



# Sanjay Ghodawat University, Kolhapur

2017-18

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FY M. Sc.

School of Science

Semester II

PHS 506

Statistical Mechanics

Max Marks: 100

26th May 2018

End Semester Examination (ESE)

Time: 3 Hrs.

10:30 AM to 1:30 PM

- Instructions:**
- 1) All questions are compulsory.
  - 2) Figures to the right indicate full marks.
  - 3) Neat diagrams must be drawn wherever necessary.
  - 4) Use of logarithmic table and non-programmable calculator is allowed.

## Q.1.A Select the correct alternative.

Marks (8) CO

1. The first Law of thermodynamics is conservation of 1 506.1
  - a) Momentum
  - b) Energy
  - c) Both (a) and (b)
  - d) None of these
2. Which of the following is not Maxwell's thermodynamic relation 1 506.1
  - a)  $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$
  - b)  $\left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P$
  - c)  $\left(\frac{\partial T}{\partial V}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$
  - d)  $\left(\frac{\partial P}{\partial V}\right)_T = \left(\frac{\partial S}{\partial T}\right)_V$
3. In a grand canonical ensemble, a system A of fixed volume is in contact with large reservoir B then 1 506.2
  - a) A can exchange only energy with B
  - b) A can exchange only particles with B
  - c) A can exchange neither energy nor particles with B
  - d) A can exchange both energy and particles with B
4. Which of the following relations between free energy F and the canonical partition function Z, is true? 1 506.2
  - a)  $F = -\frac{\partial}{\partial T} \log Z$
  - b)  $F = kT^2 \frac{\partial}{\partial T} \log Z$
  - c)  $F = -kT \log Z$
  - d)  $F = kT \frac{\partial}{\partial V} \log Z$
5. The entropy of an ideal gas at absolute zero is 1 506.3
  - a) 0
  - b)  $Nk_B$
  - c) can not be calculated
  - d)  $\infty$
6. The Fermi energy of free electron gas at absolute zero is of the order of 1 506.3
  - a) electron volts
  - b) MeV
  - c) keV
  - d) ergs

7. A first order phase transition is characterized by 1 506.4
- a) A divergence of the specific heat at  $T_C$ , b) A cusp in the average energy  $T_C$   
the critical temperature
- c) A constancy of entropy in the transition d) A latent heat involved in the transition process
8. The temperature at which gas liquefies is called as ..... 1 506.4
- a) critical temperature b) boiling temperature  
c) melting temperature d) fusing temperature

**Q.1.B Fill in the Blank**

**Marks (6) CO**

1. The Gibbs function  $G$  in thermodynamics is defined as  $G=H-TS$  (symbols have their usual meaning). In an isothermal, isobaric reversible process  $G$ ..... 1 506.1
2. The number of co-ordinate in the phase space of a single particle is..... 1 506.1
3. Linear harmonic oscillator is the example of ..... ensemble. 1 506.2
4. The relative mean square fluctuations in energy is given by the formula..... 1 506.2
5. For Fermi-Dirac statistics, the symmetry of wave function is..... 1 506.3
6. The phase transition nature of first order phase transition is..... 1 506.4

**Q.1.C State whether True or False**

**Marks (6) CO**

1. If a system A is in thermal equilibrium separately with B and C, then B and C are also in thermal equilibrium with each other, this is the statement of First law of thermodynamics. 1 506.1
2. In microcanonical ensemble the total number of particles  $N$  and the energy  $E$  are constants while in a canonical ensemble  $N$  and temperature  $T$  are constant. 1 506.2
3. Electron follows the Bose-Einstein statistics. 1 506.3
4. According to Stefan's law, total energy radiated per unit area per unit time is proportional to  $T^{1/4}$  1 506.3
5. Heat is exchanged in first order phase transition. 1 506.4
6. Saturation curve terminates at triple point of water. 1 506.4

**Q.2 Answer the following questions.**

**Marks (20) CO**

- a) Explain Liouville's theorem in classical presentation. 12 506.1
- b) Define thermodynamic potentials. Derive their relationship with state variables. 8 506.1

**OR**

- |       |   |   |       |
|-------|---|---|-------|
| b) i) | Differentiate between macroscopic and microscopic states. | 4 | 506.1 |
| ii)   | Write a note on phase space and $\gamma$ -space           | 4 | 506.1 |

**Q.3 Answer the following questions.**

**Marks (20) CO**

- |    |  |    |       |
|----|--|----|-------|
| a) | What do you understand by the canonical partition function? Derive the expression for canonical partition function for ideal gas. Hence obtain its thermodynamic properties. | 12 | 506.2 |
| b) | Write a note on Gibb's paradox   | 8  | 506.2 |

**OR**

- |       |                                       |   |       |
|-------|---------------------------------------|---|-------|
| b) i) | Write a note on statistical ensemble. | 4 | 506.2 |
|       | Write a short note on fluctuation.    | 4 | 506.2 |

**Q.4 Answer the following questions.**

**Marks (20) CO**

- |    |  |    |       |
|----|--|----|-------|
| a) | Derive the expression for equation of state for ideal gas in quantum statistics. | 12 | 506.3 |
| b) | Explain the free electron theory.  | 8  | 506.3 |

**OR**

- |       |  |   |       |
|-------|--|---|-------|
| b) i) | Write a note on Einstein's explanation of Planck's law | 4 | 506.3 |
| ii)   | Differentiate between Bosons and Fermions              | 4 | 506.3 |

**Q.5 Answer the following questions.**

**Marks (20) CO**

- |    |   |    |       |
|----|---|----|-------|
| a) | Derive the Clausius Clayperon latent heat equation. What do mean by critical indices? | 12 | 506.4 |
| b) | Write a note on conditions of phase equilibrium                                       | 8  | 506.4 |

**OR**

- |       |  |   |       |
|-------|--|---|-------|
| b) i) | Explain the concept of second order phase transition | 4 | 506.4 |
| ii)   | Explain P-T diagram of one component system          | 4 | 506.4 |