ST JOSEPH'S UNIVERSITY, BENGALURU -27
M.Sc. PHYSICS – II SEMESTER
SEMESTER EXAMINATION: APRIL 2023
(Examination conducted in May 2023)
PH 8221 – EXPERIMENTAL PHYSICS II
(For current batch students only)

Time: 2 Hours **Max Marks: 50**

This paper contains 2 printed pages and no parts
Answer any Five Questions and Each question carries 10 Marks.
[5 X 10 = 50]

1. a) Draw a neat diagram of an oil sealed rotary vacuum pump. Explain the principle, and working. Explain the function of oil.

   b) Calculate for 1 mol of ideal gas (a) the average translational energy (E) per molecule in random motion at T= -196°C (temperature of boiling liquid nitrogen) as well as at T = 23°C and (b) the total translational energy (E) of molecules in random motion at the temperature specified at (a). (7+3)

2. a) Explain the principle and working of a Hot Cathode Ionization Gauge? Give a neat diagram. Mention the pressure ranges in which these gauges are used.

   b) Calculate the total translational energy (E) of molecules in random motion in a mole of ideal gas at T = 23°C in joules, calories, and electron volts. (7+3)

3. a) What is meant by sputtering? Describe the different sputtering techniques useful for thin film preparation.

   b) Discuss the glow discharge phenomena, with particular reference to its use in thin film preparation (5+5)

4. a) Write the difference between evaporation and sputtering techniques for thin film preparation

   b) The throughput of a rotary-vane vacuum pump in the viscous range for nitrogen is 380 mbar m^3 h^{-1} at T=15°C. The throughput of a diffusion pump in the molecular range for nitrogen is 10^{-3} mbar liters s^{-1} at T=15°C. Calculate the throughput of these pumps for hydrogen at T=15°C (Given η_{N_2}=170.8 μpoise, η_{H_2}=91.0 μpoise, $M_{H_2}=2\,X\,10^{-3}\ Kg\,mol^{-1}$ $M_{N_2}=28\,X\,10^{-3} Kg\,mol^{-1}$). (6+4)

5. a) How does an Atomic Force Microscope (AFM) work? What is the difference between contact and non-contact mode?

   b) Briefly explain the working principle of Scanning Tunneling Microscope. (7+3)

6. a) Write down the thermodynamic relation pertaining to adiabatic demagnetization of a paramagnetic salt. Show how a cooling will result ?

   b) In one experiment by Cornell and Wieman, a Bose-Einstein condensate contained 2000 ^{87}Rb atoms within a volume of about $10^{-15} m^3$. Estimate the temperature at which Bose- Einstein condensation should have occurred. (given m= 85.4678 u). (6+4)

7. a) 1g of a paramagnetic substance, obeying Curie's law is placed in a magnetic field of 10,000 oersteds and a temperature of 3K. Calculate the cooling produced when the field is reduced reversibly and adiabatically to zero. The Curie constant per gram is 0.05 CGS units and the specific heat at constant field is 0.01 cal. $g^{-1} K^{-1}$.

   b) State and explain the condition for Bose-Einstein condensation mathematically

   c) Draw the phase diagram of liquid Helium at low temperatures. Explain its super fluid nature.

   (3+4+3)