

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 salient features of black body radiation spectrum. 2½
- b) State De-Broglie's hypothesis for matter waves. Express De-Broglie's equation in terms of energy. 2½
- c) What is photoelectric effect. Explain failures of classical mechanics with respect to photoelectric effect. 2½
- d) An electron is confined to a box of length  $10^{-10} \text{ m}$ . 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  $1 \text{ Å}$  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  $\alpha$ -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  $\alpha$ -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  ${}_1\text{H}^2 = 2.01478$  a.m.u. and mass of  ${}_2\text{He}^4 = 4.00388$  a.m.u. 2
- iii) What are merits of liquid drop model? 3

**OR**

- B) a) What is  $\beta$ -decay. Explain three types of  $\beta$ -decay. 2½
- b) What is  $\gamma$ -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.

- |    |                                                |   |
|----|------------------------------------------------|---|
| 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 $\alpha$ -particle.        | 1 |
| j) | What are different properties of neutrino?     | 1 |
| k) | Write note on “stellar energy”.                | 1 |
| l) | Define chain reaction.                         | 1 |

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