Name of the Department   :   Physics & Astrophysics

Name of Course   :   B.Sc. Prog..-CBCS_DSE

Semester   :   VI- Semester

Name of the Paper   :   Nuclear and Particle Physics

Unique Paper Code   :   42227639

Question Paper Set Number :   Set- A

Duration: 3 Hours   Maximum Marks: 75

All questions carry equal marks. Attempt any four of the following questions. Some useful data is given at the end for solving problems.

Q1. (a) Calculate and compare the binding energy per nucleon of $^{16}_{8}O$ and $^{238}_{92}U$ nuclei.   **(6)**

(b) Determine the radius of a $^{197}_{79}Au$ nucleus. How much minimum kinetic energy (in MeV) must an alpha particle possess in order to approach it within a distance of the order of its radius?   **(3+3.75)**

(c) Draw a general neutron vs proton curve for stable nuclei. Discuss its characteristics and significance.   **(6)**

Q2.(a) Discuss the salient features of shell model. Give three experimental evidences indicating the presence of shell structure in nuclei.   **(8)**

(b) Give three important properties of neutrino. How does it account for the phenomenon of beta decay?   **(6)**

(c) The half-life of the alpha emitter $^{210}_{84}Po$ is 138 days. What mass of $^{210}_{84}Po$ is needed for an activity of 10 milli-Curie?   **(4.75)**

Q3.(a) What necessary conditions should be satisfied for a nuclear reaction to take place? Give two examples each of deuteron and triton induced nuclear reactions.   **(6.75)**

(b) Give three important differences between direct and compound nucleus reactions. **(6)**

(c) What is meant by threshold energy of nuclear reaction? Compute the value of threshold energy for the reaction $^{93}_{41}N_b(p,d)^{92}_{41}N_b$.   **(6)**

Q4.(a) Explain the principle, construction and working of a linear accelerator.   **(6)**

(b) Draw a block diagram of scintillation counter and explain its working principle.   **(7)**

(c) The radius of the central wire of a proportional counter is 0.1mm and the radius of the cylindrical tube is 2 cm. Calculate the electric field developed at (i) the surface of the wire (ii) the surface of the cylindrical tube, when the potential difference of 1500 V is applied between the two electrodes.   **(5.75)**

Q5.(a) Give any two processes by which heavy and light charged particle interact with matter. How is the motion of an alpha particle in matter different from that of an electron?   **(6)**

(b) The linear absorption coefficient of lead for 1MeV gamma rays is 74 m^{-1}. Calculate the thickness of lead needed to reduce the intensity to 1 % of its original value.   **(5)**

(c) Explain the processes of pair production and annihilation. **(7.75)**

Q6. (a) What are quarks? List the different types of quarks and give their basic properties. Write the quark composition for the following mentioned particles composition for the particles P,n, π^0, π^+ and their corresponding anti-particles. **(8)**

(b) Determine whether the following processes are allowed or forbidden: **(4)**

(i) $\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$

(ii) $\pi^- + p \rightarrow k^- + \Sigma^-$

(c) Distinguish between Leptons and Hadrons. Name three particles of each kind. **(6.75)**

Useful data:

$m(^{16}_8O) = 15.994915\,u$

$m(^{238}_{92}U) = 238.050786\,u$

$m(^{1}_1H) = 1.007825\,u$

$m(^{2}_1H) = 2.014102\,u$

$m(neutron) = 1.008665\,u$

$m(^{93}_{41}Nb) = 92.906382\,u$

$m(^{92}_{41}Nb) = 91.907211\,u$

$R_o= 1.4$ F