8.8 - Surface Tension

↳ (N/m) acting force over the surface of the liquid / unit length of the surface perpendicular to the force.

↳ work: associated with creation of additional surface area at constant V and T is

↳ $dA = \gamma d\sigma$

↳ A is helmholtz energy

↳ $\gamma$ is surface tension

↳ $\sigma$ unit element of area

$dA \leq 0$ for spontaneous process at constant V and T

if droplet radius increases r to r+dr, area increase by $d\sigma$

$\sigma = 4\pi r^2$ so $d\sigma = 8\pi r dr$

↳ took derivative

work done in expansion of droplet $= 8\pi\gamma r dr$

Normal force with distance $= 8\pi\gamma r$

↳ $F = 8\pi\gamma r$

net effect of force $= 4\pi r^2 P_{outer} + 8\pi\gamma r = 4\pi r^2 P_{inner}$ ✓

$P_{inner} = P_{outer} + \frac{2\gamma}{r}$

* $P_{inner} - P_{outer} \to 0$ as $r \to \infty$

$$P_1 - P_2 = \frac{2\gamma}{r_1} - \frac{2\gamma}{r_2} = 2\gamma\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

capillary rise - liquid where the level of zero pressure due to net upward force by attraction of $H_2O$ molecules to solid surface.

Capillary depression – where liquid does not wet walls of container

$$h = \frac{2\gamma}{\rho g r}$$

Contact angle – liquid-surface, difference in surface tension @ Solid liquid interference

Intermediate cases

↳ Complete wetting $\theta = 0°$

↳ Nonwetting, complete $\theta = 180°$

$$P_{inner} = P_{outer} + \frac{2\gamma\cos\theta}{r} \quad \text{and} \quad h = \frac{2\gamma\cos\theta}{\rho g r}$$

Ex. Insle strength → water supply to top of surface.