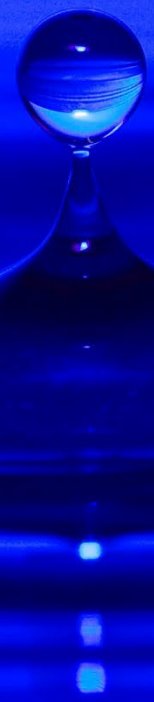
MEC516/BME516: Fluid Mechanics I

Midterm Review Problem:

Manometer Pressure Analysis



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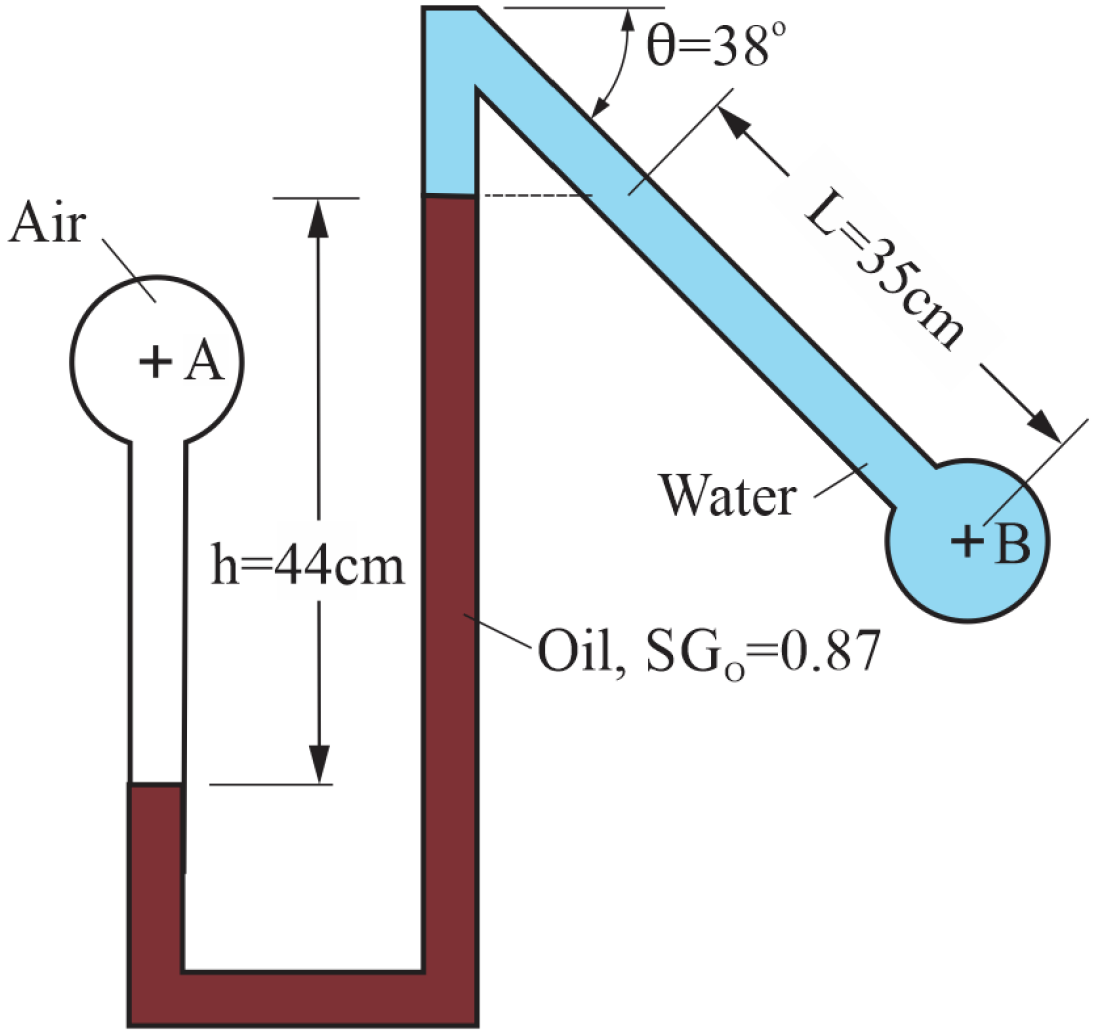
Midterm Problem: Manometer

For the manometer shown in the sketch:

