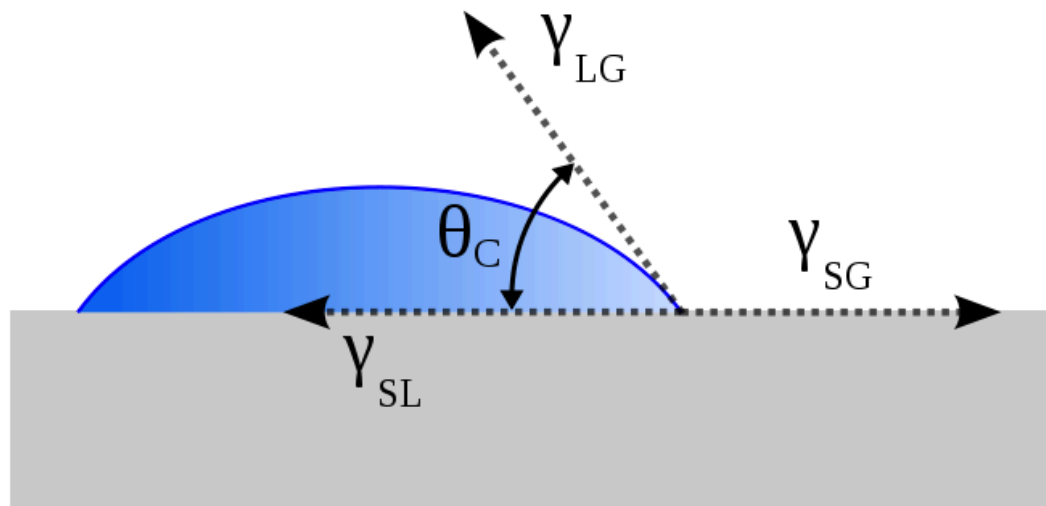Exercices- surface tension-high surface area Thu 6/09

1) Let's consider a drop of water on Teflon. The surface tension for Teflon-water is 92 mM/m, the surface tension of water-air is 72 mN/m and the surface tension of Teflon-air is 20 mN/m. Calculate the contact angle of the drop on the Teflon surface. Draw the drop.

Answer:

Young equation:

$$\gamma_{SL} + \gamma_{LG}cos\theta_C = \gamma_{SG}$$

$$cos\theta_C = \frac{\gamma_{SG} - \gamma_{SL}}{\gamma_{LG}} = -1$$

$$\theta_C = 180°$$

2) **Take a leaf of ladies mantle.** Pour a small drop of water (diameter ≤1mm) on an undamaged and clean area of the leaf.

-what is the contact angle of the water drop on the leaf?

- Tilt the leaf back and forth and observe how easy it is to get rid of the water from the leaf.

- Rub your finger on a part of the leaf and repeat the experiment.

Take a microscope glass slide
Pour a small drop of water (diameter ≤1mm) on an undamaged and clean area of the slide.

-what is the contact angle of the water drop on the slide?

- Tilt the slide back and forth and observe how easy it is to get rid of the water from the slide.

What is the difference between the lady's mantle leaf and the microscope slide? Is the lady's mantle leaf surface hydrophilic? Hydrophobic?

3) How are surfactants positioned in a soap bubble? Make a drawing.
Answer:

Water film
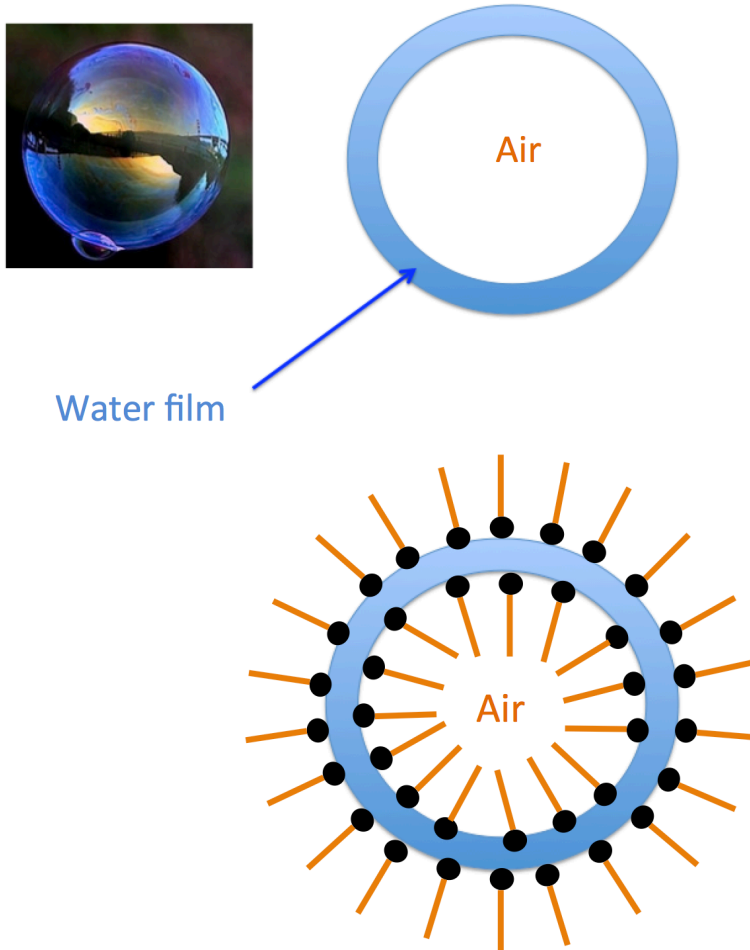
4) Let's consider and oil in water emulsion. The volume of water is 1 l and there is 10% (volume) oil. The oil dropplets are 1µm in radius and the interfacial tension between oil and water is 50 mN/m. Calculate the oil-water total interfacial energy of this emulsion.

Answer: $V_{oil} = 0.1\ V_{water}$

$$V_{droplet} = \frac{4}{3}\pi r^3$$

Number of droplets: $N_{droplet} = \dfrac{V_{oil}}{V_{droplet}} = \dfrac{0.3\ V_{water}}{4\pi r^3}$

Total oil water area:

$$A_{oil-water} = N_{droplet} \times A_{droplet} = \frac{0.3\ V_{water}}{4\pi r^3} \times 4\pi r^2 = \frac{0.3\ V_{water}}{r}$$
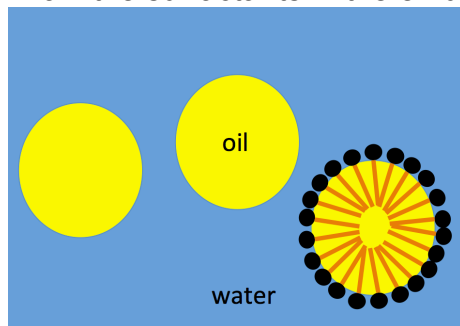
Total interfacial energy:

$$E_{oil-water} = A_{oil-water} \times \gamma_{oil-water} = \frac{0.3\ V_{water}}{r}\gamma$$

$$E_{oil-water} = \frac{0.3\times10^{-3}}{10^{-6}}50\times10^{-3}\ N.m = 15\ N.m = 15\ J$$

5) Now surfactant is added to stabilize the emulsion (the interfacial tension between oil and water in the presence of surfactant is approximately 10 mN/m).
Draw the surfactants in the emulsion.

What is the total interfacial energy now?

Answer: 3J