Basic knowledge

Fundamentals of hydrostatics

Hydrostatics is the study of fluids at rest. The experimental units from GUNT cover the basic principles of the following topics from the field of hydrostatics: hydrostatic pressure, buoyancy, surface tension, capillarity/adhesion.

Physics and properties of fluids

- pressure measurement with manometers and pressure sensors
- temperature measurement
- vapour pressure curve
- change of state of the gases

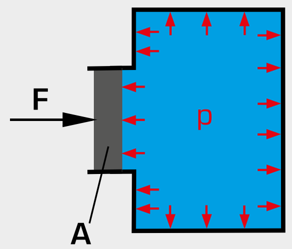
Forces

- Coriolis force
- surface tension and forces
- buoyancy forces
- hydrostatic pressure and resultant forces

Hydrostatic pressure

The pressure in fluids at rest does not depend on the direction. It is linearly dependent on the amount of fluid over the element being studied, or the diving depth respectively.

The hydrostatic pressure for incompressible fluids that are not subject to gravity is calculated according to Pascal's law.



Pascal's law

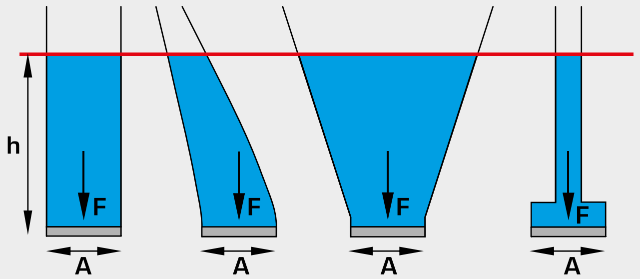
The effect of a force **F** on a motionless liquid generates a pressure **p** within the liquid, which at any point acts equally in all directions. The pressure always acts perpendicular to the boundary surface **A** of the liquid.

All force and pressure processes in liquids are based on this law.

$$p = F / A$$

Hydrostatic paradox

The hydrostatic pressure generates a force **F** on the area **A**. If these areas are equal, this force only depends on the level **h**; the shape of the vessel is irrelevant.

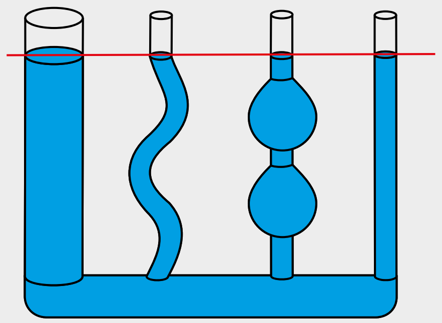


h level, **F** force, **A** area, **red line** level

Communicating vessels

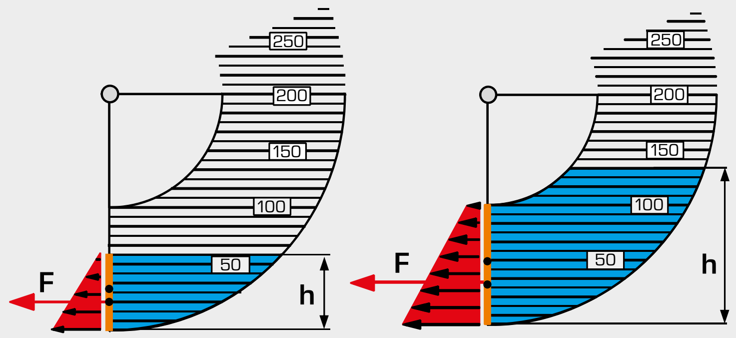
Communicating vessels are tubes that are open at the top and interconnected at the bottom. Regardless of the shape and size of the tubes, the level of the fluid in them is the same.

Applications include water levels, locks and drain traps in sewers.



Hydrostatic pressure on walls

In addition to the ground pressure of a fluid, it is often important to also know the hydrostatic pressure on boundary surfaces, for example in order to calculate the forces acting on the side walls (channel, aquarium etc.) or on weirs.

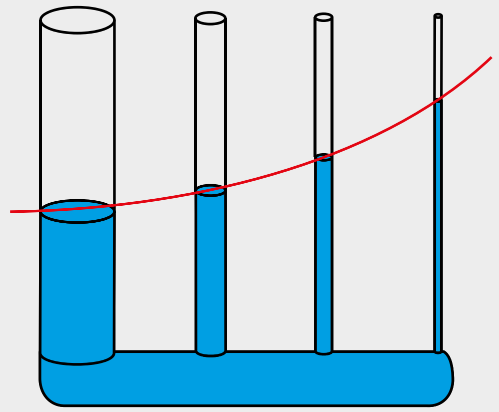


h level, **F** resultant force, **A** effective area, pressure profile, water level

Capillarity

Liquids in capillaries rise or fall due to molecular forces between the liquid and the wall or between the liquid and air. The height of rise in the capillary depends on the surface tension and the diameter of the capillary.

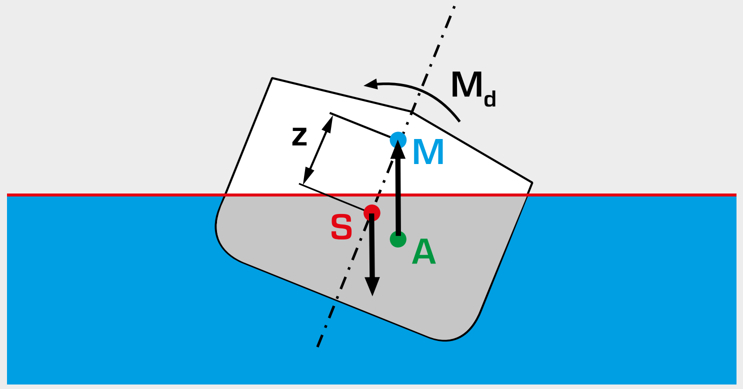
In wetting liquids (e.g. water) the surface level in the capillary rises. In non-wetting liquids (e.g. mercury) the level falls.



Stability of floating bodies

In order to be able to assess whether a body floats stably or could capsize, it is necessary to determine its metacentre **M**. The location of the metacentre depends on the centre of gravity of the displaced water **A** and the angle of heel. The body floats stably when the metacentre **M** is located above the centre of gravity **S**. Then the restoring moment M_d has a 'righting' effect.

The distance between the centre of gravity and the metacentre is known as the metacentric height **z**.



M metacentre, **S** center of gravity,
A center of buoyancy, **z** metacentric height,
M_d restoring moment that straightens the floating body back up,
red line water level