Physics 101

Lecture 28

Monday Mar. 15, 2004

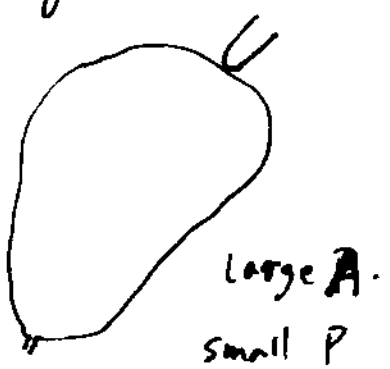
Fluids.

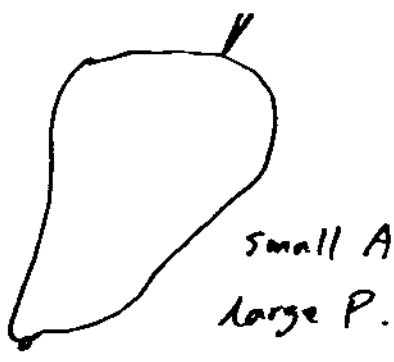
Topics: Density
Pressure
Pascal's principle
Buoyancy

Ref: 15-1, 2, 3, 4, 5 6.

- Fluids —— Liquids and gases. (can flow and take on the shape of container)
- Density: $\rho = M/V$. kg/m^3
- Pressure: How much force per unit area.
$P = F/A$ $N/m^2 = Pascal \equiv Pa$

e.g: Popping a Balloon. same force F, different A.





- Pressure and depth at static equilibrium.

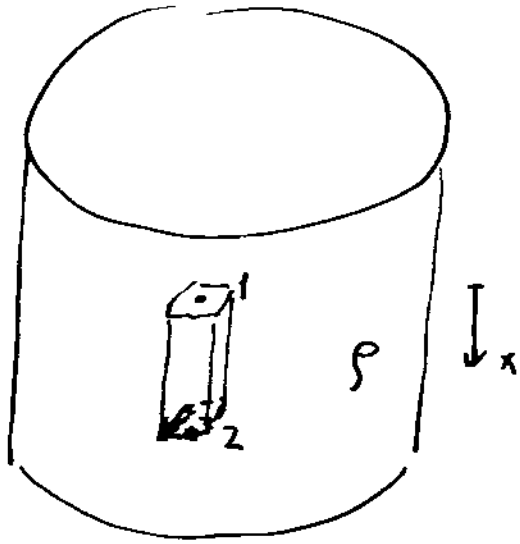
$$P_1 A - P_2 A + mg = 0$$

$$P_2 = P_1 + \frac{mg}{A}$$

$$= P_1 + \frac{\rho V g}{A}$$

$$\therefore \quad P_2 = P_1 + \rho g h .$$

OR: $\boxed{P_2 - P_1 = \rho g h .}$



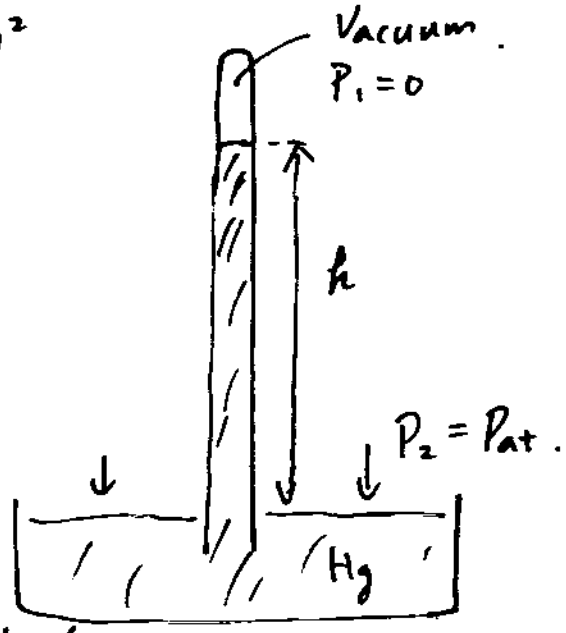
- Atmospheric pressure

— due to air in the atmosphere

$$P_{atmos} = 1.01 \times 10^5 \ N/m^2$$

$$= 1.01 \times 10^5 \ Pa$$

- Barometer



$$P_{at} = P_2 = \rho g h$$

e.g.: 

