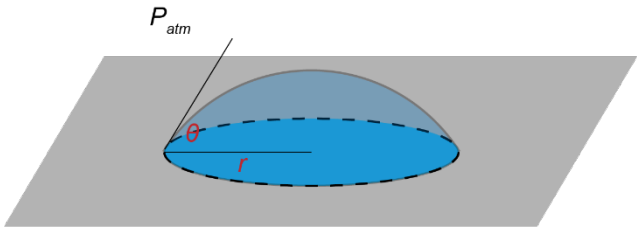
ME-446 Homework #1

Problem 1: Sessile Droplet
A sessile droplet refers to a droplet that rests on a surface without spreading out completely. Consider such a droplet of water on a substrate, taking the shape of a spherical cap.

Given:

- the ambient air pressure $\boldsymbol{P_{atm}}$
- the liquid-air surface tension $\boldsymbol{\gamma}$
- the radius of the footprint of the droplet $\boldsymbol{r}$
- the angle between the spherical cap and the substrate $\boldsymbol{\theta}$

Determine the liquid pressure in the droplet.

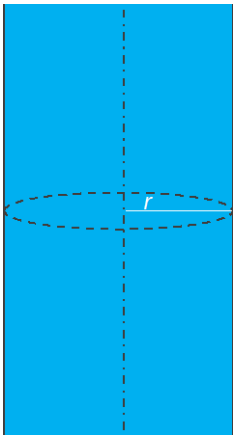


Problem 2: Water jet
Now, consider the case of a cylindrical water jet.

Given:

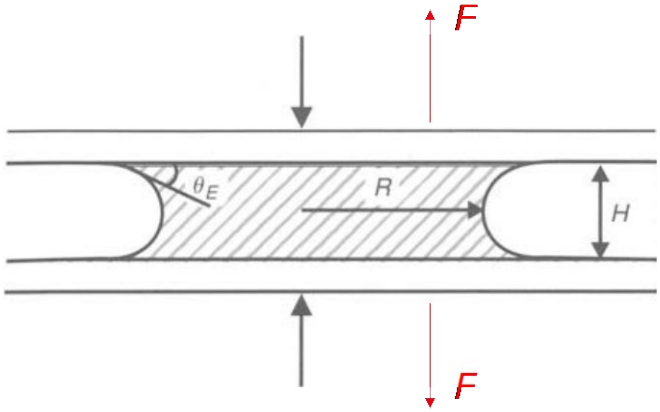
- the ambient air pressure $\boldsymbol{P_{atm}}$
- the liquid-air surface tension $\boldsymbol{\gamma}$
- the radius of jet $\boldsymbol{r}$

Determine the liquid pressure inside the cylindrical water jet.



Problem 3: Capillary adhesion (from the De Gennes book)
Two wetted surfaces can stick together with great strength if the liquid wets them with an angle $\theta_E < 90°$. Imagine that we mash a large drop between two plates separated by a distance H. The drop forms what is called a capillary bridge characterized by a radius R and a surface area $A = \pi R^2$.

Assuming $H \ll R$, and that we know the liquid surface tension γ, determine the force F we need to separate the two plates.



Problem 4: Pendant drop

The pendant drop method is a method used to measure liquid surface tension. In the figure below, we are looking at a liquid drop suspended from a needle in air. The shape of the drop results from the relationship between the liquid-air surface tension and gravity.

With the figure below, given:

- the liquid density $\boldsymbol{\rho}$
- the surface mean curvature at point 1, $\boldsymbol{\kappa_1}$
- the surface mean curvature at point 2, $\boldsymbol{\kappa_2}$
- and the height difference between point 1 and point 2, $\boldsymbol{H}$

Determine the surface tension of the liquid.