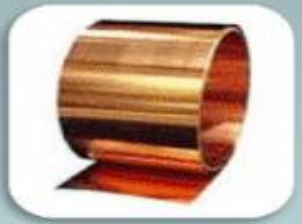










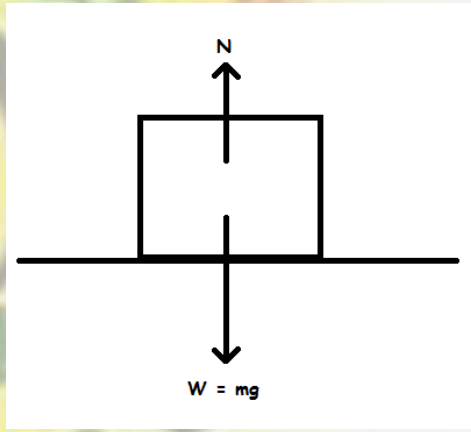





PROPERTIES OF MATTER

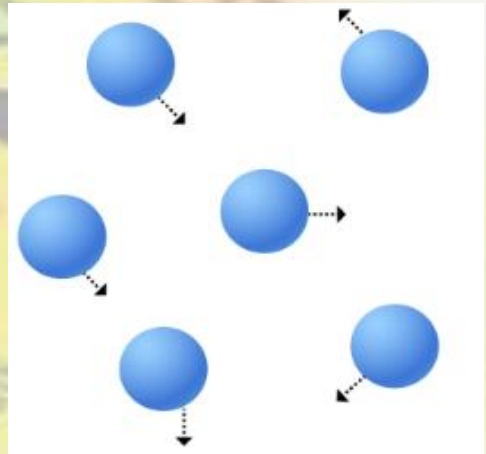
Basic Definitions

- Any substance which has mass and occupies space is called matter.
- Mass(kg) means the measure of content in a body.
- Volume(m^3) means space occupied by a body.
- Weight(N) means force exerted due to gravity. W = mg.



Properties of particles of matter

- Particles are very small in size.
- Particles are always in motion.
- Particles are generally attracted to each other.
- Particles have spaces between them.



Solid

- Rigid
- Fixed Shape
- Fixed Volume
- High Density
- Closely tight and organized particles
- Slightly Compressible

Liquid

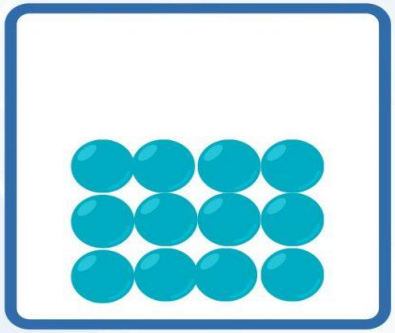
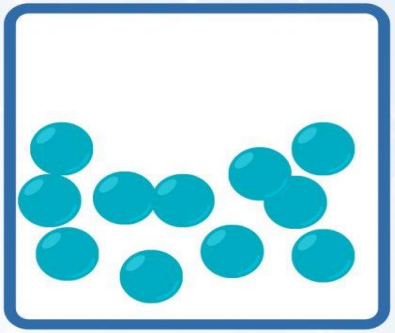
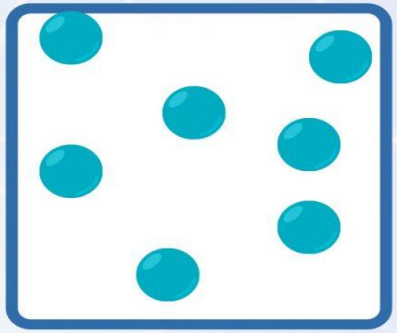
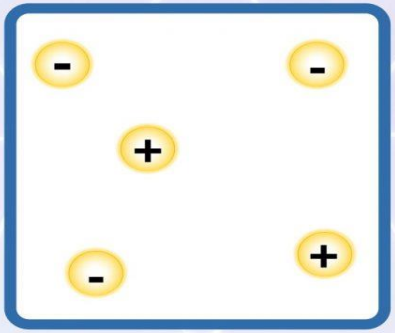
- Not Rigid
- No Fixed Shape
- Fixed Volume
- Average to High Density
- Closely tight but not disorganized particles
- Slightly Compressible

