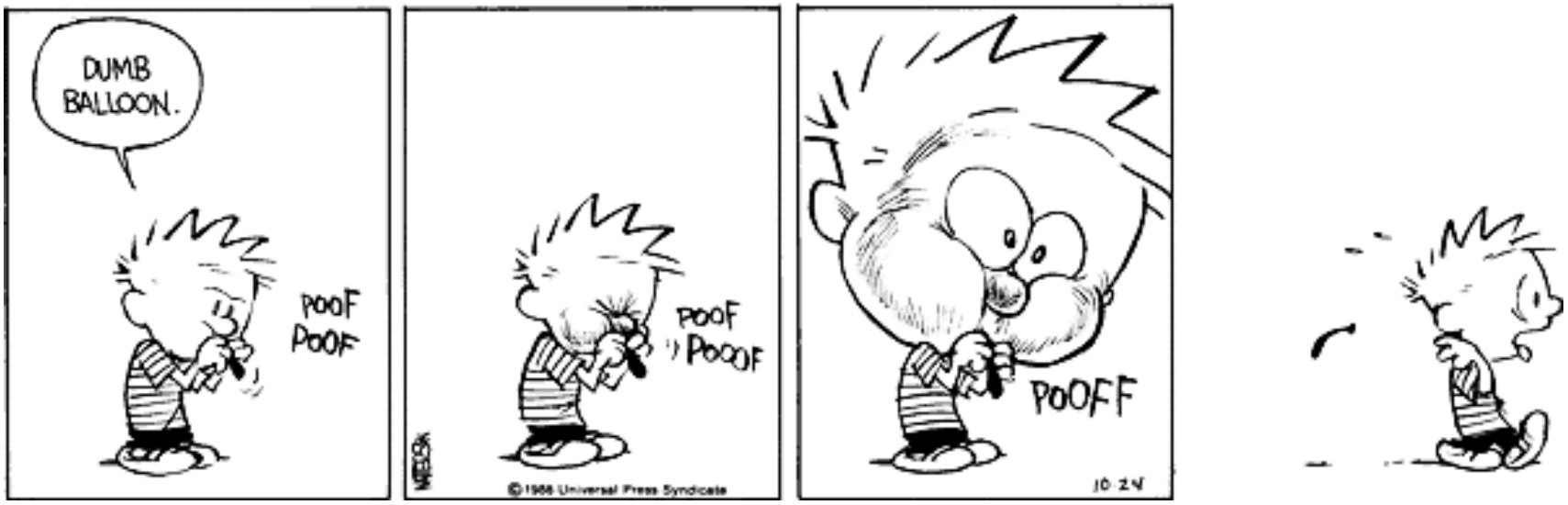
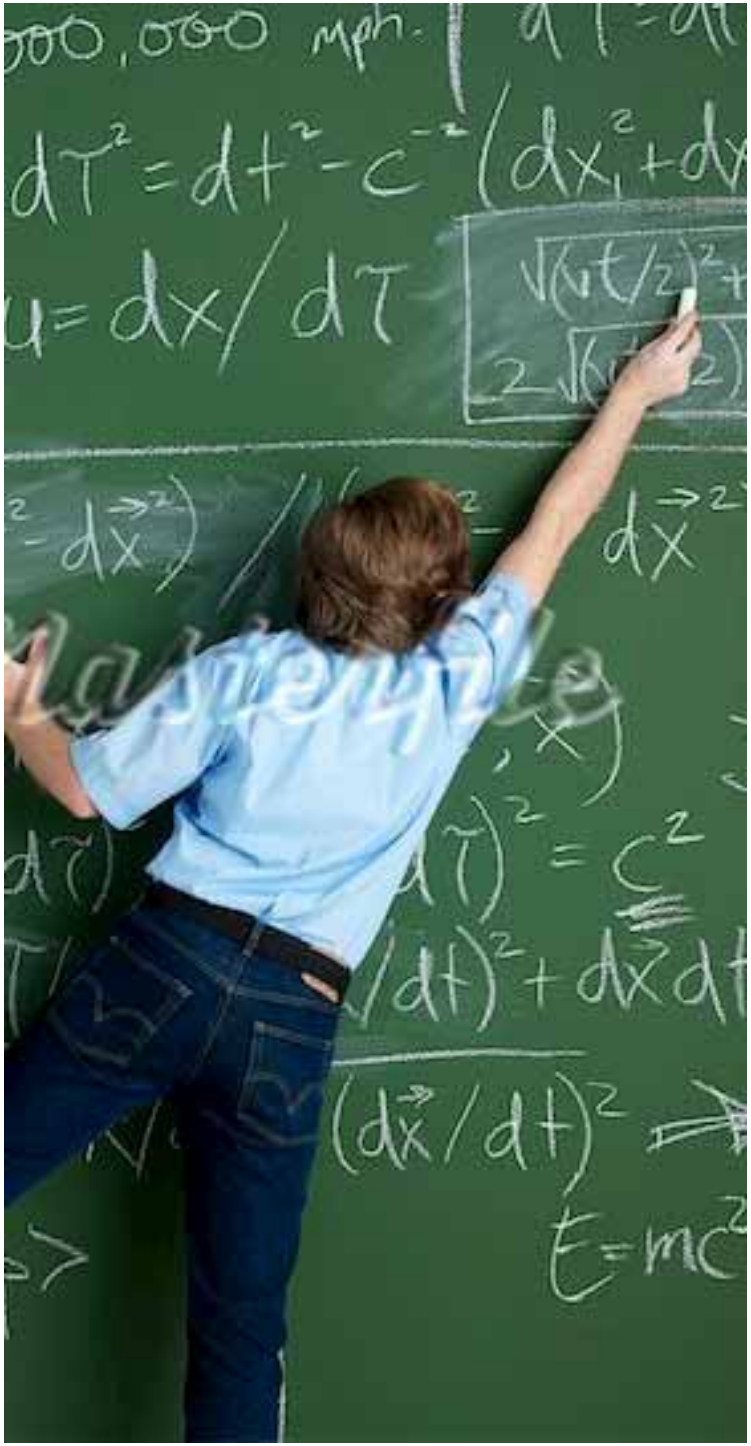
- **Theme Music: Billy Joel**

