PHY 3513 Fall 2000 – Homework 3

Due at the start of class on Friday, September 22.

Answer all questions. To obtain full credit, you must explain your reasoning and show all working. Please write neatly and include your name on the front page of your answers.

1. Callen Problem 1.8–7.

In every thermodynamic equation, the left- and right-hand sides must have the same dependence on system size: if the LHS is extensive (or intensive), then the RHS must also be extensive (or intensive).

2. Callen Problem 1.10–1.

Addition: In some cases, the RHS of the fundamental equation is not extensive. In each such case, fix up the entropy by inserting extra N's where necessary. Then carry on and check whether the modified fundamental equation is physically acceptable.

Hint: Depending on your comfort level with reduced molar variables, you may find it easiest to work with the dimensionless quantities $\tilde{s} = S/(NR)$, $\tilde{u} = U/(NR\theta)$, and $\tilde{v} = V/(Nv_0)$, i.e., to examine the properties of $\tilde{s}(\tilde{u}, \tilde{v})$ rather than of S(U, V, N).

3. Callen Problem 1.10–3.

Clarifications: (a) This problem considers a closed composite system formed from two subsystems A and B, which obey the fundamental relations

$$S_A = \left(\frac{R^2}{v_0\theta}\right)^{1/3} (N_A U_A V_A)^{1/3}, \text{ and } S_B = \left(\frac{R^2}{v_0\theta}\right)^{1/3} (N_B U_B V_B)^{1/3},$$

respectively. Here S_A is the same as $S^{(A)}$, etc. Assume that $U_A \ge 0$ and $U_B \ge 0$. (b) You should plot the total entropy of the composite system, $S = S_A + S_B$, as a function of $U_A/(U_A + U_B)$.