23

D 11696 (Pages : 3) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

Answer **all** *questions.*
Each question carries weightage 1.

1. What are the basic functions of the working fluid in an oil rotary pump ?
2. Give an idea about the fundamental principle of the working of getter ion pump.
3. Explain the function of the quartz crystal in a thickness monitor for thin films.
4. What is the mechanism of the sputter ion deposition technique for thin film fabrication ?
5. Explain why the successive accelerating tubes in a linear accelerator have progressively increasing lengths.
6. What are the special advantages of ion implantation technique ?
7. Back angles are preferred in the RBS technique for materials analysis. Why ?
8. What is a unit cell ? What is its shape and parameters ?

(8 × 1 = 8 weightage)

Turn over

Section B

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

9. (a) With the help of a neat diagram discuss the working principle and working of a turbo molecular pump.

   (b) Explain the concept of pumping speed.

10. (a) Describe the glow discharge technique for thin film fabrication.

    (b) Write a note on multi layer optical filters and their uses.

11. (a) What is PIXE ? Explain the general set up for trace element analysis via this technique providing a neat sketch of the same.

    (b) Discuss the application of the PIXE techniques for human hair samples.

12. (a) State and explain Bragg's law of X-ray diffraction.

    (b) Describe the instrumentation for single crystal diffraction studies.

$(2 \times 5 = 10$ marks)

Section C

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

13. A vacuum chamber in the form of a sphere with radius of 25 cm is pumped by a diffusion pump starting from an inlet pressure 1×10^{-3} Torr to an ultimate pressure of 8×10^{-7} Torr. If the effective pumping speed of 150 litres/sec, calculate the pump down time.

14. A vacuum evaporation unit is used to coat a thin aluminium film on a substrate kept at a distance of 15 cm from the heating boat 1 gram of the metal is taken in the boat and is evaporated completely. Find the thickness of the thin film obtained, in microns ($\rho = 2.7$ g/cm^3). The film thickness is measured in an interferometer using light of wavelength 589 nm. Obtain the fringe shift if $\mu = 1.5$.

15. The r.f. field in a cyclotron used for accelerating alpha particles is 15 MHz. The cyclotron has a radius of 0.6 m. Obtain the strength of the magnetic field and the maximum energy acquired by the ions.

16. The thermal column of a nuclear reactor provides a neutron flux of 10^{12} n/cm^2/s. A sample containing ^{10}B is subjected to NAA using the (n, r) reaction in this column. What is the isotope produced ? The radio activity produced has a half life of 30 minutes. Gamma counting is started 15 minutes after irradiation is over. 1,000 gammas are detected for 2 minutes using a HPGe detector of efficiency 2%, kept subtending a solid angle of 2×10^{-3} sr at the sample. Calculate the mass of the isotope in the sample, assuming $\sigma = 100$ mb.

17. An experiment is carried out to determine the particle size of a powder sample using X-ray diffraction. The FWHM of the diffraction peak at 31.8° is obtained as 0.5 degrees, when Cu kα radiation of energy 8.04 keV is used. Calculate the particle size.

18. A linear accelerator operating at r.f. frequency of *f* kHz and *rf* field amplitude of V k Volts is used to accelerate ions of charge *ne* and mass *m* with an initial energy of E0 keV. Derive expressions for the length of the n^{th} drift tube and the exit energy of the ions after *n* drift tubes.

19. The reaction X (a, b) Y with a *q*-value Q is used for analysis of a sample containing the isotope X by detecting the outgoing particles *b* at an angle 0 to the incident beam direction. Using the principles of conservation of energy and momentum, deduce an expression relevant to the qualitative analysis of the sample for X.

(4 × 3 = 12 weightage)