Gas

- Not Rigid
- No Fixed Shape
- No Fixed Volume
- Low Density
- Far apart and disorganized particles
- Highly Compressible

States of Matter



Solid ⇄ Liquid ⇄ Gas ⇄ Plasma

Melting / Freezing

Vaporization / Condensation

Ionization / Deionization

Two More States of Matter

- Plasma: The state consists of super energetic and super excited particles which are in the form of ionized gases. Due to the presence of plasma, the sun and stars glow.
- Bose-Einstein Condensate (BEC) They are formed by cooling a gas of extremely low density to super low temperatures.

  Proposed by - S.N. Bose and Albert Einstein.

  Proved by – Carl E. Wiemen , Eric A. Cornwell, Wolfgang Ketterle in 2001.

Thrust and Pressure

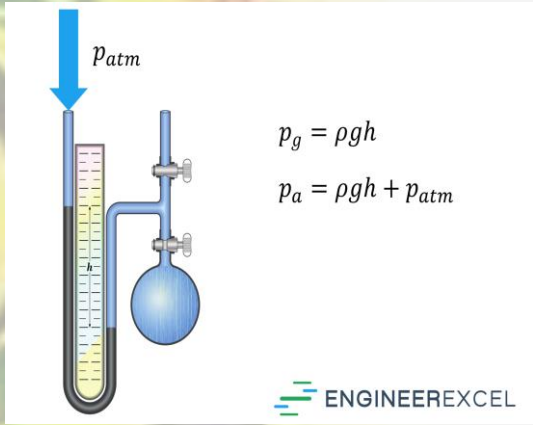
- Thrust is the force or push acting on an object perpendicular to its surface.
- Pressure(p) = $\frac{\text{Force(F)}}{\text{Area(A)}} = \frac{\text{Thrust}}{\text{Area}}$
- The unit of pressure is N/m^2 also called pascal (Pa).
- Barometer is a device used to measure atmospheric pressure. Atmospheric pressure for 76cm mercury column= 1.01×10^5 Pa.

Density

- Density (d) = $\frac{\text{Mass(m)}}{\text{Volume(V)}}$
- If equal volume of two liquids of densities $d_1$and d_2 are mixed together, then the density of the mixture is d =$\frac{d_1 + d_2}{2}$.
- The relative density is defined as the ratio of the density of the substance to the density of water at 4°C.
- Relative density has no unit.The density of water at 4°C is 1000 kgm−3

