1.5 $P = F/A$ $F = mg$ $g = 9.807\ m/s^2$

$P = 3000\ bar$ $D = 4\ mm$ $A = \frac{\pi}{4} D^2 = 12.566\ mm^2$

$$m = \frac{F}{g} = \frac{PA}{g} = 384.4\ kg$$

1.10 $\rho_{Hg} = 13.5\ g/cm^3$ $g = 9.807\ m/s^2$

↑ density of mercury

$P = 400\ bar$

$$h = \frac{P}{\rho g} = 302.3\ m$$

1.14 Cost of bulb = $\frac{\$5}{1000\ hr} \times 10 \frac{hr}{day} \times 365 \frac{day}{yr} = \$18.25/yr$

Cost of electricity = $\frac{\$0.1}{kW\ hr} \times 10 \frac{hr}{day} \times \frac{70\ kW}{1000} \times 365 \frac{day}{yr} = \$25.55/yr$

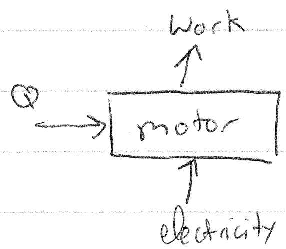
total cost = $43.80/yr

1.18 $m = 1250\ kg$ $u = 40\ m/s$

$E_K = \frac{1}{2} m u^2 = 1000\ kJ$

Work $= E_K = 1000\ kJ$

2.4



$W = Q + \text{electricity}$

$Q = \text{Work} - \text{electricity} = 932 - 1067 = -135$
(watts) (watts) (watts)

$1.25\,hp = 932\text{ Watts} = \text{Work}$

$\text{electricity} = 9.7\,A \times 110\,V = 1067\text{ Watts}$

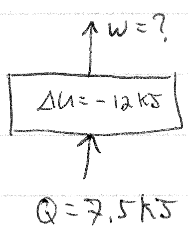
$\therefore$ motor produces 135 Watts of heat

2.7 Phase rule: $F = 2 - \pi + N$

$N = 1 \quad \pi = 4$

If statement is true then $F = -1$ $\therefore$ claim is invalid

2.12



$\Delta U = Q + W$

a) $W = \Delta U - Q = -12 - 7.5 = -19.5\,kJ$

b) $\Delta U = 0 + W = -12\,kJ$

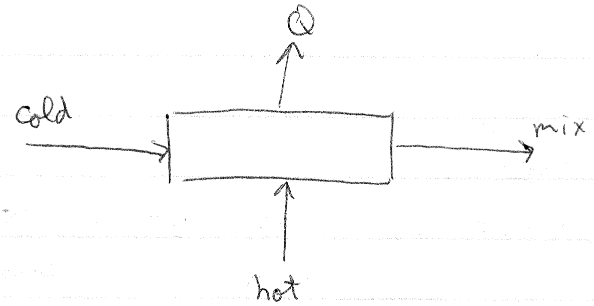
2.17 density of water $\rho = 1000\,kg/m^3$ Note: Question is looking for power, $\frac{J}{s}$

$\Delta z = 50m \quad u = 5m/s$

$\dot{W} = F \times \Delta z = m \times g\,\Delta z = \rho u A g\,\Delta z = 1000 \times 5 \times \pi \left(\frac{2}{2}\right)^2 \times 9.8 \times 50$

$\dot{W} = 7.697 \times 10^3\,kW$

2.23



$$\dot{m}_c H_c + \dot{m}_h H_h - \dot{m}_m H_m - Q = 0$$

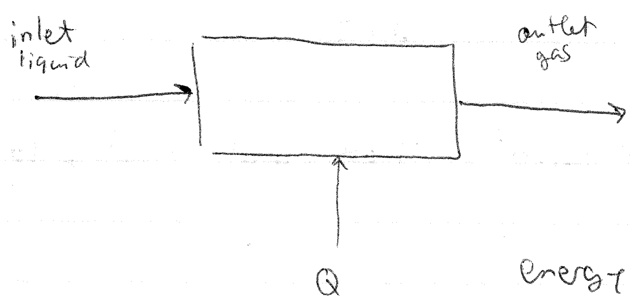
(cold) (hot) (mix) (heat)

