TDC Odd Semester Exam., 2020
held in July, 2021

PHYSICS

(Pass)

(5th Semester)

Course No. : PHSP–501

(Quantum Mechanics, Atomic and Nuclear Physics)

Full Marks : 35
Pass Marks : 12

Time : 2 hours

The figures in the margin indicate full marks for the questions

Answer **five** questions, taking **one** from each Unit

UNIT—I

1. *(a)* What is photoelectric effect? Does every photon incident on a photocathode cause emission of an electron? 1+1=2

(b) Derive Einstein's photoelectric equation. 5

2. *(a)* Show that the group velocity of a wave associated with a material particle is same as the particle velocity. 3

(b) State the de Broglie hypothesis of matter waves. Find the de Broglie wavelength of an electron in the first Bohr orbit of hydrogen atom. 2+2=4

UNIT—II

3. *(a)* State and explain Heisenberg's uncertainty principle. 3

(b) By applying uncertainty principle, explain non-existence of electrons in the atomic nucleus. 4

4. *(a)* What are the limitations of Bohr's theory of hydrogen atom? 2

(b) Deduce an expression for the total energy of electron in *n*th orbit of hydrogen atom. 5

UNIT—III

5. *(a)* Discuss the principle and action of a Bainbridge mass spectrometer to determine the isotopic masses. 5

(b) What are the properties of positive rays? 2

6. *(a)* At what wavelength will emission from n 4 to n 1 for the H-atom be observed? 2

(b) Derive an expression for the total energy of electron in nth Bohr orbit. Hence show that energy of the electron is inversely proportional to the square of the principal quantum number. 5

UNIT—IV

7. *(a)* State and explain Bohr's correspondence principle. 4

(b) What do you mean by fine structure of spectral lines? What are the modifications introduced by Sommerfeld to explain the observed fine structure of spectral lines? 1+2=3

8. *(a)* Give a brief account of Franck-Hertz experiment. What inferences are drawn from this experiment? 5

(b) An X-ray beam of wavelength 0·97 Å is obtained in the third order after reflection at 60° from the crystal plane. Another beam is obtained in the first order after reflection at 30° from the same crystal plane. Find the wavelength of second X-ray beam. 2

UNIT—V

9. *(a)* Give the theory of successive disintegration of radioactive substance. 4

(b) Calculate the half-life and mean life of the radioactive substance whose decay constant is 4 28 10 ^{4} per year. 3

10. *(a)* What is a nuclear reactor? 2

(b) Write short notes on any *two* of the following : 2½×2=5

(i) Linear accelerator

(ii) Origin of cosmic rays

(iii) Cyclotron

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