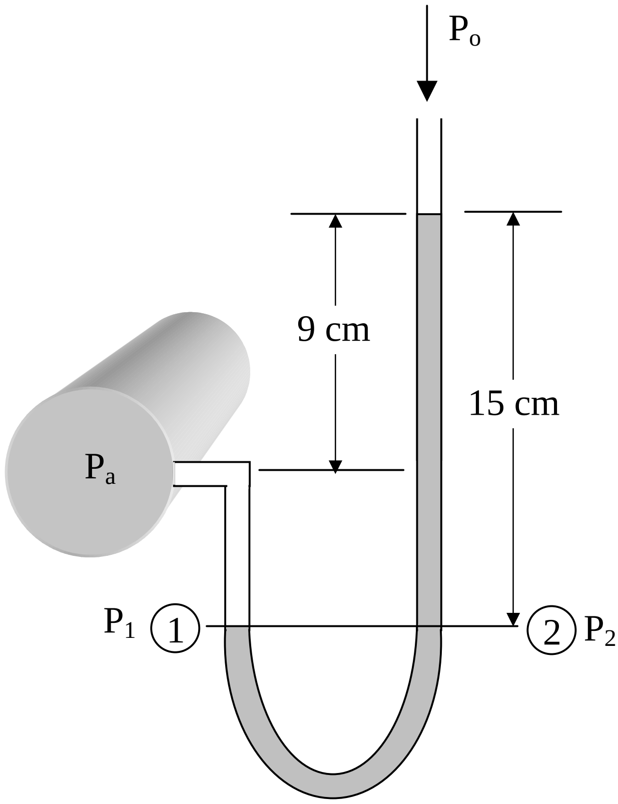
Example -3.4-

A simple manometer is used to measure the pressure of oil sp.gr. 0.8 flowing in a pipeline. Its right limb is open to atmosphere and the left limb is connected to the pipe. The center of the pipe is 9.0 cm below the level of the mercury in the right limb. If the difference of the mercury level in the two limbs is 15 cm, determine the absolute and the gauge pressures of the oil in the pipe.



Solution:

$\rho = 0.8\,(1000) = 800\ kg/m^3$

$P_1 = P_2$

$P_1 = (0.15 - 0.0\,9)m(800\ kg/m^3)9.81m/s^2 + P_a$

$P_2 = (0.15)\ m\ (13600\ kg/m^3)\ 9.81\ m/s^2 + P_o$

$P_a = 15\ (13600)\ 9.81 + P_o + [(15 - 9)cm\ (800\ kg/m^3)\ 9.81\ m/s^2]$

$= 1.20866 \times 10^5$ Pa (Absolute pressure)

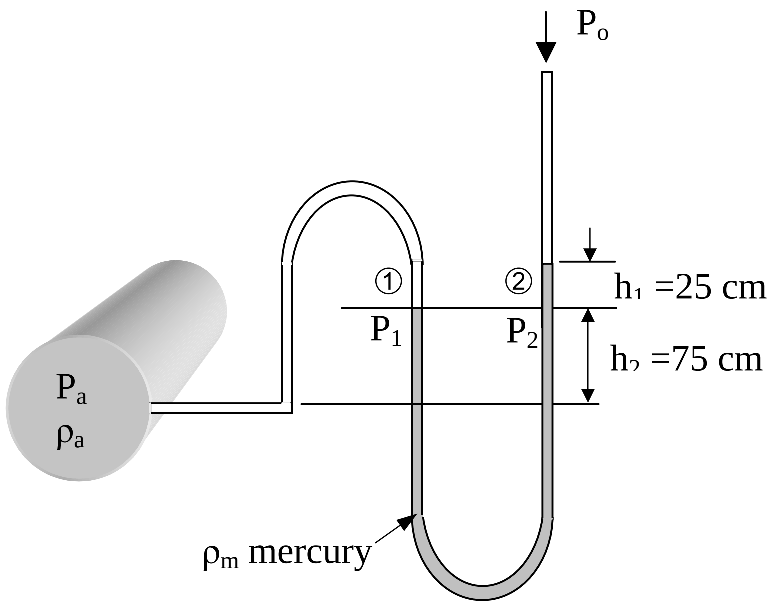
The gauge press. = Abs. press. – Atm. Press.

$= 1.20866 \times 10^5 - 1.0325 \times 10^5$

$= 1.9541 \times 10^4$ Pa

Example -3.5-

The following Figure shows a manometer connected to the pipeline containing oil of sp.gr. 0.8. Determine the absolute pressure of the oil in the pipe, and the gauge pressure.



