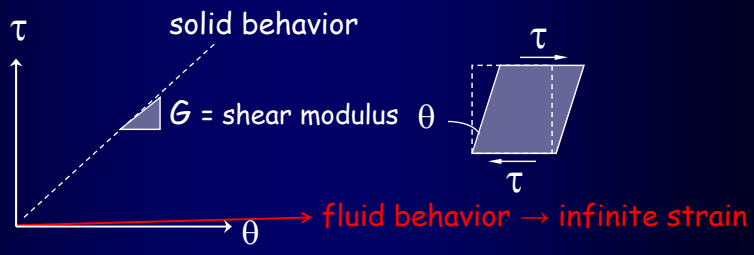
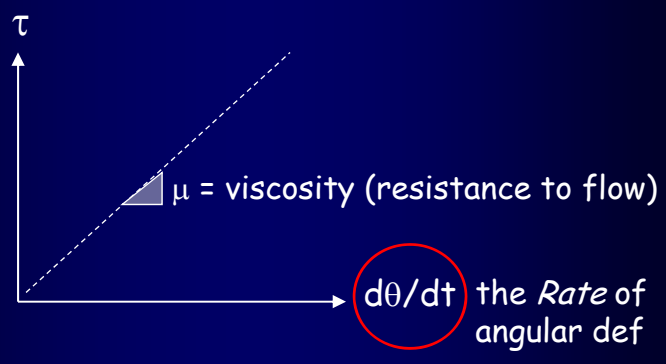
What is a Fluid?

Defining a Fluid

- a substance that "flows"
  - more formally, a material that *deforms without bound when subjected to shear*



Fluid Behavior



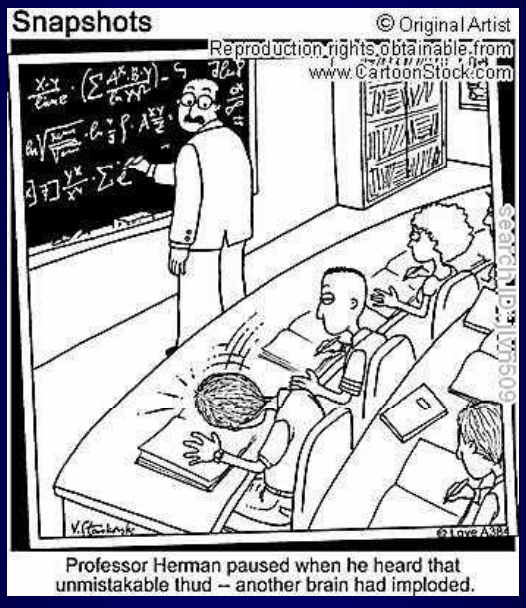
Favorite fluids: water, oil, honey, beer, air, etc

Basis of Fluid Mechanics

1) *Hydro**statics*** – distributed loads on submerged objects due to static water pressures

2) *Hydro**dynamics*** - theoretical, mathematical equations of fluid flow
   - theorists: Newton , Bernoulli

3) *Hydraulics* - empirical, experimental (lab) measurements of fluids, fitted to mathematical functions
   - experimentalists: Reynolds, Nikuradse, Froude



Applications of fluid mechanics

- water supply, pipelines, conveyance systems
- stormwater management
- hydromachinery (pumps, turbines, propellers)
- flood waves, groundwater
- weather prediction, windpower
- aerodynamics

But what about the grading?

- 75% exams*
- 20% homework**
- 5% effort***

**Three of them – a lot like HW problems*

*** Make sure you complete and understand the homework - key to success in CE 251. Make use of office hours!*

****Attendance, participation, the extra stuff*

CE 251 vs. CE 321…

- CE 251 is more narrowly focused (its about *mechanics* – forces, energy, motion, material props, etc)
  - math and physics and problem-solving – tiny bit of chemistry, no biology, no geology, no poop
- CE 251 has no labs … but we will do some experiments/demos in class

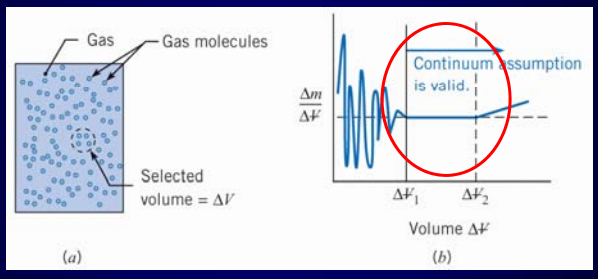
Last Day of CE 251, a few years ago…

Outcome 1 ….. or Outcome 2, the choice is yours

on to Chapter 1

Some basic ideas

- "Continuum assumption"
  - We don't care too much what the individual molecules are up to, we'll look at lots of them together – 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 the =

$$\frac{p}{\gamma} + z + \frac{V^2}{2g} = constant$$

$$V = \frac{1.49}{n} R_h^{2/3} S^{1/2}$$

DIMENSIONS

Table 1.2 PRIMARY DIMENSIONS

Dimension	Symbol	Unit (SI)
Length	L	meter (m)
Mass	M	kilogram (kg)
Time	T	second (s)
Temperature	θ	kelvin (K)
~~Electric current~~	~~i~~	~~ampere (A)~~
~~Amount of light~~	~~C~~	~~candela (cd)~~
~~Amount of matter~~	~~N~~	~~mole (mol)~~

Units

Practical advice:

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

   EX: a 55-gal drum of water weighs what?

$$55\,\cancel{gal}\ x\ \frac{\cancel{ft^3}}{7.48\,\cancel{gal}}\ x\ 62.4\,\frac{lbs}{\cancel{ft^3}} = 458.8\ lbs$$

3. Check your units at the end to see that they make sense!