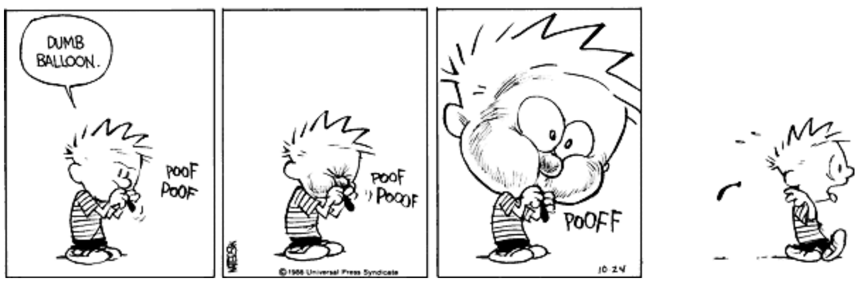
November 14, 2013 Physics 131 Prof. E. F. Redish

- **Theme Music: Pearl Jam**
  Even Flow
- **Cartoon: Bil Watterson**
  Calvin and Hobbes



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 whose density is less than that of the fluid will float, one whose density is greater than that of the fluid will sink.
- An object less dense than the fluid will float with a fraction of its volume under the fluid equal to the ratio of its density to the fluid's density.

Foothold ideas: Surface tension

- Due to the intermolecular interactions holding a liquid together, the surface of a liquid experiences a tension.
- The pull across any line in the surface of the liquid is proportional to the length of the line.

$$F_{\text{surface tension}} = \gamma L$$

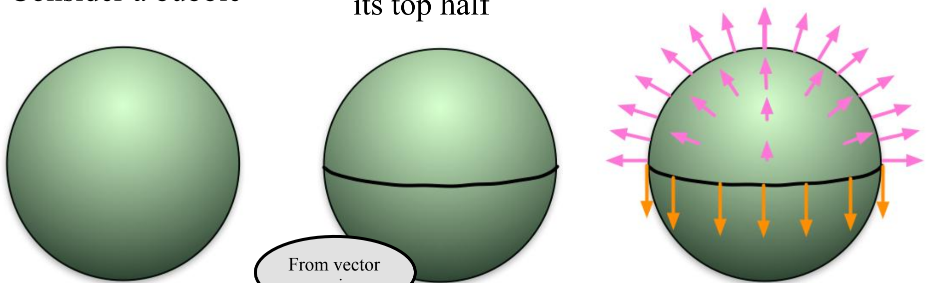
A bursting water balloon

Laplace Bubble Law

Consider a bubble

Now consider its top half

What forces act on it?



From vector averaging

$$F^{\uparrow}_{\text{air pressure inside}\rightarrow\text{top half}} = \tfrac{1}{2}pA = \tfrac{1}{2}p(2\pi r^2) = \pi p r^2$$

$$F^{\downarrow}_{\text{s.t. of bot half}\rightarrow\text{top half}} = \gamma L = \gamma(2\pi r) = 2\pi\gamma r$$

Force from pressure inside (up) must cancel pull of surface tension from the bottom half (down)

$$p = \frac{2\gamma}{r}$$

SMALLER bubble has bigger pressure!