

$\theta = 107^\circ$  which gives  $\cos \theta = -0.44$   
 $\theta = 111^\circ$

The formula also predicts that when the contact angle is  $0^\circ$ , the liquid will spread out into a micro-thin layer over the surface. Such a surface is said to be fully wettable by the liquid.

== The breakup of streams into drops ==

In day-to-day life all of us observe that a stream of water emerging from a faucet will break up into droplets, no matter how smoothly the stream is emitted from the faucet. This is due to a phenomenon called the Plateau-Rayleigh instability, which is entirely a consequence of the effects of surface tension.

The explanation of this instability begins with the existence of tiny perturbations in the stream. These are always present, no matter how smooth the stream is. If the perturbations are resolved into sinusoidal components, we find that some components grow with time while others decay with time. Among those that grow with time, some grow at faster rates than others. Whether a component decays or grows, and how fast it grows is entirely a function of its wave number (a measure of how many peaks and troughs per centimeter) and the radii of the original cylindrical stream.

== Thermodynamics ==

As stated above, the mechanical work needed to increase a surface is  $\gamma \Delta A$ . Hence at constant temperature and pressure, surface tension equals Gibbs free energy per surface area:

where  $G$  is Gibbs free energy and  $A$  is the area.

Thermodynamics requires that all spontaneous changes of state are accompanied by a decrease in Gibbs free energy.

From this it is easy to understand why decreasing the surface area of a mass of liquid is always spontaneous ( $\Delta G < 0$ ), provided it is not coupled to any other energy changes. It follows that in order to increase surface area, a certain amount of energy must be added.

Gibbs free energy is defined by the equation,  $G = H - TS$ , where  $H$  is enthalpy and  $S$  is entropy. Based upon this and the fact that surface tension is Gibbs free energy per unit area, it is possible to obtain the following expression for entropy per unit area:

$$S = -\left(\frac{\partial G}{\partial T}\right)_A$$

Kelvin's Equation for surfaces arises by rearranging the previous equations. It states that surface enthalpy or surface energy (different from surface free energy) depends both on surface tension and its derivative with temperature at constant pressure by the relationship:

$$H = \gamma - T \left(\frac{\partial \gamma}{\partial T}\right)_P$$

== Thermodynamics of soap bubbles ==

The pressure inside an ideal (one surface) soap bubble can be derived from thermodynamic free energy considerations. At constant temperature and particle number,  $\Delta G$ , the differential Helmholtz energy is given by

$$\Delta G = -P \Delta V + \gamma \Delta A$$

where  $\Delta P$  is the difference in pressure inside and outside of the bubble, and  $\gamma$  is the surface tension. In equilibrium,  $\Delta G = 0$ , and so,

$$\Delta P = \frac{2\gamma}{r}$$

For a spherical bubble, the volume and surface area are given simply by

$$V = \frac{4}{3}\pi r^3$$

and

$$A = 4\pi r^2$$

Substituting these relations into the previous expression, we find

<formula> ,

which is equivalent to the Young ? Laplace equation when  $R_x = R_y$  . For real soap bubbles , the pressure is doubled due to the presence of two interfaces , one inside and one outside .

===== Influence of temperature =====

Surface tension is dependent on temperature . For that reason , when a value is given for the surface tension of an interface , temperature must be explicitly stated . The general trend is that surface tension decreases with the increase of temperature , reaching a value of 0 at the critical temperature . For further details see Eötvös rule . There are only empirical equations to relate surface tension and temperature :

Eötvös :

<formula>