Reg. No .... Name **8P244**

M Sc DEGREE END SEMESTER EXAMINATION - APRIL 2018

SEMESTER 2 : PHYSICS

COURSE : **16P2PHYT08 ; THERMODYNAMICS AND STATISTICAL MECHANICS**

(For Regular - 2017 admission)

Time : Three Hours Max. Marks: 75

Section A
Answer any 5 (1 marks each)

1. If system expands at constant pressure then its called:
   (a) Isothermal (b) Isobaric (c) adiabatic (d) none of these
2. At low temperatures for a diatomic molecule having only vibrational motion will have heat capacity
   (a) k_B (b) exponentially decreasing (c) linearly decreasing (d) Constant
3. What is the microscopic definition of the temperature parameter β?
   (a) $\beta(E) = \partial \ln \Omega / \partial E$ (b) $\beta(E) = k \partial \ln \Omega / \partial E$
   (c) $\beta(E) = k \partial \Omega / \partial E$ (d) none of these
4. Is the entropy of a system exactly equal to zero in the ground state?
   (a) Yes, it is. In fact this is the content of the third law of thermodynamics.
   (b) This is a meaningless question because the ground state of a system can never be reached since it is not possible to reach absolute zero experimentally.
   (c) No, it isn't. It is equal to k ln f_0 , where f_0 is the degeneracy of the ground state.
   d) Depends on the path.
5. The Clapeyron equation is used to:
   (a) Determine the maxwells relations
   (b) Determine the enthalpy change associated in phase transistions
   (c) Compute Cp and Cv dependence in phase transistions.
   (d) Compute the thermal expansion coefficient.

(1 x 5 = 5)

Section B
Answer any 7 (2 marks each)

6. What do you understand by the statement “systems are in mechanical equilibrium”.
7. Show that for a single mole of an ideal gas $C_P = C_V + R$.
8. Differentiate between microstate and macrostates. Give examples.
9. Write down the expression for density of states D(k)dk for a single particle in 1 dimension
10. Obtain the partition function for a diatomic having rotational motion alone.
11. Obtain average Energy in terms of free energy.
12. Obtain the expression for free energy at high temperatures for a diatomic molecule having rotational motion alone
13. Obtain the grand partition function of a Fermi and bose system for a particular ‘k’.
14. Discuss the Fermi Dirac distribution function n(k) for low temperatures graphically ?
15. Write down the expression for number of Bose condensed particles.

(2 x 7 = 14)

Section C
Answer any 4 (5 marks each)

16. Two identical blocks of copper one at 100^0Cand other at 0^0C are placed in thermal contact and thermally isolated from everything else. Given that the heat capacity at constant volume of each block is C, independent of temperature obtain an expression for the increase in entropy of the universe when the 2 blocks of copper are in thermal equilibrium
17. How many ways can one choose five objects out of 12 if either the order of the choice is important, or the order of the choice is not important only the objects chosen?
18. The average kinetic energy ($=3k_B T/2$) of hydrogen atoms in a stellar gas is 1eV. What is the ratio of the number of atoms in the second excited state (n=3) to the number in the ground state (n=1)? The energy levels of the hydrogen atoms are $e_n = -a/n^2$ where a=-13.6 eV, and the degeneracy of the nth level is $2n^2$.
19. Calculate the partition function in 3 dimensions for a particle whose energies varies as $e(k) = ak^3$
20. Obtain the expression of entropy as a function of $n(k)$ and discuss when $S \rightarrow 0$.
21. Show that the entropy S(k) for a fermi particle vanishes when the fermi distribution function n(k) goes to zero or 1.

(5 x 4 = 20)

Section D
Answer any 3 (12 marks each)

22. Derive the eos for vacancies in a crystal.

OR

23. Discuss Carnot engine working in detail.

24. Obtain the general expression for entropy for a diatomic molecule possessing vibrational motion alone.

OR

25. State and prove equipartition theorem.

26. Discuss methods of calculating the chemical potentials.

OR

27. Derive the probability distribution for a grand canonical ensemble.

(12 x 3 = 36)