Surface tension

- Surface tension is a force per unit length (N/m)
- (if surface has two sides, e.g. a bubble, this becomes 2l)

Surface tension & surface area

\[ \gamma = \frac{\text{force}}{\text{length}} = \frac{F}{2d} \]
Surface tension - capillaries

- Cohesive forces: liquid
- Adhesive forces: liquid

Cohesive forces dominant? Yes
Adhesive forces dominant? No

Strong cohesive forces but weaker adhesive forces.

Contact angle zero for clean glass. Water attracted to glass - adheres.

Surface tension - capillaries

- Mercury does not wet glass.
- Water wets glass.

At equilibrium...
- Adhesion force is upwards
- Cohesive force is downwards.

Contact angle zero for clean glass. Water attracted to glass - adheres.

Surface tension - capillaries
Surface tension - capillaries

\[ h = \frac{2 \gamma \cos \theta}{\rho g r} \]

Application

Capillary rise of sap in trees (water in summer):

\[ \rho = 1.0 \times 10^3 \text{ kg/m}^3 \]
\[ \gamma = 0.073 \text{ N m}^{-1} \]
\[ T = 2.5 \times 10^{-5} \text{ m} \]

That's not enough for a tree!

Sap exerts 5 atm of "negative" pressure on membranes.

Surface tension - bubbles
Surface tension - $p = 4\pi r$