Last Lecture

- Energy and Gravity

Today

- Properties of Fluids

Important Concepts

- Temperature is a measure of heat (internal energy).
- Pressure points "outward" in all directions.
- Pressure depends on height or depth.
- Buoyancy force is equal to the force of gravity on the displaced fluid.
- Strange things can happen when fluids start to flow.

Important Reminders

- Exam #3 is this Friday at 10am.
  - Covers topics through last week's classes and assignments and yesterday's MasteringPhysics.
  - Recent topics include momentum, simple harmonic motion, gravity & orbits.
- No more 8.01L assignments this semester.
- IAP class schedule is posted under “General Info”.
- Recitation switches will be allowed in case of scheduling conflicts with other IAP classes.

Fluid Properties

- A fluid is any substance in which the atoms and molecules are not held rigidly in place.
  - Examples: Gas, liquid, glass
- A quantity of fluid is characterized by:
  - Mass (or equivalently the numbers of atoms)
  - Volume (or Density which is mass/volume)
  - Temperature
  - Pressure

Temperature

- A quantitative measure of the amount of internal heat energy contained in an object.
  - "Heat" is dominantly kinetic energy (linear and rotational) with some contribution from molecular vibrations.
- Work done on an object can increase either its mechanical energy, its temperature, or both
- It is also possible to convert heat back into mechanical energy (i.e. to do work on something)
Units of Temperature

°Celsius (Centigrade) scale is defined so that water freezes at 0 degrees and boils at 100 degrees.

Physicists frequently use the Kelvin. A change of 1 degree Kelvin equals a change of 1 degree Celsius but 0 degrees K is ~273.16 degrees Celsius.

At 0 degrees K, the heat energy is zero (absolute zero).

The US still commonly uses Fahrenheit.

Degrees F = ((9/5) degrees C) + 32.0

Pressure

Basic definition is Force/Area (Newtons per meter²).

- 1 Pascal = 1 N/m² English is lb/in²
- Also 1 torr = 1 mm depth of mercury (Hg) = 1.33x10² N/m²
- 1 atm = 1.01x10⁵ N/m² = 14.6 lb/in² = 760 torr = 30¹⁰Hg

For fluids, pressure points “outward” in all directions.

At a fixed height or depth, the magnitude of the pressure is the same in all directions.

The source of pressure can be internal (heat) or external due to an applied force such as gravity.

Some Derived Results

Found from applied F=ma

Pressure versus height (if no flow):

\[ P_2 - P_1 = -\rho g (y_2 - y_1) \quad y \text{ is positive upward} \]

\[ P = P_0 + \rho gh \]

Buoyancy forces (causes things to float):

\[ F_B = \rho_{\text{fluid}} g V_{\text{disp}} \]

\[ V_{\text{submerged}} = \frac{\rho_{\text{object}}}{\rho_{\text{fluid}}} \]

More Derived Results

Found from applied Work/Energy

Bernoulli’s Equation (causes things to fly):

\[ P + \rho g y + \frac{1}{2} \rho v^2 = \text{Constant} \]