Ex/UG/SC/PHY/UG/GE/TH/04/2022

BACHELOR OF SCIENCE EXAMINATION, 2022

(2nd Year, 2nd Semester)

[MODERN PHYSICS]

PAPER – GE/TH/04

Time : Two hours Full Marks : 50

Answer any five questions.

1. Draw the energy distribution curve of black body radiation. Discuss the new idea introduced by Planck to explain the distribution curve. Deduce Planck's radiation formula.
   Prove that in the limits of very short wavelengths, Planck's formula reduces to Wien's formula.
   1+2+5+2

2. a) Mention any two aspects of photoelectric effect which cannot be explained in terms of classical wave theory of radiation.
   b) Light of wavelength 4500 Å ejects photoelectrons from a sodium surface (work function 2.3 eV). The stopping potential is experimentally found to be 0.46 volts. Calculate the value of Planck's constant.
   c) What is the physical significance of wave function in wave mechanics? State and explain Heisenberg's uncertainty principle. 2+3+(2+3)

3. a) What is Compton scattering and which aspect (wave or particle) of the radiation is revealed by it?
   b) Derive an expression for the change in wavelength due to Compton scattering of high energy photons by electrons regarded as free. Calculate the minimum and maximum possible change in wavelength of incident radiation. 3+(5+2)

4. a) What is radioactivity? From decay rate deduce the law of exponential disintegration of a radioactive substance. Hence find the expression for mean life of that substance.
   b)What do you mean by secular radioactive equilibrium? 0.34g of Ra-226 is in secular equilibrium with 10^3 Kg of U-238. Find the half-life of U-238, if that of Ra-226 is 1620 years.
   (1+ 2.5+2.5) +(1+3)

[Turn over

5. a) Explain the terms i) mass defect and ii) packing fraction.

   b) Draw the binding energy per nucleon versus mass number curve and explain the significance of its different portions.

   c) Find the ratio of the radii of the two nuclei having mass numbers 27 and 8.

   4+4+2

6. a) What are the differences between crystalline and amorphous solids. Give examples of each.

   b) What do you mean by co-ordination number of a crystal lattice and hence find the coordination number of a FCC lattice.

   c) What is the nearest neighbour distance for a BCC lattice of side 'a'?

   d) Show that for Bragg diffraction to occur the wavelength of x-rays must not exceed twice the interplanar spacing.

   e) The diffraction pattern of a copper metal was measured with X-ray radiation of wavelength 1.315 Å. The first order Bragg diffraction peak was found at an angle of 50.5°. Calculate "d"-thespacing between the diffracting planes in the copper metal.

   [2x5]

7. a) Explain the differences between dia-, para- and ferro-magnetic materials. Compare the susceptibility versus temperature curves of diamagnetic and ferromagnetic materials.

   b) Develop the Langevin (classical) theory of diamagnetism and derive the expression of diamagnetic susceptibility.

   (3+2)+5