Solution:

$\rho_a = 0.8\,(1000) = 800\ kg/m^3$

$P_1 = P_2$

$P_1 = P_a - h_2\,\rho_a\,g$

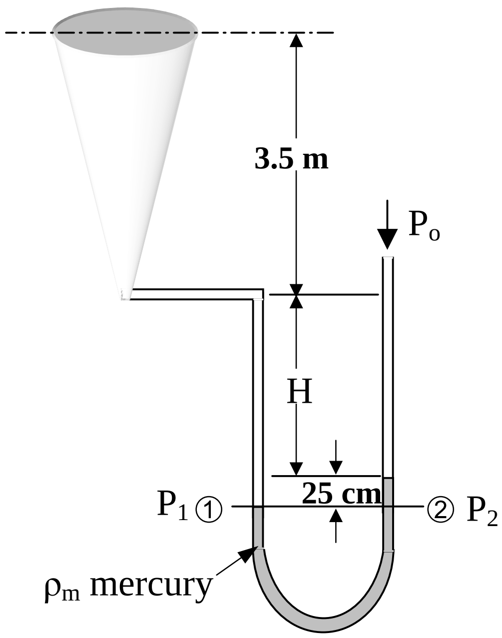
$P_2 = P_o + h_1\,\rho_m\,g$

$\Rightarrow P_a = P_o + h_1\,\rho_m\,g + h_2\,\rho_a\,g$

$= 1.0325 \times 10^5 + (0.25)\ m\ (13600\ kg/m^3)\ 9.81\ m/s^2 + (0.75)\ m\ (800\ kg/m^3)\ 9.81\ m/s^2$

$= 1.40565 \times 10^5$ Pa

Example -3.6-



A conical vessel is connected to a U-tube having mercury and water as shown in the Figure. When the vessel is empty the manometer reads 0.25 m. find the reading in manometer, when the vessel is full of water.

Solution:

$P_1 = P_2$

$P_1 = (0.25 + H)\ \rho_w\ g + P_o$

$P_2 = 0.25\ \rho_m\ g + P_o$

$\Rightarrow (0.25 + H)\ \rho_w\ g + P_o = 0.25\ \rho_m\ g + P_o$

$\Rightarrow H = 0.25\ (\rho_m - \rho_w)/\ \rho_w$

$= 0.25\ (12600\ /1000) = 3.15$ m

When the vessel is full of water, let the mercury level in the left limp go down by (x) meter and the mercury level in the right limp go to up by the same amount (x) meter.

i.e. the reading manometer = (0.25 + 2x)

$P_1 = P_2$

$P_1 = (0.25 + x + H + 3.5)\ \rho_w\ g + P_o$

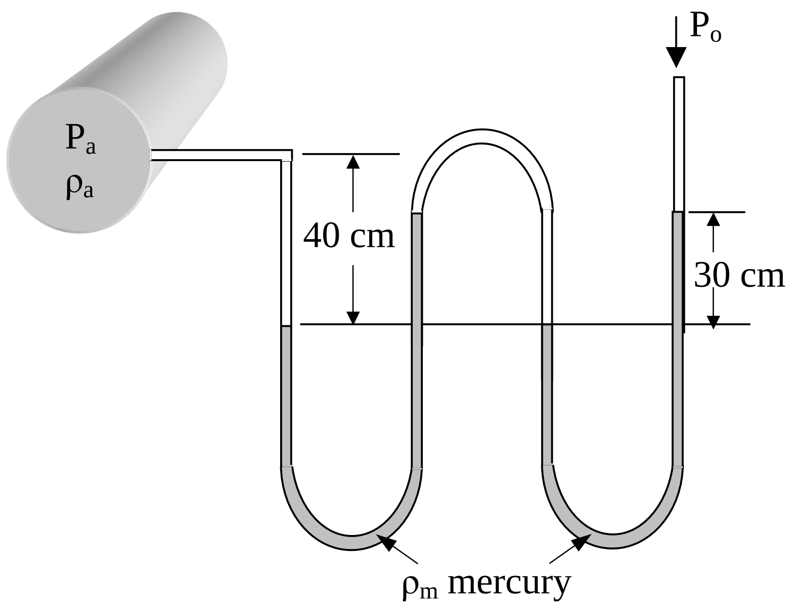
$P_2 = (0.25 + 2x)\ \rho_m\ g + P_o$

$\Rightarrow (0.25 + x + H + 3.5)\ \rho_w\ g + P_o = (0.25 + 2x)\ \rho_m\ g + P_o$

$\Rightarrow 6.9 + x = (0.25 + 2x)\ (\rho_m/\ \rho_w) \Rightarrow x = 0.1431$ m

The manometer reading = 0.25 + 2 (0.1431) = 0.536 m

Example -3.7-



The following Figure shows a compound manometer connected to the pipeline containing oil of sp.gr. 0.8. Calculate P_a.

Solution:

$\rho_a = 0.8\ (1000) = 800\ kg/m^3$

$P_a + 0.4\ \rho_a\ g - 0.3\ \rho_m\ g + 0.3\ \rho_a\ g - 0.3\ \rho_m\ g - P_o = 0$

$\Rightarrow P_a = P_o + 0.7\ \rho_a\ g - 0.6\ \rho_m\ g$

$= 1.01325 \times 10^5 - 0.7\ (800)\ 9.81 + 0.6\ (13600)\ 9.81$

$= 1.75881 \times 10^5$ Pa