B.Sc. T.Y. (CBCS Pattern) Sem-V

# USDSEPHT09 - Physics-I : Elements of Modern Physics

P. Pages : 3 **GUG/W/22/13093**

Time : Three Hours * 3 8 3 0 * Max. Marks : 50

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

**Either:**

**1.** a) i) Describe Davission & Germer's experiments. How does it prove the wave nature of particles. **6**

ii) State & Explain De-Broglie's hypothesis. **2**

iii) Calculate De-Broglie's wavelength of proton which has K.E. of 1 MeV. (Given- $M_p = 1.67 \times 10^{-27}$ kg & $h = 6.62 \times 10^{-34}$ J.S. ) **2**

**OR**

b) a) State and explain both Heisenberg's uncertainty principle. **2½**

b) Explain the characteristics of Black body radiation. **2½**

c) Show that electron do not exist inside the Nucleous. **2½**

d) An electron confined to a box of length $10^{-10}$ m. Calculate minimum uncertainty in velocity. (Given- $M_e = 9 \times 10^{-31}$ kg) **2½**

**Either:**

**2.** a) i) Write Schrodinger time independent wave equation for a free particle in 3 – dimensional rectangular box. Solve it to obtain the eigen value of energy. **6**

ii) What is well behaved wave function. State the condition for it. **2**

iii) Find the values of momentum & energy for an electron in a box of length $1A^{\circ}$ for n = 1. **2**

**OR**

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

b) State the postulate of quantum mechanics. **2½**

c) Derive time independent Schrodinger equation for the matter waves. **2½**

d) Find the eigen values of an operator $\frac{d^2}{dx^2}$ for the function **2½**

i) $\psi = \cos x$

ii) $\psi = e^x$

**Either:**

**3.** a) i) Explain Gamow's theory of $\alpha-$decay in detail. **5**

ii) What do you mean by mass defect & binding energy of nucleus. Draw and explain the graph of binding energy per nucleon versus mass number. **3**

iii) Calculate the binding energy of an $\alpha-$ particle from the following data. **2**

Mass of Helium nucleus = 4.001265 u

Mass of proton = 1.007276 u

Mass of neutron = 1.008665 u

And 1u = 931.5 MeV.

**OR**

b) a) What are nuclear forces. Discuss the properties of nuclear forces. **2½**

b) Describe a few properties of nucleus. **2½**

c) Define mean life or average life period of a radioactive substance. How it is related to half life period of a radio active substance. **2½**

d) Calculate the time required for 10% of a sample of thorium to disintegrate. Assume the half life of thorium to be $1.4\times10^{10}$ years. **2½**

**Either:**

**4.** a) i) What is $\beta-$ decay. Explain three types of $\beta-$ decay. **3**

ii) Draw a neat diagram of a nuclear power reactor & explain its working. **5**

iii) What is a chain reaction. Explain controlled chain reaction. **2**

**OR**

b) a) What are difficulties involved in explaining $\beta-$ decay spectrum. How these are eliminated. **2½**

b) What is $\gamma-$ decay. Explain the origin of gamma ray. Discuss cobalt – 60 decay scheme. **2½**

c) Explain nuclear fission 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

& 1 u = 931.5 MeV.

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

a) What is block body? **1**

b) Write energy – time uncertainty principle. **1**

c) What is the momentum of photon of wavelength $6\times10^{-7}\,\text{m}$. **1**

d) What is free particle? **1**

e) What is normalized wave function. **1**

f) Write Schrodinger time dependent equation in 3 – Dimensions. **1**

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

h) State law of radioactive decay. **1**

i) Define atomic mass unit (a.m.u.) **1**

j) What are different properties of neutrino. **1**

k) What is nuclear fusion. **1**

l) What is stellar energy. **1**

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