(a) Derive an expression for the pressure difference $p_A - p_B$ in terms of the column dimensions (h, L), angle (θ) and the fluid specific weights $(\gamma_{oil}, \gamma_{water})$

(b) Calculate pressure difference, $p_A - p_B$ in kilopascals (*kPa*)



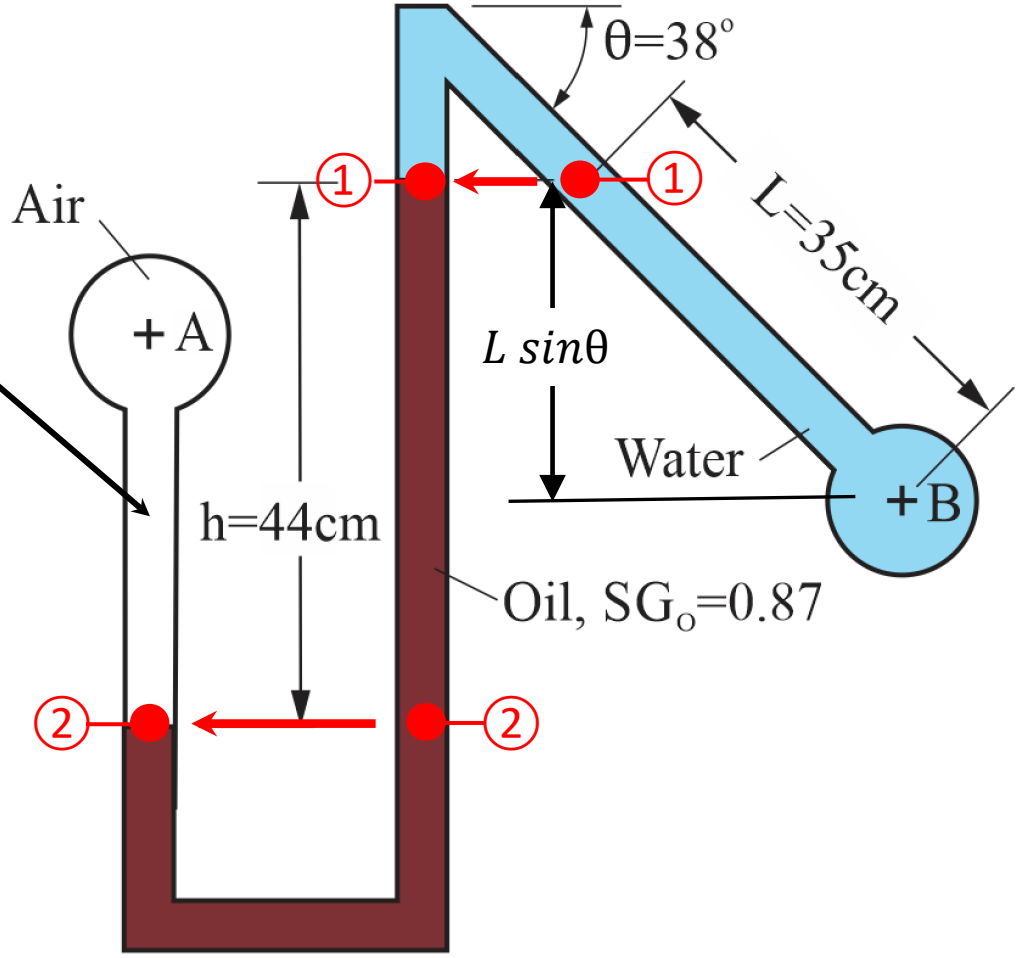
(a) Expression for $p_A - p_B$

Starting at point B → ①

Pressure change in air is negligible: $\gamma_{gas} \ll \gamma_{liquid}$

$$\underbrace{\underbrace{p_B - \gamma_{water} L \sin\theta}_{= p_1} + \gamma_{oil} h}_{= p_2 = p_A} - \gamma_{air} \Delta h_{air} = p_A$$

