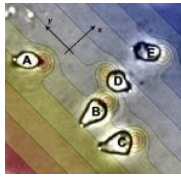
Physics 131-Physics for Biologists I



Professor: Wolfgang Losert

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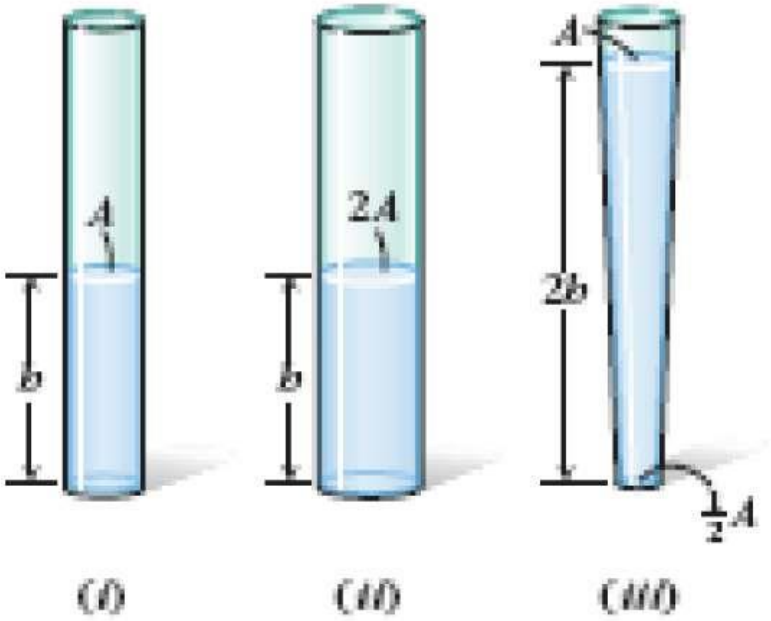
Research Experience

Next semester we plan to offer the opportunity for some Physics 131 students to participate in collaborative projects with biomedical researchers on campus and at the NIH. This would be a for-credit hands-on research activity, two afternoons a week.

We may include a one week course during winter break

Consider the containers at right. Which of the following correctly compares the *Force* (*F*) of the water at the bottoms of the containers?

1. $F_1 = F_2 = F_3$
2. $F_3 > F_1 > F_2$
3. $F_3 > F_1 = F_2$
4. **$F_2 > F_1 > F_3$**
5. $F_1 = F_3 < F_2$
6. Other ranking
7. Not Sure



Whiteboard, TA & LA

Buoyancy

Example: Wood sphere in water

Weight of the wood:

$\mathbf{F}_g = -\rho_{Wood} V\mathbf{g}$

The fluid "provides" as much buoyant force as the weight of fluid pushed out of the way $\mathbf{F_B} = \rho_{fluid} V\mathbf{g}$

Net force on wood:

$\mathbf{F_{net}} = \rho_{fluid} V\mathbf{g} - \rho_{Wood} V\mathbf{g} = (\rho_{fluid} - \rho_{Wood}) V\mathbf{g}$

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.

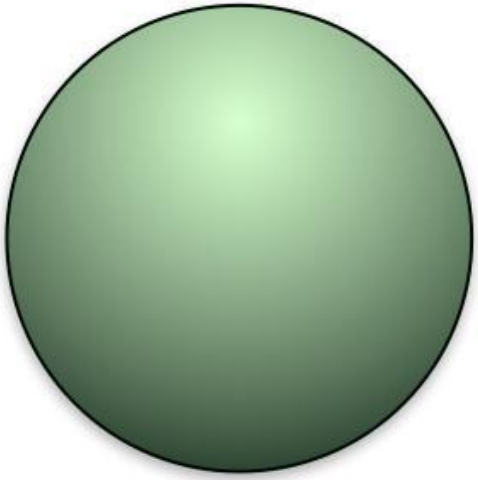
$$F_{\text{surface tension}} = \gamma L$$

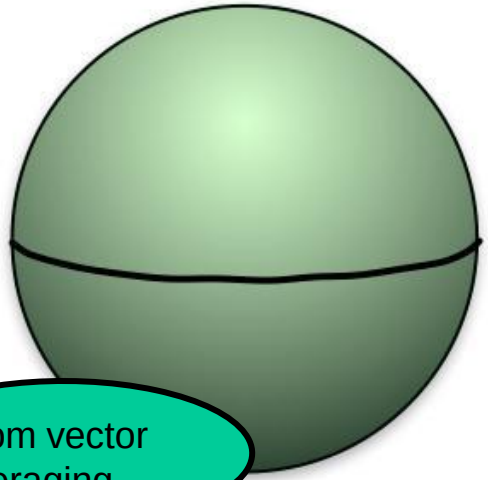
Laplace Bubble Law

Consider a bubble

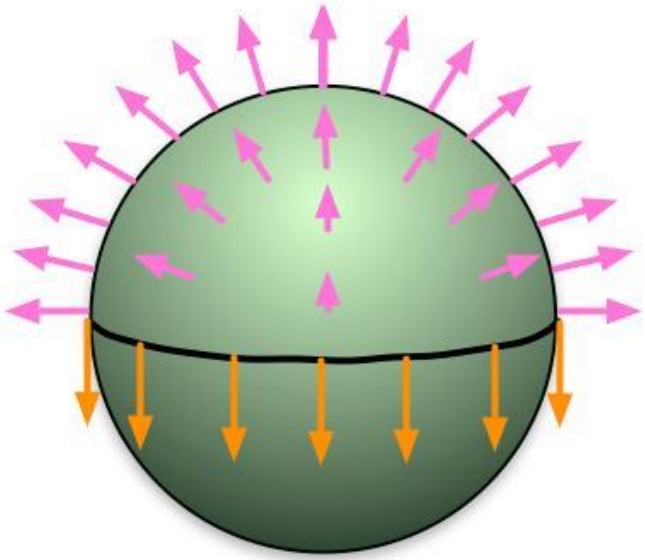
Now consider its top half

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!

