Roll No. | | | | | | | | | | | | | **Total No. of Pages : 02**

Total No. of Questions : 09

B.Sc. Honours (Mathematics) (Sem.–3)

ELEMENTS OF MODERN PHYSICS

Subject Code : UC-BSHP-214-19

M.Code : 78500

Date of Examination : 19-12-22

Time : 3 Hrs. **Max. Marks : 60**

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION - B & C. have FOUR questions each.**
3. **Attempt any FIVE questions from SECTION B & C carrying EIGHT marks each.**
4. **Select atleast TWO questions from SECTION - B & C.**

SECTION-A

l. Write short notes on :

a. What is the ultraviolet catastrophe in the black body radiation experiment?

b. Define the work function of a metal surface.

c. State the correspondence principle.

d. What is the drawback of Bohr's atomic model?

e. What is the significance of ''Wavefunction'' in quantum mechanics?

f. What are characteristic X-rays and how they are produced?

g. Using the Heisenberg uncertainty condition explains that electrons cannot exist inside the nucleus of 5×10^{-15}m.

h. How expectation value of any physical quantity can be calculated from its wavefunction?

i. Differentiate between the inertial and non-inertial frame of reference?

j. At what speed does the kinetic energy of a particle equal its rest energy?

SECTION-B

2. a) Describe the photoelectric effect. How Einstein's photon model overcame the limitations of wave theory in explaining the photoelectric effect.

b) Find the de Broglie wavelength of an electron moving with the velocity 1×10^{8}m/s

3. a) Describe the Compton effect and minimum conditions required for observing the Compton effect.

   b) X-rays of wavelength 10.0 pm are scattered from a target, (i) Find the wavelength of the x-rays scattered through 30°. (ii) Find the maximum wavelength present in the scattered x-rays.

4. Describe the motion of a particle confined in a dimensional box of length "L". Derive an expression for wavefunction and eigenvalues of the confined particle if its interaction potential V=0.

5. A particle limited to the x-axis has the wave function $\varphi = bx$ between $x = 0$ and $x = 1$; $\Phi = 0$ elsewhere.

   a) Find the probability that the particle can be found between $x = 0.40$ and $x = 0.60$.

   b) Find the expectation value $\langle x \rangle$ of the particle's position

SECTION-C

6. Describe Michelson Morley's interferometer experiment setup in detail and outline the physical significance of its ''negative'' results in explaining the existence of the hypothetical ''Ether'' medium.

7. a) Derive the expression for relavistic momentum using the special theory of relativity,

   b) An astronaut whose height on the earth is exactly 6 ft is lying parallel to the axis of a spacecraft moving at 0-90c relative to the earth. What is his height as measured by an observer in the same spacecraft? By an observer on the earth.

8. a) Describe Bohr's postulate for describing the atomic model and derive the expression for the total energy of an electron in the hydrogen atom.

   b) Experiments indicate that 13.6 eV is required to separate a hydrogen atom into a proton and an electron; that is, its total energy is $E = -13.6$ eV. Find the orbital radius and velocity of the electron in a hydrogen atom.

9. a) Describe Spin-orbit coupling and how it affects the atomic spectra?

   b) Find the equatorial velocity v of an electron under the assumption that it is a uniform sphere of radius $r = 5.00 \times 10^{-17}$ m that is rotating about an axis through its center.

NOTE : Disclosure of Identity by writing Mobile No. or Marking of passing request on any paper of Answer Sheet will lead to UMC against the Student.