Chapter (10)

Fluid

(ρ) Density $= \dfrac{\text{mass}}{\text{volume}} \left(\dfrac{kg}{m^3}\right)$ $\qquad \dfrac{g}{cm^3}$

$\rho_{water} = 1000\ kg/m^3$

Specific gravity $(x) = \dfrac{\rho_x}{\rho_{water}}$

$S.G(x) = 7.5 \Longrightarrow \dfrac{\rho_x}{1000} \Longrightarrow 7500\ kg/m^3$

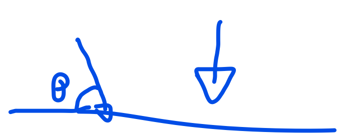
$\rho_x = 3\rho_y$ $\qquad \rho = \dfrac{m}{V}$ $\qquad S.G_x = \dfrac{\rho_x}{\rho_w}$

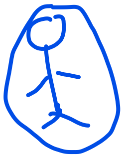
$y = 3\ m^3$

$S.G(x) = 7.5 \longrightarrow \rho_x = 7500$ $\qquad \dfrac{7500}{3} = \dfrac{m}{3}$

(y) mass $= ??$ $\qquad \dfrac{7500}{3} = \dfrac{3\rho_y}{3}$ $\qquad m = 7500\ kg$

$P = \dfrac{F}{A} \sin\theta$ $\quad (N/m^2)$ $\quad$ (pascal)



 60kg

2 feet = 500 cm^2

$1 m^2 = 100 cm$

$1 m^2 = 10\,000 cm^2$

?? = 500 cm^2

(N/m^2) F = ??

P_1

$P = \frac{F}{A} = \frac{600}{0.05} = 12000$ Pas

12 kpas

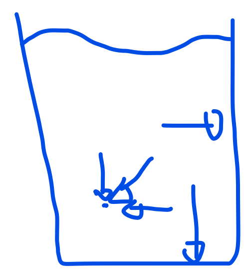
1 Feet → F ??

P_2

$P = \frac{F}{A} = \frac{600}{0.025} = 24000$ Pas

Static fluids

(1) At any point inside the liquid, the pressure is the same in all direction.

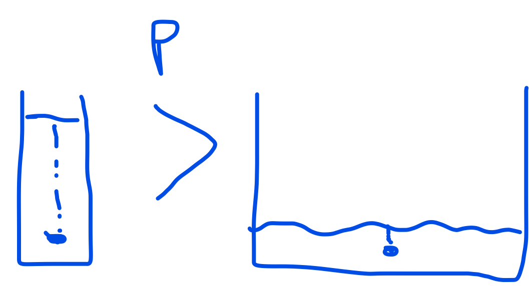


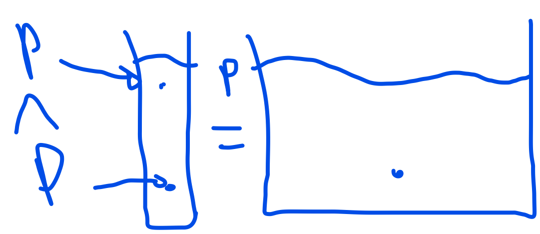
(2) The pressure of any static fluid is always perpendicular to the surface

$\rho = \frac{m}{V}$ $m = \rho V$

$P = \frac{F}{A} = \frac{mg}{A} = \frac{\rho V g}{A} = \frac{\rho \cancel{A} h g}{\cancel{A}}$