$$\dot{m}_c C_p(T_c - T_{ref}) + \dot{m}_h C_p(T_h - T_{ref}) - \dot{m}_m C_p(T_m - T_{ref}) - Q = 0$$

$$1 \times 4.18\,(298 - T_{ref}) + 0.8 \times 4.18\,(348 - T_{ref}) - 1.8 \times 4.18\,(T_m - T_{ref}) - 30 = 0$$

$$\boxed{T_m = 316\text{ K} = 43^\circ\text{C}}$$

2.28



energy in: $H_1 + E_{k1} + Q$

energy out: $H_2 + E_{k2}$

~~$H_{in} - H_{out} + Q = 0$~~

$$H_1 + E_{k1} + Q - H_2 - E_{k2} = 0$$

$$Q = H_2 - H_1 + \Delta(E_k)$$

$$Q = H_2 - H_1 + \frac{u_2^2 - u_1^2}{2}$$

$$\boxed{Q = 2411.6\text{ kJ/kg}}$$

2.36 $T_1 = 300\ K$ $P = 1\ bar$ $V_2 = 3V_1$

molar mass air = 28.9 g/mol

$$n = 34.602\ mol = \frac{1\ kg}{28.9\ \frac{g}{mol}} \times 1000$$

$$V_1 = 83.14 \times \frac{T_1}{P} = 24942\ \frac{cm^3}{mol}$$

$$W = -n\int_{V_1}^{V_2} P\,dV = nP(V_1 - V_2) = nP(-2V_1)$$ [Note: P = const]

$$\boxed{W = -nP2V_1 = -172.61\ KJ}$$

$$\frac{T_2}{T_1} = \frac{V_2}{V_1}$$ (from ideal gas EOS and const P)

$T_2 = T_1 \times 3$

$$\Delta H = C_p(T_2 - T_1) = 17.4\ KJ/mol$$

$$Q = n\Delta H = 602.08\ KJ$$ (const P)

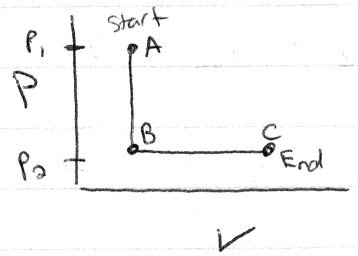
$$\Delta U = \frac{Q+W}{n} = 12.41\ \frac{KJ}{mol}$$

2.37

Possible process

Step AB: isochoric cooling

Step BC: isobaric heating



Step AB:

$T_1 = 293\,K$

$P_1 = 1000\,kPa$

$V_1 = \frac{RT_1}{P_1} = 2436\,\frac{m^3}{mol} = V_2$

$P_2 = 100\,kPa$

$T_2 = \frac{P_2V_2}{R} = \frac{\frac{100}{1000} \times 2436}{8.314} = 29\,K$

$\Delta U_{AB} = C_v(T_2 - T_1) = \frac{5}{2}R(29 - 293) = -5487\,J/mol$

$\Delta H_{AB} = C_p(T_2 - T_1) = \frac{7}{2}R(29 - 293) = -7682\,J/mol$

Step BC:

$T_1 = 29\,K$ $\quad$ $T_2 = 333\,K$

$P_1 = 100\,kPa$ $\quad$ $P_2 = 100\,kPa$

$V_1 = 2436\,\frac{m^3}{mol}$ $\quad$ $V_2 = \frac{RT_2}{P_2} = 27685\,m^3/mol$

$\Delta U_{BC} = C_v(T_2 - T_1) = \frac{5}{2}R(333 - 29) = 6318\,J/mol$

$\Delta H_{BC} = C_p(T_2 - T_1) = \frac{7}{2}R(333 - 29) = 8846\,J/mol$

2.37 (cont)

so $\Delta U_{process} = \Delta U_{AB} + \Delta U_{BC} = -5487 + 6318 = 831 \text{ J/mol}$

$\Delta H_{process} = \Delta H_{AB} + \Delta H_{BC} = -7682 + 8846 = 1163 \text{ J/mol}$

OR the easy way (if we only want to know about ΔU and ΔH for the process):

$\Delta U_{process} = C_v(T_2 - T_1) = \frac{5}{2}R(333 - 293) = 831 \text{ J/mol}$

$\Delta H_{process} = C_p(T_2 - T_1) = \frac{7}{2}R(333 - 293) = 1163 \text{ J/mol}$