

PH421 - Thermal and Statistical Physics

Assignment 9 - Mar 5, 2008

1. Some equations of thermodynamics

(a) Starting with the fundamental relation

$$dE = TdS - pdV, \quad (1)$$

derive the relationship

$$T \left. \frac{\partial P}{\partial T} \right|_V - P = \left. \frac{\partial E}{\partial V} \right|_T \quad (2)$$

(b) Show that the relationship

$$C_P - C_V = -T \frac{\left(\left. \frac{\partial V}{\partial T} \right|_P \right)^2}{\left. \frac{\partial V}{\partial P} \right|_T}, \quad (3)$$

which is valid for any fluid, and in which C_P and C_V are respectively the heat capacities at constant pressure and at constant volume, reduces to the familiar $C_P - C_V = \nu R$ for an ideal gas.

(2) A simple model for the heat capacity of graphite

Assume that a specimen of graphite is composed of many layers. Each carbon atom can perform oscillations in 3 dimensions, two of which along the plane of the layer, and one perpendicular. At STP, the structure of graphite is such that the oscillations of each C atom in the plane of the layer has $\hbar\omega_{\parallel} \gg kT$. In the direction perpendicular to the plane of the layer, the oscillations have $\hbar\omega_{\perp} \ll kT$. Calculate the molar specific heat C_V of graphite at STP.