



# Exercise Set 5

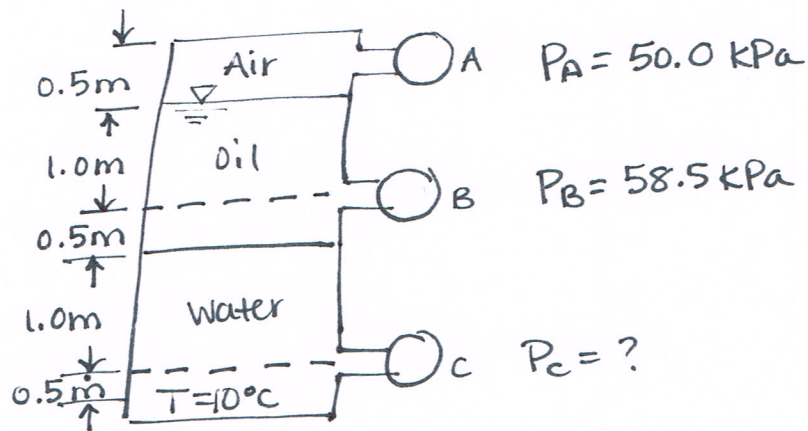
3.16 ← GRADED.

3.54 ~~GRADED~~

3.66

3.16) For the closed tank with Bourdon-tube gages tapped into it, what is the specific gravity of the oil and the pressure reading on gage C?

SKETCH:



KNOWN:

Closed tank

$T = 10^\circ\text{C}$

$\gamma = 9810 \text{ N/m}^3 \Rightarrow \text{Table A.5}$

UNKNOWN:

S.G. of oil

$P_C = ?$

SOLUTION:

Hydrostatic equation (from oil surface to elevation B).

$$P_A + \gamma z_A = P_B + \gamma z_B$$

$$50,000 \frac{\text{N}}{\text{m}^2} + \gamma_{\text{oil}}(1\text{m}) = 58,500 \frac{\text{N}}{\text{m}^2} + \gamma_{\text{oil}}(0\text{m})$$

$$\gamma_{\text{oil}} = 8500 \text{ N/m}^3$$

specific Gravity:

$$\text{S.G.} = \frac{\gamma_{\text{oil}}}{\gamma_{\text{water}}} = \frac{8500 \text{ N/m}^3}{9810 \text{ N/m}^3} = \boxed{0.87 = \text{S.G.}}$$

Hydrostatic equation (in water):

$$P_C = (P_{\text{atm of oil}}) + \gamma_{\text{water}}(1\text{m})$$

Hydrostatic equation (in oil):

$$P_{\text{atm of oil}} = (58,500 \text{ Pa} + \gamma_{\text{oil}}(0.5\text{m}))$$

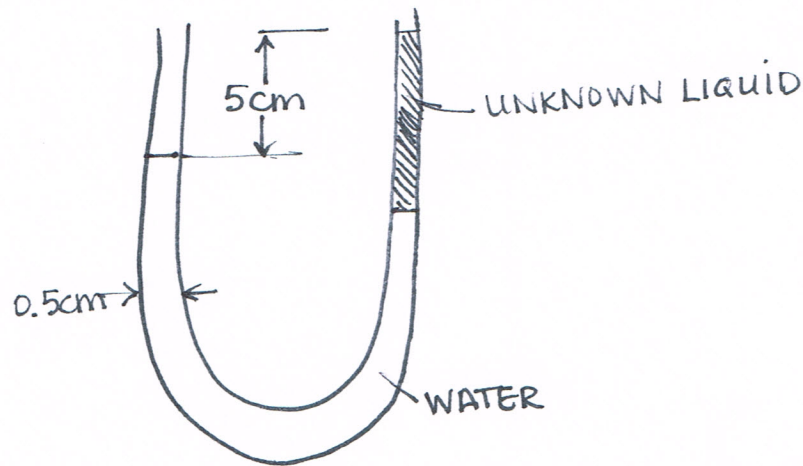
2.16 continued

$$\begin{aligned}P_c &= 58,500 \text{ Pa} + \gamma_{\text{oil}}(0.5 \text{ m}) + \gamma_{\text{water}}(1 \text{ m}) \\&= (58,500 \text{ Pa} + 8500 \text{ N/m}^3 (0.5 \text{ m})) + 9810 \text{ N/m}^3 (1 \text{ m}) \\&= 72,560 \text{ N/m}^2\end{aligned}$$

$$\boxed{P_c = 72.56 \text{ kPa}}$$

3.54) A device for measuring the specific weight of a liquid consists of a U-tube manometer as shown. The manometer tube has an internal diameter of 0.5 cm and originally has water in it. Exactly  $2 \text{ cm}^3$  of unknown liquid is then poured into one leg of the manometer, and a displacement of 5 cm is measured between the surfaces as shown. What is the specific weight of the unknown liquid?

SKETCH:



UNKNOWN:

$\gamma$  of unknown liquid ( $\text{N/m}^3$ )

SOLUTION:

Find the length of the column of the unknown liquid

$$V = (\pi/4)(0.5 \text{ cm})^2 l = 2 \text{ cm}^3$$

$$\Rightarrow l = 10.186 \text{ cm}$$

manometer equation (from water surface in left leg to liquid surface in right leg)

$$0 + (10.186 \text{ cm} - 5 \text{ cm})(10^{-2} \text{ m/cm})(9810 \text{ N/m}^3) - [(10.186 \text{ cm})(10^{-2} \text{ m/cm}) \times \gamma_{\text{liq}}] = 0$$

$$\gamma_{\text{liq}} \Rightarrow 508.7 \text{ Pa} - 0.10186 \gamma_{\text{liq}} = 0$$

$$\boxed{\gamma_{\text{liquid}} = 4995 \text{ N/m}^3}$$



3.66) Two cylindrical tanks have bottom areas  $A$  and  $4A$  respectively, and are filled with water to the depths shown

- Which tank has the higher pressure at the bottom of the tank?
- Which tank has the greater force acting downward on the bottom circular surface?

~~UNKNOWN~~  
UNKNOWN:

a) ?

b) ?

GOVERNING EQNS:

$$P = -\gamma \Delta z$$

SOLUTION:

- Which tank has the higher pressure at the bottom?

Tank 1:  $P_1 = \gamma h$  at the bottom

Tank 2:  $P_2 = \gamma \left(\frac{1}{2}h\right) = \frac{1}{2}\gamma h$  at the bottom

Tank 1 has the higher pressure @ the bottom

- Which tank has the greater force acting downward at the bottom?

$$F = PA$$

Tank 1:  $F_1 = PA = \gamma h A$

Tank 2:  $F_2 = PA = \left(\frac{1}{2}\gamma h\right)(4A) = 2\gamma h A$

Tank 2 has the greater force acting downward on the tank bottom