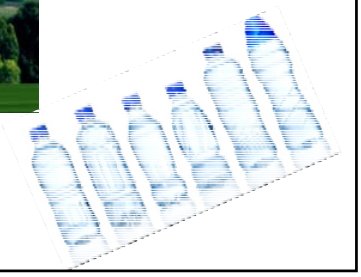
Fluid Statics (chapter 1, 2 of your textbook)

Large dams or small bottles - Design starts from fluid-statics calculations



Important applications: manometer, submerged surface, buoyancy, rigid-body rotation, fluid transportation

Learning objectives:

- Governing Equation of fluid statics
- Manometry (use of fluid statics principle in pressure measurement)
- Forces on submerged surfaces

Fluid, like everything else, is made of discrete molecules

Fluid, in this course, is treated as a continuous media, referred as *continuum*

Continuum approximation

Small fluid volume (sometimes we will call **fluid particle**) contains many many (~10^{23}) atoms/molecules

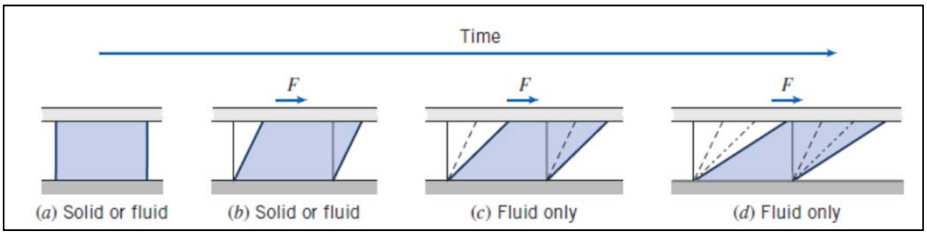
Another way of putting it: our **length-scale** is way bigger than molecular **length-scale**

The **continuum-scale**: preferred choice for **engineering applications**

Governing Equation of Fluid Statics

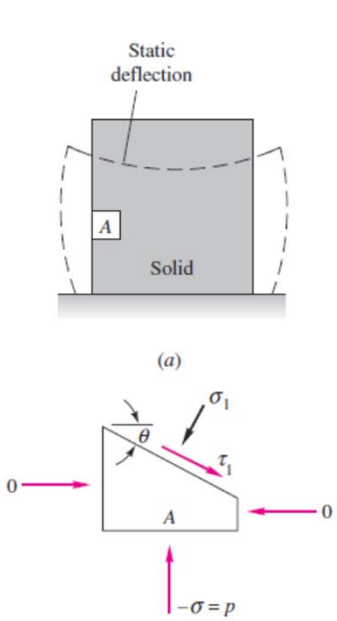
What is fluid, roughly?

Material that flows (deforms continuously) under shear stress

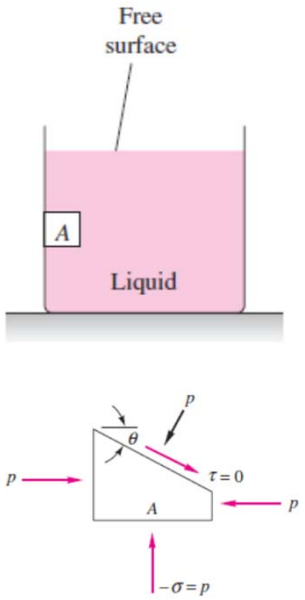


A corollary of the above concept:

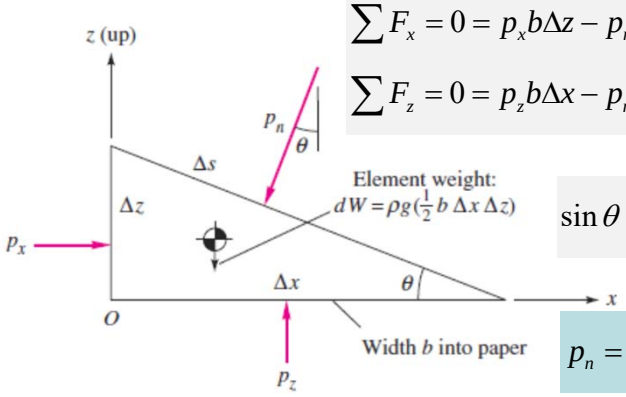
Under static condition, fluid sustains only normal stress



While solid deforms to sustain shear, fluid flows under shear; zero shear prevails in static fluid



Equilibrium of a fluid element



$$\sum F_x = 0 = p_x b\Delta z - p_n b\Delta s \sin\theta$$

$$\sum F_z = 0 = p_z b\Delta x - p_n b\Delta s \cos\theta - \frac{1}{2}\rho g b \Delta x \Delta z$$

$$\sin\theta = \frac{\Delta z}{\Delta s};\cos\theta = \frac{\Delta x}{\Delta s}$$

$$p_n = p_x = p_z - \frac{1}{2}\rho g \Delta z$$

For an infinitesimal fluid element $\Delta z \to 0 \Rightarrow p_n = p_x = p_z$

Pressure at a point is a scalar
(direction-independent)