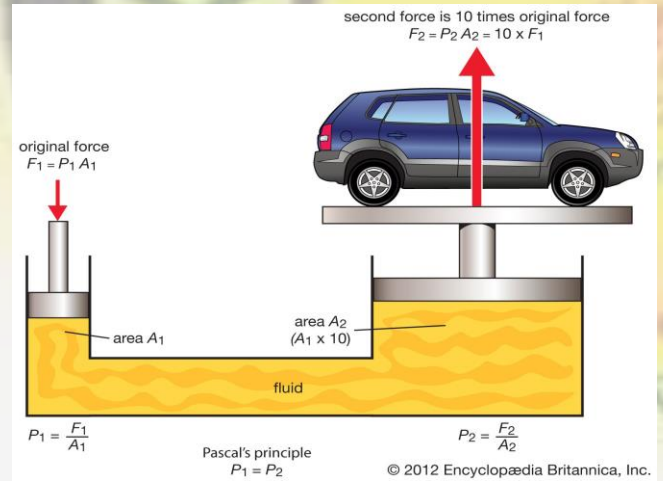
Pressure of Liquid

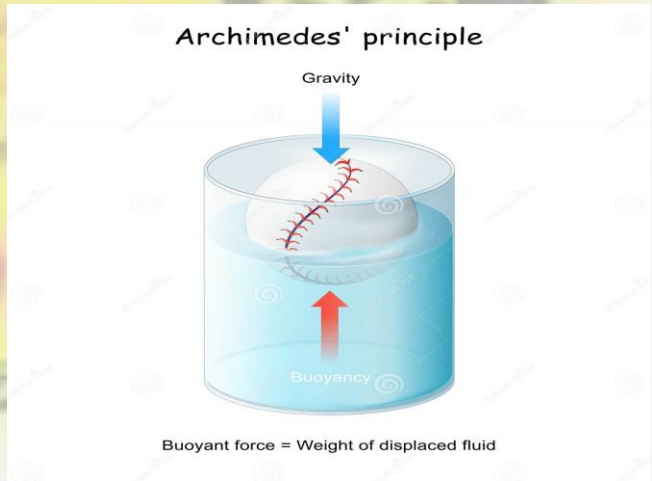
- Pressure exerted by a liquid column is ρgh.
- Pressure inside a liquid is same at every point on the same horizontal plane.
- The pressure exerted by the liquid is normal to any surface with which the liquid is in contact.
- The pressure at any point within the liquid is independent of shape of liquid surface as well as the area of liquid surface.
- Centre of pressure is that point of the body immersed in liquid at which the resultant liquid pressure acts.



Pascal Law and Buoyant force

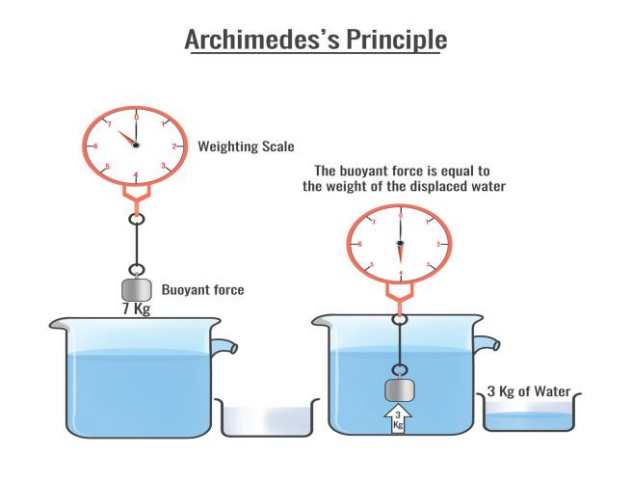
- Pascal law states that any pressure change in a confined fluid will be transmitted equally in all directions.
- Buoyant force is the upward force acting on a body immersed in a liquid.



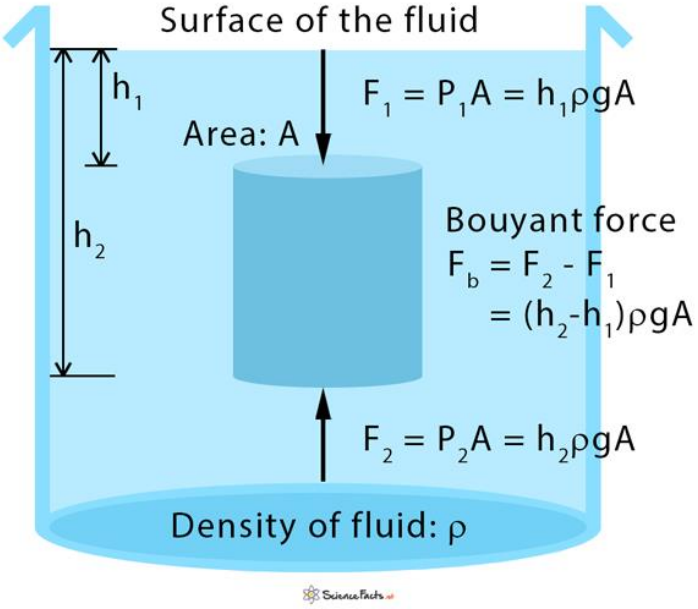


Archimedes' Principle

- Archimedes principle, which states that the buoyant force on an object is equal to the weight of the fluid displaced by the object.
- When a body (totally or partially) is immersed in liquid at rest, it appears lighter.