  Pressure

- **Cartoon: Bill Watterson**

  Calvin and Hobbes





The Equation of the Day

Pressure and depth

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

Whiteboard Renaming Exercise

- On the left half of your whiteboard, 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!

Whiteboard Renaming Exercise

- 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!

Whiteboard Renaming Exercise

- On the right half of your whiteboard, rewrite your two equations (still large!) 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.

Whiteboard Renaming Exercise

- 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.

Foothold ideas: Liquids

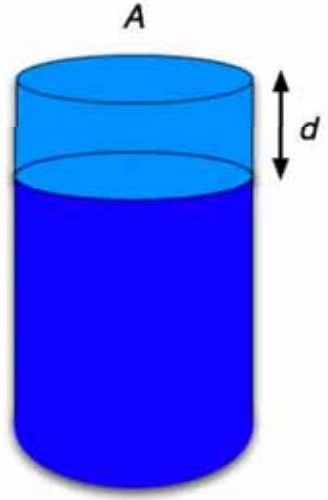
- In a liquid the molecules are close enough that their mutual (short ranged) attractions hold them together (e.g. H-bonding in H_2O).
- A liquid maintains its volume but changes its shape easily in response to small forces.
- The relation of *p*, *V*, and *T* in a liquid is <u>WAY</u> more complicated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

Foothold ideas: Pressure 2

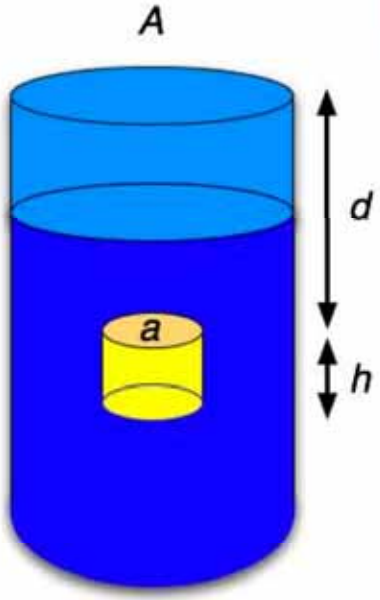
- A constrained fluid has an internal pressure –like an internal force at every point in all directions. (Pressure has no direction.)
- At a boundary or wall, the pressure creates a force perpendicular to the wall. $\vec{F} = p\vec{A}$
- The pressure in a fluid increases with depth.

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

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



Foothold ideas: Buoyancy



- ***Archimedes' principle***:
  When an object is immersed in a fluid (in gravity), the result of the fluid's pressure variation with depth is an upward force on the object equal to the weight of the water that would have been there if the object were not.
- As a result, an object less dense than the fluid will float, one denser than the fluid will sink.
- An object less dense than the fluid floats with a fraction of its volume under the fluid equal to $\frac{\rho_{object}}{\rho_{fluid}}$