Your 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.

Duration :3 hours

1. Calculate the binding energy per nucleon for ${}^{56}_{26}Fe$ nucleus given that its atomic mass is 55.934942 u. (3)
   Assuming nuclei to be spherical, determine the nuclear mass density of ${}^{12}_{6}C$. (3)
   What is the relationship between amu and energy? (2)
   State, very briefly, the significance of electric quadrupole moment of a nucleus. Support the answer with diagrams. (4)
   Represent graphically the variation of binding energy per nucleon with mass number and explain the energy release in the fission process using this graph. (6.75)

2. What are the basic assumptions of nuclear shell model? Characterize the successive shells according to the single-particle terms that describe the shell, i.e., the principal quantum number n, the orbital angular momentum quantum number l, and the total angular momentum quantum number j . (3+6)
   Determine the Coulomb repulsion energy of the 2 protons in ${}^{3}_{2}He$ assuming them to be separated by the nuclear radius. (3)
   What is the exchange theory of nuclear forces? Write the name of the particles exchanged between the nucleons. Discuss four features of nuclear forces. (2+0.75+ 4= 6.75)

3. State the assumptions of Gamow's theory of alpha decay. What is the Geiger Nuttall law for alpha decay and represent it graphically In the energy spectrum of the alpha particles emitted in an alpha decay, very closely spaced lines are observed why? (2+2+1+2 =7)
   Discuss the role of neutrino in explaining the conservations of energy and angular momentum in a beta decay. (5)
   Determine the Q value of the alpha decay of ${}^{236}_{94}Pu$ to ${}^{232}_{92}U$ and calculate the kinetic energy of the daughter nucleus. (3.75+3=6.75)

4. State the differences between direct reactions and compound nucleus formation reactions. (4)
   Why are neutrons in particular, useful as bombarding agents in nuclear reactions. Write 2 neutron induced nuclear reactions. (3+2=5)
   State the assumptions made in the study of Coulomb scattering of charged particles by matter. (5)
   Calculate the excitation energy of the compound nucleus $({}^{236}_{92}U)^*$formed in the absorption of thermal neutron by ${}^{235}_{92}U$.
   ${}^{235}_{92}U + n \rightarrow ({}^{236}_{92}U)^*$ neglect the kinetic energy of the neutron. (4.75)

5. What is meant by the threshold frequency in photoelectric effect? (2)
   In a Compton scattering experiment, a 250 keV photon is scattered through an angle of 60°. Calculate the energies of the scattered photon and the Compton electron. (2+3=5)
   List the different types of scintillators used for detection of nuclear radiation. (3)
   Explain the principle and working of a GM counter. (2+6.75=8.75)

6. Tabulate the composition of anti proton and Σ^+, according to Quark model including the quark content, Baryon number and charge. (4) .
   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 violated.
   i) $\pi^+ + n \rightarrow \Lambda^0 + K^+$
   ii) $\Xi^0 \rightarrow \Sigma^0 + \Lambda^0$
   iii) $K^- + p \rightarrow \Omega^- + K^+ + K^0$
   (9)

A uniform magnetic field of 1.6 T is used in a cyclotron which has the Dee's radius of 0.55 m. Calculate:

(a) the energy to which a proton can be accelerated. Mass of a proton is 1.67 x 10^{-27} kg.

(b) The total number of complete revolutions made by the protons in attaining this energy. (3+2.75=5.75)

Useful data for atomic masses

M($^{235}_{92}U$) $= 235.0439\ u$; M($^{236}_{92}U$) $= 236.0456u$; M($^{236}_{94}Pu$) = $236.046071u$; M($^{232}_{92}U$) $= 232.037168u$;

M($^{1}_{1}H$) $= 1.007825\ u$; mass of neutron $=1.008665u$

Coulomb constant = 1/ $4\pi\epsilon_0$ $= 9\ X\ 10^9\ \frac{Nm^2}{C^2}$