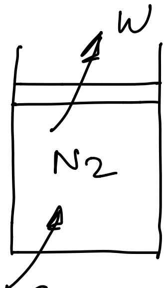
CHE 260 QUIZ 1
2017.

1).



$P_1 = 1500\ kPa$ $\qquad$ $P_2 = 750\ kPa$

$T_1 = 750K.$

Polytropic process $Pv^n = c.$

Assuming ideal gas $Pv = RT$

$$\Rightarrow \frac{P_1 v_1}{T_1} = \frac{P_2 v_2}{T_2}$$

and $P_1 v_1^n = P_2 v_2^n$

Combining

$$T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} = 750\left(\frac{750}{1500}\right)^{\frac{0.2}{1.2}}$$

$$T_2 = 668.2\ K.$$

For a polytropic process

$$W_{12} = \frac{P_2V_2 - P_1V_1}{n-1} = mR\frac{(T_2 - T_1)}{n-1}$$

$$w_{12} = \frac{W_{12}}{m} = R\left(\frac{T_2 - T_1}{n-1}\right) = \frac{0.2968\ (668.2 - 750)}{1.2 - 1}$$

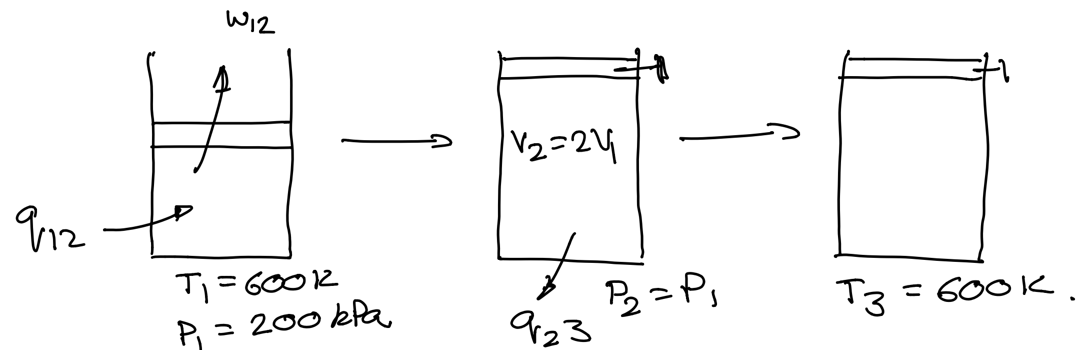
$$w_{12} = -121.4\ kJ/kg.$$

$$q_{12} = (u_2 - u_1) - w_{12} = c_v(T_2 - T_1) - w_{12}$$

$$= 0.7448(668.2 - 750) + 121.4$$

$$q_{12} = 60.5\ kJ/kg$$

2)



for 1→2 $\quad T_2 = T_1 \dfrac{V_2}{V_1} = 600 \times 2 = 1200\,K$

$$W_{12} = -P(V_2 - V_1) = -mR(T_2 - T_1)$$

$$w_{12} = \frac{W_{12}}{m} = R(T_1 - T_2) = 0.287(600-1200)$$

$$w_{12} = -172.2 \text{ kJ/kg}$$

$$q_{12} = h_2 - h_1 = c_p(T_2 - T_1)$$

$$= 1.0035(1200-600) = 602.1 \text{ kJ/kg}.$$

For 2→3 $\quad V_3 = V_2 = 2V_1 \Rightarrow w_{23} = 0$

$$P_3 = P_2 \frac{T_3}{T_2} = P_1 \frac{T_1}{2T_1} = \frac{P_1}{2}$$

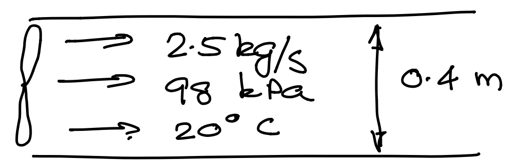
$$P_3 = \frac{200}{2} = 100 \text{ kPa}$$

$$\cancel{w_{23}}^{\,0} + q_{23} = u_3 - u_2 = c_v(T_3 - T_2)$$

$$q_{23} = 0.7165(600-1200)$$

$$= -429.2 \text{ kJ/kg}$$

(3)



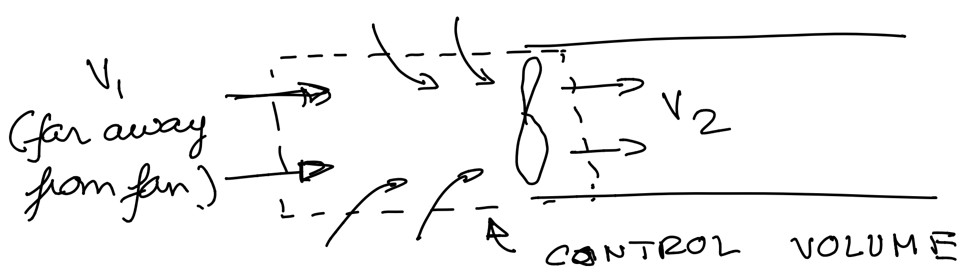
Mass flow rate $\dot{m} = \frac{AV}{v}$ where $v = \frac{RT}{P}$

$$\Rightarrow \dot{m} = AV\frac{P}{RT}$$

$$\Rightarrow \text{Velocity} = V = \frac{\dot{m}RT}{AP} \quad ; \quad A = \frac{\pi D^2}{4}$$

$$\Rightarrow V = \frac{\dot{m}RT}{\frac{\pi D^2}{4}P} = \frac{2.5 \times 0.287 \times 293}{\frac{\pi \times 0.4^2}{4} \times 98}$$

$$V = 17.1 \text{ m/s}$$



Energy Balance

$$\underbrace{\cancel{\dot{Q}}}_{0} + \dot{W} = \dot{m}\left[\underbrace{\cancel{(h_2-h_1)}}_{0\ (\Delta T=0)} + \frac{V_2^2 - \overset{0}{\cancel{V_1^2}}}{2} + \underbrace{\cancel{g(z_2-z_1)}}_{0\ (\Delta z=0)}\right]$$

Assume $V_1 \approx 0$ → velocity far from fan is negligible.

$$\Rightarrow \dot{W} = \frac{\dot{m}V_2^2}{2} = 2.5 \times \frac{17.1^2}{2} = 366 \text{ W}$$