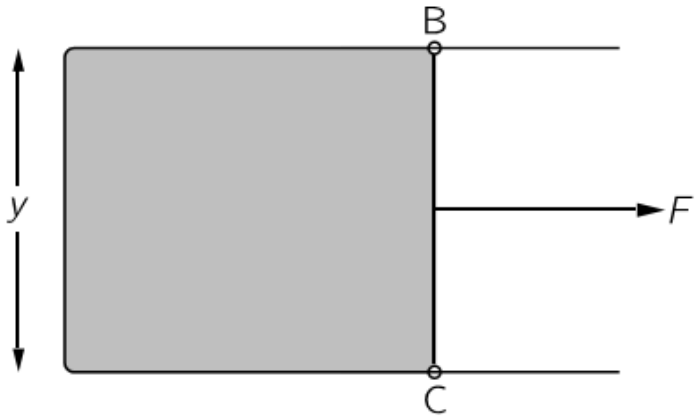
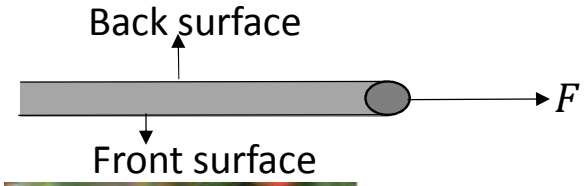
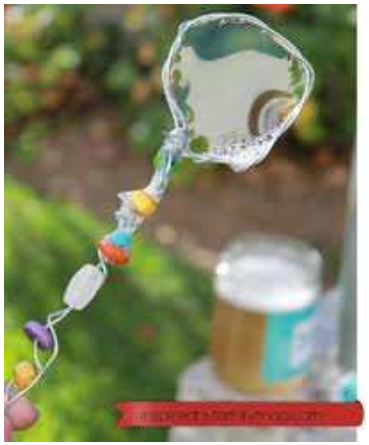
Surface tension of a thin film of liquid







Consider a wire frame as shown in the figure and a **thin film of liquid** is formed inside the frame (Similar to the one formed used a wand, when children are making bubbles, see the figure below). The wire BC is free to slide along the frame. The force F applied to BC balances the force due to the surface tension of the liquid acting on BC. Since a liquid film has **two** surfaces, the length of the line over which the force acts is given by

$$l = 2y$$

From

$$\gamma = \frac{F}{l} = \frac{F}{2y}$$

Solving for F yield

$$F = 2y\gamma$$

Capillary action

Cohesive forces - are attractive force between the molecules of the same material (in this case liquid)

Adhesive forces - are attractive force between the molecules of the different materials (in this case liquid and the container)

Capillary Action – is the tendency of liquids to **rise** or to be **depressed** in tubes of small diameter.

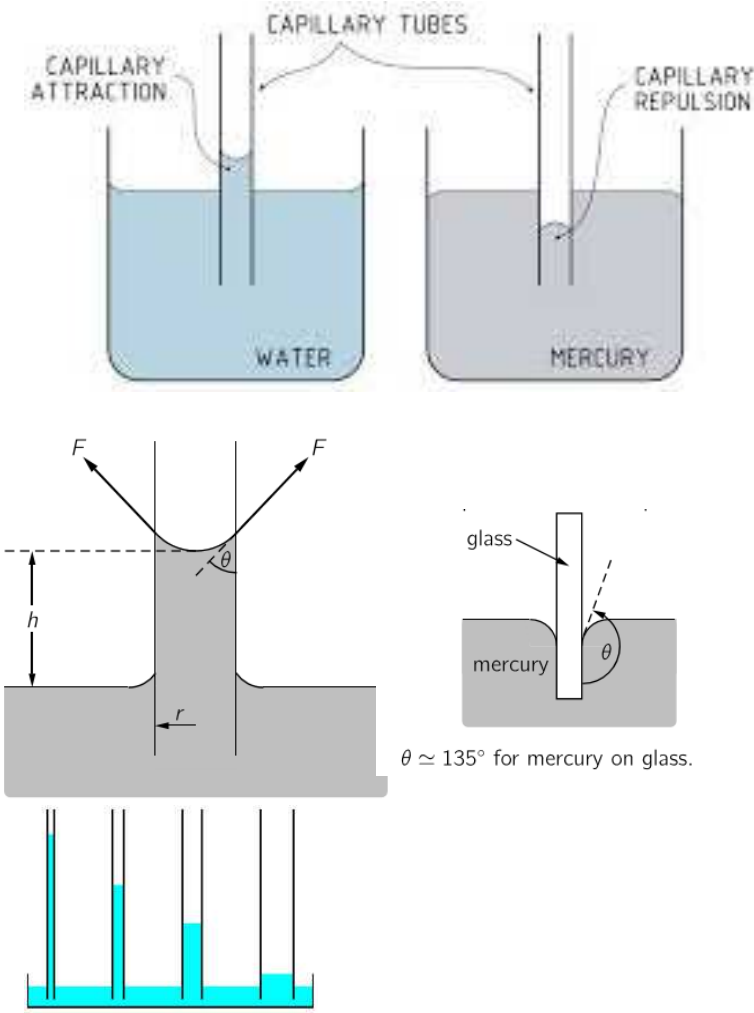
If the **adhesive** forces are **greater** than **cohesive** forces, **the liquid will rise**.
If the **adhesive** forces are **less** than **cohesive** forces, **the liquid will be depressed**.

