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Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE [REGULAR/SUPPLEMENTARY] EXAMINATION, NOVEMBER 2022

(CBCSS)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2019 Admission onwards)

Time : Three Hours

Maximum : 30 Weightage

Section A

Answer **all** *questions.*

Each question carries weightage 1.

1. Explain what happens in rotary oil pump if it stops working under vacuum conditions. Suggest a method to solve this problem.
2. Define with units throughput Q and pumping speed S of a vacuum pump. Plot the variation of S with pressure for a rotary.
3. Give *two* advantages of the spottering technique for thin film fabrication over the vacuum evaporation techniques.
4. What special technique is used in a tandem Van de Graaff accelerator to increase the available ion energy over that from a normal Van de Graaff accelerator ?
5. Explain two disadvantages of a Cyclotron.
6. Explain the origin of the background in the $P_1 \times E$ spectrum of a realistic sample.
7. Briefly describe the method for determination of depth profile of impurity concentration in a sample.
8. Explain the difference between single crystal and powder diffraction using X-rays.

(8 × 1 = 8 weightage)

Turn over

Section B

Answer any **two** *questions.*
Each question carries weightage 5.

9. (a) Explain, using a diagram, the principle and working of a rotary oil pump.

   (b) What is a gas ballast and its use ?

10. (a) Explain why vacuum is required for thin films by the thermal evaporation techniq

    (b) Describe the set up and its working for the above technique for thin film fabricatio neat diagram for explanation.

11. (a) Explain the theory, construction and working of a modern synchrotron providing sketch.

    (b) Mention two of its important applications.

12. (a) Illustrate the principle of the RBS technique for elemental analysis.

    (b) With reference to a diagram of the experimental set up for the above technique, ex the same is used for a practical application.

$(2 \times 5 = 10$ w

Section C

Answer any **four** *questions.*
Each question carries weightage 3.

13. Calculate the pumping speed of a rotary oil pump to produce a vacuum level of 2×10^{-3} minutes inside a cubical pressure chamber of side 20 cm, starting from atmospheric pres

14. In the measurement of the thin film thickness by the optical interference method, the maximum for a light of wavelength λ, is observed to coincide with the $(n+1)^{st}$ order max a nearby wavelength λ_2, at normal incidence. Deduce the expression for the thickness of the refractive index μ of the film and the wave lengths.

15. It is required to obtain $^{32}_{16}S$ ions with an energy of 4 MeV per nucleon using a tandem Graaff accelerator. The charge state of the ions selected is 10+. what should be the potential ? What will be the velocity of the ions ? (1 amu = 931.4 MeV).

16. The $^{7}Li(p,\alpha)$ reaction is being used to estimate the lithium content in a sample. What is the residual nucleus ? Is there a threshold energy for this reaction ? What is the value in the laboratory ? The detector for the emitted particles is kept at 45° to the incident proton beam energy whose is 5 MeV above the threshold. Obtain the energy of the alphas detected. (Given the nuclide masses : ^{7}Li : 7.01601, ^{1}H = 1.007825, and ^{4}He : 4.002603, all in amu).

17. Polonium (Mass number = 209) is the only element known to crystallize in simple cubic structure. Its density is 9.196 g/cm^3. Calculate the lattice constant a. Cu kα radiation of energy 8.04 Kev is used to study the crystal structure using X-ray diffraction. Obtain the angle at which first order reflection occurs from the set of planes parallel to one of its faces.

18. Deuterons are accelerated in a cyclotron. Determine the frequency of the accelerating voltage source given the strength of the magnetic field = 1.5 T and the mass of the particles = 3.3×10^{-27} kg. If the ions come out of the cyclotron with a kinetic energy of 16 MeV, calculate the cyclotron radius at which they leave the machine.

19. Considering each phase of the entire process for materials analysis by Neutron Activation technique, give a step by step derivation of the expression for the number of gamma rays detected by a HPGe detector per second in terms of the mass m of the particulars isotope in the sample, the beam current I and other relevant parameters of the experimental set up.

(4 × 3 = 12 weightage)