Two balloons are connected by a pipe with a valve. When the valve is opened, what will happen?

1. The big balloon will get smaller and the small get larger until the two are equal.
2. The big balloon will get larger and the small get smaller until the small one is very small.
3. Something else will happen.

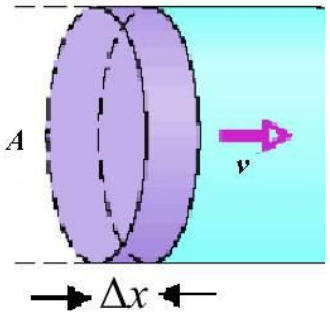
http://www.physics.umd.edu/deptinfo/facilities/lecdem/services/demos/demosf3/f3-02.htm

Whiteboard, TA & LA

Fluid Flow Basics
Matter Current (incompressible)

- Q = Current = (volume crossing a surface)/s $\quad [Q] = \mathrm{L}^3/\mathrm{T}$

$$\vec{Q} = \frac{\left(A\Delta\vec{x}\right)}{\Delta t} = \frac{\left(A\vec{v}\Delta t\right)}{\Delta t} = A\vec{v}$$

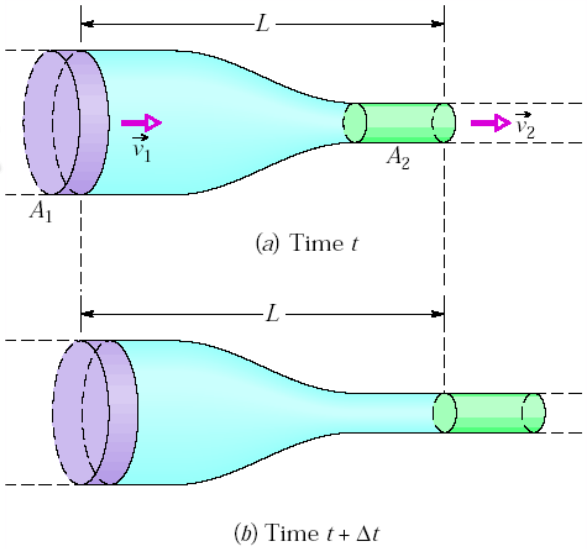


- Conservation of matter:
  "What goes in must come out

$$\Delta V_{in} = \Delta V_{out}$$

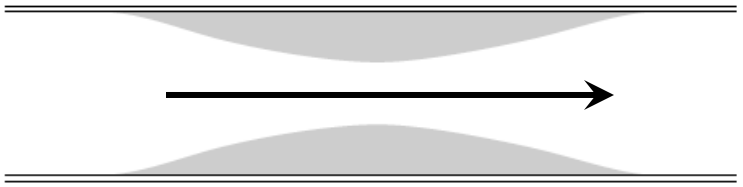
$$A_1\left(v_1\Delta t\right) = A_2\left(v_2\Delta t\right)$$

$$Q = Av = \text{ constant}$$



Blood flows through a coronary artery that is partially blocked by deposits along the artery wall. Through which part of the artery is the flux (volume of blood per unit time) largest?

1. The narrow part
2. The wide part
3. **Same in both**



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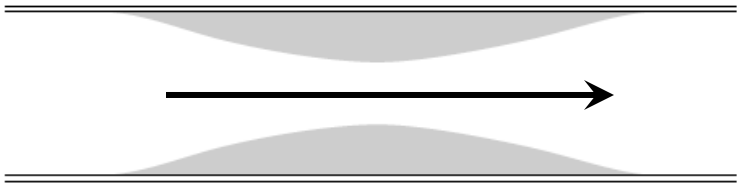
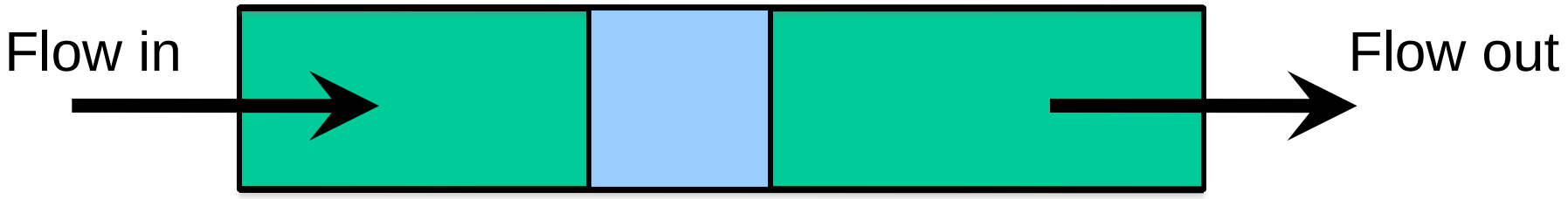


Sketch the forces



Where is the pressure highest?

1. **Left**
2. Right
3. The same
4. Depends on whether you are pushing or pulling

Whiteboard, TA & LA

Fluid Flow Basics
Pressure drop

- If we have a fluid moving at a constant rate and there is drag, N2 tells us there must be another force to balance the drag.
- The internal pressure in the fluid must drop in the direction of the flow to balance drag.