

## Homework 2, PHY 7500, Fall 2008 (due on September 16)

1. (1.7). Study the statistical mechanics of an extreme relativistic gas ( $E \gg mc^2$ ) characterized by the single-particles energy states

$$\varepsilon(n_x, n_y, n_z) = \frac{hc}{2L}(n_x^2 + n_y^2 + n_z^2)^{1/2}. \quad (1)$$

Calculate heat capacity.

2. (2.4). By “evaluating” the volume of the relevant region of its phase space, show that the number of microstates available to a rigid rotator with angular momentum  $\leq M$  is  $(M/\hbar)^2$ . Hence determine the number of microstates that may be associated with the quantized angular momentum  $M_J = \hbar\sqrt{j(j+1)}$ , where  $j = 0, 1/2, 2, 3/2, \dots$ . Interpret the result physically.

3. (2.8). Following the method of Appendix C, replacing eqn. (C.4) by the integral

$$\int_0^\infty e^{-r} r^2 dr = 2 \quad (2)$$

show that

$$V_{3N} = \int \dots \int_{0 \leq \sum_{i=1}^N r_i \leq R} \prod_{i=1}^N (4\pi r_i^2 dr_i) = (8\pi R^3)^N / (3N)!. \quad (3)$$