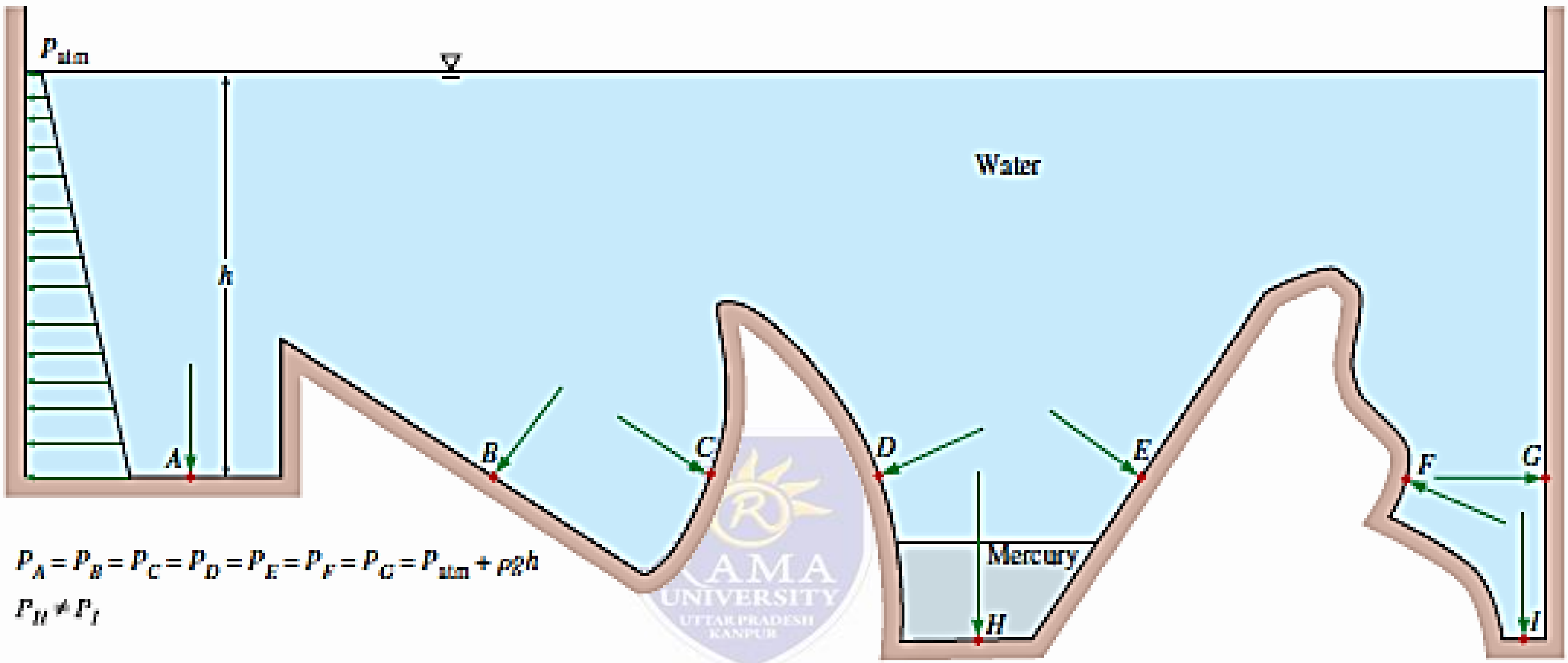
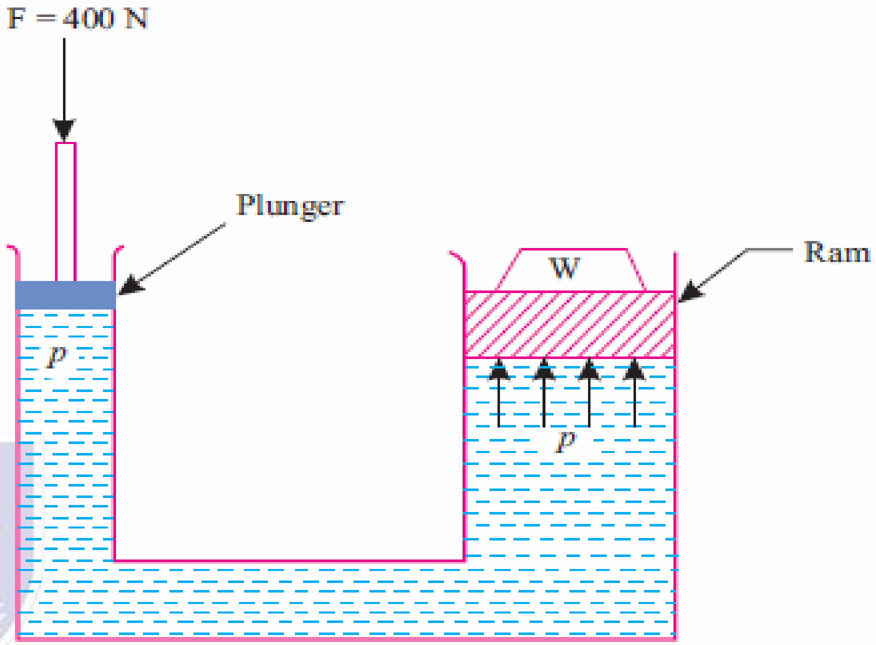