$P = \rho h g$





$P_1 = \rho g h_1$ $\qquad$ $P_1 = P_{atm} + \rho g h_1$

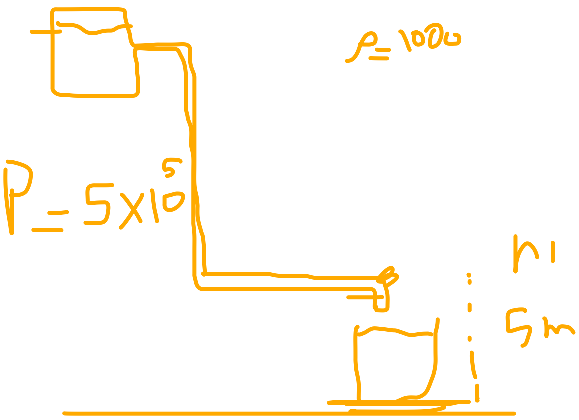
$P_2 = \rho g h_2$

$P_2 - P_1 = \rho g h_2 - \rho g h_1$

$\Delta P = \rho g (\Delta h)$

$\rho = 1000$

$\Delta P = 5 \times 10^5$



$5 \times 10^5 = 10^3 (10)\, \Delta h$

h_2

$5 + 5 \times 10 =$

$55\,m = h_2$

Atmospheric pressure

$1.013 \times 10^5\ Pa = 1.013\ bar = 1\ atm = 760\ mmHg$

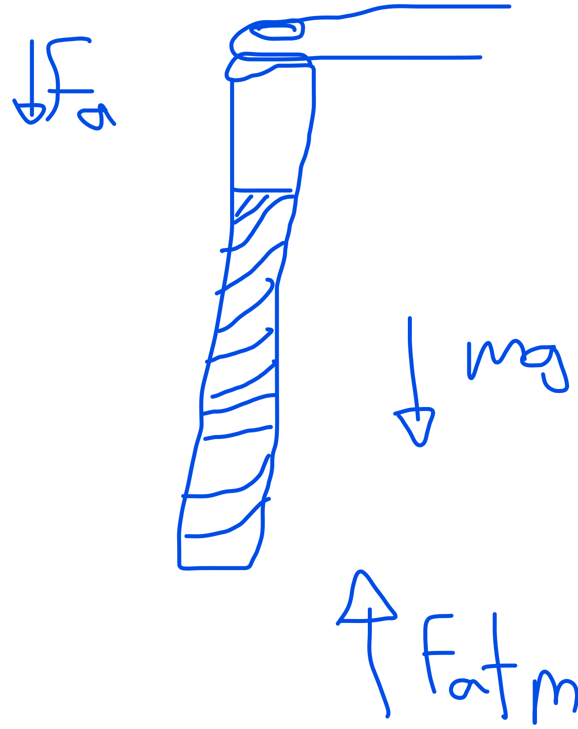
$1\ bar = 10^5\ pas$

$760\ mmHg = 1\ atm$

$F_{atm} - mg - F_a = 0$

$P_{atm}(A) - \rho V g - PA = 0$

$P_{Atm} - \rho h g - P = 0$



$$\boxed{P_{Atm} = P + \rho g h}$$

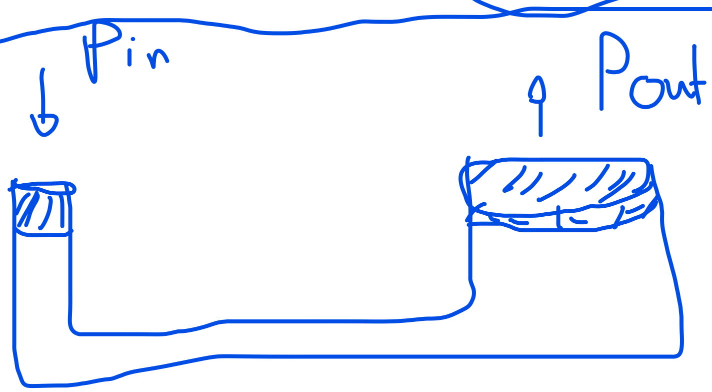
Gauge pressure

Difference between inside and outside (Gauge pressure)

$\boxed{P_{Atm} + G.P = \text{pressure in}}$

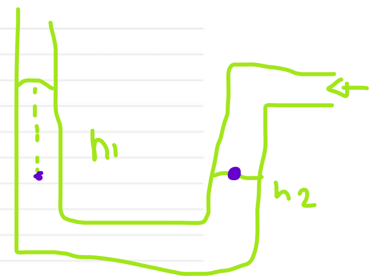
$$\frac{F_{in}}{A_{in}} = \frac{F_{out}}{A_{out}}$$

$$\frac{50}{1} = \frac{5000}{100}$$



Hydraulic lift

$P_{atm} + \rho h_1 g = P_{gas}$



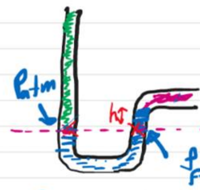
Open-tube manometer

The two points ① and ② are at the same height.

$$P_1 = P_2$$

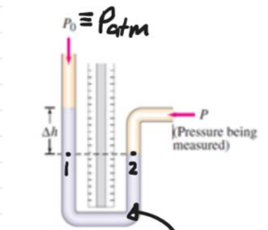
$$P_{atm} + \rho_f g \, \Delta h = P_{gas}$$

$$\therefore P_{gas} = P_{atm} + \rho_f g \, \Delta h$$



$\rho_f g h + P_{gas}$

$P_{gas} + \rho g h = P_{atm} \Rightarrow P_{gas} = P_{atm} - \rho g h$



(a) Open-tube manometer

mercury

$P_{atm} = P_{gas} + \rho g h$

$P_{gas} = P_{atm} - \rho g h$

760 mmHg

Mercury barometer

A column of mercury of height 760 mm (76 cm) results in a pressure equivalent to that of atmospheric pressure.

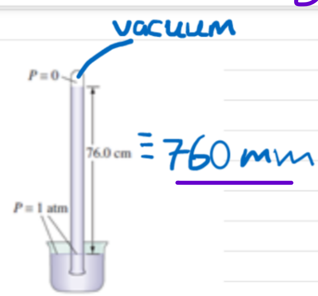
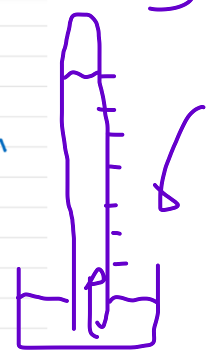


FIGURE 10–8 A mercury barometer, invented by Torricelli, is shown here when the air pressure is standard atmospheric, 76.0 cm-Hg.



