

Midterm test Thermo dynamics (Tuesday Nov. 1)

You may use your book, but please try to do the algebra by hand.

A system has the entropy given by by the following expression

$$S(U, V, N) = N k_B \left(\ln \left[\frac{V - Nb}{N} \left(\frac{4\pi m}{3h^2} \frac{U + \frac{N^2 a}{V}}{N} \right)^{3/2} \right] + \frac{5}{2} \right)$$

Problems :

- 1) Show that the relation between energy and temperature is given as

$$U = \frac{3}{2} N k_B T - \frac{N^2 a}{V}$$

- 2) Show that the equation of state is

$$P = \frac{N k_B T}{V - Nb} - \frac{N^2 a}{V^2}$$

Hint: you need to substitute the result from 1 into the equation after differentiating.

- 3) Show how the expression for the entropy can be found from the expression below for the multiplicity.

$$\Omega(U, V, N) = \frac{1}{N!} \frac{(V - Nb)^N}{(3N/2)!} \left(\frac{2\pi m}{h^2} \left(U + \frac{N^2 a}{V} \right) \right)^{(3N/2)}$$