Under hydrostatic conditions, the pressure is the same at all points on a horizontal plane in a given fluid regardless of geometry, provided that the points are interconnected by the same fluid.

Fluid Properties

- $p_z \cdot LM \cdot \sin\alpha = p_x \cdot LN$ (Q $P_z = p_z \cdot LM$)
- But, $LM \cdot \sin\alpha = LN$ ... From Fig 2.3
- $\therefore p_z = p_x$ ...(iv)
- Resolving the forces vertically:
- $P_z \cdot \cos\alpha = P_y - W$
- (where, W = weight of the liquid element)
- Since the element is very small, neglecting its weight, we have:
- $P_z \cos\alpha = P_y$ or $p_z \cdot LM \cos\alpha = p_y \cdot MN$
- But, $LM \cos\alpha = MN$ ...From Fig 2.3
- $\therefore p_z = p_y$ ...(v)
- From (iv) and (v), we get: $p_x = p_y = p_z$,
- which is independent of α.
- Hence, at any point in a fluid at rest the intensity of pressure is exerted equally in all directions,
- which is called Pascal's law.

- The diameters of ram and plunger of an hydraulic press are 200 mm and 30 mm respectively. Find the weight lifted by the hydraulic press when the force applied at the plunger is 400 N.



Hydraulic press

- Solution. Diameter of the ram, D = 200 mm = 0.2 m
- Diameter of the plunger, d = 30 mm = 0.03 m
- Force on the plunger, F = 400 N
- Load lifted, W:

$$\text{Area of ram, } A = \frac{\pi}{4}D^2 = \frac{\pi}{4} \times 0.2^2 = 0.0314 \text{ m}^2$$

$$\text{Area of plunger, } a = \frac{\pi}{4}d^2 = \frac{\pi}{4} \times 0.03^2 = 7.068 \times 10^{-4} \text{ m}^2$$

- Intensity of pressure due to plunger

$$p = \frac{F}{a} = \frac{400}{7.068 \times 10^{-4}} = 5.66 \times 10^5 \text{ N/m}^2$$

