# HYDROSTATICS

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**Hydrostatics** – a branch of fluid mechanics that deals with phenomena and forces in fluids at rest.

**Pressure** – the quotient of force ($F_\perp$) and the area (A) on which the force acts perpendicularly:

$$p = \frac{F_\perp}{A}$$

**Hydrostatic pressure** – the pressure exerted by a fluid at rest on the bottom and walls of a container due to its weight can be calculated as follows:

$$p = \rho \cdot g \cdot h$$

(The pressure does not depend on the shape of the container holding the fluid.)

ρ – density of the fluid (water, oil, etc.)

g – gravitational acceleration

h – height of the fluid column above the point where the pressure is measured

Interesting fact: In water, the pressure increases by 1 bar (100,000 Pa) every 10 meters.

**Total pressure** at a certain depth is calculated as: $p_{uk} = p_{atm} + \rho \cdot g \cdot h$

**Standard atmospheric pressure** ($p_{atm}$) is 101,325 Pa.

**Buoyancy** – the force acting on a body submerged in a fluid, pushing it upward. Buoyancy results from the difference in hydrostatic pressure on the bottom and top of the body:

$$F_{uz} = \rho_{tek} \cdot g \cdot V_{udt}$$

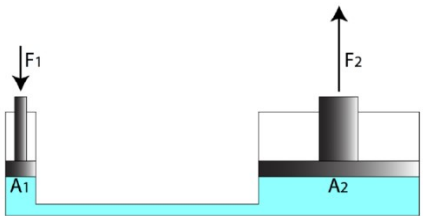
$\rho_{tek}$ – density of the fluid

$V_{udt}$ – volume of the body submerged in the fluid (buoyant force acts only on this part of the body)

**Archimedes' Principle** – a body submerged in a fluid displaces a volume of fluid equal to the volume of the submerged part of the body, and the buoyant force acting on the body is equal to the weight of the displaced fluid.

**Pascal's Principle** – the fundamental law of hydrostatics, which states: In a fluid within a closed container, external pressure is transmitted equally in all directions, meaning fluid particles transmit pressure uniformly in every direction:

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




Example: Hydraulic lift

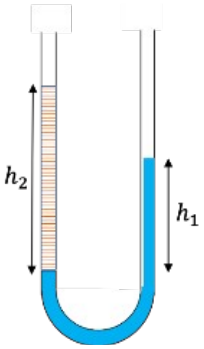
$F_2$ and $F_1$ – forces acting on areas $A_2$ and $A_1$

$A_2$ and $A_1$ – piston areas on which the forces act

(With a smaller force $F_1$, a larger force $F_2$ is overcome.)

Applications of Pascal's Principle – hydraulic lifts, automobile braking systems, etc.

**Fluid equilibrium** – a state in which the internal forces of a fluid are balanced, so there is no fluid motion (red and blude fluid – right picture). In this state, hydrostatic pressure acts uniformly in all directions.




Equilibrium of red and blue fluid in a U-tube

(Hydrostatic pressures for columns $h_1$ and $h_2$ are equal.)

**Applied pressure** – additional pressure applied to a fluid to increase the total pressure in a closed system.

**Surface tension** – the force acting on the surface of a fluid. Surface tension is a result of molecular forces between the fluid's molecules.

**Capillary action** – the phenomenon where a fluid rises or falls in narrow tubes due to a combination of cohesion (attractive forces between molecules) and adhesion (attractive forces between molecules and the tube walls).

**Barometric formula** – atmospheric pressure changes with altitude and decreases according to the so-called barometric formula:

$$p = p_0 \cdot e^{\frac{-\rho_0}{p_0} \cdot g \cdot h}$$

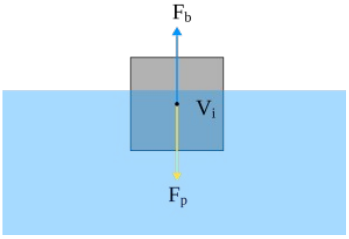
$p_0$ – air pressure at Earth's surface

$\rho_0$ – air density at Earth's surface

p – air pressure at height h

**Example of buoyant force** – a ship on water:

A ship floats due to the principle of buoyancy, based on Archimedes' Principle, which states that a body submerged in a fluid experiences an upward force equal to the weight of the displaced fluid. The ship's shape and design, along with weight distribution, allow it to remain on the surface without sinking.




The weight of the floating ship $F_p$ and its buoyant force $F_b$ must be equal in magnitude ($V_i$ is the submerged part of the ship).