Fluids

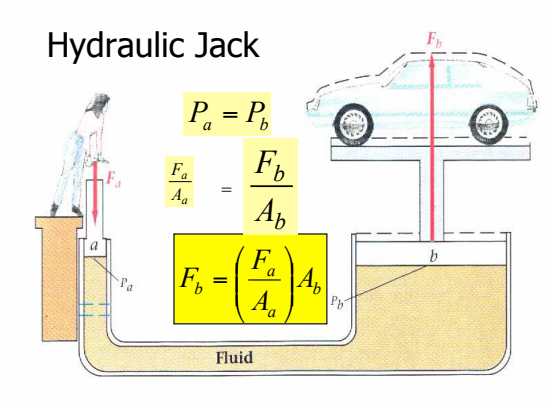
- any substance that does **not** have definite shape and exhibits the phenomenon of flow

Archimedes' Principle

Weight loss of the body when immersed in a fluid is equal to the weight of the fluid displaced.

A measure of the BOUYANT FORCE is the weight of the fluid displaced

Pressure $P = \frac{F}{A}$



Pascal's Law

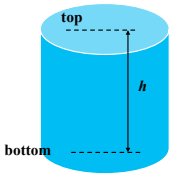
The pressure applied to an enclosed fluid is transmitted undiminished to every portion of the fluid and the walls of the enclosing vessel.

"Water seeks its own level"

The height of the liquid surface is independent of the tube shapes.

Pressure

$P = \rho gh$



$P_{absolute} = P_o + \rho gh$

atmospheric pressure

Fluid Dynamics

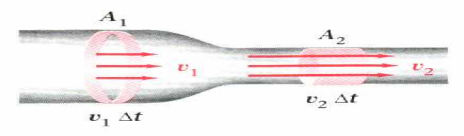
Fluid Flow
Streamline - path followed by each element of the fluid

2 Kinds of Flow
1. Laminar Flow - orderly flow of neighboring layers of fluid. Streamlines do not cross over each other.
2. Turbulent Flow - irregular, complex flow of fluids.

Fluid Flow

What happens to fluid flowing passed constrictions?

Consider a fluid moving from a cross-sectional area A_1 to a region of A_2.



$$A_1 v_1 = A_2 v_2$$ volume rate of flow

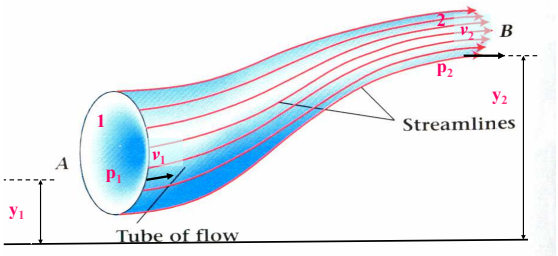
Continuity Equation

Insights into the Continuity Equation
- the flow of material (mass) through a tube of changing cross section is constant when the density of the fluid does not change.
- statement of conservation of mass.
- the product of Av is the volume rate of flow. In SI units, it is measured in m^3/s.

How can an airplane fly?-Focus on the airfoil
Other applications of Bernoulli's Principle: Carburetors, airbrushes & perfume atomizers

Bernoulli's Equation
Relates pressure, flow velocity, and height for flow of an ideal fluid.

Tube of Flow



$$p_1 + \tfrac{1}{2}\rho v_1^2 + \rho g y_1 = p_2 + \tfrac{1}{2}\rho v_2^2 + \rho g y_2$$

On what conservation law
is Bernoulli's equation based?

Bernoulli's Equation

$p_1 + (½)\rho v_1^2 + \cancel{\rho g y_1} = p_2 + (½)\rho v_2^2 + \cancel{\rho g y_2}$

for horizontal flow:

$p_1 + (½)\rho v_1^2 = p_2 + (½)\rho v_2^2$

Bernoulli's Principle

Bernoulli's Equation

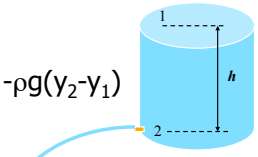
$p_1 - p_2 = (½)\,\rho(v_2^2 - v_1^2) + \rho g(y_2 - y_1)$

for $p_1 = p_2$:

$(½)\,\rho\,(v_2^2 - v_1^2) = -\rho g(y_2 - y_1)$

For $v_1 << v_2$

$$v = \sqrt{2gh}$$



v = Speed of efflux

Torricelli's Theorem