MECH 310 THERMODYNAMICS I
ASSIGNMENT 1

Problem 1

$$Pv^{1.4} = 2.3 \times 10^5 \qquad (1)$$

And

$$dP = \rho g dh \qquad (2)$$

But
$$\rho = \frac{1}{v} \qquad (3)$$

Substituting (3) into (1)

$$\rho = \frac{P^{1/1.4}}{(2.3 \times 10^5)^{1/1.4}} = 3.698 \times 10^{-3} P^{0.7143}$$

Therefore,

$$dP = 9.81 \times 3.698 \times 10^{-3} P^{0.7143} dh$$

$$h = 688.9 \int_0^{P_o} P^{-0.7143}\, dp$$

$$h = 64{,}900\ m = 64.9\ km$$

Problem 2

(b) $\Delta P = 660\ mmHg = \frac{660}{760} \times 101.3 kPa = 87.97\ kPa$

$P_{abs} = P_o - \Delta P$ =101.3 – 87.97 =13.32 kPa

Problem 3

$\rho = SG\ (\rho_{H2O}) = 0.85 \times 1{,}000 = 850\ kg/m^3$

But

$$P = P_0 + \rho g h = 96 + 850 \times 9.81 \times 0.55 = 100.6\ kPa$$

Problem 4

21.35 ^oC

Problem 5

Starting with the atmospheric pressure on the top surface of the container and moving along the tube by adding (as we go down) or subtracting (as we go up) the $gh\rho$ terms until we reach point A, and setting the result equal to P_A give

$$P_{atm} + \rho_{oil} g h_{oil} + \rho_w g h_w - \rho_{gly} g h_{gly} = P_A$$

Rearranging and using the definition of specific gravity,

$$P_A - P_{atm} = SG_{oil} \rho_w g h_{oil} + SG_w \rho_w g h_w - SG_{gly} \rho_w g h_{gly}$$

or

$$P_{A,gage} = g \rho_w (SG_{oil} h_{oil} + SG_w h_w - SG_{gly} h_{gly})$$

Substituting,

$$P_{A,gage} = (9.81 \text{ m/s}^2)(1000 \text{ kg/m}^3)[0.90(0.70 \text{ m}) + 1(0.3 \text{ m}) - 1.26(0.70 \text{ m})]\left(\frac{1 \text{ kN}}{1000 \text{ kg} \cdot \text{m/s}^2}\right)$$

$$= 0.471 \text{ kN/m}^2 = \mathbf{0.471 \text{ kPa}}$$

The equivalent mercury column height is

$$h_{Hg} = \frac{P_{A,gage}}{\rho_{Hg} g} = \frac{0.471 \text{ kN/m}^2}{(13{,}600 \text{ kg/m}^3)(1000 \text{ kg/m}^3)(9.81 \text{ m/s}^2)}\left(\frac{1000 \text{ kg} \cdot \text{m/s}^2}{1 \text{ kN}}\right) = 0.00353 \text{ m} = \mathbf{0.353 \text{ cm}}$$