|--|

Total No. of Pages : 02

Total No. of Questions : 09

# B.Sc. Honours (Physics) (Sem.–3) ELEMENTS OF MODERN PHYSICS Subject Code : BSHP-212-21 M.Code : 92455 Date of Examination : 14-12-22

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**

## 1. Write briefly :

- a. What is the ultraviolet catastrophe in the black body radiation experiment?
- b. Define the work function of a metal surface.
- c. State the factors on which Compton scattering depends.
- d. What is the physical significance of the Davisson and Germer Experiment?
- 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  $5 \times 10^{-15}$  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 it's rest energy?

### **SECTION-B**

- 2. Describe Michelson Morley's interferometer experiment setup in detail and outline the physical significance of its "Null" results in explaining the existence of the "Ether" medium?
- 3. a) Derive the relativistic length contraction using the Lorentz transformation.
  - 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?
- 4. 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, (a) Find the wavelength of the x-rays scattered through 45°. (b) Find the maximum wavelength present in the scattered x-rays.
- 5. a) Describe the photoelectric effect. How Einstein's photon model overcame the limitations of wave theory in explaining the photoelectric effect?
  - b) Find the wavelength and frequency of a 100MeV photon?

### **SECTION-C**

- 6. a) State de Broglie's hypothesis about the matter waves?
  - b) Find the de Broglie wavelength of an electron moving with the velocity  $1 \times 10^8$  m/s.
- 7. a) What is the group velocity of matter-wave? Differentiate between phase velocity and group velocity.
  - b) An electron has a de Broglie wavelength of  $2.00 \text{ pm} = 2.00 \times 10^{-12} \text{ m}$ . Find its kinetic energy and the phase and group velocities of its de Broglie waves.
- 8. 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.
- 9. A particle limited to the *x*-axis has the wave function  $\varphi = bx$  between x = 0 and x = 1;  $\varphi = 0$  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.

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