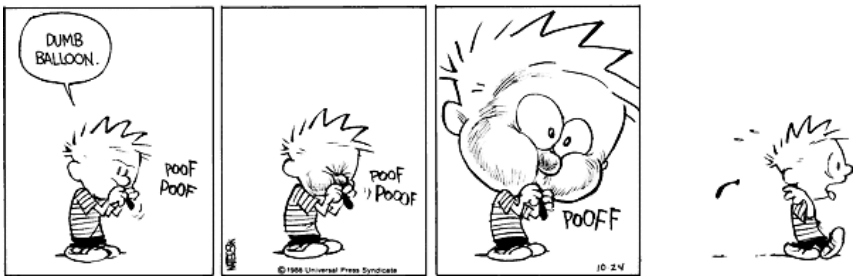
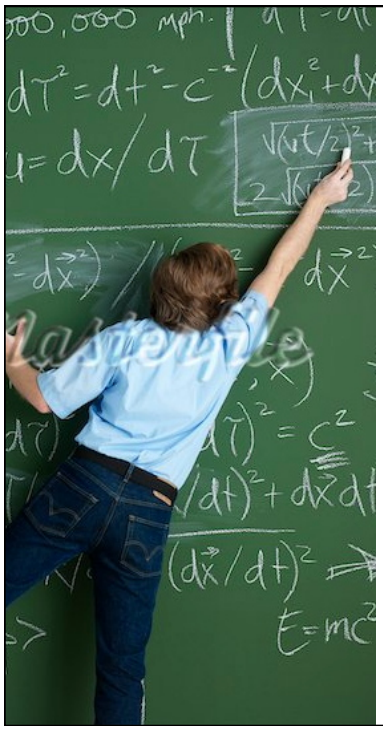
October 31, 2016 Physics 131 Prof. E. F. Redish

- **Theme Music:** Queen
  Under Pressure

- **Cartoon:** Bill Watterson
  Calvin and Hobbes



10/31/16 Physics 131 **1**



The Equation of the Day

Pressure and depth

$$p = p_0 + \rho g d$$

3 **Physics 131**

Kinds of (Models of) Matter

- Classify objects by how they deform.
  - *Solid*: don't change shape if you leave them alone or push on them (not too hard!)
  - *Gel*: look solid if you don't touch them but are "squishy" and change shape easily (jello, butter, clay,…)
  - *Liquid*: Have no shape of their own. Flow to fill a container but have constant volume.
  - *Gas*: Have neither shape nor volume but fill any container.
  - LOTS MORE!

The Renaming Game: A useful tool for complex equations

- Translate the problem:
  - "*If I heat an enclosed volume of gas so its pressure doubles, what happens to the average speed of molecules in the gas?*"

  into a pure math question about your new variables.

Renaming

- On the left half of your notebook page, write these two equations – large!

$$p = \frac{Nk_BT}{V}$$

$$k_BT = \tfrac{3}{2}mv^2$$

Be sure that your handwriting distinguishes between V and v!

Renaming

- For the situation of the problem:
  - "*If I heat an enclosed volume of gas so its pressure doubles, what happens to the average speed of molecules in the gas?*"

Identify the **variables** by putting a **circle** around them in your equations.

Identify the **constants** by putting a **box** around them in your equations.

Be sure that your handwriting distinguishes between a circle and a box!

Renaming

- On the right half of your notebook page, rewrite your two equations but replace the variables by *x, y, z* and any cluster of constants (symbols that just represent numbers that will be combined) by *a, b, c*.
- Now what do your 2 equations look like?

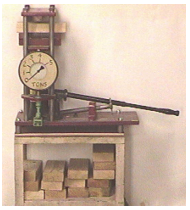
Foothold ideas: Liquids

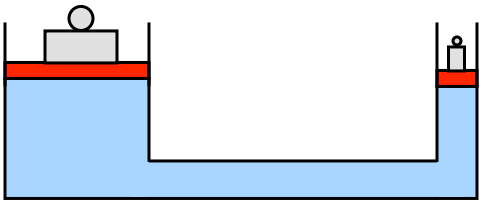
- In a liquid the molecules are close enough that their mutual (short ranged) attractions hold them together (e.g. H-bonding in H_2O).
- A liquid maintains its volume but changes its shape easily in response to small forces.
- The relation of *p*, *V*, and *T* in a liquid is WAY more complicated than in a gas.

Pascal's Principle

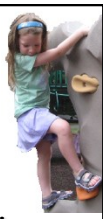
A force exerted on a part of a fluid is transmitted through the fluid and expressed in all directions.

$$\frac{W_1}{A_1} = \frac{W_2}{A_2}$$





Foothold ideas: Pressure 2



- A constrained fluid has an internal pressure –like an internal force at every point in all directions. (Pressure has no direction.)
- At a boundary or wall, the pressure creates a force perpendicular to the wall. $\vec{F} = p\vec{A}$
- The pressure in a fluid increases with depth.

$$p = p_0 + \rho g d$$

- The pressure in a fluid is the same on any horizontal plane no matter what the shape or openings of the container.