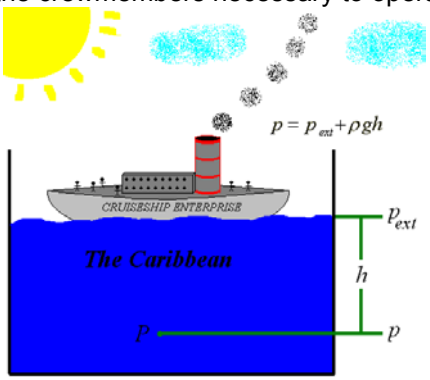
DEVICE Pascal's Demonstration

TOPIC Fluids

THEORETICAL BACKGROUND

Blaise Pascal's law states that a change in pressure applied to an enclosed fluid is transmitted, undiminished, to every point of the fluid and the walls of the containing vessel. Fundamentally, this states that, since the pressure in a fluid depends only on depth, then any increase in pressure at the surface of the fluid must be transmitted to every point in the fluid. First, let's visualize the latter statement. Imagine a situation for which an incompressible fluid is some region of water in the Caribbean Sea. Floating atop the sea is a cruise liner containing only the crewmembers necessary to operate the ship.



Notice from the diagram that the atmosphere, ship, and its crew place an external pressure on this region of the sea. The pressure p at any point P in the sea is

$$p = p_{ext} + \rho gh .$$

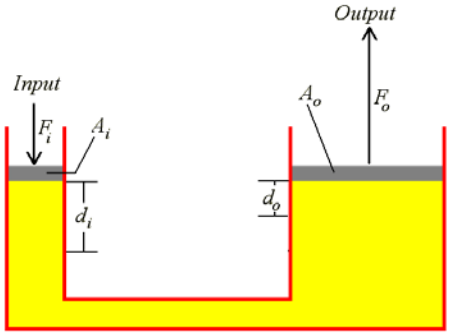
Now, suppose that the whole of Mercer University's Physics Department, its majors, friends, and family, all inclusive, were somehow, through the work and research of Dr. Balduz, beamed aboard the cruise liner, increasing the external pressure p by some amount Δp. Notice here that the values ρ, g and h are unchanged, therefore the pressure change at point P is

$$\Delta p = \Delta p_{ext} .$$

The pressure change is independent of h, and must be true for all points within the sea. Another classic example is the hydraulic lever, as illustrated in the following diagram. It can be shown that a given force applied over a given distance can be transformed to a greater force applied over a smaller distance. Here a force F_1 is applied to a small piston of area A_1. The pressure is transmitted through a fluid to a larger piston of area A_2. The pressure is the same on both sides as Pascal's law states, therefore the result is

$$P = F_1 A_1 = F_2 A_2 .$$

Here the force F_2 is larger than F_1 by the factor of A_2 / A_1.



DESCRIPTION The apparatus in our closet resembles a hydraulic lever. Two syringes of unequal volumes are grossly imbedded between wooden mounts connected to each other by a plastic tube. The system is full of a pink fluid. The syringes are representative of pistons, displaying the mechanical advantage of one over the other.

PROCEDURE

1. Record the initial volume of the fluid in each syringe. Record the top area of the syringes.
2. Apply force using mass from a lab set or a thumb to the small syringe and observe the amount of output force on the large syringe.
3. Be careful not to spill fluid!!!

SUGGESTIONS You may wish to discuss the Heimlich maneuver and hydraulic brakes in your class lecture of Pascal's Law.