

Phys 430 - 3rd HOMEWORK

1. Describe the following concepts using your own words. (Do not write equations or copy the explanation in some book):

Le Chaterlier's Principle

Nernst's theorem

Microcanonical Distribution

Positiveness of C_P and negativeness of $\left(\frac{\partial P}{\partial V}\right)_X$, $X = S, T$

2. Consider the question in the second homework which we could not solve using microcanonical ensemble: Consider an ideal gas enclosed in a volume V and consisting of N point particles whose energy momentum relation is given by $\varepsilon = cp$ where c is some constant and p is the magnitude of the momentum of the particles. For this gas, calculate:

Calculate the velocity distribution for a single particle.

Calculate the average energy for a single particle

Calculate C_V for N particles

Calculate the thermodynamic potentials F , E , W , Φ and Ω for the system

What is the chemical potential for this system?

3. Consider two objects with heat capacities C_1 and C_2 at temperatures T_1 and $T_2 < T_1$ respectively.

If the two object are brought into direct contact, heat will flow from the hotter to the colder object until equilibrium is established. (This will not be a reversible process) What will be the temperature in equilibrium?

If the two systems are brought to equilibrium using a reversible process. What is the maximum work that can be extracted from the system?

In the last case, what will be the equilibrium temperature?

4. Consider a gas enclosed in a cylinder of radius R . What would be the density profile of this gas if the cylinder is rotated at a constant angular frequency Ω around its axis of symmetry? (Hint: in the reference frame

in which the cylinder is at rest, the effects of rotation can be mimicked by an external potential of the form: $U(r) = -\frac{1}{2}m\Omega^2 r^2$ where r is the distance from the central axis)