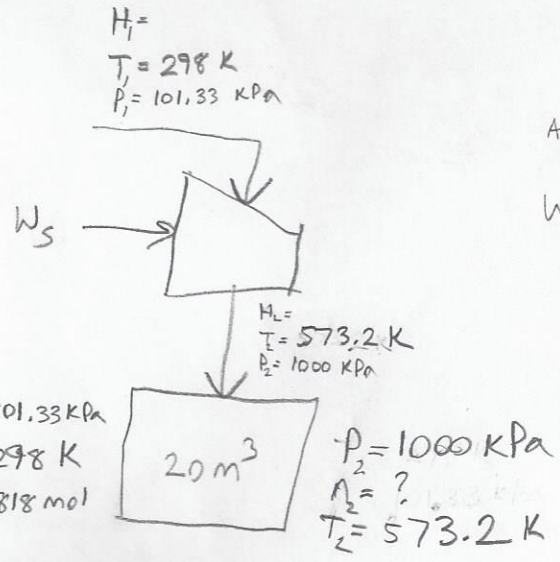
HW 5

(1)



$C_p = 7/2 R$

Adiabatic, ideal gas, isentropic

W_s = ?

$$\dot{W}_s = \dot{n}_{in} \Delta \tilde{H}$$

$$W_s = n_{in} \Delta \tilde{H}$$

$$P_1 V_1 = n_1 R T_1$$

$$(101.33 \times 10^3)(20) = n_1 (8.314)(298)$$

$$n_1 = 818 \text{ mole}$$

$$P_2 V_1 = n_2 R T_2$$

$$P_1 V_1 = n_1 R T_1$$

$$\frac{P_2}{n_2 T_2} = \frac{P_1}{n_1 T_1}$$

$$\frac{T_2}{298} = \left(\frac{1000}{101.33}\right)^{R/7/2R}$$

$$20(1000 \times 10^3) = n_2 (8.314)(573.2)$$

$$n_2 = 4196.8 \text{ mole}$$

$$n_{in} = 4196.8 - 818$$

$$n_{in} = 3378.8 \text{ mole}$$

$$\Delta S = \cancel{R} \int_{T_1}^{T_2} \frac{7/2 R}{\cancel{R}} \frac{dT}{T} - R \ln \frac{P_2}{P_1}$$

$$\cancel{\Delta S} = \frac{7}{2} R \ln \frac{T_2}{298} - R \ln \left(\frac{1000}{101.33}\right)$$

$$\ln \left(\frac{1000}{101.33}\right) = \frac{7}{2} \ln \frac{T_2}{298} \qquad T_2 = 573.2 \text{ K}$$

$$\frac{d(n\tilde{U})}{dt} = \dot{n}_{in} \tilde{H}_{in} + \cancel{Q} + \cancel{W}^{0}$$

$$\int_{n_1 \tilde{U}_1}^{(n_1 + n_{in})\tilde{U}_2} d(n\tilde{U}) = \int_0^t \dot{n}_{in} \tilde{H}_{in} \, dt$$

$$(n_1 + n_{in})\tilde{U}_2 - n_1 \tilde{U}_1 = \dot{n}_{in} \tilde{H}_{in} t$$

$$(n_1 + n_{in})\tilde{U}_2 - n_1 \tilde{U}_1 = n_{in} \tilde{H}_{in}$$

$$W_s = (3378.8 \text{ mole}) \left(8008 \frac{J}{mol \cdot K}\right)$$

$$\Delta \tilde{H} = 7/2 \left(8.314 \frac{J}{mol \cdot K}\right)(573.2 K - 298 K)$$

$$\Delta \tilde{H} = 8008 \frac{J}{mol \cdot K}$$

$$\boxed{W_s = 2.706 \times 10^4 \text{ kJ}}$$