MIN-106, Tutorial-1, 19114018, Ayushman Tripathy

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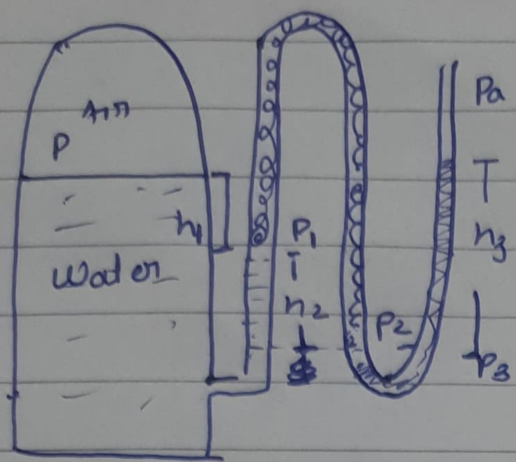

$$P_3 = P_a + \rho_3 g h_3 = P_a + \rho_{Hg} \cdot g \cdot h_3$$

$$P_1 = P + \rho_w g h_1$$

$$P_2 = P_1 + \rho_o g h_2$$

$$= P + \rho_w g h_1 + \rho_o g h_2$$

{ Here, $P_a = P_{atmosphere}$
P = Pressure in tank }

As P_2 and P_3 are at same level in static liquid

$\Rightarrow$ $P_2 = P_3$

$$\Rightarrow P + \rho_w g h_1 + \rho_o g h_2 = P_a + \rho_{Hg} g h_3$$

$$\Rightarrow P - P_a = P_{gauge} = \rho_{Hg} g h_3 - \rho_w g h_1 - \rho_o g h_2$$

$$= (\rho_{Hg} h_3 - \rho_w h_1 - \rho_o h_2) g$$

$$= (13600 \times 0.46 - 1000 \times 0.2 - 850 \times 0.3) \times 9.8 \text{ Pa}$$

$$= 56849.9 \text{ Pa} \approx 56.8499 \text{ kPa}$$

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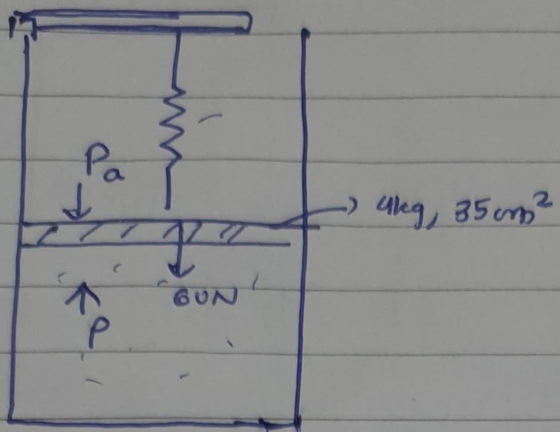
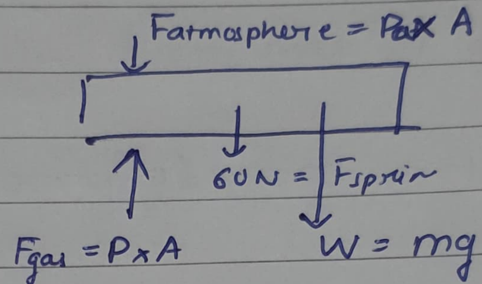


60N force is downwards as spring is compressed.

Taking equilibrium of the piston.



