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Physics 404 **HOMEWORK ASSIGNMENT #11** **Spring 2008**

Due date: Thursday, May 8 **Deadline: Thursday, May 15, 9:00a.m.**

Amended May 8 and May 12

B means a problem in Blundell & Blundell's text; GT means a problem in Gould & Tobochnik.

1. B26.6 The first part is essentially the same as 26.5. Hint: For the last line, use eq. (11.26) and the reciprocity theorem. The full result is

$$C_p - C_V = \frac{R}{1 - \frac{2a(V-b)^2}{RTV^3}}$$

To get the result in the problem, you must assume V $\gg$ b and VTR $\gg$ a. What is the physical meaning of each of these assumptions? Is each reasonable?

2. B28.3 Hints: a) Use the Clausius-Clapeyron equation; b) find the [conductive] heat flow from κ ($\Delta T/\Delta z$); c) "eventually" implies steady state, so that the heat flow through a fractional thickness x meters of ice is the same as through (1-x) meters of water.

3&4. B29.2 and B29.6 (B29.2 is too short and easy to count as a full problem, while B29.6 is longer than a usual problem.) Note that in eqs. (29.31) and (29.32), n_j should be $n_j!$, so that the denominators in both cases are $n_j!\,(g_j-n_j)!$. Furthermore, in eq. (29.35), there is this same error along with another in the term with parentheses: the denominator should be $n_j!\,(g_j-1)!$ In going from eq. (29.35) to (29.36), you should assume that $g_j \gg 1$ so that you can replace g_j-1 by g_j.

The expression you should maximize is

$$\frac{S}{k_B} + \alpha\left(N - \sum_j g_j \bar{n}_j\right) + \beta\left(E - \sum_j g_j \bar{n}_j E_j\right)$$

This is, I believe the source of using β for $1/k_BT$.

5. Consider a Fermi gas in 2 rather than 3 dimensions.

a) Find the Fermi energy in terms of N and A. *Added note:* **It is easier to do parts a) & c) together, then part b)!!**

b) Show that the average energy of the fermions is $\epsilon_F/2$.

c) Show that the density of states is independent of ϵ and write it in terms of ϵ_F and N.

d) One can show (but you do not have to) that $\mu(T) = k_BT \ln(e^{\epsilon_F/k_BT} - 1)$.

Find the limits of $\mu(T)$ as i) T goes to 0 and ii) when $k_BT \gg \epsilon_F$ and iii) show that they make sense.

e) One can also show (but you do not have to) that for low temperature $U/N - \epsilon_F/2 = (\pi^2/6)(k_BT)^2/\epsilon_F$.

Find the associated specific heat and compare to the result in 3D.

6. B30.5