19114079
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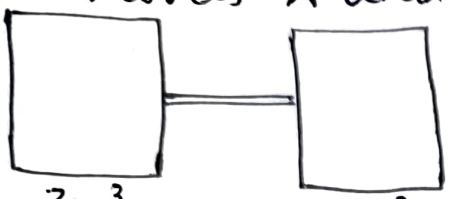
QUIZ - MIN106

1) Two vessels A and B...



$C_V = 0.718 \frac{kJ}{kg\,K}$

$R = 0.287 \frac{kJ}{kg\,K}$

7 Bar = 0.7 MPa
95°C
= 368K

3.5 Bar
478 K

$$m_A = \frac{P_A V_A}{R T_A} = \frac{700(3)}{(0.287)(368)} = 19.8833\ kg$$

$$m_B = \frac{P_B V_B}{R T_B} = \frac{(350)(3)}{(0.287)(478)} = 7.6538\ kg$$

Adiabatic mixing ⇒

Initially: $U_A = m_A C_V T_A = (19.8833)(0.718)(368)$
$= 5253.66\ kJ$

$U_B = m_B C_V T_B = (7.6538)(0.718)(478)$
$= 2626.83\ kJ$

$U_f = (m_A + m_B) C_V T_f = U_{initial}$ (∵ adiabatic)

$= (2626.83) + (5253.66) = (19.8833 + 7.6538)(0.718)\,T_f$

$$T_f = 398.57\ K$$

$$P_f = \frac{(m_A + m_B)(R)(T_f)}{V_f}$$

$$= \frac{(19.8833 + 7.6538)(0.287)(398.57)}{6}$$

$$P_f = 524.99 \text{ kPa}$$

$$S_{total} = \Delta S_A + \Delta S_B$$

$$\Delta S_A = m_A \left[C_v \ln\left(\frac{T_2}{T_1}\right) + R \ln\left(\frac{V_2}{V_1}\right) \right)$$

$$= 3.3277 \text{ kJ/K}$$

$$\Delta S_B = m_B \left[C_v \ln\left(\frac{T_2}{T_1}\right) + R \ln\left(\frac{V_2}{V_1}\right) \right)$$

$$= -2.2879 \text{ kJ/K}$$

$$\Delta S_{total} = (3.3277 - 2.2879) \text{ kJ/K}$$

$$= 0.9498 \text{ kJ/K}$$

2) A well insulated rigid tank...

Energy dissipated in resistor ⇒ heats water

$$VI(t) = m_{water}(u_2 - u_1)$$

Initially: $m = 5$

$x_1 = 0.25$

$u_1 = u_f + x u_{fg} = 417.9 + 0.25$ (2090.44

$v_1 = v_f + x v_{fg}$ @ 100 kPa. $= 940.51 \frac{kJ}{kg}$

$= 0.001043 + 0.25(1.6759)$

$v_1 = 0.420033 \frac{m^3}{kg}$

$V_1 = m v_1$

$= 5(V_1)$

$= 2.100165 m^3$

$v_1 = v_2 = v_{g\,final} = 0.420033 \frac{m^3}{kg}$

@ $v_g = 0.420033 \Rightarrow u_g = 2555.3 \frac{kJ}{kg}$

(steam table)

$\Rightarrow \Delta U = (u_{g_f} - u_i)m$

$= (2555.3 - 940.51)(5)$

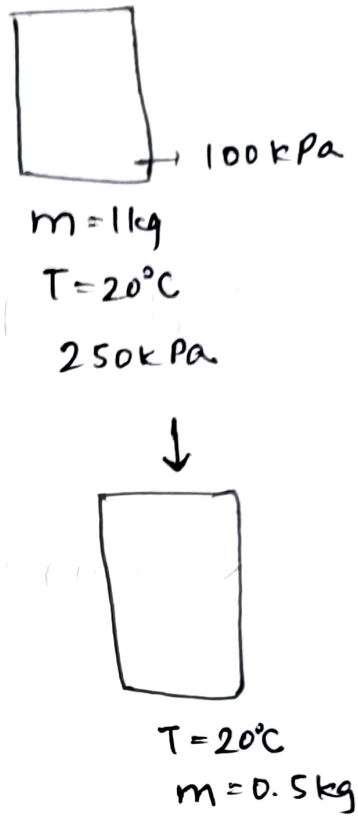
$= 8073.95$ kJ

$(8073.95)(1000) = 110(8)(t)$

$\boxed{t = 9174.94 \text{ seconds}}$

3) A piston cylinder contains...

$$m_e = m_1 - m_2$$



$$\Rightarrow m_1 u_1 = m_2 u_2 + m_e\left(h_e + \frac{Ve^2}{2}\right) + W \quad \text{--- (1)}$$

P → constant

$$W = P(V_2 - V_1)$$

@(1): 20°C ⇒ compressed liquid

$$V_1 = 0.0010017 \ \frac{m^3}{kg}$$

$$u_1 = 83.86 \ \frac{kJ}{kg}$$

(2) 20°C ⇒ T & P don't change

$$V_2 = V_1 \ \& \ u_2 = u_1$$

$$m_2 = \frac{m_1}{2} = 0.5\,kg \Rightarrow m_e = 0.5\,kg$$

$$W = -\frac{P(V_1)}{2}$$

$$= -250 \times \frac{1}{2} \times 0.0010017$$

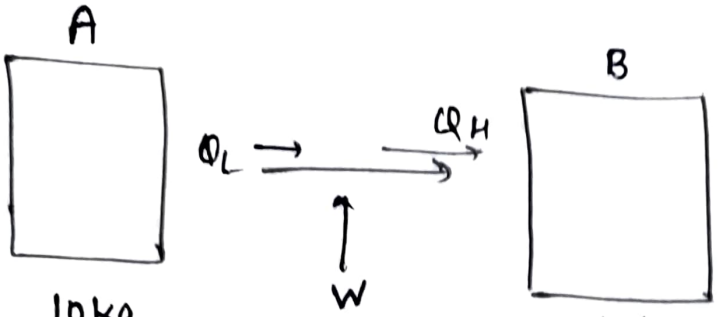
$$= -0.1252125\ kJ$$

$$\frac{1}{2}\left(83.86+\frac{V_e^2}{2}\right)-0.1252125=\frac{1}{2}(83.86)$$

$$\frac{V_e^2}{4}=0.125125\times10000$$

$$\boxed{V_e=22.38\ m/s}$$

4) Two Blocks...



$$\Rightarrow mC_p \ln\left(\frac{T_1}{313}\right) + mC_p \ln\left(\frac{T_1+100}{313}\right) = 0$$

$$\Rightarrow \ln\left(\frac{T_1}{313}\right) = -\ln\left(\frac{T_1+100}{313}\right)$$

$$(T_1)(T_1+100) = (313)^2$$

$$T_1^2 + 100T_1 - (313)^2 = 0$$

$$T_1 = \frac{-100 \pm \sqrt{10^4 + 4(313)^2}}{2}$$

$$\boxed{T_1 = 266.97\,K}$$

$$W = Q_H - Q_L$$

$$= mC_p(266.97 + 100 - 313) - mC_p(266.97 - 313)$$

$$= 10(0.4)(2(266.968 + 100 - 2(313)))$$

$$\boxed{W = 31.744\,kJ}$$