Roll No……

Unique Paper Code : 32227504

Name of Paper : Nuclear and Particle Physics

Name of Course : **B.Sc.(Hons.)Physics-CBCS-DSE**

Semester : **V**

Duration: **3 Hours** Maximum Marks: **75**

All questions carry equal marks.

Attempt four questions in all.

Use of Scientific calculator is allowed.

1. Compare the binding energies per nucleon for $^{20}_{10}Ne$ and $^{238}_{92}U$. (4)
   Calculate the value of nuclear magneton. (3)
   Using the uncertainty principle, estimate the energy that a proton must possess to be a part of the nucleus. (4)
   Show that the nuclear density is the same for all the nuclei. (3)
   Draw the N-Z curve and discuss its significance. (4.75)

2. How does the liquid drop model account for Nuclear fission? For a given odd A nucleus, sketch a plot of M(A, Z) versus Z. What kind of curve is it ? (4+5=9)
   Name a nuclear model which falls in the category of an independent particle model. (1.75)
   Write down the ground state configuration for protons and neutrons and determine the spin and parity of $^{17}_{8}O$ nucleus using the shell model. (2+2+2=6)
   State the values of the electrical dipole moment and electrical quadrupole moment if the nucleus is assumed to have a spherically symmetric distribution of charge. (2)

3. Show that the kinetic energy (T_d) of the alpha particle emitted by a parent nucleus of mass number A is given by $T_d = Q\frac{A-4}{A}$ where Q is the disintegration energy for the reaction. (5)
   Which conservation laws were apparently being violated in the observed beta decay and how did the neutrino hypothesis correct these? (6)
   State two differences between internal conversion and photoelectric effect. (2)

$^{11}_{6}C$ decays to $^{11}_{5}B$ by β^+ (beta positive) emission. Write the decay equation. Calculate the maximum and minimum energies of the emitted neutrino. (0.75+2.5+2.5 =5.75)

4. What is meant by a nuclear reaction? Give two examples each of deuteron and tritium induced nuclear reactions.(2+2+2=6)
   State three characteristics of compound nucleus formation reactions. (3)
   For the reaction $^{11}_{5}B + ^{2}_{1}H \rightarrow ^{9}_{4}Be + ^{4}_{2}He$, the alpha particles coming out at 90° with respect to the direction of the incident deuteron beam have an energy of 6 MeV. Considering the energy of the incident deuteron beam as 1.6 MeV , calculate the Q value of the reaction .
   For simplification , treat the masses as the respective mass numbers. (6)
   Define nuclear reaction cross section and state its units. (3+0.75=3.75)

5. Define cut off wavelength in photo electric effect (2)
   Calculate the maximum change in wavelength of a beam of 2.2 MeV photon which is Compton scattered by electrons. (3)
   1 MeV gamma rays are incident on a block of lead. Calculate the thickness of lead which will reduce the intensity of the incident beam to 1/100 of its initial intensity. Consider the linear absorption coefficient of lead as $75\ m^{-1}$. (6)
   Explain the principle and working of an ionization chamber for nuclear radiation detection. (2+5.75=7.75)

6. Draw the baryon octet and specify the Baryons at the vertices and at the centre. (3)
   Explain which of the following reactions are allowed or forbidden under the conservation of strangeness, conservation of baryon number, conservation of charge, conservation of isospin, conservation of z component of Isospin, conservation of Lepton number. Also state the kind of interaction followed. Else state the conservation laws that are violated.

   i) $\Omega^- \rightarrow \Xi^0 + K^-$
   ii) $p + n \rightarrow \Xi^- + K^+ + \Sigma^+$ (3+3= 6)

   Tabulate the composition of Ξ^0 and K^- according to Quark model including the quark content, charge and strangeness. (2+2=4)
   Describe the principle and working of a cyclotron (2+3.75= 5.75)

Useful data. The given masses are atomic masses.

M($^{20}_{10}Ne$) = 19.992440 u; M($^{238}_{92}U$) = 238.050783 u ; M ($^{1}_{1}H$) = 1.007825 u ; mass of a neutron = 1.008665 u

M($^{11}_{6}C$) = 11.0114334 u ; M($^{11}_{5}B$) = 11.009305 u , rest mass of an electron = 0.5 MeV , rest mass of electron = 0.0005 u