Pressure and Depth in a Static Fluid

- **Example 1:** Say we took the top of our column to be the top of the water, the pressure there is atmospheric pressure. Then the pressure at the bottom of our column, relative to atmospheric pressure should be \((P - P_{\text{atm}}) = \rho gh\) measured in Pa.

- **Example 2:** More detailed problem. I put in a mystery fluid and found that for the same height that gave pressure of “3” above atmosphere, I got a “2.5” above atmosphere. What is the density of the fluid?

- **Conceptual Question 1:** Why do people get varicose veins in their lower legs?

- **Demo**

- **Conceptual Question 2:** Can you use a straw to sip a drink on the moon?

- **Example 3:** column of liquid yields pressure. As a kid I tried making a super straw by connecting a series of straws length-wise. The best I could do was suck water up about 3 straws, or .6 m. What must be the air pressure in my mouth?

Pressure Gauges

- **Basic Relation**

- **Mercury Barometer**
  - Demo: water barometer
  - Ex. 4: What pressure, in Pa does this height \((10^{10}\text{ m})\) correspond to? Density of mercury = \(13.6 \times 10^3 \text{ kg/m}^3\).

- **Open – tube manometer**
  - Demo
  - Relation
  - Ex. 5: Since water isn’t a hazardous material, let’s say we use a water barometer instead of a mercury one. For the same pressure being gauged, how many times higher would the water column rise?

Pascal's Principe

- **Definition**

- **Omni-directionality**

- \(\Delta P \sim \Delta h\)

- **Pascal’s Principle Statement**
  - Equation
  - Conceptual Question 3. A sealed container of water is full except for a tube that is attached to it, as the drawing shows. Water is poured into this tube, and before the tube is full the container bursts. Why?

- **Ex. 6:** Say I had a syringe (Big) with a plunger radius of 0.01 m, and one of plunger radius 0.005 m (small). I take a tube and connect the two by sticking it on where the needles would go. Then I put a
1 kg mass on the plunger of small syringe. What mass on the big syringe could balance it at equal elevation?

Archimedes’ Principle a.k.a. Buoyancy

- Demo
- Definition
- Equation
- Demo: Archimedes Bucket.
- Derivation
- Example 7: Say a chunk of wood floats with ½ its volume above water and ½ below, how is its density related to the density of water?

- Conceptual Question 4. A steel beam hangs vertically underwater from a cable, another hangs horizontally. Does either beam have a greater buoyant force?

- Conceptual Question 5 When a diver dives, the pressure gets greater as he/she drops, does the buoyancy?

15.3 Fluids in Motion

- Intro
- Ideal Fluid
  - Streamlines
  - Demo
  - The Equation of Continuity
    - The principle
    - Systems
      - Traffic
      - Water
    - Demo
- Conceptual Question 6: Why does a water column get smaller as water falls from a faucet?
- Conceptual Question 7: What would it do if it were shot up?

- Example 8. An interesting alternative to a traditional syringe and needle for administering shots is something of a ballistic syringe. The medicine is ejected so quickly out the end of the syringe that its momentum carries it on into the patient. Guessing at some of the parameters, say the syringe has an inner radius of 0.5 cm, and the exit hole has an inner radius of 0.1 mm. If the plunger can be accelerated to 10 m/s, with what speed does the medicine exit the syringe?
28. Figure 11.12 shows a mercury barometer. Consider two barometers, one using mercury and another using an unknown liquid. Suppose that the pressure above the liquid in each tube is maintained at the same value \( P \), between zero and atmospheric pressure. The height of the unknown liquid is 16 times greater than the height of the mercury. Find the density of the unknown liquid.

32. In the hydraulic press used in a trash compactor, the radii of the input piston and the output plunger are \( 6.4 \times 10^{-3} \) m and \( 5.1 \times 10^{-2} \) m, respectively. The height difference between the input piston and the output piston is negligible. What force is applied to the trash when the input force is 330 N?

40. Only a small part of an iceberg protrudes above the water, while the bulk lies below the surface. The density of ice is 917 kg/m\(^3\) and that of sweater is 1025 kg/m\(^3\). Find the percentage of the iceberg's volume that lies below the surface.

50. Oil flowing with a speed of 1.22 m/s through a pipeline with a radius of 0.305 m. How many gallons of oil (1 gal = \( 3.79 \times 10^{-3} \) m\(^3\)) flow in one day?