Register Number:

DATE:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27

M.Sc. PHYSICS – IV SEMESTER

SEMESTER EXAMINATION – APRIL 2017

PH 0115 : EXPERIMENTAL PHYSICS

Time: 2.5 hours **Maximum Marks:70**

This paper contains no parts and 2 printed pages.

Answer any **7** questions. Each question carries **10** marks. **(7X10=70)**

First question is compulsory.

1. a) A paramagnetic salt is cooled from 2.25 K to 2 K by adiabatic demagnetisation. Calculate the strength of magnetic field used if specific heat at constant field C_B = 0.42 J/g/K and Curie constant is 0.042 erg-K/g/(Oersted)^2.
   b) If the volumetric flow rate of gas is 2000 l/s at a pressure of 10^{-3} Torr, calculate the throughput of gas.
   c) Find the Reynolds number if a gas of viscosity 0.9Ns/m^2 and relative density of 1400 kg/m^3 flows through an 80mm pipe with a velocity of 5m/s? If the mean free path of gas is 5.1 x 10^{-3} cm, calculate the Knudsen number. In which regime of gas flow is the system? Is this the regime in which the main vacuum pump works? (3+2+5)

2. a) Obtain an expression for the final temperature in adiabatic demagnetization of a paramagnetic salt assuming specific heat to be constant over the entire temperature range and justify that this process produces cooling.
   b) Can any paramagnetic substance be used to produce this effect? Explain. (8+2)

3. a) Helium II is called a superfluid. Which two properties of liquid Helium II supports this nature? Explain.
   b) Explain what are the thermal conductivity and thermal capacity requirements of the regenerator material used in cryo-refrigerators?
   c) Why do Teflon seals don't work well in cryostats at low temperatures? In what different ways can the system be sealed? Explain. (4+3+3)

4. a) Why does lead serve as a better regenerator material below 20K compared to copper? Explain.Why is the temperature range of cryo-refrigerators which use conventional regenerator materials limited to above 10K? Which regenerator materials are typically used in the second stage of cryo-refrigerators for further cooling to lower temperatures? Explain.

b) Compare the Stirling cycle cryocooler with Gifford McMahon cryocooler in terms of principle of operation, design (what maintains the required constant phase difference necessary for efficient operation), the frequency and efficiency of each of them and their applications. (4+6)

5. Explain the working of Pirani gauge. How is the effect of ambient temperature on the output of this gauge taken care of? Explain why and how is this gauge better than the thermocouple gauge to measure pressure. (5+2+3)

6. In order to build a liquid Helium Bath cryostat, explain the design requirements, the appropriate materials to be used in the construction and the precautions to be taken while using and evacuating it. (10)

7. a) Compare the characteristics of an oil diffusion pump and turbomolecular pump. Is there any similarity between the two pumps?

   b) What do you understand by compression ratio of a turbo molecular pump? What role does it play in designing the vacuum system? What are the factors on which it depends? If the compression ratio of this pump for N_2 is 10^7 then what is the compression ratio for H_2? (4+6)

8. Explain the process of DC sputtering for thin film deposition with the detailed explanation of the dynamics of glow discharge plasma. Also, draw the V-I characteristics of the discharge tube. (10)

9. a) Compare the various imaging modes of Atomic Force Microscope in terms of their mode of operation, the regime in which they operate, cantilever geometry, spring constant and probe tips.
   b) Explain the lens system assembly used in Transmission Electron Microscope. (6+4)

10. a) What is the principle of working of Scanning Tunnelling Microscope? What are the factors on which tunnelling current depends?
    b) How is the sample preparation done for non-conducting samples in Scanning Electron Microscope.
    c) Why is lift height mode of scanning used in Magnetic Force Microscope? (6+2+2)