2016

PHYSICS

PAPER : PHY 203

NUCLEAR PHYSICS-I

Full Mark : 80

Time : 3 Hrs

Figures in the right hand margin indicate full marks for the question

1. Answer the following $1 \times 5 = 5$

(a) The ratio of sizes of $^{208}_{82}Pb$ and $^{26}_{12}Mg$ nuclei is approximately - 1

(i) 2 (ii) 4 (iii) 8 (iv) 16

(b) In nuclei of $Z < 20$, the ratio of number of neutron to proton is - 1

(i) More than 1 (ii) Less than 1

(iii) Much greater than 1 (iv) Nearly equal to 1

(c) The ground state of a deuteron is a - 1

(i) Pure $^3S_1$ state

(ii) Pure $^3P_1$ state

(iii) Mixture of $^3S_1$ and $^3P_1$ states

(iv) Mixture of $^3S_1$ and $^3D_1$ states

(d) The spin and parity of ground state of $^{17}_{8}O$ 1

(i) $\frac{1^+}{2}$ (ii) $\frac{5^+}{2}$ (iii) $\frac{1^-}{2}$ (iv) $\frac{5^-}{2}$

(e) The quark structure of Δ^{++} is 1

(i) uuu (ii) udu (iii) sss (iv) ddd

2. Answer the following (any five) $2 \times 5 = 10$

(a) What do you mean by energy resolution of a detector. The energy resolution of NaI detector and germanium detector are about 8% and 0.1 % respectively for γ-rays of 1 MeV. Which detector is better as far as the energy resolution of the detector is concerned. 2

(b) What do you mean by stopping power. Write down the Bethe-Bloch equation. 2

(c) Why the electric field is maximum near the Anode wire of a GM tube. What do you mean by Townsend avalanche. 2

(d) Explain why a nucleus that can decay by positron emission can also undergo electron capture decay. 2

(e) Give two evidences to show that nuclear force between a neutron and a proton is not purely central. 2

(f) What are the strange particles and why they are called strange? 2

3. Answer the following (Any five) $5 \times 5 = 25$

(a) Using single particle shell model, calculate the spin and parity of $^{42}_{19}K$. 5

(b) Calculate the depth of n-p potential in deuteron bound state by taking a simplified finite square well potential. Given, Binding energy of deuteron = 2.225 MeV and the range of interaction = 2.1 fm.5

(c) A $^{23}_{12}MG$ emits positron to become $^{23}_{11}Na$. Find the end-point energy of the decay if the masses of parent and product nuclei are 23.002 u and 22.99618 u respectively. If in a particular decay,

electron takes 20% of the decay energy, calculate the energy of the emitted neutrino of that particular decay. 5

(d) Why Coulomb energy correction is necessary in the semi-empirical mass formula ? Use the liquid drop model to establish which of the isobars $^{125}_{52}Te$ and $^{125}_{51}Sb$ decays into the other. What kind of decay occurs ? 2+3

(e) Electron scattering experiment was performed with $^{16}_{8}O$ nucleus at 420 MeV. The first minimum of the diffraction like pattern is found to be at 54^0. Calculate the approximate radius of the nucleus. 3+2

(f) Derive an expression for comparative half-life using Fermi's theory of $\beta-$decay. On the basis of comparative half-life how di"erent $\beta-$emitters are categorized? 3+2

4. Answer the following (any four) $4 \times 10 = 40$

(a) Calculate the skin thickness of atomic nucleus using Woods-Saxon function? Describe in details how $K\alpha-$Xrays can be used to measure the nuclear radius. 3+7

(b) Discuss Fermi's theory of beta decay and derive an expression to find the number of electrons emitted between T_e and T_e+dT_e. What is Fermi factor? Draw Kurie plot for allowed transition. Discuss why in the Kurie plot, at low energy region, there is a deviation between theory and experimental data? 10

(c) Draw the variation of current vs. applied voltage for a typical gas-filled de-tector and identify ionization chamber, proportional counter, GM counter and spark counting regions. Draw the block diagram and discuss the construction and working principle of GM counter. What is the quenching mechanism of a GM detector. 10

(d) Apply necessary conservation laws, decide which of the following reactions are allowed. If allowed, by which process of interaction ?

(i) $\pi^- + p \rightarrow \Lambda^0 + n$

(ii) $\Lambda^0 \rightarrow n + \pi^0$