Surface Phenomena

Related Effects

- capillary effects
- influence on thermodynamic equilibrium
- surface tension

Specific Surface Area

$$= \frac{\text{Surface Area of Pores}}{\text{Volume of Solid}}$$

Example (for spheres)

$$= \frac{3}{r} \quad (\text{units m}^{-1})$$

surface phenomena increase with specific surface area

sandstone vs. shale?

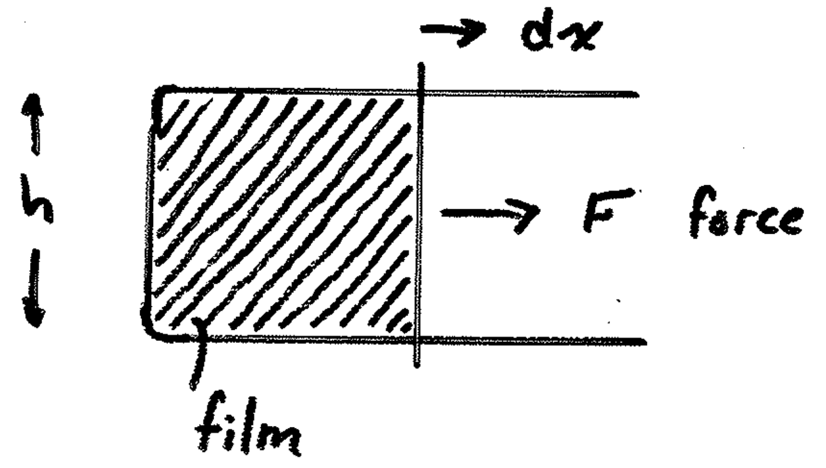
Surface Phenomena

analogy between surface and elastic membrane

work dW must be done to increase area by dA

$$dW = \gamma dA$$

surface energy ($J m^{-2}$) or
surface tension ($N m^{-1}$)

