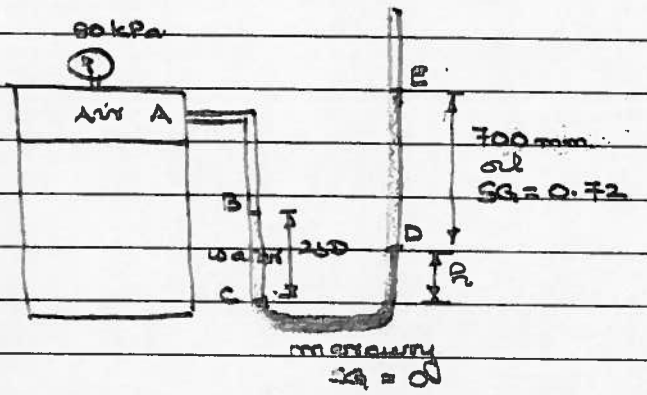
ENGR 251/4 xx : Thermodynamics

Quiz #1 Solutions:

1.




$P_E = P_{atm}$

$P_D = P_E + 700\text{ mm oil}$

$P_C = P_D + R_{mm\ mercury}$

$P_B = P_C - 250\text{ mm water}$

$P_A = P_B$

$\therefore P_A = P_{atm} + 700\text{ mm of oil} + R\text{ mm of mercury} - 250\text{ mm of water.}$

$\therefore P_A(\text{gage}) = 700\text{ mm of oil} + R\text{ mm of mercury} - 250\text{ mm of water.}$

$$\therefore 80\text{ kPa} = \frac{0.700 \times 0.72 \times 1000 \times 9.81}{1000}\text{ kPa} + \frac{R \times 10^{-3} \times 13.6 \times 1000 \times 9.81}{1000}\text{ kPa} - \frac{0.250 \times 1000 \times 9.81}{1000}\text{ kPa}$$

$$80 = 4.944 + R \times 10^{-3} \times 133.4 - 2.453$$

$$\therefore R = 581.0\text{ mm}$$

(2) (a) 2kg $H_2O$ at 100°C and 5MPa

$T = 100°C$ ($P_{sat} = 101.42 kPa$) (A4)

$P = 5 MPa$.

$P > P_{sat}$ ∴ Compressed liquid

A7: $P = 5 MPa$

$T = 100°C$

$v = 0.0010410 \ m^3/kg$

$V = mv$

$= 2 \times 0.0010410 = 0.0020820 \ m^3$

(b) 2kg of saturated mixture, $V = 1.0 \ m^3$, $T = 110°C$

(a) $P = P_{sat @ T}$

$= 143.38 kPa$. (A4)

(b) $v = \frac{1.0}{2} = 0.50 \ m^3/kg$.

$v_f = 0.001052 \ m^3/kg$

$v_g = 1.2094 \ m^3/kg$

$v = v_f(1-x) + v_g x$.

$\therefore x = \frac{v - v_f}{v_g - v_f} = \frac{0.50 - 0.001052}{1.2094 - 0.001052} = 0.4129$

(c) Saturated mixture, $x = 0.60$, $V = 1.0 \ m^3$, $T = 110°C$

A:4 $v_f = 0.001052$ $v_g = 1.2094$ $u_f = 461.27$ $u_{fg} = 2056.4$

$v = (1-x) v_f + x v_g$

$= 0.40 \times 0.001052 + 0.6 \times 1.2094 = 0.72606 \ m^3/kg$.

$m = \frac{V}{v} = \frac{1.0}{0.72606} = 1.377 \ kg$.

$u = u_f + x u_{fg}$

$= 461.27 + 0.6 \times 2056.4 = 1695.1 \ kJ/kg$

$\therefore U = mu$

$= 1.377 \times 1695.1 = 2334.2 \ kJ$.

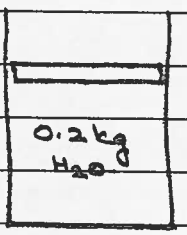
(d) $U = 1000$ kJ, $P = 50$ kPa $T = 100°C$.

A6: $v = 3.4187$ m³/kg $u = 2511.5$ kJ/kg.

$$m = \frac{U}{u} = \frac{1000}{2511.5} = 0.3982 \text{ kg}.$$

$$V = mv = 0.3982 \times 3.4187 = 1.361 \text{ m}^3.$$

3.




) Initial: $x_1 = 0.80$, $P_1 = 100$ kPa.

A5: $v_f = 0.001043$ $v_g = 1.6941$

$u_f = 417.4$ $u_{fg} = 2088.2$.

$$\therefore v_1 = 0.2 v_f + 0.8 v_g = 1.3554 \text{ m}^3/\text{kg}$$

$$u_1 = u_f + x u_{fg} = 2088.0 \text{ kJ/kg}.$$

Final $P = 100$ kPa, $T = 150°C$

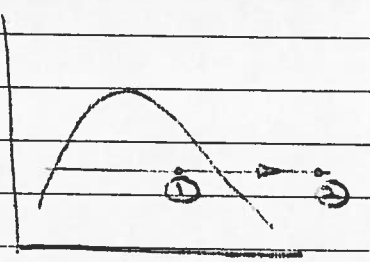
$T_{sat@P} = 99.61°C$

∴ Super-Heated steam.

A6: $v_2 = 1.9367$ m³/kg

$u_2 = 2582.9$ kJ/kg.

(a)




(b) $V_2 - V_1 = mv_2 - mv_1$

$= 0.2 (1.9367 - 1.3554) = 0.11626$ m³

$U_2 - U_1 = mu_2 - mu_1$

$= 0.2 (2582.9 - 2088.0) = 98.98$ kJ.