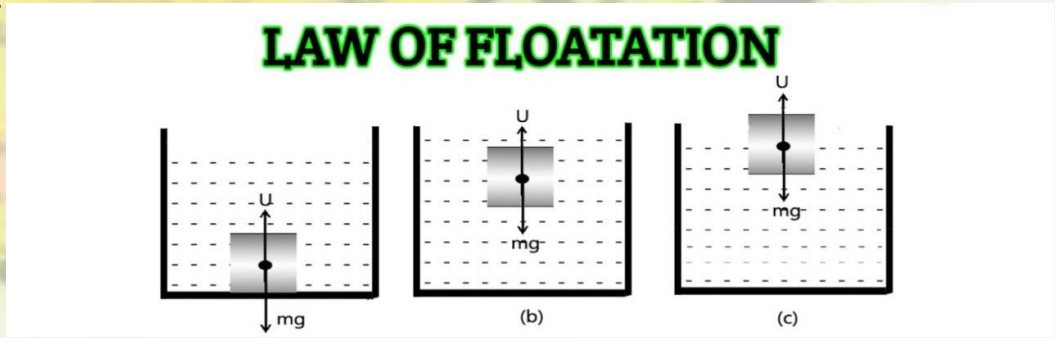


Archimedes' Principle Equation



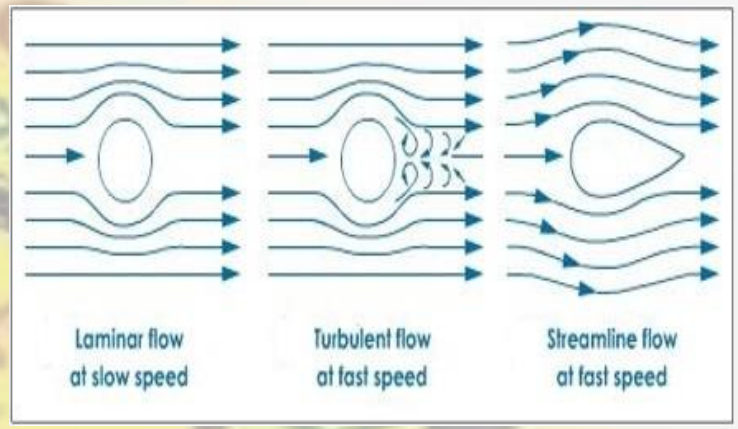
Laws of Flotation

- w > F , i.e. weight of body is greater than upthrust of liquid, in this condition body will sink.
- w = F , i.e. weight of body is equal to the upthrust of liquid, in this condition, the body floats with whole of its volume inside the liquid.
- w < F , i.e. weight of body is less than upthrust of liquid ,body will float with some of its part outside the liquid.



Flow of fluids

- Streamlined flow
- Laminar Flow
- Turbulent Flow
- For a fluid, the critical velocity is the limiting velocity of the fluid flow up to which the flow is streamlined and beyond which the flow becomes turbulent.



$$V_c = \frac{(\mathrm{Re})_c \eta}{\rho l}$$

Re - Reynold's Number.

ρ - Density of fluid.

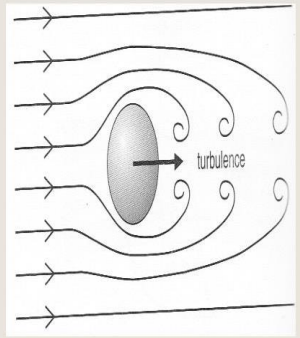
l - Characteristic length.

For Laminar Flow:

