1.

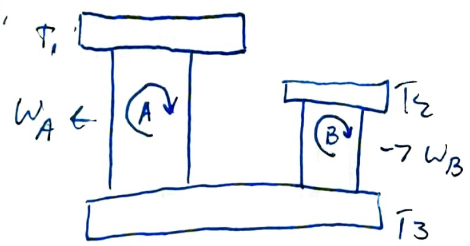
$$COP_{HP} = \frac{1}{.55} = 1.82$$

$$COP_R = COP_{HP} - 1 = .82$$

$$.55 = 1 - \frac{T_C}{T_H}$$

$$T_H = 362.74\,^{\circ}C$$

2.



$T_1 = 1050\,K$

$T_2 = 800\,K$

$T_3 = 330\,K$

$$1 - \frac{T_3}{T_1} = \frac{W_A}{Q}$$

A. $1 - \frac{330}{1050} \times \frac{Q_A}{2} = W_A \Rightarrow W_A = \frac{12}{35} Q_A$

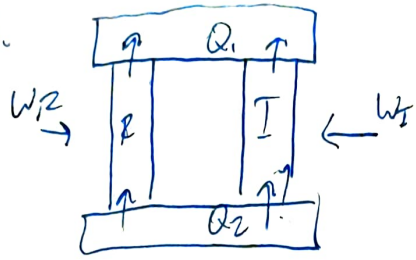
B $1 - \frac{330}{800} \times \frac{Q_H}{2} = W_B \Rightarrow W_B = \frac{47}{160} Q_H$

$$W_T = W_A + W_B = \frac{713}{1120} Q_H$$

$$\eta = \frac{W}{Q} \rightarrow \eta = \frac{713}{1120} = \boxed{.637}$$

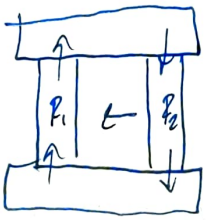
b) $W_T = \frac{713}{1120} \cdot (450\,kJ) = \boxed{286.47\,kJ}$

3.



$W_2 > W_I$

Heat goes from T_2 to T_1, reverse & violate Planck Statement since you cannot get heat from 1 reservoir



$W_2 > W_1$

opposes Planck Statement

so $COP_1 \leq COP_2$

nor

$COP_2 \geq COP_1$

$\Rightarrow COP_1 = COP_2$

4. $V = 60\ m^3$, $M_{mol} = 29$, $k = 1.4$ $P = 2.8$ kW

$T_1 = 12^\circ C \rightarrow 285.15$ K Performance = 3.2

$T_2 = 26^\circ C \rightarrow 299.15$ K $R = 8314/29$

$\frac{C_P}{C_V} = 1.4$ $P = .4\ C_V$

$Q_H = 74.39(1003)(26+2)$
$= 1044.69$

$P_1 V_1 = mRT_1$

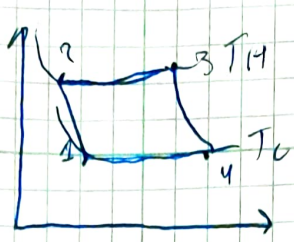
$101325(60) = m(286.6)(285.15)$

$m = 74.39$

$COP = \frac{\dot{Q}_H}{P_{avg}}$ $\dot{Q}_H = 3.2(2.8)$
$= 8.96$

$t = \frac{Q_H}{\dot{Q}_H} = \frac{1044.69}{8.96} = 116.59$

5.



$m = .04$ kg

$m_{mol} = 44$

$\gamma = 1.24$

$T_H = 800°C = 1073.15$ K

$T_C = 273.15$ K

$P_{max} = 9$ MPa $= 9000$ kPa

$V_{max} = .75\ m^3$

$T_H \cdot V_H^{\gamma-1} = T_C V_C^{\gamma-1}$

$1073.15 \cdot V_H^{.24} = 273.15 (.75)^{.24}$

$V_H = .00251\ m^3$

$n = m/M = \frac{.04}{44} = 9.09E-4$

$PV = nRT$

$P = 9.09E-4\,(8314)\,(1073.15)$

$P = 3234.5$ kPa

$Q = PV \cdot \ln(P_{max}/P) = 32.315(.00251)\ln(9000/32.315)$

$Q = .457$

$\eta = 1 - T_C/T_H = .705 = W/Q = \frac{W}{.457} = .341$

$Q_C = Q - W = .457 - .341 = .1169$

6. $h_1 = h_{f2} + x_1(h_{g2} - h_{f2})$

$h_1 = 31.975 + .2337(241.51 - 31.975)$

$h_1 = 80.94$

b) $h_2 = 236.27$

c) $\dot{Q}_L = \text{carnot}(h_2 - h_1)$

$= .37(236.27 - 84.94) = 57.56$

$\dot{Q}_H = .37(263.72 - 84.84) = 66.1$

d) $P = \dot{Q}_H - \dot{Q}_L = 8.6617$ kW