Due May. 31, Thursday

Problem 1 (20 point) For a single simple harmonic oscillator, show that the integral of the difference between the classical value of the heat capacity and the quantum heat capacity is precisely the zero point energy. That is, show that

$$\int_0^\infty dT \left[C(T \to \infty) - C(T)\right] \;=\; \frac{1}{2}\hbar\omega \tag{1}$$

where $C(T)$ is the heat capacity.

Problem 2 (20 point) A cylinder is separated into two compartments by a freely sliding piston. Two ideal Fermi gases are placed into the two compartments, numbered 1 and 2. The particles in compartment 1 has spin 1/2 and those in compartment 2 has spin 3/2, while all particles have the same mass. Find the equilibrium density ratios of the two gases at $T = 0$ and $T \to \infty$.

Problem 3 (20 point) Kardar 7.9

Problem 4 (20 point) Kardar 7.11

Problem 5 (20 point) Kardar 7.12

Problem 6 (20 point) Kardar 7.1