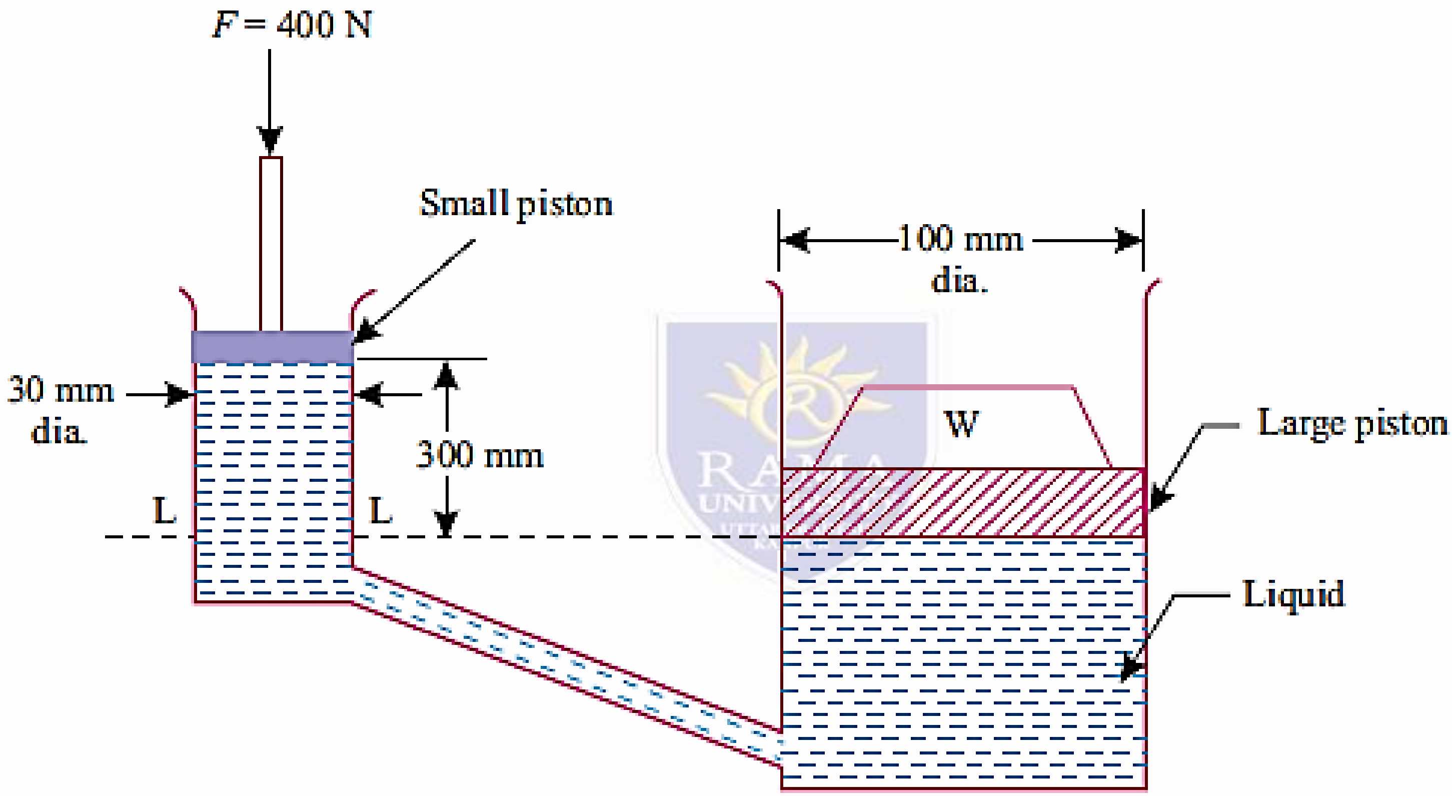
- Since the intensity of pressure will be equally transmitted (due to Pascal's law), therefore the
- intensity of pressure at the ram is also = p = 5.66 × 105 N/m2

$$\text{But intensity of pressure at the ram} = \frac{\text{Weight}}{\text{Area of ram}} = \frac{W}{A} = \frac{W}{0.0314} \text{N/m}^2$$

$$\therefore \frac{W}{0.0314} = 5.66 \times 10^5 \text{ or } W = 0.0314 \times 5.66 \times 10^5 \text{ N} = 17.77 \times 10^3 \text{ N or } \mathbf{17.77 \text{ kN (Ans.)}}$$

Fluid Static –Pascal Law Numerical

- For the hydraulic jack shown in Fig. 2.5 find the load lifted by the large piston
- when a force of 400 N is applied on the small piston.
- Assume the specific weight of the liquid in the jack is 9810 N/m3.



$$\text{Area of small piston, } a = \frac{\pi}{4}d^2 = \frac{\pi}{4} \times 0.03^2 = 7.068 \times 10^{-4} \text{ m}^2$$

$$\text{Diameter of the large piston, } D = 100 \text{ mm} = 0.1 \text{ m}$$

$$\text{Area of large piston, } A = \frac{\pi}{4} D^2 = \frac{\pi}{4} \times 0.1^2 = 7.854 \times 10^{-3} \text{ m}^2$$

$$\text{Force on small piston, } F = 400 \text{ N}$$

Load lifted, *W*:

$$\text{Pressure intensity on small piston, } p = \frac{F}{a} = \frac{400}{7.068 \times 10^{-4}} = 5.66 \times 105 \text{ N/m}^2$$

Pressure intensity at section *LL*,

$$p_{LL} = \frac{F}{a} + \text{Pressure intensity due to height of 300 mm of liquid}$$

$$= \frac{F}{a} + wh = 5.66 \times 10^5 + 9810 \times \frac{300}{1000}$$

$$= 5.66 \times 10^5 + 2943 = 5.689 \times 10^5 \text{ N/m}^2$$

Pressure intensity transmitted to the large piston = 5.689 × 105 N/m2
Force on the large piston = Pressure intensity × area of large piston
= 5.689 × 105 × 7. 854 × 10–3 = 4468 N Hence, load lifted by the large piston = 4468 N (Ans.)

ABSOLUTE AND GAUGE PRESSURES