$\mathrm{Re} < 2{,}500$

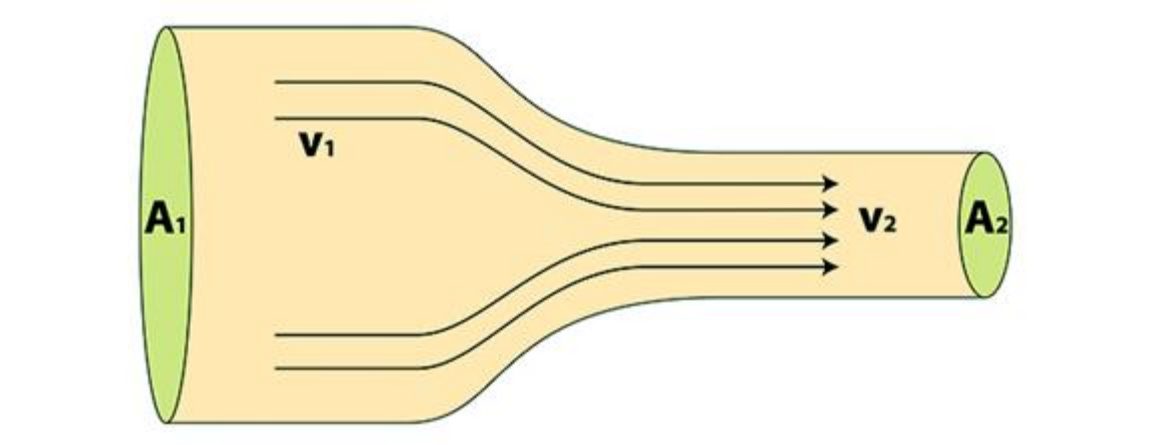
For Turbulent Flow:

$\mathrm{Re} > 2{,}500$



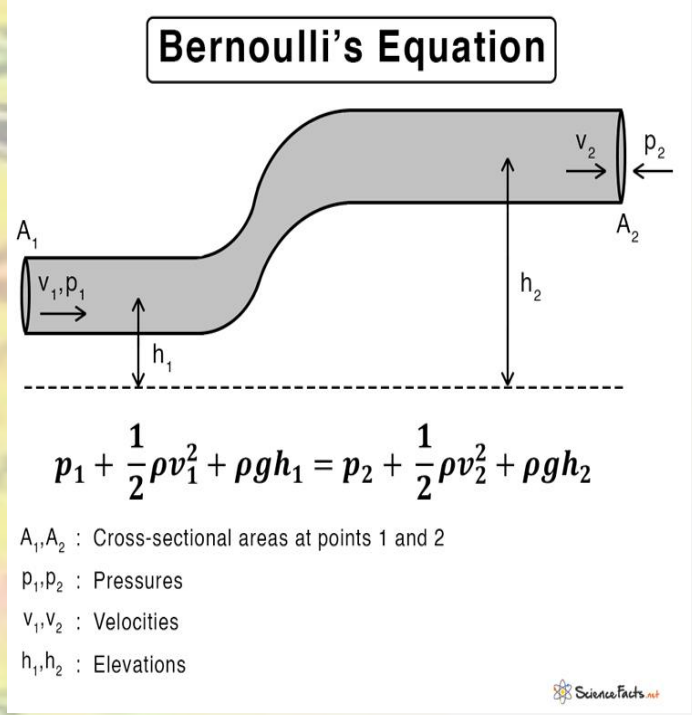
Equation of continuity

- In a non-viscous liquid inside a tube $A \times v = constant$ throughout the tube.