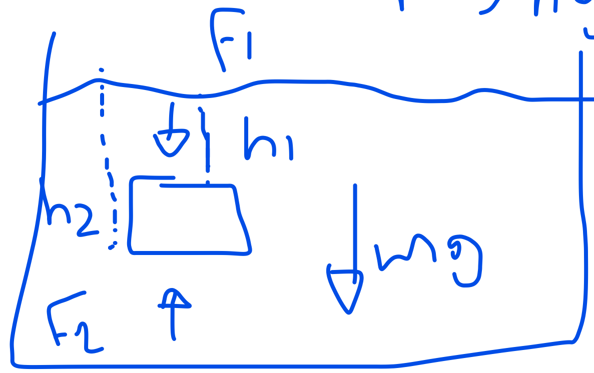
Question: If water is used instead of mercury, find the height of the water column to balance the atmospheric pressure.

Bouyant force

$dV = m$

$F = PA$

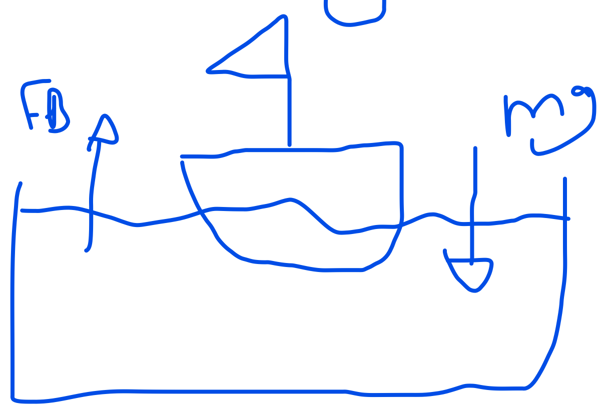
$P = \rho h g$



$$F_2 - F_1 = F_B$$

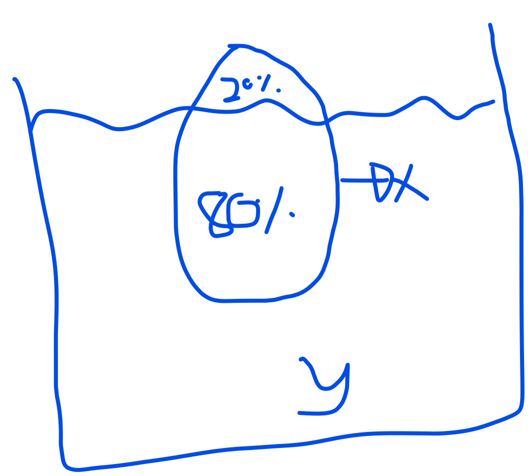
$$F_B = A\underline{\rho g h_2} - \rho A g h_1$$

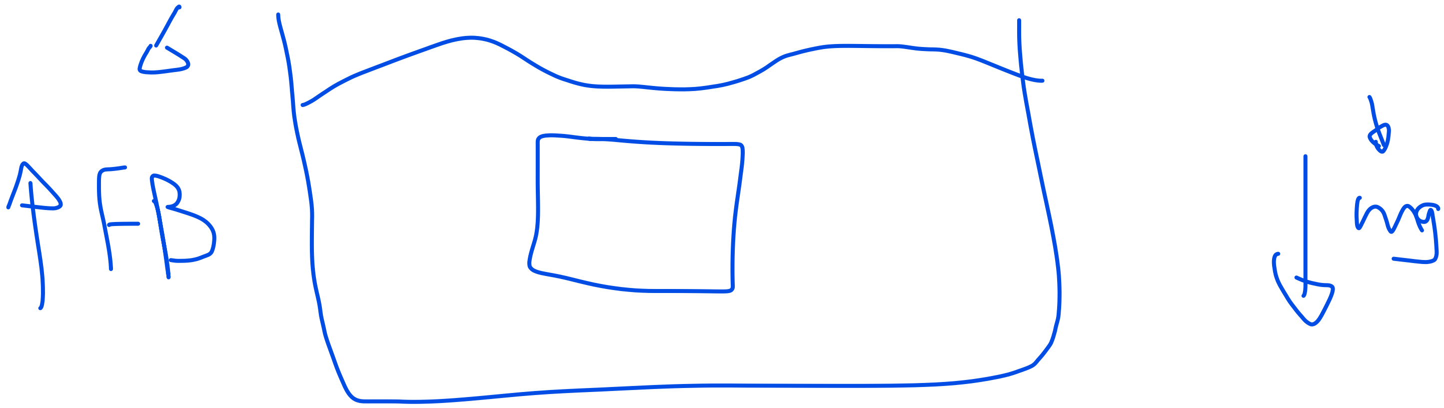
$$F_B = A g \rho \Delta h = \underline{\rho V} g = mg$$



$$\rho_w V g > \rho_s V g$$

$$\rho_x = 80\% \, \rho_y$$




FB
mg