

5.60/BE.110: Thermodynamics and Kinetics (r08)
Recitation Handout for 9/28/2006

Quick summary of today's topics:

Natural variables for state functions, and the fundamental equations:

- $U = U(S, V) : dU = TdS - PdV$
- $H = H(S, P) : dH = TdS + VdP$
- $A = A(T, V) : dA = -SdT - PdV$
- $G = G(T, P) : dG = -SdT - VdP$

General criterion for spontaneity:

- $dU + P_{ext}dV - T_{surr}dS < 0$ for spontaneous processes.

Partial derivatives of entropy:

- $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$
- $\left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P$
- $\left(\frac{\partial S}{\partial T}\right)_V = \frac{1}{T} \left(\frac{\partial U}{\partial T}\right)_V = \frac{C_V}{T}$
- $\left(\frac{\partial S}{\partial T}\right)_P = \frac{1}{T} \left(\frac{\partial H}{\partial T}\right)_P = \frac{C_P}{T}$

Main Course:

Suppose that your friend walks up to you one day with a box 2 ft long and 6 in. on a side and says, "Look here, I've got a box of tricks! See this pipe sticking out the top and the pipes sticking out either end? If you hook a compressed air line to the center pipe, cold air will come out the left and hot air will come out the right end. How about that?"

Can it work, or can't it work? Without having knowledge of the Second Law, one could only guess, and you would most likely base your guess on your previous dealings with this friend. However, the Second Law allows us to determine *with a calculation* whether this device is possible or not. Given the information below, determine whether the friend is a phony or a genius.

- The box is thoroughly insulated;
- The box is also completely rigid.