

B.Sc. T.Y. (CBCS Pattern) Semester-V
USDSEPHT09 - Physics Paper-I - Elements of Modern Physics

P. Pages : 3

Time : Three Hours



GUG/W/24/13093(S)

Max. Marks : 50

- Notes :
1. All questions are compulsory.
 2. Draw neat and well labelled diagrams wherever necessary.

Either :

1. a) i) State De-Broglie's hypothesis for matter waves. Obtain De-Broglie's equation in terms of energy. 2
- ii) Describe Davisson-Germer experiment. How does it prove the wave nature of particles. 6
- iii) An electron is confined to a box of length 10^{-8} meter. Calculate the minimum uncertainty in its velocity, Given $m_e = 9 \times 10^{-31} \text{ kg}$, $h = 6.63 \times 10^{-34} \text{ J.s}$. 2

OR

- b) a) Explain the characteristics of Black body radiation. 2½
- b) What is photoelectric effect. Explain failures of classical mechanics with respect to photoelectric effect. 2½
- c) Calculate De-Broglie wavelength of proton which has kinetic energy of 1 MeV. 2½
Mass of proton is $1.67 \times 10^{-27} \text{ kg}$.
- d) State and explain Heisenberg's uncertainty principle. 2½

Either :

2. a) i) Write Schrodinger's wave equation for a free particle in one dimensional box. Solve it and obtain eigen value of momentum and energy for it. 6
- ii) Find the values of momentum and energy for an electron in a box of length 1 Å for $n=1$. 2
- iii) What is eigen function and eigen values? Explain them with suitable examples. 2

OR

- b) a) Explain significance of stationary states in quantum mechanics. 2½

- b) What is operator? Explain any two quantum mechanical operator. 2½
- c) Find the lowest energy and momentum of an electron in one dimensional potential well of width 1 Å. Express the result in eV. (Mass of an electron = 9.1×10^{-31} kg) 2½
- d) Derive Schrodinger's time independent wave equation for the matter waves. 2½

Either :

3. a) i) Explain the term mass defect and packing fraction. 2
- ii) What is binding energy of the nucleus? Obtain an expression for binding energy per nucleon. Discuss graphically the variation of average binding energy per nucleon with mass number. 6
- iii) Calculate the binding energy in MeV of an α -particle from the following data: 2
 mass of proton = 1.00758 amu, mass of neutron = 1.00898 amu and
 mass of the He-nucleus = 4.0028 amu.

OR

- b) a) Define mean life or average life period of a radioactive substance. How it is related to half life period of a radioactive substance. 2½
- b) Write the relation between mass number and radius of nucleus and find radius of ${}_{13}\text{Al}^{27}$ nucleus. 2½
- c) What are nuclear forces. Discuss the properties of nuclear forces. 2½
- d) What are α , β and γ – rays? Give their properties. 2½

Either :

4. a) i) Draw a neat diagram of a nuclear power reactor and explain its working. 5
- ii) Calculate the energy liberated when a helium nucleus is formed by fusion of two deuterium nuclei. 2
 The mass of ${}_1\text{H}^2 = 2.01478$ a.m.u. and mass of ${}_2\text{He}^4 = 4.00388$ a.m.u.
- iii) Explain why fusion reactions are called thermonuclear reactions. 3

OR

- b) a) What are merits of liquid drop model? 2½
- b) What is Mossbauer effect? Explain it. 2½

- c) What is β -decay? Explain three types of β -decay. 2½
- d) Calculate the energy released in MeV when deuteron fuses with a tritium to form a heavy nucleus and one neutron. 2½
 Mass of deuterium = 2.01474 u.
 Mass of helium = 4.00387 u.
 Mass of tritium = 3.01700 u.
 Mass of neutron = 1.00898 u.
 And 1 u = 931.5 MeV.

5. Attempt **any ten** of followings.

- a) What is the uncertainty relation between Energy and time? 1
- b) What is Wave packet? 1
- c) What is the momentum of photon of wavelength 6×10^{-7} meter? 1
- d) What is step potential? 1
- e) Explain physical significance of wave function, Ψ . 1
- f) Write Schrodinger's time dependent wave equation. 1
- g) What is Bohr Magnetron? 1
- h) What is the statement of law of radioactive decay? 1
- i) State semi-empirical mass formula. 1
- j) Define chain reaction. 1
- k) What is nuclear fusion? 1
- l) What is stellar energy? 1
