ch 15 ~~notes~~ ex.

(15.1) $|Q_H| = 2000\,J$ $|Q_c| = 1700\,J$

$\varepsilon = 1 - \frac{|Q_c|}{|Q_H|} = 1 - \frac{1700}{2000} = 85\%$

$\varepsilon = 1 - \frac{1700}{2000} = 15\%$

(15.2) $\varepsilon = 1 - \frac{T_c}{T_H} = 1 - \frac{0+273}{100+273} = 27\%$

(15.3) a) $|Q_{frozen}| = mc\Delta T + mL_{f}$

$= (2.00\,kg)(4186\,J/kg\,k \cdot 20\,k + 3.335\times10^5\,J/kg)$

$= 834\,kJ$

$K = \frac{|Q_c|}{|W|}$ $|W| = \frac{834\,kJ}{4.00}$

$= 209\,kJ$

$W = -209\,kJ$ because you do work on the fridge to make it run

b) $|W| = |Q_H| - |Q_c|$

$|Q_H| = |W| + |Q_c|$

$= 209\,kJ + 834\,kJ$

$= 1.04\,MJ$

(15.4) $K = \frac{1}{\frac{T_H}{T_c} - 1} = \frac{1}{\frac{273+20}{273-20} - 1}$

$= 6.33$

(15.5) $\varepsilon_{max} = \varepsilon_{carnot} = 1 - \frac{T_c}{T_H}$

$= 1 - \frac{273+20}{273+300} = 49\%$

$K_{max} = K_{carnot} = \frac{1}{\frac{T_H}{T_c} - 1} = \frac{1}{\frac{573}{293} - 1} = 1.05$

(15.6) $\Delta S = \frac{mL}{T} = \frac{0.150\,kg \cdot 3.335\times10^5\,J/kg}{273\,k}$

$= 183\,J/k$

(15.7) a) T_0, V_0, T_f, V_f, ideal

$\Delta S = \int_0^f \frac{dQ}{T}$

$dQ = dU + dW$

$dU = nC_v dT$ $dW = PdV$

$dQ = nC_v dT + PdV$

$\Delta S = \int_i^f \frac{nC_v dT}{T} + \int_i^f \frac{PdV}{T}$

$PV = nRT$ $\frac{P}{T} = \frac{nR}{V}$

$\Delta S = nC_v \int_i^f \frac{dT}{T} + nR \int_i^f \frac{dV}{V}$

$= nC_v(\ln T_f - \ln T_0) + nR(\ln V_f - \ln V_0)$

$= nC_v \ln \frac{T_f}{T_0} + nR \ln \frac{V_f}{V_0}$

b) isochoric - constant V

$\hookrightarrow \Delta S = nC_v \ln \frac{T_f}{T_0}$

isothermal - constant T

$\hookrightarrow \Delta S = nR \ln \frac{V_f}{V_0}$

(15.8) $Q = \Delta U + W$

$\Delta S = \int_i^f \frac{Q}{T} = nC_v \ln \frac{T_f}{T_0} + nR \ln \frac{V_f}{V_0}$

$\Delta T = 0$

$\Delta S = nR \ln \frac{V_f}{V_0}$

(5-9) ΔS to T_C: $\Delta S = \frac{|Q|}{T_C}$

ΔS from T_H: $\Delta S = \frac{-|Q|}{T_H}$

$\Delta S_{total} = \frac{|Q|}{T_C} - \frac{|Q|}{T_H}$

(5-10) ΔS for any transfer

$\Delta S = mc \ln \frac{T_f}{T_0}$

$\Delta S_1 = m_1 c_1 \ln \frac{T}{T_H}$

$\Delta S_2 = m_2 c_2 \ln \frac{T}{T_C}$

$\Delta S_{total} = m_1 c_1 \ln \frac{T}{T_H} + m_2 c_2 \ln \frac{T}{T_C}$

(5-11) $\Delta S = m_1 c_1 \ln \frac{T}{T_H} + m_2 c_2 \ln \frac{T}{T_C}$

(5-12) $\Delta S = mc \ln \frac{T_f}{T_0}$

$= (3.00\text{ kg})(4186\text{ J/kgK}) \ln \frac{100+273}{273}$

$= 3919\text{ J/K}$

(5-13) a) $\varepsilon = 1 - \frac{T_C}{T_H} = 1 - \frac{300\text{K}}{500\text{K}} = 40\%$

b) $|W| = \varepsilon |Q_H| = (0.4)(2000\text{ J})$

$= 800\text{ J}$

c) $\Delta S = 0$ $\Delta S_{hot} = \frac{-|Q|}{T_H}$

$= \frac{-2000\text{ J}}{500\text{K}} = -4\text{ J/K}$

$\Delta S_{cold} = \frac{|Q|}{T_C}$

$= \frac{2000\text{J} - 800\text{J}}{300\text{K}} = 4\text{ J/K}$

d) $\Delta S_{eng} = 0$

(5-14) $\Delta S = mc_{ice} \ln \frac{T_f}{T_0} + \frac{mL}{T} + mc_{water} \ln \frac{T_f}{T_0}$

$= (2.00\text{kg})\left[2050\frac{\text{J}}{\text{kgK}} \ln \frac{273}{253} + \frac{3.335\frac{\text{J}}{\text{kg}}}{273\text{K}} + 4186\frac{\text{J}}{\text{kgK}} \ln \frac{298}{273}\right]$

$= 3489\text{ J/K}$

ΔS_{room} = reservoir, takes heat away

$\Delta S = -\frac{|Q|}{T_R}$

$Q = mc_{ice}\Delta T_1 + mL + mc_{water}\Delta T$

$= (2.00\text{kg})(2050\text{ J/kgK} \cdot 20\text{K} + 3.335\times10^5 + 4186 \cdot 25\text{K})$

$= 958\text{ kJ}$

$\Delta S = -\frac{958\text{ kJ}}{298\text{ K}} = -3216\text{ J/K}$

$3489 - 3216 \geq 0$, so it's ok

(5-15) a) # of macrostates is $N+1$

# of microstates is very large

b) $\binom{N}{n} = \frac{N!}{n!(N-n)!}$

$(_N C_n)$