How high the liquid rise of how low it is depressed depends on the following parameters

- **Contact angle -** is the angle measured **within the liquid**, between the solid surface and the tangent plane to the liquid surface at the point of contact.
- **Radius** of the tube.

Mathematically, the height is given by

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

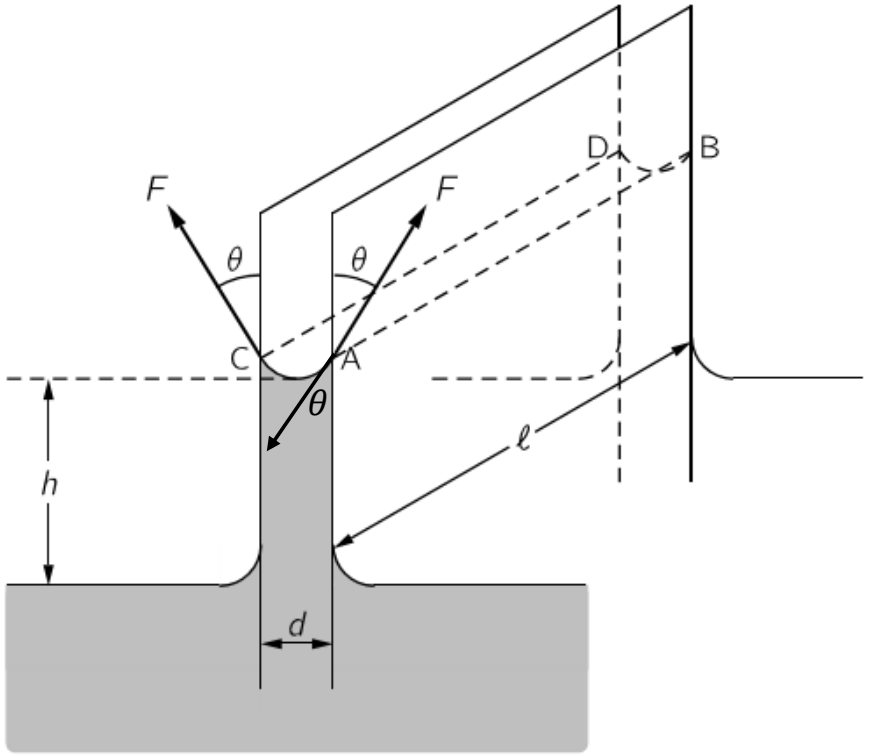


Application of Capillary action

A blood sample is collected in a tube through capillary action

Plants take in water through capillary action

Capillary action between two plates



The height at which the liquid rise between two narrow parallel plates is given by

$$h = \frac{2\gamma cos\theta}{d\rho g}$$

Example

Example 6.7: Contact angle between glass and water.
Water rises to a height of 14.5 cm in a slightly greasy capillary tube of radius 0.10 mm dipped vertically in the water. What is the angle of contact between this glass and water? (For water $\gamma = 7.3 \times 10^{-2}$ N m^{-1} and $\rho = 1000$ kg m^{-3} .)

Example 6.7.1: Contact angle between glass and water
Two rectangular glass plates are spaced 1.0 mm apart. If the contact angle is 40°, determine how high the water will rise above the level of the water in the dish in the space between the plates.