4/12/18
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[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **620** **I**

Unique Paper Code : 32227504

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

Name of the Paper : Nuclear and Particle Physics

Semester : V

Time : 3 Hours ***Maximum Marks : 75***

Instructions for Candidates :

(i) Write your Roll No. on the top immediately on receipt of this question paper.

(ii) **Five** questions have to be attempted.

(iii) Question **NO.1** is compulsory.

(iv) Attempt any **four** from the ramaining set of questions .

(v) Use of Scientific Calculator is permitted.

1. Attempt any **five** questions :

(a) Why do stable nuclei have more neutrons than protons ? 3

(b) A certain odd parity shell model state can accommodate a maximum of 12 nucleons. What are its j and l values ? 3

(c) Define and give **two** examples each of : 3

(a) baryons and (b) leptons

P.T.O.

(d) Calculate the value of Q in the β^- decay of

$^{3}_{1}H$ (mass =3.01605 u) (assumed to be at rest)

into $^{3}_{2}He$ (mass = 3.016030 u). 3

(e) Define threshold energy of the projectile in a nuclear reaction. 3

(f) Give reasons for the decrease in cross-section of neutron induced reactions with increase in neutron energy. 3

2. (a) Calculate the kinetic energy of electrons required to probe the size of $^{40}_{20}Ca$. Assume that the probe is able to distinguish ("see") a distance, at least half the radius. 5

(b) Explain the stripping reactions and deuteron pick up reactions with examples. 5

(c) In a nuclear reaction a 6MeV proton is incident on a stationary $^{12}_{6}C$ target as observed in the laboratory frame. Assuming the masses of proton and $^{12}_{6}C$ as 1 u and 12 u respectively, determine the total kinetic enerrgy in the centre of mass frame. Use non-relativistic dynamics. 5

3. (a) Using the shell model of nucleus , compute the neutron proton asymmetry energy. 7

(b) Explain the principle of a Scintillation counter. 5

(c) Determine the efficiency of a Geiger Muller counter which reads 950 counts per minute when 990 charged particles are incident on it, per minute. 3

4. (a) State the assumptions of Gamow's theory of alpha decay and derive the following expression for the transmission probability (T) of the alpha particle.

$$\ln T = \frac{4e}{\hbar}\left(\frac{m}{\pi \epsilon_0}\right)^{\frac{1}{2}} Z^{\frac{1}{2}} (R_0)^{\frac{1}{2}} - \left(\frac{e^2}{\hbar \epsilon_0}\right)\left(\frac{m}{2}\right)^{\frac{1}{2}} ZE^{-\frac{1}{2}}$$

Where E (in MeV) and m are respectively the kinetic energy and mass of the alpha particle. Z is the atomicc number of the nucleus minus the alpha particle. R_0 is the radius of the nucleus expressed in Fermi (10^{-15}m).

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(b) The range of alpha particle in air is expressed as $0.0032\ E^{3/2}$. Determine the range of alpha particle with E =5 MeV, in Aluminium which has the relative stopping power of 1600. Density of Aluminium is 2.7×10^3 Kg/m^3 mass number is 27 and atomic number is 13. 7

5. (a) Indicate, with an explanation, whether the following interactions proceed through the strong, electromagnetic or weak interactions, or whether they do not occur.

(i) $\tau^+ \rightarrow \mu^+ + \gamma$ (ii) $p \rightarrow \pi^0 + e^+$

(iii) $p \rightarrow n + e^+ + \gamma_e$ 6

(b) Discuss the principle of a linear accelerator. 5

(c) A cyclotron with dees of radius 90 cm is subjected to a transverse magnetic field of 0.8 Tesla. Calculate the energy to which a deuteron of mass 3.34×10^{-27} Kg can be accelerated. 4

6. (a) Sketch the Baryon Octet based on the quark model and assign the required quantum numbers. 8

(b) When does a nucleus undergo gamma decay ? State the differences between internal conversion and photoelectric effect. 7

7. (a) State **four** characteristics of nuclear forces 5

(b) The radius of Ge is found to be twice the radius of $^{9}_{4}Be$. Using this information determine the number of nucleons in Ge. 5

(c) Find the threshold wavelength of gamma rays needed to produce a proton anti-proton pair. 5

Useful data :

$M\left(^{1}_{1}H\right) = 1.007825\ u;$

Mass of a neutron = 1.008665u

$M\left(^{2}_{1}H\right) = 2.014102\ u;$ $\quad M\left(^{4}_{2}He\right) = 4.002603\ u$