T8B.2: Use the magic of logarithms when calculating ΔS from Eq. T8.8:

$$S(U,V,N) = \frac{3}{2}\, Nk \ln\left(\frac{4m\pi e V^{2/3} U}{3h^2 N}\right) - k\ln(N!) \approx Nk\left[\frac{3}{2}\ln\left(\frac{4m\pi e U}{3h^2 N}\right) + \ln\left(\frac{Ve}{N}\right)\right]$$

So

$$\Delta S/Nk = \frac{3}{2}\ \ln\left((V_f/V_i)^{2/3}(U_f/U_i)\right) = \frac{3}{2}\ \ln\left((V_f/V_i)^{2/3}(T_f/T_i)\right) = \frac{3}{2}\ \ln\left(2/2^{2/3}\right) = \frac{1}{2}\ \ln(2) = 0.3466$$

T8S.5: We assume that the ocean does not change temperature so its $\Delta S_o = Q_o/T_o$ and that aluminum has a constant specific heat $c_{\text{Al}} = 0.9$ J/g· K:

$$Q_{\text{Al}} = mc\Delta T = 1000 \cdot 0.9 \cdot (-75) = -67,500 \text{ J}$$

$$\Delta S_{\text{Al}} = mc\ln(T_f/T_i) = 1000 \cdot 0.9 \ln(278/353) = -215 \text{ J/K}$$

$$\Delta S_o = Q_o/T_o = \frac{+67,500 \text{ J}}{278} = 243 \text{ J/K}$$

T8S.7: Note that U does not change in this process so $Q = W = nRT\ln(V_f/V_i)$ and then

$$\Delta S = nR\ln(V_f/V_i) = .4 \cdot 8.31 \cdot \ln(.015/.005) = 3.65 \text{ J/K}$$

T8S.8: First we find the final temperature…recall $Q = mc\Delta T$ from Ch. 18 of HRW:

$$\begin{aligned}
m_{\text{Cu}}c_{\text{Cu}}(T_f - T_{i\ \text{Cu}}) + m_{\text{w}}c_{\text{w}}(T_f - T_{i\ \text{w}}) &= 0 \\
(m_{\text{Cu}}c_{\text{Cu}} + m_{\text{w}}c_{\text{w}})\, T_f &= m_{\text{Cu}}c_{\text{Cu}}T_{i\ \text{Cu}} + m_{\text{w}}c_{\text{w}}T_{i\ \text{w}} \\
T_f &= \frac{m_{\text{Cu}}c_{\text{Cu}}T_{i\ \text{Cu}} + m_{\text{w}}c_{\text{w}}T_{i\ \text{w}}}{m_{\text{Cu}}c_{\text{Cu}} + m_{\text{w}}c_{\text{w}}} \\
&= \frac{320 \cdot 0.3878 \cdot -35 + 420 \cdot 4.186 \cdot 22}{320 \cdot 0.3878 + 420 \cdot 4.186} = 18.24^\circ\text{C}
\end{aligned}$$

Using a quasistatic replacement process:

$$\Delta S_{\text{Cu}} = mc\ln(T_f/T_i) = 320 \cdot 0.387 \cdot \ln(291.4/238.15) = 25.0 \text{ J/K}$$

$$\Delta S_{\text{w}} = mc\ln(T_f/T_i) = 420 \cdot 4.186 \cdot \ln(291.4/295.15) = -22.5 \text{ J/K}$$