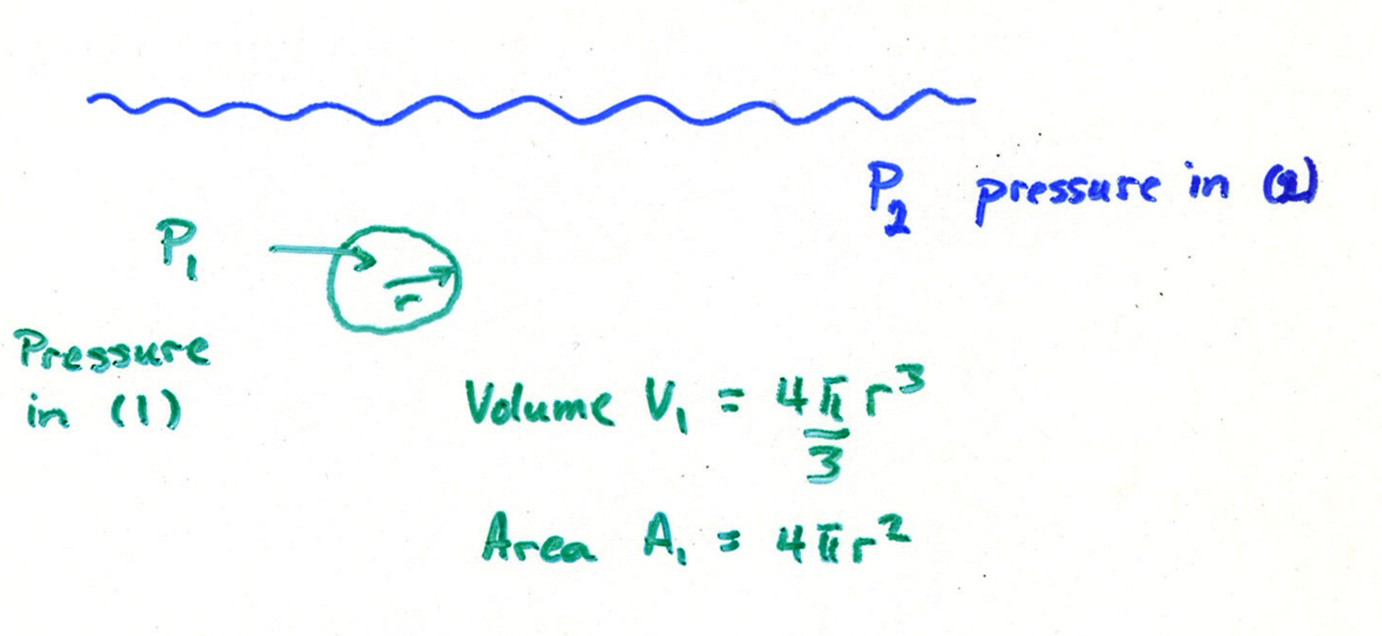


Work $dW = F \cdot dx = \gamma dA = \gamma (2h\,dx)$

$$\boxed{\therefore \gamma = \frac{F}{2h}}$$

Curved Surfaces

A small sphere of fluid (1) immersed in another fluid (2)



Mechanical Equibilibrium

work done by changing r should be zero

$$-P_1 dV_1 - P_2 dV_2 + \gamma dA = 0 \qquad \text{(for equilibrium)}$$

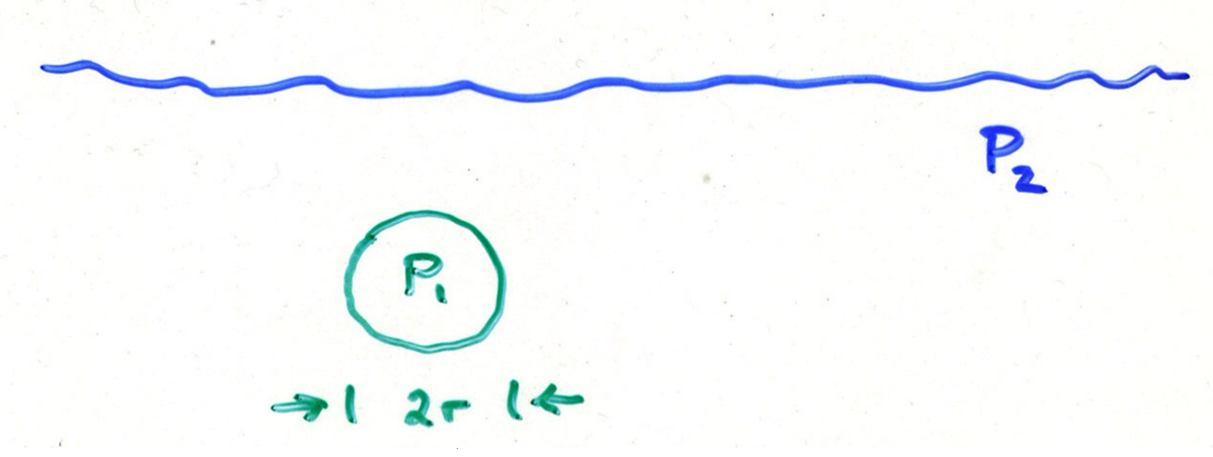
where

$$dV_1 = 4\pi r^2 dr$$

$$dV_2 = -4\pi r^2 dr$$

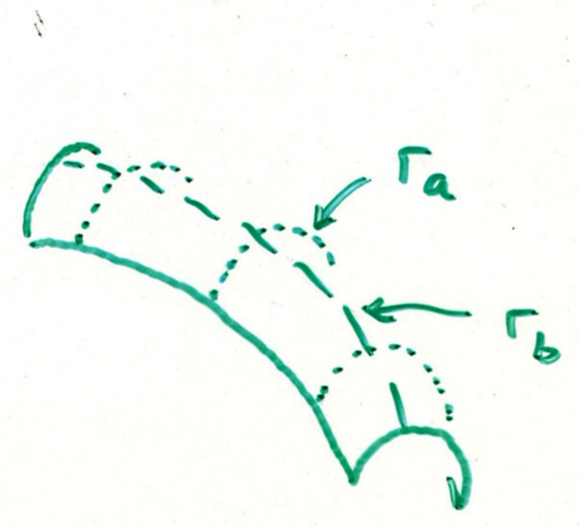
$$dA = 8\pi r dr$$

Laplace's Equation (Mechanical Equilibrium)



$$P_1 - P_2 = \frac{2\gamma}{r}$$

What if the surface isn't a sphere?



Mean radius r_m

$$\frac{1}{r_m} = \left(\frac{1}{r_a} + \frac{1}{r_b}\right)$$

More General Equation

$$P_1 - P_2 = \frac{2\gamma}{r_m}$$