B.Sc. T.Y. (C.B.C.S. Pattern) Sem-V

USDSEPHT09 - Physics Paper-I - Elements of Modern Physics

P. Pages : 3 **GUG/W/19/13093**

Time : Three Hours * 3 8 8 3 * Max. Marks : 50

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

1. Either :

a) i) State and explain Heisenberg's uncertainty principle. **2**

ii) Describe the gamma ray microscope experiment to prove the Heisenberg's uncertainty principle. **4**

iii) Show that electrons do not exist inside the nucleus using Heisenberg's uncertainty principle. **2**

iv) Find the uncertainty in the momentum of a particle when its position is determined within 0.01 cm (Given $\hbar = 1.05 \times 10^{-34}$ 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 energy. **2½**

c) Explain the concept of wave particle duality. **2½**

d) Find the energy of a neutron in eV, given that de-Broglie wavelength of neutron is 1A° and its mass, $m_n = 1.67 \times 10^{-27}$ kg ($h = 6.63 \times 10^{-34}$ J.S) . **2½**

2. Either :

a) i) Give physical significance of a wave function and state the conditions for a wave function to be well behaved. **3**

ii) Obtain an expression for energy of a free particle in one dimensional rigid box. **4**

iii) Find the energy difference between the ground state and the first excited state for an electron in a box of length 1A° (given $m = 9.1 \times 10^{-31}$kg). **3**

OR

b) a) What is eigen function and eigen value? Explain them with example. **2½**

b) Derive Schrödinger's wave equation in time independent form. **2½**

c) Explain the tunnel effect with neat diagram using quantum mechanics. **2½**

d) Calculate the ground state energy for an electron moving back and forth between potential barriers 10^{-7} cm apart **2½**

(given $m = 9.1\times10^{-28}$ gm and $h = 6.63\times10^{-27}$ evg.s)

3. Either :

a) i) What is α - decay? Give its characteristics. **2**

ii) Explain in detail Gamow's theory of α - decay. **6**

iii) Obtain an expression for Geiger – Nuttal Law from Gamow's theory. **2**

OR

b) a) What is binding – energy? Explain how the stability of nucleus can be checked with the help of B – E per nucleon curve. **2½**

b) The half life of a radioactive element is 10 days. How long will it take for 90% of the sample to disintegrate? **2½**

c) Explain the different properties of nucleus. **2½**

d) Explain mean life period of a radioactive element and derive an expression for it. **2½**

4. Either :

a) i) Describe the construction and working of nuclear reactor. **5**

ii) Explain the various stages in the fission process as given by the liquid drop model. **3**

iii) What is chain reaction? How is it obtained? **2**

OR

b) a) Explain β - ray spectrum. **2½**

b) What are difficulties involved in explaining β - ray spectrum? How these are eliminated. **2½**

c) Explain why fusion reactions are called thermonuclear reactions? **2½**

d) Calculate the energy liberated when a helium nucleus is formed by fusion of two deuterium nuclei. The mass of $H_2 = 2.014102$ amu and mass of **2½**

$_2He^4 = 4.002604$ amu .

5. Solve **any ten** of the following.

a) What is wave packet? **1**

b) Draw the experimental set up for Davisson and Germer experiment. **1**

c) What is the momentum of photon of wavelength $6\times10^{-7}\,\text{m}$. **1**
(Given $h = 6.63\times10^{-34}\,\text{J}\cdot\text{S}$)

d) What is normalized wave functions. **1**

e) Write Schrödinger's time dependent equation in three dimensions. **1**

f) What is an operator? **1**

g) Define range of $\alpha-$particle. **1**

h) Give the relation between half life and mean life of a radioactive element. **1**

i) Enumerate the important characteristics of the nuclear forces. **1**

j) What are the different properties of neutrino? **1**

k) Write a note on 'Stellar energy'. **1**

l) When a nucleus emits gamma ray photon, what happens to its atomic number and its actual mass? **1**

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