$$\therefore \quad P_a \cdot A + 60N + mg = P \cdot A$$

$$\Rightarrow \quad P = P_a + \frac{60N + mg}{A}$$

$$= 95\,kPA + \left[\frac{(60 + 4\times 9.8)}{35\times 10^{-4}\,m^2}\right]_{\text{in Pa}} \times 10^{-3}\,kPa$$

$$= 95\,kPA + 28.3428\,kPA$$

$$P = 123.3428\,kPA$$

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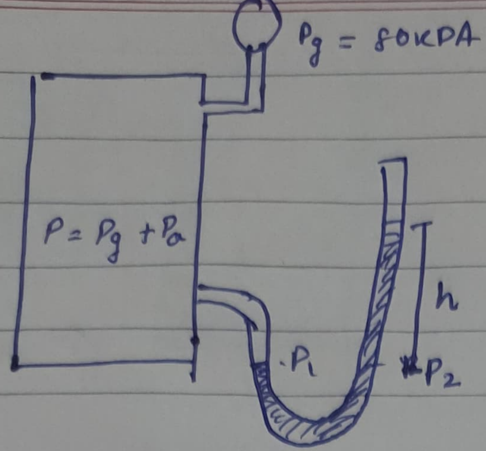

Considering the density of gas to be very low compared to the liquid.

We have $P_g = P - P_a = 80kPA$

Also, $P_1 = P_2$ {same level in same fluid}

$$P_2 = P_a + \rho g h$$

$$\Rightarrow P_g = P_a + 80\,kPa = P_a + \rho g h$$

$$\Rightarrow 80\,kPa = \rho g h$$

$$\Rightarrow h = \frac{80 \times 10^3}{9.8 \times \rho}$$

(a) if $\rho = 13600 \Rightarrow h = \dfrac{80 \times 10^3}{9.8 \times 13.6 \times 10^3} = 0.6002\,m$

(b) if $\rho = 1000 \Rightarrow h = \dfrac{80 \times 10^3}{9.8 \times 10^3} = 8.163\,m$

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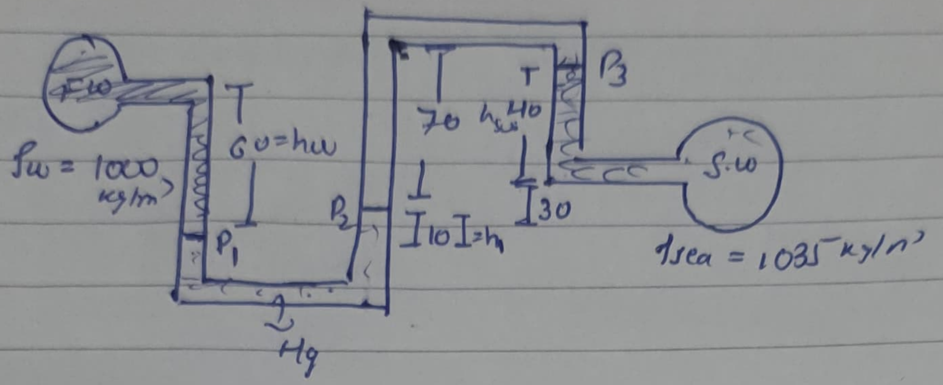

$$P_w + \rho_w g h_w = P_1$$

$$P_2 + \rho_{Hg} g h_1 = P_1$$

$P_3 \approx P_2$ {as pressure diff. due to 'air' would be very negligible}

$$P_3 + \rho_{sw} g h_{sw} = P_{sw}$$

$$P_w + \rho_w g h_w = P_2 + \rho_{Hg} g h_1; \quad P_2 = P_3 = P_{sw} - \rho_{sw} g h_{sw}$$

$$P_2 = P_w + \rho_w g h_w - \rho_{Hg} g h_1$$
$$= P_{sw} - \rho_{sw} g h_{sw}$$

$$\Rightarrow P_w - P_{sw} = -\rho_w g h_w + \rho_{Hg} g h_1 - \rho_{sw} g h_{sw}$$

$$= (-1000 \times 0.6 + 13600 \times 0.1 - 1035 \times 0.4) \times 9.8$$

$$= 3390.8\ Pa$$

$$\boxed{P_w - P_{sw} = 3.3908\ kPa}$$

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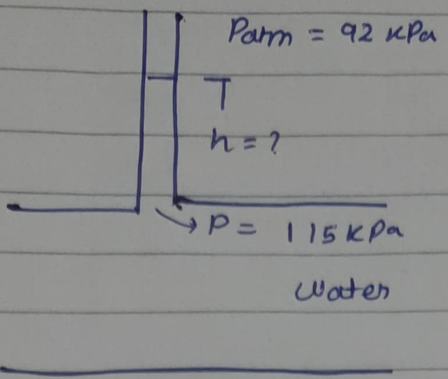