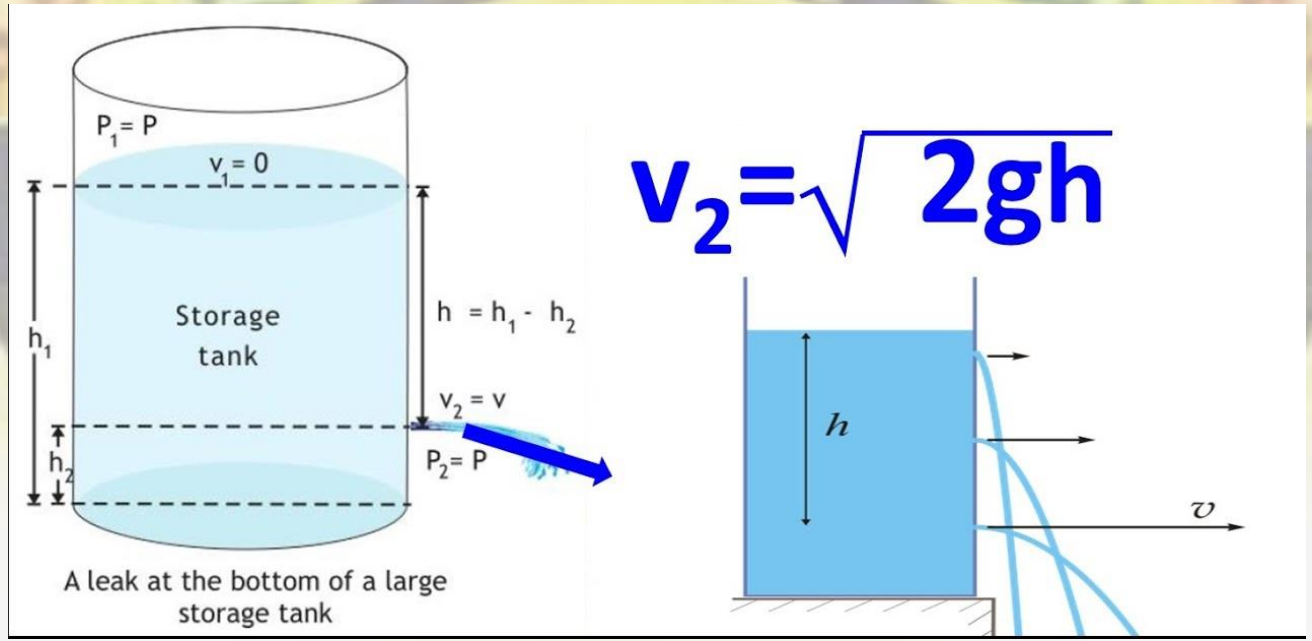
Energy of a Flowing Liquid

- Pressure Energy
- Kinetic Energy
- Potential Energy
- The total Energy of a liquid flowing inside a tube is constant throughout. This is called Bernoulli's Principle.
- Bernoulli's theorem is applicable only to streamline flow of a fluid. It is not valid for non-steady or turbulent flow.
- Venturimeter, Pitot tube, Bunsen's burner, atomizer, filter pump and Magnus effect are based upon Bernoulli's theorem.



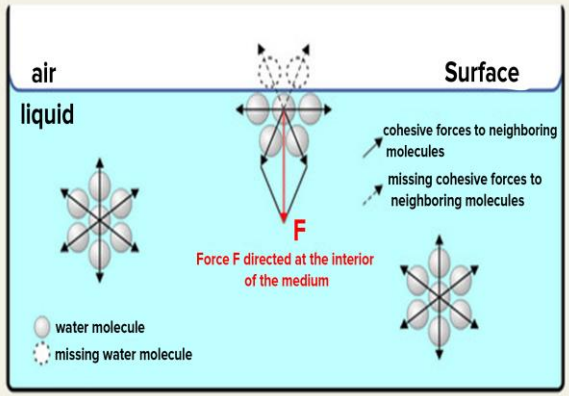
Torricellis' Theorem

It states that the velocity of efflux i.e. the velocity with which the liquid flows out of an orifice(i.e. a narrow hole) in a vessel containing liquid is equal to



