Enrollment No: _____ Exam Seat No:_____

C.U.SHAH UNIVERSITY

Winter Examination-2018

Subject Name: Nuclear and Particle Physics

Subject Code: 5SC03NPP1 Branch: M.Sc. (Physics)

Semester: 3 Date: 29/11/2018 Time: 02:30 To 05:30 Marks: 70

Instructions:

(1) Use of Programmable calculator and any other electronic instrument is prohibited.
(2) Instructions written on main answer book are strictly to be obeyed.
(3) Draw neat diagrams and figures (if necessary) at right places.
(4) Assume suitable data if needed.

SECTION – I

Q-1 Attempt the Following questions (07)

a. How is the charge of a nucleus expressed?
b. Name the wave mechanical properties of a nucleus.
c. What do you mean by long range of alpha particles?
d. State the Geiger-Nuttal law.
e. What information does one get from the fine structure of the alpha spectrum?
f. Which particle was thought to carry away 2/3rd energy in a beta decay process?
g. Define total cross section.

Q-2 Attempt all questions (14)

a. Explain the concept of binding energy in relation to mass defect of a nucleus. Explain in detail the binding energy per nucleon (BE/A) plot. **(09)**
b. Taking into consideration the wave function of a nucleus, explain the concept of parity, also mentioning its two types. **(03)**
c. What is the importance of Quadrupole moment? **(02)**

OR

Q-2 Attempt all questions (14)

a. Derive the expression for the magnetic moment of a nucleus. **(06)**
b. Name and explain the two coupling methods used to determine the total angular momentum of a nucleus. **(04)**
c. Name and differentiate the two statistics. **(04)**

Q-3 Attempt all questions (14)

a. Write a note on alpha decay paradox. **(08)**
b. What difficulties were encountered while explaining the beta spectrum? How was it overcome? **(06)**

OR

Q-3
a. Derive the expression for density of states in a beta decay process. **(08)**
b. Find the Q-value (disintegration energy) for a spontaneous alpha decay process? **(03)**

c. Prove experimentally the violation of parity in a beta decay process. **(03)**

SECTION – II

Q-4 **Attempt the Following questions** **(07)**

a. In an isobaric family, by which processes does nuclei attain stability?
b. Define nucleon emission.
c. According to the single particle shell model, which particle defines the entire properties of the nucleus?
d. State the CPT theorem.
e. Does quantum numbers contribute in defining the shells of nucleus? If so how?
f. State the Gellmann-Nishijima condition.
g. According to the quark model, baryons are made up of how many quarks and anti quarks?

Q-5 **Attempt all questions** **(14)**

a. Point out the difference between internal conversion and pair production. **(03)**
b. Explain direct reactions with its two types. **(05)**
Check whether the following reaction is possible or not based on the conservation of charge and mass number:
$^{236}_{92}U \rightarrow {}^{144}_{56}Ba + {}^{89}_{36}Kr + 3n + 177MeV$
c. Determine the ground state properties of i) $^{15}_{8}O$, ii) $^{16}_{8}O$ and iii) $^{16}_{7}O$. **(06)**

OR

Q-5 **a.** Explain the volume and surface energy terms contributing towards the binding energy in a semi empirical mass formula. **(04)**
b. Explain the concept of mass parabola for odd A nuclei with suitable example. **(06)**
c. Check if the following reactions are possible or not taking into consideration laws of conservation of charge, lepton number, baryon number and strangeness: **(04)**
$n \rightarrow p + e^- + \vartheta_e^-$

Q-6 **Attempt all questions** **(14)**

a. Taking into consideration the laws of conservation of charge (Q), lepton number (L), baryon number (B), isospin (I), I_3 and hypercharge (Y); check whether the following nuclear reaction is allowed or not: **(06)**
$p + p \rightarrow \Lambda^0 + K^0 + p + \pi^+$
b. The quark content of a neutron is (udd); determine its charge (Q), baryon number (B), I_3 and strangeness (S). **(05)**
c. A particle Δ^+ is having quark content (uud); determine its charge (Q), baryon number (B) and strangeness(S). **(03)**

OR

Q-6 **Attempt all Questions** **(14)**

a. Explain the evidence that led to the shell model. **(06)**
b. Determine the ground state properties of i) $^{12}_{6}C$ and ii)$^{13}_{6}C$. **(03)**
c. Considering the laws of conservation of charge (Q), lepton number (L), baryon number (B), hypercharge (Y) and isospin (I) check whether the following reaction is allowed or not: $\pi^+ + n \rightarrow K^0 + K^+$ **(05)**