$\gamma_{air} \Delta h_{air} \approx 0$

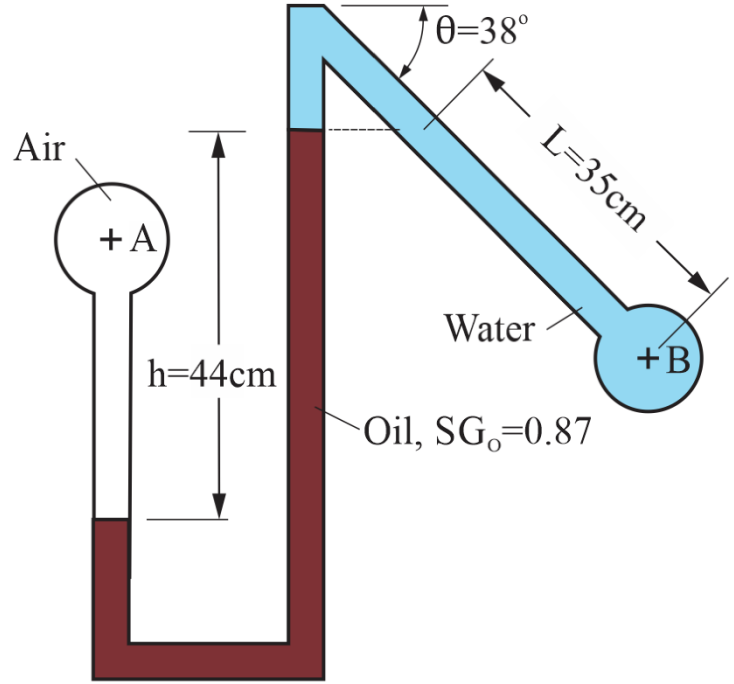


Rearranging:

$$p_A - p_B = \gamma_{oil} h - \gamma_{water} L \sin\theta$$

Answer

(b) Calculate $p_A - p_B$ in kilopascals (kPa)



$$p_A - p_B = \gamma_{oil} h - \gamma_{water} L \sin\theta$$

Specific Weights:

$$\gamma_{oil} = SG_o \rho_{water} g = 0.87 \left(1000 \frac{kg}{m^3}\right) 9.81 \frac{m}{s^2} = 8530\ N/m^3$$

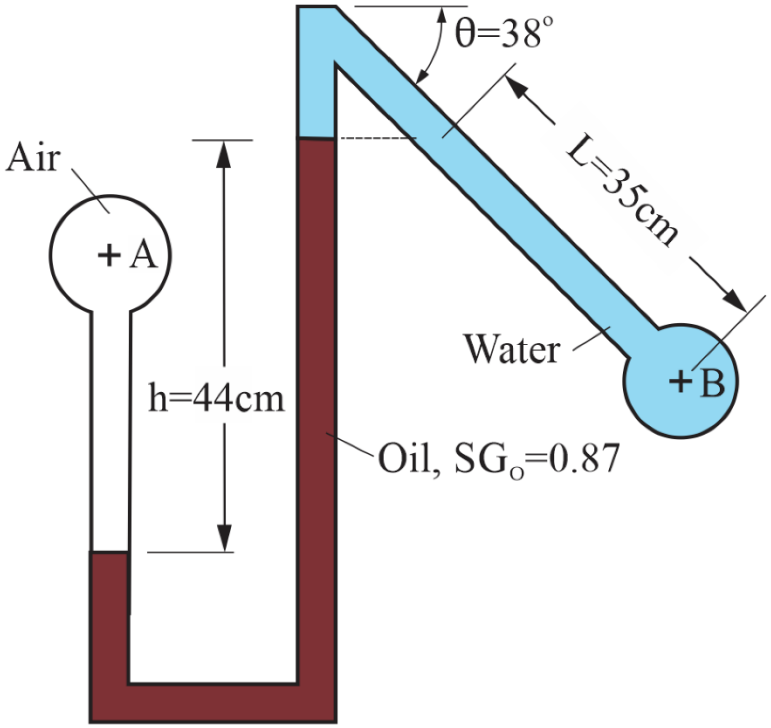
(at 4°C)

$$\gamma_{water} = \rho_{water} g = \left(998 \frac{kg}{m^3}\right) 9.81 \frac{m}{s^2} = 9790\ N/m^3$$

Substituting in the values:

$$p_A - p_B = 8530 \frac{N}{m^3}(0.44m) - 9790 \frac{N}{m^3}(0.35m)\sin(38^o) = 1644\ Pa = 1.64\ kPa$$

Answer



3D Fluid Simulation with *Blender* (free open source)

Video Credit: Fattu Tutorials https://youtu.be/HZG6raTnavA

END NOTES

- All the videos (and pdf copies) for this course are available at www.drdavidnaylor.net
- Presentation prepared and delivered by Professor David Naylor