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D 91058 (Pages : 3) Name.....

Reg. No.....

# THIRD SEMESTER M.A./M.Sc./M.Com. DEGREE [REGULAR] EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

## PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2019 Syllabus year)

Time : Three Hours Maximum : 30 Weightage

### General Instructions

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

### Section A

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

1. What is a liquid nitrogen trap ? How does it work ?
2. Explain the phenomenon of oil back streaming in a diffusion pump. How can this be prevented ?
3. Give the basic principle of the technique of using ion sputtering process for thin film fabrication.
4. Briefly describe thermo electric power and its measurement.
5. How high voltages are developed on the terminal of a Van de Graaff accelerator without sparking ?
6. Explain the basis for using the Nuclear Reaction Analysis technique for materials analysis.
7. Explain the high sensitivity and multi-elemental nature of the PIXE method of trace element analysis.
8. State and explain the Scherrer equation in X-ray diffraction.

(8 × 1 = 8 weightage)

### Section B

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

9. (a) What is the role of the cryo surface in a vaccum pump ?

   (b) Describe in detail with the help of a neat diagram, the structure and working of a cryo pump.

**Turn over**

10. (a) Explain using a neat diagram the principle and details of the optical interferometer meth of thickness measurement of thin films.

(b) Write a note on electrical conductivity measurement of thin films.

11. (a) What is the basic principle behind the operation of a Cyclotron, with supporting diagram.

(b) Give the details of the components of the accelerator and its working.

12. (a) Outline the basic theory of materials analysis by the NAA technique.

(b) Describe the instrumentation and procedure for the above, giving the necessary diagram.

(2 × 5 = 10 weightag

## Section C

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

13. For a vacuum pump with an effective pumping speed of 1000 litres/s at a pressure of $10^{-3}$ Tor calculate the throughput. Also, draw the variation of the pumping speed *vs.* pressure for a rotar pump.

14. A quartz crystal monitor having an initial thickness of 0.2 mm and density 2.3 g/cm$^3$ is used in thin film fabrication unit. For a given aluminium thin film deposit the reduction in crystal frequen is found to be 2 kHz. Calculate the initial crystal frequency and the thickness. Given ρ f aluminium = 2.7 g/cm$^3$ and the crystal frequency constant N = $1.537 \times 10^5$Hz – cm.

15. A proton linear accelerator has 40 drift tubes of gradually increasing lengths. The r.f. voltag amplitude used is 400 kV and frequency is set to 200 MHz. Calculate the length of the 25$^{th}$ dri tube and the exit energy of the protons, given that the ion source injects 80 keV protons into th first drift tube.

16. A sample containing traces of silicon impurity is to be analyzed using the RBS technique wit 8 Mev alpha particles. The silicon detector is kept at an angle of 150°. Calculate the energies of th two scattered alpha peaks corresponding to the two isotopes of Si with masses 28 and 30. Wha should be the minimum resolution of the detector in order that these two peaks are just resolved

17. Potassium with atomic mass 39 has a b.c.c. structure with a lattice parameter $a = 0.52$ nm. Estimat its density based on the crystal structure. When μo $k\alpha$ radiation (17.926 keV) is used for X-ra diffraction measurement of the K crystal sample, obtain the angle at which a strong peak corresponding to reflections from the [111] planes will be observed.

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18. Derive an expression for the energy of ions of mass M and charge state $q$ after the stripper foil, accelerated through a tandem van de Graaff accelerator of terminal potential V Mega volts. Thus , obtain the energy and velocity of $5^+$ $^{32}S$ ions delivered by the accelerator of V = 12. Calculate also the number of such ions delivered per second if the beam current is 20 namps.

19. Considering each phase of the entire procedure for trace analysis by the PIXE technique using a proton accelerator, give a step by step derivation of the expression for the number of X-rays detected by the Si (Li) detector per second in terms of the mass $m$ of the particular element investigated and the beam current I and other relevant parameters.

(4 × 3 = 12 weightage)