

4/EH-24 (iv) (Syllabus-2015)

2 0 1 8

(April)

PHYSICS

(Elective/Honours)

(Atomic, Nuclear and Solid-State Physics)

[PHY-04(T)]

Marks : 56

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Answer Question No. **1** and *any four* from the rest

1. (a) A monochromatic X-ray beam of frequency 1.95×10^{18} Hz undergoes Compton scattering from a carbon block, find the wavelength of X-rays scattered at angle of 180° . [Given Planck's constant $(h) = 6.62 \times 10^{-34}$ Js, rest mass of electron $(m_e) = 9.11 \times 10^{-31}$ kg, velocity of electromagnetic wave in vacuum $(c) = 3 \times 10^8$ m/s]

4

(2)

(3)

- (b) A ray of ultraviolet light of wavelength 3000 Å falling on the surface of a material whose work function is 2.28 eV, ejects an electron. What will be the kinetic energy and velocity of the emitted electron? [Given Planck's constant (h) = 6.62×10^{-34} Js, mass of electron (m_e) = 9.11×10^{-31} kg] 4
- (c) If the magnetization and flux density of a magnetic material be 3200 A/m and 0.005 Wb/m², calculate the susceptibility and relative permeability of the material. 4
2. (a) Discuss the mobility of ions moving through a gas under an electric field E . 3
- (b) Describe Thomson's method for the determination of e/m of an electron. 6
- (c) Discuss the basic principle of a cathode ray oscilloscope. 2
3. (a) State the fundamental postulates of Bohr's theory of hydrogen atom. What interpretation do you give to the negative sign of the energy value? 2+1=3
- (b) What are characteristic X-rays? Distinguish between continuous X-radiations and characteristic X-ray emission spectra. 1+3=4
- (c) Describe the construction and principle of operation of a He-Ne laser. 4
4. (a) Describe one method of measuring ionization current. 4
- (b) Explain why the Thomson's parabola does not extend to the vertex. What important results have been obtained from positive ray analysis? 1+2=3
- (c) What do you understand by mean life of a radioactive substance? Show that the mean life of a radioactive substance $\bar{T} = \frac{1}{\lambda}$, where λ is the decay constant. 1+3=4
5. (a) What is meant by pair production? What is the minimum energy requirement of the agent causing the phenomenon? 1+1=2
- (b) Discuss the working principle of linear accelerator and hence deduce the drift tube length of the accelerator. 2+2=4
- (c) Explain the principle of action of scintillation counter. Describe their usefulness in the study of nuclear radiations. 2+1=3
- (d) Describe briefly about the discovery of a neutron. 2
6. (a) What is controlled nuclear chain reaction? Describe how this can be achieved in a nuclear reactor indicating the function of each part of the reactor. 1+4=5

- (b) Explain briefly the important features of the collective model of nuclei. How does the collective model help in understanding the nuclear fission? $2+2=4$
- (c) Discuss the origin of cosmic rays. 2
7. (a) What do you understand by packing fraction of a crystal? Calculate the packing fraction for a face-centred cubic (f.c.c.) structure. $1+3=4$
- (b) Derive the expression for the interplanar spacing of the set of (hkl) planes of a cubic lattice. 4
- (c) Show that a five-fold rotation axis is not compatible in crystals. 3
8. (a) Discuss the experimental evidence on the occurrence of superconductivity in metals and alloys. 3
- (b) Discuss the breakdown of classical theory of electrical conductivity with special reference to mean free path of electrons and molar specific heat of metals. $2\frac{1}{2}+2\frac{1}{2}=5$
- (c) Distinguish between type-I and type-II superconductors. 3
