

## HW7, PHYS 3113

P1 (6.20)

- (b) Evaluate the partition function for a single harmonic oscillator. Use the formula

$$\frac{1}{1-x} = 1 + x + x^2 + x^3 + \dots$$

to simplify your answer as much as possible.

- (c) Use the formula

$$\bar{E} = -\frac{1}{Z} \frac{\partial Z}{\partial \beta}$$

to find an expression for the average energy of a single oscillator at temperature  $T$ . Simplify your answer as much as possible.

- (d) What is the total energy of the system of  $N$  oscillators at temperature  $T$ ?

P2 (6.42)

- (a) Find an expression for the Helmholtz free energy of a system of  $N$  harmonic oscillators.  
(b) Find the expression for the entropy of this system as a function of temperature.

P3 (6.44) Consider a large system of  $N$  indistinguishable noninteracting molecules. Find an expression for the Helmholtz free energy of this system in terms of  $Z_1$ , the partition function for a single molecule. (Use Stirling's approximation to eliminate the  $N!$ ). Then use your result to find the chemical potential, again in terms of  $Z_1$ .