

In the name of God

# Department of Physics Shahid Beheshti University

## CRITICAL PHENOMENA

### Exercise Set 1: Review on necessary parts

(Due Date: 1401/07/24)

1. Thermodynamical potentials: enumerate different types of thermodynamical potentials. Deduce why we need to more than one potential in thermodynamical systems while for a gravitational system we can examine it with only one gravitational potential.
2. Different regimes in Physics; Determine the specific measure accordingly one can distinguish between each following regimes:  
A: Classical and Quantum regimes  
B: Relativistic and Non-relativistics regimes  
C: Interactive and Non-interactive regimes  
D: Collisional and Non-collisional regimes

3. 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 three state equations of this system representing the thermal equilibrium.

4. According to the Vander Walss equation

$$(P + (N/V)^2 a)(V - Nb) = NKT$$

Compute the internal energy and entropy in terms of temperature and volume.

5. Suppose that after 100 second after Big-Bang the equation of state is written by  $U = 3PV$ . In addition, the internal energy for photon gas is  $U = \sigma VT^4$ . Compute Entropy. Suppose that, our universe to be expanded adiabatically by factor  $a(t)$ . Determine the relation between temperature and scale factor.
6. In a box isolated from environment with volume  $V$ . We divide it into two parts with  $xV$  and  $(1-x)V$  parts. Pressures and temperatures in both partition are equal. There are  $xn$  and  $(1-x)n$  moles in the left and right parts, respectively. Now we remove the partition, how many changes will be occurred in Entropy?
7. Derive the most probable speed of an ideal classical Gas in D-dimension.
8. A tire of a typical car was getting punctured due to a pin.  
A: Calculate the flux of exhaust air.  
B How much time does it take for the tire to achieve out of service?

Good luck, Movahed

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