Q2

(a) $E_{in} = E_{out}$ (steady, open-system)

$\cancel{W_{in}} + \cancel{Q_{in}} + \dot{m}(h + \cancel{KE} + \cancel{PE})_{in} = \cancel{W_{out}} + Q_{out} + \dot{m}(h + KE + \cancel{PE})_{in}$

no work, no Q_{in}, no ΔPE.

$\dot{m}(h + KE)_{in} = Q_{out} + \dot{m}(h + KE)_{out}$

$Q_{out} = \dot{m}(h_{in} - h_{out} + KE_{in} - KE_{out})$

$h = Pv$, $v = \frac{V}{m}$, $PV = mRT$

$\Rightarrow h = \frac{PV}{m} = RT$

$Q_{out} = \dot{m}\left(R(T_{in} - T_{out}) + \frac{V_{in}^2 - V_{out}^2}{2000}\right)$

$Q_{out} = 80\left(0.287(15 + 273.15 - 45 - 273.15) + \frac{260^2 - 85^2}{2000}\right)$

$Q_{out} = 80(-8.61 + 30.1875)$

$= 1726\ W$

(b) $\dot{Q}_{conv} = h A_s (T_s - T_\infty)$

$A_s = 0.7\ m^2$

$T_s = 30°C$

$T_a = 15°C$

$T_s - T_\infty = 15\ K$

$1726 = h(0.7)(15)$

$h = 164\ \frac{W}{m^2 \cdot K}$