

## ↻ 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.

8.01L Fall 2005

12/06/2005

## 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.

8.01L Fall 2005

12/06/2005

## 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

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## 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)

8.01L Fall 2005

12/06/2005

## 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

8.01L Fall 2005

12/06/2005

## Pressure

- ⇒ Basic definition is Force/Area (Newtons per meter<sup>2</sup>)
  - ⇒ 1 Pascal = 1 N/m<sup>2</sup> English is lb/in<sup>2</sup>
  - ⇒ Also 1 torr = 1 mm depth of mercury (Hg) = 1.33x10<sup>2</sup> N/m<sup>2</sup>
  - ⇒ 1 atm = 1.01x10<sup>5</sup> N/m<sup>2</sup> = 14.6 lb/in<sup>2</sup> = 760 torr = 30" Hg
- ⇒ 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

8.01L Fall 2005

12/06/2005

## Some Derived Results

- ⇒ Found from applied F=ma
- ⇒ Pressure versus height (if no flow):
  - $P_2 - P_1 = -\rho g(y_2 - y_1)$   $y$  is positive upward
  - $P = P_0 + \rho gh$
- ⇒ Buoyancy forces (causes things to float):

$$F_B = \rho_{fluid} g V_{disp} \quad V_{disp} \text{ is the volume of fluid displaced}$$

$$\frac{V_{submerged}}{V_{object}} = \frac{\rho_{object}}{\rho_{fluid}}$$

8.01L Fall 2005

12/06/2005

## More Derived Results

- ⇒ Found from applied Work/Energy
- ⇒ Bernoulli's Equation (causes things to fly):

$$P + \rho gy + \frac{1}{2} \rho v^2 = \text{Constant}$$

8.01L Fall 2005

12/06/2005