$$P_{atm} + \rho_w g h = P$$

$$\Rightarrow h = \frac{P - P_{atm}}{\rho_w g}$$

$$= \frac{(115 - 92) \times 10^3}{1000 \times 9.8}$$

$$= 2.3469 \text{ m}$$

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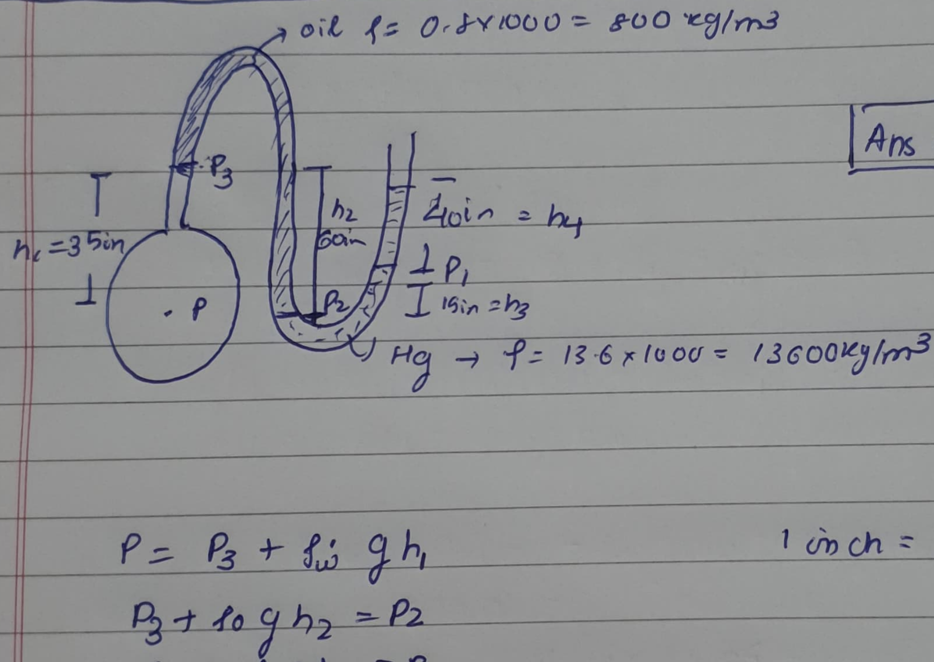

$$\boxed{Ans = 147.509 \text{ kPa}}$$

1 inch = 0.0254 m

$$P = P_3 + \rho_w g h_1$$

$$P_3 + \rho_o g h_2 = P_2$$

$$P_a + \rho_o g h_4 = P_1$$

$$P_1 + \rho_{Hg} g h_3 = P_2$$

$$\Rightarrow P_2 = P_1 + \rho_{Hg} g h_3 = P_3 + \rho_o g h_2$$

$$= P_a + \rho_o g h_4 + \rho_{Hg} g h_3 = P_3 + \rho_o g h_2$$

$$= P - \rho_w g h_1 + \rho_o g h_2$$

$$\Rightarrow P = P_a + \rho_o g (h_4 - h_2) + \rho_{Hg} g h_3 + \rho_w g h_1$$

$$= 92 \text{ kPa} + [\underset{kg/m^3}{800} \times \underset{in}{(40 - 60)} + 13600 \times 15 + 1000 \times 35] \times \underset{m/in}{0.0254} \times \underset{m/s^2}{9.8} \times 10^{-3} \text{ kPa}$$

$$= 92 \text{ kPa} + 55.509 \text{ kPa} = 147.509 \text{ kPa} \quad \therefore \boxed{P_{absolute} = 147.509 \text{ kPa}}$$