In the name of God

## Department of Physics Shahid Beheshti University

## ADVANCED STATISTICAL MECHANICS I

## Exercise Set 1

## (Date Due: 1395/07/15)

- **1.** Differential variables: according to definition for volume expansion coefficient  $\beta \equiv \frac{1}{V} \left(\frac{\partial V}{\partial T}\right)_P$  and isothermal contraction coefficients,  $\kappa \equiv -\frac{1}{V} \left(\frac{\partial V}{\partial P}\right)_T$ ,
  - **A** : Compute  $\beta$  and  $\kappa$  for the case P(V b) = nRT
  - **B** : Compute  $\beta$  and  $\kappa$  for the case PV = nRT(1 + b/V)
- 2. Zero law of thermodynamics: suppose that A, B and C are in thermal equilibrium. For A and C, we have:

$$P_A V_A - n_A r_A P_A - P_C V_C = 0$$

and for B and C, we have:

$$P_B V_B - P_C V_C + \frac{n_B r_B P_C V_C}{V_B} = 0$$

Find 3 state equations of this system which are in thermal equilibrium.

- **3.** Prove that Carnot engine has maximum efficiency.
- 4. A refrigerator with power equates to 100W and a heater with 100W are in a room. Which system makes more heat in the room. Explain your answer.
- 5. Compute the chemical potential of ideal gas.
- 6. Compute the Helmholtz free energy of ideal gas.
- 7. In a box isolated from environment its volume is V. We divided it into two parts with xV and (1-x)V. Pressures and temperatures in both partition are equal. There are xn and (1-x)n in left and right parts, respectively. Now we remove the partition, how many changes will be occurred in Entropy?

Good luck, Movahed