Smart, Structured & Syllabus-Aligned Content

RICE EDUCATION



General SCIENCE

WBCS

PRESSURE & FLUID DYNAMICS

(REFERENCE MATERIAL)

PRESSURE & FLUID DYNAMICS

THRUST AND PRESSURE

• **Thrust:** Total force exerted perpendicular (normally) to a given surface. It is a **Vector quantity** (SI: Newton [N]; CGS: Dyne).
• **Pressure:** Thrust per unit contact area: **P = F / A.** It is a **Scalar quantity**.
  - SI Unit: Pascal (Pa) or N/m² | CGS Unit: dyne/cm² (1 Pa = 10 dyne/cm²).

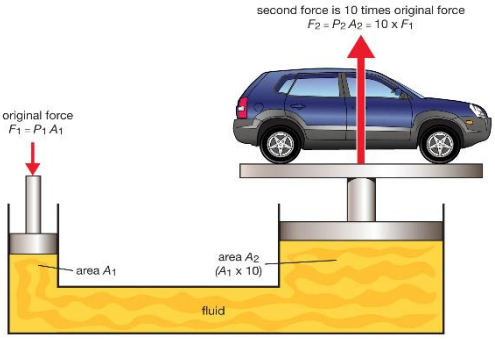
Applications of P = F / A in Daily Life:

• **Sharp knives cut better:** Smaller edge area creates huge pressure for a given applied force.
• **Broad straps on school bags:** Increase surface area to reduce the pressure exerted on shoulders.
• **Railway sleepers & Wide truck tyres:** Broad base distributes weight over large surface area, minimizing ground damage.

LIQUID & ATMOSPHERIC PRESSURE

• **Liquid Column Pressure: P = h × ρ × g** (h = depth, ρ = density, g = acceleration due to gravity).
  - Pressure increases with depth; hence dam walls are built noticeably thicker at the bottom.
  - At a given horizontal depth, pressure acts equally in all directions.
• **Standard Atmospheric Pressure (1 atm):** Pressure exerted by a 76 cm (760 mm) column of mercury (Hg) at 0°C at sea level (1 atm ≈ 1.013 × 10^5 Pa ≈ 760 torr).
• **Barometer (Torricelli):** Measures atmospheric pressure.
  - **Sudden drop:** Indicates storm or cyclone.
  - **Gradual drop:** Indicates rainfall.
  - **Gradual rise:** Indicates clear and fair weather.
• **High Altitudes:** Atmospheric pressure drops; boiling point of water decreases below 100°C. Pressure cookers raise boiling temperature above 100°C by trapping steam.

PASCAL'S LAW & ARCHIMEDES' PRINCIPLE



• **Pascal's Law:** Pressure exerted anywhere in an enclosed confined fluid is transmitted equally and undiminished in all directions.
  - **Applications:** Hydraulic brakes, hydraulic lift, hydraulic press.
• **Archimedes' Principle:** An object immersed wholly or partially in a fluid experiences an apparent loss of weight equal to the weight of fluid displaced.
• **Instruments:**
  - **Hydrometer:** Measures relative density / specific gravity of liquids.
  - **Lactometer:** Tests the purity of milk (based on relative density).
• **Ice in Water:** Pure ice floats with 9/10th submerged and 1/10th exposed. When floating ice melts completely, the water level remains strictly unchanged.

BERNOULLI'S PRINCIPLE, SURFACE TENSION & VISCOSITY

• **Bernoulli's Principle:** In steady streamline flow of an ideal fluid, an increase in velocity occurs simultaneously with a decrease in pressure.

- **Applications:** Dynamic lift of aircraft wings (aerofoil), blowing off roofs during storms, cricket ball swing (Magnus effect), scent atomizers/spray guns.

• **Surface Tension:** Tendency of liquid surfaces to shrink into minimum surface area like a stretched elastic membrane (SI: N/m; CGS: dyne/cm).

- Raindrops & soap bubbles are spherical due to surface tension.
- Detergents and heating reduce surface tension of water, facilitating deep dirt removal.

• **Viscosity :** Internal frictional resistance between adjacent layers of fluid (SI: Pa·s or Decapoise; CGS: Poise; 1 Pa·s = 10 Poise).

- Viscosity of liquids decreases with heating, while viscosity of gases increases with heating.

Device / Natural Phenomenon	Governing Physical Principle
Hydraulic Brakes / Hydraulic Lift	Pascal's Law
Aeroplane Lift / Storm Blowing Roofs	Bernoulli's Principle
Spherical Shape of Raindrops	Surface Tension
Lactometer (Milk Purity) & Hydrometer	Archimedes' Principle
Atmospheric Pressure Measurement	Torricellian Barometer
Cooking Fast at High Altitudes	Pressure Cooker (Elevated Boiling Point)
Hot Soup Tastes Better	Lower Surface Tension (Spreads over tongue)

IMPORTANT FACTS:

- Hydraulic brakes and hydraulic lifts operate strictly on Pascal's Law.
- Dynamic lift of an airplane and spray atomizers function on Bernoulli's Principle.
- Raindrops assume a spherical shape due to Surface Tension.
- A sudden sharp fall in barometer reading indicates an approaching storm/cyclone.
- When an ice cube floating in a glass of water melts completely, the water level remains identical.

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PREVIOUS YEAR QUESTION

Q1:Two cars, passing each other at high speed, are in danger of side-swiping because:(WBCS Pre 2019)

(A) of the increase in air pressure in the space between them.

(B) of decrease in the velocity of air molecules between them.

(C) of decrease in air pressure in the space between them.

(D) of the increase in the velocity of air molecules between them.

Answer: (C) of decrease in air pressure in the space between them.

Q2:Hydraulic press is based on:(WBCS Pre 2015)

(A) Archimedes' Law

(B) Pascal's Law

(C) Reynolds' Law

(D) Bernoulli's Law

Correct Answer: (B) Pascal's Law

Q3:A tube-well will not work if the depth of water below the ground is:(WBCS Pre 2010)

(A) 20 ft

(B) 25 ft

(C) 28 ft

(D) 38 ft

Answer: (D) 38 ft

Q4:A body is floating in a liquid partly immersed. The body and the liquid are taken to the Moon. The body:(WBCS Pre 2018)

(A) will continue to float as before.

(B) floats with greater part immersed.

(C) floats with lesser part immersed.

(D) will sink.

Answer: (A) will continue to float as before.

Q5:A boat floating in a tank is carrying some passengers. If the passengers drink water directly from the tank, how will it affect the water level of the tank? (WBCS Pre 2021)

(A) It will go down.

(B) It will rise.

(C) It will remain unchanged.

(D) It will depend on the atmospheric pressure.

Answer: (C) It will remain unchanged.

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