Ch 4 solutions

19] There are two paths here. The first is longer but is based on the 1st Law.

$\Delta U = Q - W \rightarrow Q = \Delta U + W = nC_v\Delta T + p\Delta V$ (since p = constant)

$T_2 = T_1 P_2V_2/P_1V_1 = 273.15 \frac{1.0}{1.0}\frac{3}{1} = 819.45\,k \Rightarrow \Delta T = 546.3\,k$

$V_1 = nRT_1/P_1 = \frac{1 \cdot 8.3145 \cdot 273.15}{1.013\cdot10^5} = 0.02242\,m^3$

$V_2 = 3V_1 = 0.06726 m^3 \Rightarrow \Delta V = 0.04484\,m^3$

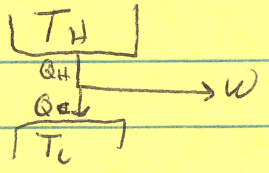
$\Rightarrow Q = 1 \cdot \frac{3}{2}R(546.3) + 1.013\cdot10^5 \cdot 0.04484 = \boxed{1.14\cdot10^4\ J}$

Shortcut: $Q = nC_p\Delta T = 1\cdot\frac{5}{2}R\,546.3 = \boxed{1.14\cdot10^4\ J}$

20] $W = \int p\,dV = nRT_1\int\frac{dV}{V} = nRT_1\ln\frac{V_2}{V_1}$ since T = constant

$= 1\cdot8.3145\cdot\ln 2 = \boxed{1717\ J}$

26]



a) $W = eQ_H = 0.3\cdot500 = \boxed{150\ J}$

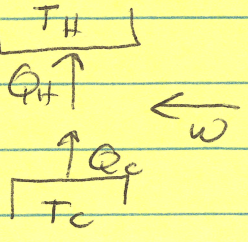
b) $e = 1 - Q_c/Q_H \Rightarrow Q_c = Q_H(1-e) = \boxed{350\ J}$

28] $Q_H/hour = 100{,}000kg \cdot 30\cdot10^6\frac{J}{kg} = 3\cdot10^{12}\ J/hour$

$Work/hour = 500\cdot10^6\,w\cdot3600\,s/hr = 1.8\cdot10^{12}\ J/hour$

$e = \frac{W}{Q_H} = \boxed{0.6}$

31]



a) $Q_H = 80J$ $k_R = 6.0$ $\frac{1}{k_R} = \frac{Q_H - Q_c}{Q_c} = \frac{Q_H}{Q_c} - 1$

$\rightarrow Q_H/Q_c = \frac{1}{k} + 1 \rightarrow Q_c = Q_H/\frac{1}{k}+1 = \boxed{68.6\ J}$

b) $W = Q_c/k_R = \boxed{11.4\ J}$

32) a) $Q_C = k_R W =$ **600 J**

b) $Q_H = Q_C\left(\frac{1}{k}+1\right) =$ **800 J**

33) $k_p = \frac{T_C}{T_H - T_C} = \frac{200.15}{543.15 - 200.15} =$ **0.584**

34) $W = Q_c / k_R$ where $Q_c = 1.0\,J$ and $k_R = \frac{T_c}{T_H - T_c}$

a) **0.07 J** b) **0.50 J** c) **2.0 J** d) **2000 J** assuming $T_c = 0.15\,K$

67) $k_p = \frac{T_H}{T_H - T_C} = \frac{295.15}{22} = 13.416$

$Q_H = W \cdot k_p = 300w \cdot 3600s \cdot 13.416 =$ **$1.45 \cdot 10^7$ J**

81) $e = 1 - T_c/T_H = 0.545$ $\quad Q_H = 10^4\,J$

$e = W/Q_H \Rightarrow W = eQ_H = 5450\,J$ per cycle

$\Rightarrow 5450\,J/5s =$ **1090 Watts**