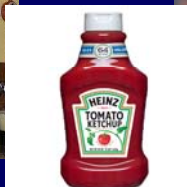


A Brief Introduction to Fluid Mechanics (CE 251)

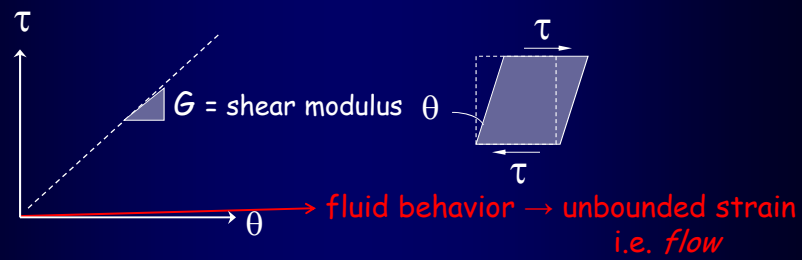
Fall 2017
Prof. Brandes



What is a Fluid?

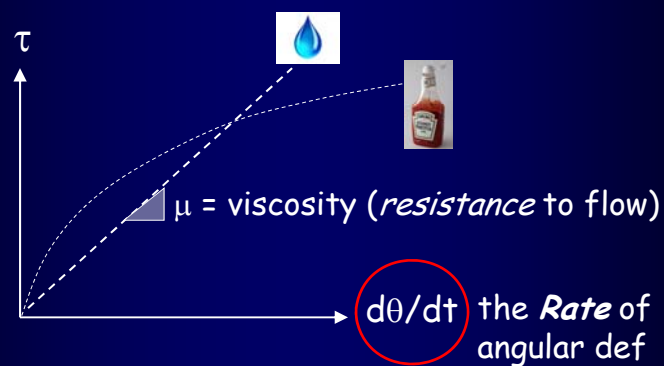


Solid Behavior - *Deformation* (ES 230)



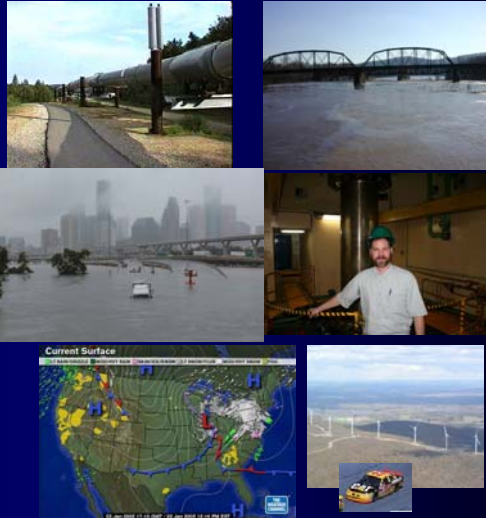
- So, a fluid is a substance that *deforms without bound when subjected to shear, i.e. it "flows"*:
water, air, maple syrup, beer, etc

Fluid Behavior - *Flow*



Applications of fluid mechanics

- water supply, pipelines, conveyance systems
- stormwater management
- hydromachinery (pumps, turbines, propellers)
- groundwater & wells
- weather prediction, windpower, aerodynamics
- medicine (blood flow)



A practical application

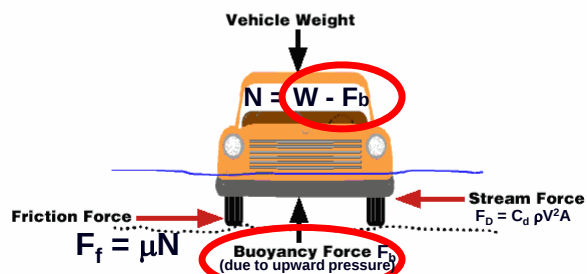


Analysis:

Forces on Vehicles Crossing Streams

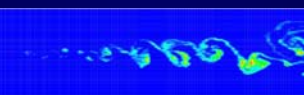
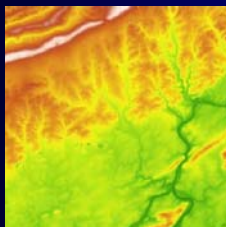
The car will float downstream when:

$$\text{Stream Force} > \text{Friction Force}$$



Source: Steve Waters—Senior Hydrologist, Maricopa County Arizona Flood Control District

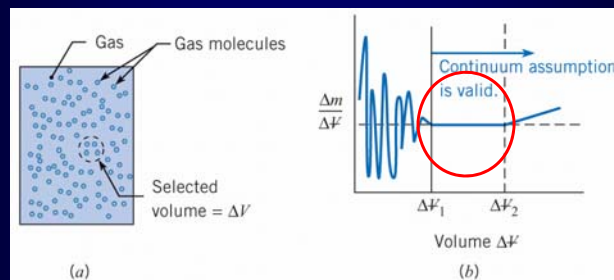
Fluids are beautiful!



on to some important
concepts in Chapter 1
- Please read it!

THE FLUID AS A “CONTINUUM”

- We don't care too much what the individual molecules are up to, we'll look at how they behave as a unit - thus, the fluid as a CONTINUOUS medium



DIMENSIONS

- ♦ "Dimensional Homogeneity"
 - Equations derived from fundamental principles of math and physics *must* have the same dimensions (M, L, t, T) on both sides of =

$$\frac{p}{\gamma} + z + \frac{V^2}{2g} = \text{constant} \quad (\text{Theoretical})$$

$$C_f = \frac{0.523}{\ln^2(0.06 \text{Re}_L)} - \frac{1520}{\text{Re}_L} \quad (\text{Empirical})$$

UNITS

1. Don't switch systems (e.g., English to SI)
2. **Carry units through calculations**, don't add what you *think* the units should be at the end

EX: What is the weight (lbs) of a 55-gal drum of water?

$$55 \cancel{\text{gal}} \times 62.4 \frac{\text{lbs}}{\cancel{\text{ft}^3}} \times \frac{\cancel{\text{ft}^3}}{7.48 \cancel{\text{gal}}} = 458.8 \text{ lbs} \quad (\text{"grid method"})$$

3. Check your units at the end to see that they make sense (weight = lbs or N, not ft/s or kg)!

Components of Fluid Mechanics

- 1) *Fluid properties* - density, viscosity, etc
- 2) *Hydrostatics* - pressures and loads on submerged objects due to a static fluid
 - Archimedes
- 3) *Hydrodynamics* - theoretical, mathematical equations of fluid flow
 - theorists: Newton , Bernoulli
- 4) *Hydraulics* - empirical (experimental) measurements of fluids, fitted to mathematical functions
 - experimentalists: Da Vinci, Reynolds, Nikuradse, Froude