

B.Sc. Third Year (CBCS Pattern) Sem-V
USDSEPHT09 - Physics Paper-I - Elements of Modern Physics

P. Pages : 3

Time : Three Hours



GUG/W/23/13093 (S)

Max. Marks : 50

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

Either :

1. A) i) Describe Davission and Germer's experiments. How does it prove the wave nature of particles. 6
- ii) State and explain Heisenberg's uncertainty principle. 2
- iii) Find the uncertainty in the momentum of a particle when its position is determined within 0.01 cm. (Given $h = 1.05 \times 10^{-34} \text{ J.s}$) 2

OR

- B) a) What are the silent features of black body radiation spectrum. 2½
- b) State De-Broglie's hypothesis for matter waves. Express De-Broglie's equation interms of energy. 2½
- c) What is photoelectric effect. Explain failures of classical mechanics with respect to photoelectric effect. 2½
- d) An electron confined to a box of length 10^{-10} m . Calculate minimum uncertainty in velocity. (Given - $m_e = 9.1 \times 10^{-31} \text{ kg}$) 2½

Either :

2. A) i) Give physical significance of a wave function and state the conditions for a wave function to be well behaved. 2
- ii) State the boundary conditions for a free particle in one dimensional box. 2
- iii) Write Schrodinger's wave equation for a free particle in one dimensional box. Obtain an expression for energy of a free particle in one dimensional rigid box. 4
- iv) Find the values of momentum and energy for an electron in a box of length 1 \AA for $n = 1$. 2

OR

- B) a) What is eigen function and eigen value? Explain them with example. 2½

- b) Derive Schrodinger's time independent wave equation for the matter waves. 2½
- c) What is an operator? Explain any two quantum mechanical operator. 2½
- d) Calculate the ground state energy for an electron moving back and forth between potential barriers 10^{-7} cm apart. 2½
 (Given, $m = 9.1 \times 10^{-28}$ gm and $h = 6.63 \times 10^{-27}$ erg. second)

Either :

3. A) i) What are nuclear forces. Discuss the properties of nuclear forces. 2
- ii) Calculate the binding energy of an α -particle from the following data. 2
 Mass of Helium nucleus = 4.001265 u.
 Mass of Neutron = 1.008665 u.
 And 1 u = 931.5 MeV.
- iii) Explain in details account of Gamow's theory of α -decay. 6

OR

- B) a) What is binding-energy? Explain how the stability of nucleus can be checked with the help of binding energy per nucleon curve. 2½
- b) Write the relation between mass number and radius of nucleus and find radius of ${}_{13}\text{Al}^{27}$ nucleus. 2½
- c) Define mean life or average life period of a radioactive substance. How it is related to half life period of a radioactive substance. 2½
- d) Explain the different properties of nucleus. 2½

Either :

4. A) i) Describe the construction and working of nuclear reactor. 5
- ii) Calculate the energy liberated when a helium nucleus is formed by fusion of two deuterium nuclei. The mass of ${}^2_1\text{H} = 2.01478$ a.m.u. and mass of ${}^4_2\text{He} = 4.00388$ a.m.u. 2
- iii) What are merits of liquid drop model? 3

OR

- B) a) What is β -decay. Explain three types of β -decay. 2½
- b) What is γ -decay. Explain the origin of gamma ray. Discuss cobalt -60 decay scheme. 2½
- c) Explain nuclear fusion on the basis of liquid drop model. 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. Solve **any ten** of the following.

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|---|---|
| a) What is black body? | 1 |
| b) What is wave packet? | 1 |
| c) What are application of uncertainty principle. | 1 |
| d) What is free particle? | 1 |
| e) What is step potential? | 1 |
| f) What is normalized wave function? | 1 |
| g) State law of radioactive decay. | 1 |
| h) State semi-empirical mass formula. | 1 |
| i) Define the range of α -particle. | 1 |
| j) What are different properties of neutrino? | 1 |
| k) Write note on “stellar energy”. | 1 |
| l) Define chain reaction. | 1 |
