

**Second Year Examination of the
Three Year Degree Course, 2001**

(Faculty of science)

PHYSICS

Paper-I

(Thermodynamics and Statistical Physics)

Time: 3 Hours

[Maximum Marks :50]

Attempt any **five** questions,
selecting at least **one** question from each unit,
All questions carry equal marks.

UNIT-I

1. (a) Explain the principle of cooling a system by adiabatic demagnetization. 4

(b) Explain the terms 'mean free path', and 'collision cross section' for particles in a gas. 2+2

(c) Two particles in a gas move with the same speed making an angle θ with each other. Calculate the speed of one of the particle relative to the other? 2

2. (a) Find an expression for the work done by an ideal gas in its adiabatic expansion. 4

(b) How are the root-mean-square, average and most probable speeds of particles in a gas defined? Find out the rms speed of atoms in argon gas at 300K. Atomic weight of argon is 40. 3+3

UNIT-II

3. What is Joule-Thomson coefficient? Derive a general expression for it and, hence, find the Joule-Thomson coefficient for a Van der Waals gas. 2+4+4
4. (a) Derive Maxwell's second thermodynamic relation. 5
- (b) Express the difference in two heat capacities of a system in terms of its other measurable macroscopic parameters. 5

UNIT-III

5. (a) A black-body of volume V is at temperature T . Find out the number of vibrations of the radiation between wavelengths λ and $\lambda+d\lambda$. 6
- (b) A furnace is at temperature T . The maximum of the radiation intensity emitted by it occurs at wavelength λ_m . Temperature of the furnace is raised to $2T$. At what wavelength will now the maximum occur, and by what factor will the maximum height increase or decrease? 2+2
6. (a) Find average energy of a Plank oscillator. 6
- (b) The operating temperature of a tungsten filament in an incandescent lamp is 2460 K, and its absorptance (or absorptivity) is 0.35. Find the surface area of the filament of a 100-W lamp. 4

UNIT-IV

7. (a) A system consists of four spin-half particles fixed in space. Tabulate all the possible microstates of the system. 5
- (b) A system consisting of N spin-half particles fixed in space is kept in magnetic field B . The probability of a particle with its spin being found parallel to B is p . Find out the probability of macrostate in which the number of spins parallel to B is n . 5

8. Write down the Bose-Einstein distribution function, and derive an expression or the spectral distribution of energy density of black-body radiation. 2+8

UNIT-V

9. What do you understand by 'Platinum temperature'? Is it identical with ideal gas temperature? If not, explain how Platinum resistance thermometer is used to measure temperatures, and in what range. 2+2+6

10.(a) Describe a method for measuring critical constants of a gas 6.

(b) How is the Solar Constant determined? 4

Constants

Avogadro Number (N_A) = 6.02×10^{23} /mole

Stefan Boltzmann constant (σ) 5.67×10^{-8} W/m²-K⁴

Boltzmann constant (k) = 1.38×10^{-23} J/K