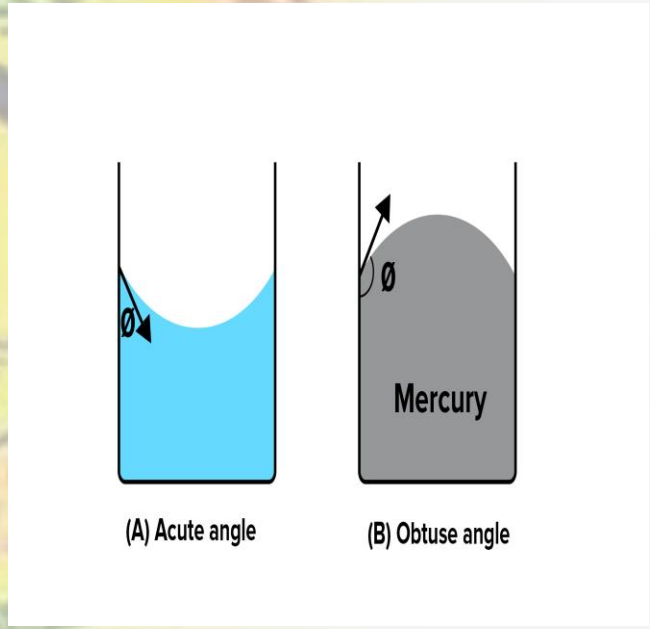
Surface Tension

- Surface tension of a liquid is measured by the normal force acting per unit length on either side of an imaginary line drawn on the free surface of the liquid and tangential to the free surface.
- If a force Facts on an imaginary line of length l, then surface tension. Its SI unit is Newton/meter. $T = \frac{F}{l}$
- The force of attraction applied between molecules of the same substance is called cohesive force, while the attractive force between molecules of different substances is called adhesive force.
- The surface tension of a liquid decreases with an increase in temperature and becomes zero at the critical temperature.



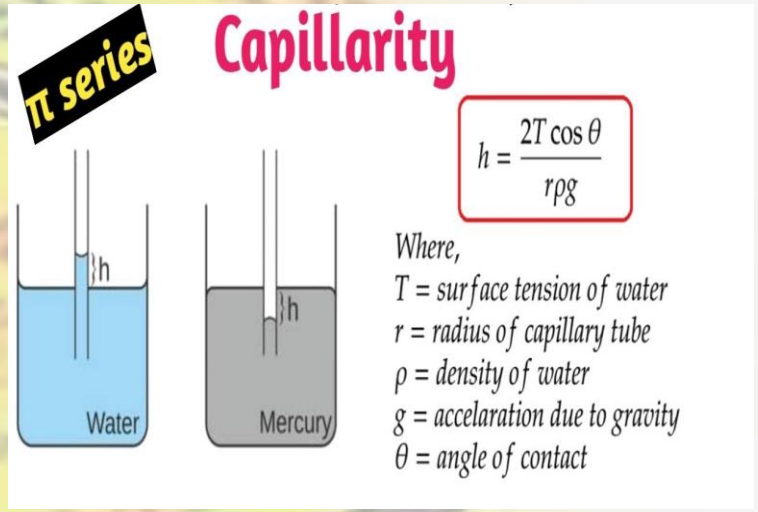
Angle of Contact

- The angle inside the liquid between the tangent to the solid surface and the tangent to the liquid surface at the point of contact is called the angle of contact for that pair of solid and liquid.
- The angle of contact for pure water and clean glass is zero. For ordinary water and glass it is about 8°.
- The angle of contact for water and silver is 90°.
- The liquids which wet the solid have an acute angle of contact. Meniscus of these liquids will be concave.
- The liquids that do not wet the solid have an obtuse angle of contact for mercury and glass the angle of contact is 135°. Meniscus of these liquids will be convex.



Capillarity

- If a capillary tube is dipped in a liquid, liquid ascends or descends in the capillary tube. This phenomenon is called capillarity.
- The liquids which wet glass for which the angle of contact is accute, rise up in capillary tube, while those which do not wet glass, for which the angle of contact is obtuse are depressed down in the capillary.



Viscosity is Internal friction present between two layers of a liquid which resists the flow of liquid is viscosity.

- A liquid with high viscosity is thick and flows slowly.
- A liquid with low viscosity is thin and flows quickly.
- Different liquids have different viscosities.

- **Water** **Honey** **ketchup** **Tooth paste**




Viscosity

- It is the property of the liquid by virtue of which, it opposes the relative motion between its adjacent layers.
- Viscosity is the property of liquids and gases both.
- If viscous force F is acting between two layers of liquid of area A and having a velocity gradient $\frac{dv}{dx}$ between them, then $F = -\eta A \frac{dv}{dx}$.
- The viscosity of a fluid is measured by its coefficient of viscosity.It's SI unit is ($N\text{-}s/m^2$)
- With the rise in temperature, the viscosity of liquids decreases, and that of gases increases.
- The viscosity of the liquid increases with an increase in pressure.

