Date:

Registration number:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BENGALURU-27
M.Sc. PHYSICS - IV SEMESTER
SEMESTER EXAMINATION: APRIL 2022
(Examination conducted in July 2022)

PH0118 – Experimental Physics II

(For supplementary candidate)

Time- 2 ½ hrs Max Marks-70

This question paper contains Two printed pages and Two parts

Part A
Answer any FIVE questions. Each question carries 10 marks

[5 x 10 = 50]

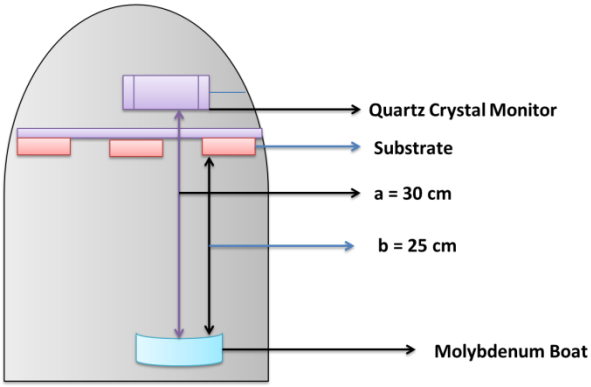
1. (a). How the vacuum should be classified based on the pressure range. What are the suitable pump selections to attain ultra-high vacuum range?
   (b). With a neat sketch, explain the physical principle of the rotary pump. [5+5]
2. (a). Describe the construction and working principle of Ionization gauges for pressure.
   (b). Construct the ultra-high vacuum system. Explain the role of the essential components in the ultra-high vacuum system. [5+5]
3. (a). With a neat sketch, describe the construction and working principle of Sputtering process.
   (b). Explain the vacuum evaporation mechanism with suitable diagram. [5+5]
4. (a). Explain the construction of scanning electron microscope (SEM) and transmission electron microscope (TEM).
   (b). Describe the physical principle of scanning tunneling microscope with a suitable sketch. [6+4]
5. (a). With a suitable diagram, explain the working of continuous flow cryostat.
   (b). Draw and explain the phase diagram of liquid Helium (^{4}He). [5+5]
6. Describe the working principle of the following systems. (i). Stirling -cryocooler and Gifford Mcmahon (GM) cryocooler. [5+5]
7. Explain Joule-Thomson Throttling and its use in liquification of gases. Derive the expression for the Joule-Thomson Coefficient in term of Joule-Thomson expansion.

Part B

Answer any Four questions. Each question carries 5 marks

[4 x 5 = 20]

8. Define tooling factor. Calculate the tooling factor of thermal evaporation for the given condition as shown in the figure.



9. Define De Broglie wavelength. Calculate de Broglie wavelength associated with an electron accelerated by a potential difference of 100 volts.

10. The formula for the mean free path of a given gas is $\lambda = \frac{K.T}{\sqrt{2}.\pi.p.d_m^2}$ where

    K = Boltzmann's Constant ($1.381 \times 10^{-23} JK^{-1}$)
    T = Temperature (in Kelvin)
    p = Pressure (in Pascals)
    d = Molecular radius (~ 400 pm for air)

    If a chamber is operated at ultra-high vacuum (10^{-8}mbars), what is the mean free path inside the chamber?

11. With a neat sketch, describe the inside- out and outside-in leak detection methods.

12. Define the characteristic of superfluid. Explain why Helium II has been referred to be superfluid.

13. Explain the difference between Thermionic and Penning Ionization gauges used to measure vacuum pressure.

List of Physics Constants

Speed of light in vacuum (c)	2.997925×10^{8} ms^{-1}
Charge of electron (e)	1.6021×10^{-19} C
Rest mass of electron (m)	9.109×10^{-31} kg
Atomic mass unit (m_u)	1.6604×10^{-27} kg
Electron radius (r_e)	2.828×10^{-15} m
1 Angstrom unit (Å)	10^{-10} m
Avogadro's number (N_A)	6.02252×10^{26} kmol^{-1}
Boltzmann constant (k_B)	1.38054×10^{-23} jK^{-1}
Thermal energy at 300K (k_BT)	0.0258 J
Planck's constant (h)	6.626×10^{-34} Js
Permeability of free space (μ_o)	$4\pi \times 10^{-7}$ Hm^{-1}
Permittivity of free space (ε_o)	8.854×10^{-12} Fm^{-1}
Rydberg constant for Hydrogen (R_H)	1.0967758×10^{7} m^{-1}
Universal gas constant ($Ru = N_Ak_B$)	8.3143×10^{3} Jkmol^{-1}K