Register Number:
Date:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. PHYSICS - IV SEMESTER
SEMESTER EXAMINATION: APRIL 2018
PH0115 – EXPERIMENTAL PHYSICS II

Time- 2 1/2 hrs **Max. Marks-70**

This paper contains 2 printed pages and no parts.

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

1. a) Why is Stainless Steel preferred over Aluminium in making vacuum chambers even though Aluminium is lighter and easier to machine? Explain.

   b) Brass is used in making various parts in the vacuum system but it cannot be used below the pressure of 10^{-6} Torr. Why?

   c) Why is Quartz used in making windows of the viewing ports in the vacuum chamber? What is the disadvantage of using Quartz?

   d) Why is baking the chamber an essential step in ultra-high vacuum systems?

   e) What decides the lowest attainable pressure with an oil-sealed pump? (2+2+2+2+2)

2. Draw a diagram and explain the working of sputter-ion pump. Explain why this pump cannot work effectively above a pressure of 10^{-5} Torr and which pumps are used as roughing pumps for the sputter ion pump? (6+4)

3. a) Calculate the temperature of Oxygen after expanding by adiabatic throttling through a pressure difference of 150 atm, having C_p = 7.0 cal/mol-K and Vander Waals constant a=1.32 litre^2-atm/mole^2 and b=3.12x10^{-2} lit / mole, R= 8.31 x 10^{-2} litre-atm/mole-K and 1 cal = 4.18 J, 1 litre = 10^3 cm^3 and 1 atm = 1.013 x 10^5 N/m^2.

   b) Determine the fall in temperature of a paramagnetic salt produced by adiabatic demagnetisation when the sample initially magnetised with field 'H' of 20,000 oersted at temperature of 1K, is demagnetised. Specific heat at constant applied field 'H' i.e. C_H = 0.4 cal/g and Curie constant = 0.01 erg-K/g/ (oersted)^2. 1 cal = 4.18 Joules and 1 joule = 10^7 erg. (5+5)

4. a) With diagram, explain how leak detection is done in vacuum systems using mass spectrometer.
   b) A vacuum pump with pumping speed of 1500 litre/s is connected to the vacuum chamber through a tube. Tubes with following lengths are available i)200 mm with

diameter 150 mm ii)300 mm with diameter 300 mm. Which one should be used and why? The conductance of the tube is given as $12.2\frac{r^3}{l}$ where r is diameter of the tube in cm and l is length of the tube in cm and C is measured in litre/s.

(6+4)

5. a) What is Joule-Thomson throttling? What is it's relevance in the field of low temperature?
   b) Give a complete description of liquefaction of Hydrogen using Joule-Thomson regenerative cooling technique with the help of a neat diagram. You can use the following data to support your description: (4+6)

Hydrogen	Critical Temperature: 33K	Temperature of Inversion: 193K	Liquefaction temperature: 20K

6. Derive Ehrenfest's equations starting with equation for Gibb's free energy and justify that the temperature of λ- transition or λ- point decreases with increase in pressure. What type of phase transition happens in liquid Helium at that λ- point? Explain. (10)

7. a) Explain the principle and working of Gifford Mcmahon (GM) cryocooler in detail.
   b) Mention any one advantage and one disadvantage of this cryocooler over Pulse-tube cryocooler. (8+2)

8. a) Explain the principle of DC sputtering technique of thin film deposition.
   b) Explain the working Atomic Force Microscope work in tapping mode? (5+5)

9. An experimentalist working in the thin films lab is required to design a set-up for thin film coating using pulsed laser ablation technique. Stating what this deposition technique is, specify the design requirements of the system in detail. (10)

10. a) Why is the resolution of Transmission electron microscope better than Scanning electron microscope(SEM)?
    b) Why are only those electrons that are near the sample surface used to produce secondary electrons images in SEM?
    c) Which conditions would be most favourable for the collection of backscattered electron images from an insulating material - 10 keV gold coated sample or 15 keV carbon coated sample? Why?
    d) In Scanning Tunnelling Microscope, the tip-sample separation is 4 to 7 Å where as in the Atomic Force Microscope it is less than 4 Å. Why?
    e) What is the purpose of objective lens and condenser lens in Transmission electron microscope? (2+2+2+2+2)