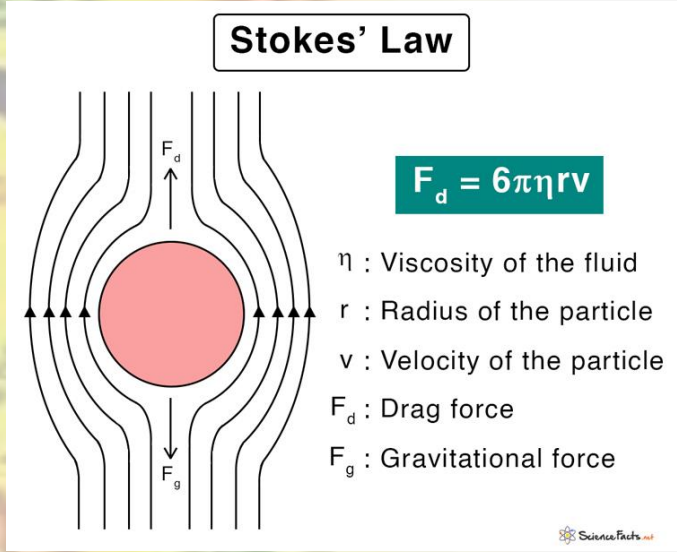
Stokes law

- When a small spherical body of radius r is moving slowly with a constant velocity v through a perfectly homogeneous medium (liquid or gas) of infinite extension and coefficient of viscosity η, then the retarding viscous force acting on the body is

  $F = 6\pi\eta r v$

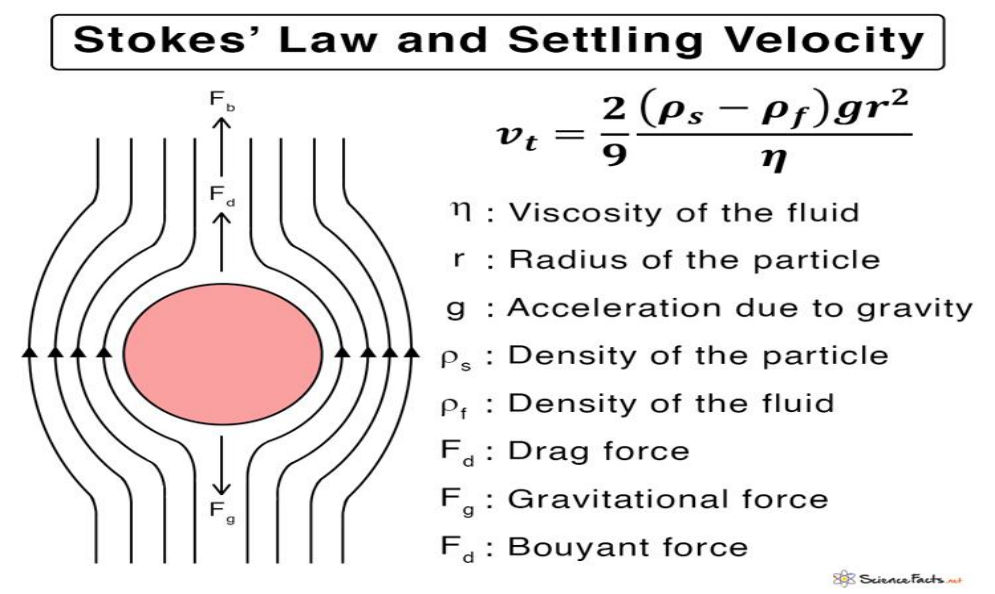
  where, v=velocity of the body

  r=radius of the body



Terminal Velocity

- When a body falls in a viscous medium, its velocity first increases and finally becomes constant. This constant velocity is called terminal velocity.



Poiseuille's Formulae

- Poiseuille studied the rate of flow of a liquid through a horizontal capillary tube and concluded that the volume (V) of liquid flowing out per second through a capillary tube is:

$$V \propto \frac{pr^4}{\eta l} \text{ or } V = \frac{\pi}{8}\frac{pr^4}{\eta l}$$

where, p = pressure difference across the two ends of the tube.
r = radius of the tube.
l = length of the tube.
η=the coefficient of viscosity of the liquid.

THANK YOU