Worksheet 24: Fluids and Pressure

Objectives

- Determine the pressure within a fluid.
- Apply Pascal's principle to hydraulics problems.

Summary

Pressure

Pressure is the perpendicular component of force applied to a unit area, $p = F/A$.

Density

Density $\rho = dm/dV$.

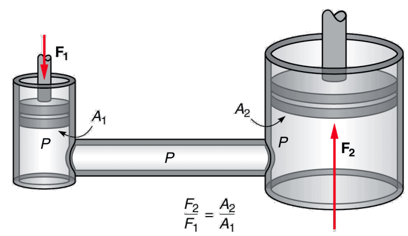
Static pressure

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

where $p =$ pressure at depth h, $p_0 =$ pressure at the top, and $\rho =$ density of the fluid.

Problems

1. If a downward force $F_1 = 50$ N is applied to the small piston with area $A_1 = 100\ \text{cm}^2$, what upward force F_2 does the fluid apply to the large piston with area $A_2 = 1000\ \text{cm}^2$?



2. If the small piston with area $A_1 = 100\ \text{cm}^2$ moves down 10 cm, how far does the large piston with $A_2 = 1000\ \text{cm}^2$ move up?

3. A hydraulic lift in a garage uses a piston with a cross section of area $500\ \text{cm}^2$.
   a. If the lift needs to raise a 2000-kg truck, what must be the pressure inside the cylinder?

b. Atmospheric pressure is a little bit more than 1 bar (1 bar = 100,000 Pa). What is the pressure inside the cylinder in bar?

c. The lift is powered by a piston with a cross section of area 10 cm^2. What force from this piston is needed to raise the truck?

d. If the truck is to be raised 1.8 m, how far does the driving piston need to move? (It will need to use many strokes to do this.)

4. The lowest known point on Earth is the Challenger Deep, at the southern end of the Mariana Trench. Its depth is estimated as 10,920 meters below sea level. If the sea water column has a constant density of 1025 kg/m^3, what is the water pressure (gauge pressure) at the bottom of the Challenger Deep?

5. If the air in Earth's atmosphere had a constant density of 1.204 kg/m^3 (its density at STP), how thick would the atmosphere be?