10.12.18 (M)

This question paper contains 4 printed pages.

Your Roll No. .....

S. No. of Paper	: **764**	**I**
Unique Paper Code	: **32227504**	
Name of the Paper	: **Nuclear and Particle Physics**	
Name of the Course	: **B.Sc. (H) Physics : DSE-2**	
Semester	: **V**	
Duration	: **3 hours**	
Maximum Marks	: **75**	

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

*Attempt **five** questions in all. Question No. 1 is compulsory. Attempt any **four** questions from the remaining set of questions. Use of scientific calculator is permitted.*

1. Attempt any *five* questions:

(a) Calculate the Fermi energy, Fermi momentum and the well depth of a nucleus with $N = Z = A/2$.

(b) What isospin value is expected from an even mass nuclide (Z, N) ?

(c) Why do unstable nuclei emit alpha particles and not protons or neutrons?

(d) Define separation energy for neutrons.

(e) Give the Lepton and Baryon numbers for electrons, protons, neutrons and positrons.

(f) What is meant by the saturation of nuclear forces?

3×5=15

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2. (a) Find the most stable isobar for A = 57 using the liquid drop model. Assume the constants as a_1 = 14 MeV, a_2 = 13 MeV, a_3 = 0.59 MeV, a_4 = 19 MeV, a_5 = $(\pm, 0)$ 33.5 MeV where a_1 is the volume constant, a_2 is the surface energy constant, a_3, a_4, a_5 are respectively coulombic, asymmetric and pairing constants. Do not derive the semi-empirical mass formula.

(b) Thermal neutrons are captured by $^{10}B_5$ to form $^{11}B_5$ which decays by α-particle emission to $^{7}_{3}Li$. Calculate:

(i) The Q value of the decay in MeV.

(ii) The kinetic energy of the α-particles in MeV.

8,7

3. (a) Determine the applied voltage required to operate a proportional counter with a maximum radial field of 10^6 Vm^{-1}. The radius of the wire and tube are respectively 0.003 cm and 1 cm.

(b) The alpha particles emitted in the decay of $^{219}_{86}Ru$ have energies 6.82 MeV, 6.55 MeV and 6.43 MeV. Determine the energies of gamma rays emitted by the daughter nuclei.

(c) Give three characteristics of nuclear forces. 5,5,5

4. (a) In an absorption experiment with 1.14 MeV γ radiation from $^{65}_{30}Zn$, it is found that the intensity of radiation is reduced to 2% when it passes through 25 cm of aluminium. Determine the mass absorption coefficient of aluminium for this radiation. Density of aluminium is 2700 kg/m^3 and $M(^{26}_{13}Al) = 26.9815$.

(b) Calculate the binding energy per nucleon for $^{56}_{26}Fe$ and compare this with the value of the proton separation energy. Given $M(^{56}_{26}Fe)$=55.934939 u, $M(^{55}_{25}Mn)$= 54.938046 u.

(c) Find the height of the Coulomb barrier between an alpha particle and daughter nucleus $^{A}_{Z}D$, assuming that the nuclear potential has a sharp edge at a radius of 1.4 $A^{1/3}$ fm. 5,5,5

5. (a) Using the quark model draw the Baryon octet. State the quantum number of all the particles in the octet.

(b) Give the principle of a linear accelerator.

(c) A cyclotron, in which the transverse magnetic flux density is 1.5 weber/m^2, is used to accelerate protons. Determine the frequency of the source. 7,4,4

6. (a) What are the advantages of a GM counter over the ionization chamber for radiation detection?

(b) Give *two* differences between direct and compound nuclear reactions.

(c) Indicate giving reasons if the following reactions proceed through the weak, strong or electromagnetic interactions or they do not occur:

(i) $\pi^0 \rightarrow \gamma + \gamma$

(iii) $e^+ + e^- \rightarrow \mu^+ + \mu^-$ 5,5,5

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7. (a) What is Cerenkov radiation? Calculate the threshold velocity for electrons to produce this radiation when it travels through a medium of refractive index 1.6.

(b) Alpha particles and deuterons are accelerated under identical conditions in a cyclotron. The extracted beam of these particles is passed through an absorber. What is the ratio of the range of alpha particle to the range of the deuteron?

(c) Using the uncertainty principle, estimate the energy required for a proton to be a part of the nucleus.

5,5,5

USEFUL DATA:

$M(^{11}_{5}B) = 11.0119305$ u ; $M(^{1}_{1}H)=1.007825$ u ; Mass of a neutron=1.008665 u; $M(^{7}_{3}Li) = 7.016004$ u; $M(^{4}_{2}He) = 4.002603$ u.