Hg: $\rho = 13.6 \ kg/cm^3 = 1.36 \times 10^4 \ kg/m^3$

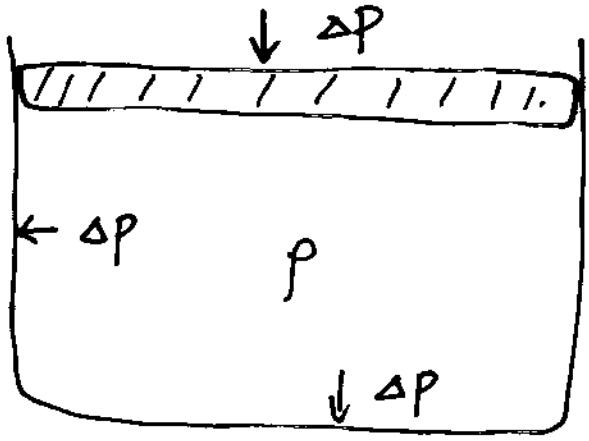
$h = 760 \ mm = 0.76 \ m .$

$P_{at} = 1.36 \times 10^4 \times 0.76 \times 9.81 = 1.01 \times 10^5 \ N/m^2 = 1.01 \times 10^5 \ Pa .$

- The pressure in a fluid acts equally in all directions and acts perpendicularly to any surface.

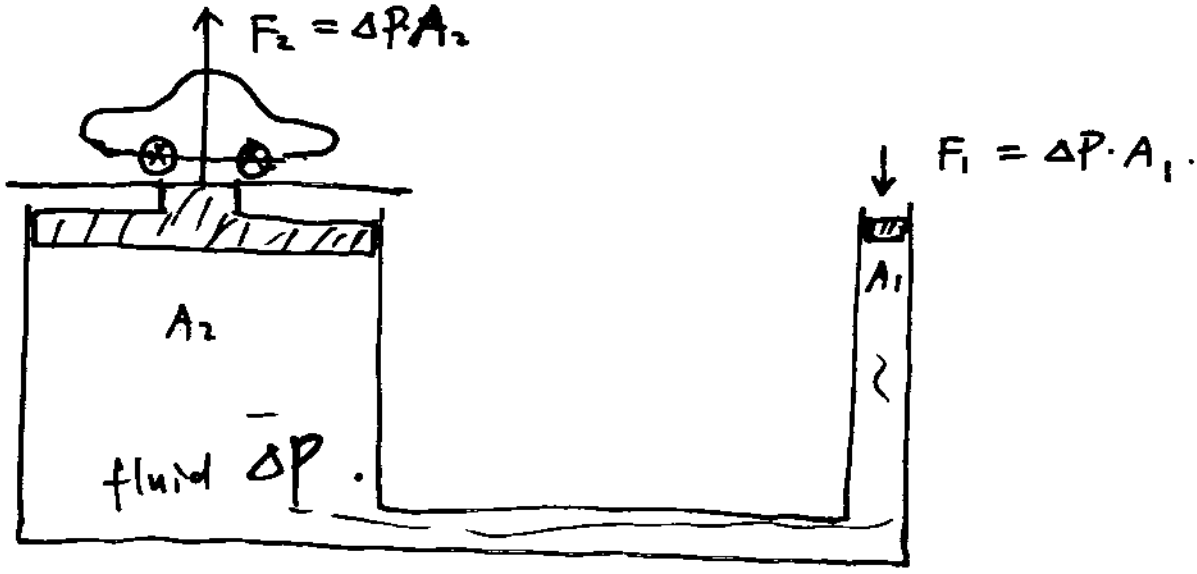
- Pascal's Principle

An external pressure applied to an enclosed fluid is transmitted unchanged to every point in the fluid.



ΔP is the same everywhere.

e.g. Hydraulic Lift.



Since ΔP is the same everywhere

$$\frac{F_2}{A_2} = \frac{F_1}{A_1}.$$

$$F_2 = \frac{A_2}{A_1} F_1$$ if we make $A_2 \gg A_1$,

Then $F_2 \gg F_1$.

You only need a small force F_1 to lift a car!

i.e, a hydraulic lift can "magnify" force F_1.

- But No free lunch! — We can't save work.

If we want to lift the car by a distance d_2,

We would have to apply F_1 by a longer distance d_1

$\because$ $A_1 d_1 = A_2 d_2$ (same Volume), $d_1 = \frac{A_2}{A_1} d_2 \gg d_2$

Then, $F_1 d_1 = F_2 d_2$ (same work!)