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SARDAR PATEL UNIVERSITY
M.Sc. (PHYSICS) (Fourth Semester) Examination
Day & Date: Monday & 18/03/2019
Time: 10:00 AM to 01:00 PM
Title: NUCLEAR AND PARTICLE PHYSICS
Course Code: PS04CPHY21

Instruction: Figures to the right indicate marks.

Total Marks: 70

Q.1 Write answer of all questions by showing your choice against the question number. [8]

(1) Exchange of spin co-ordinates only takes place in _____ interaction.
  (a) Majorana (b) Wigner (c) Heisenberg (d) Bartlett

(2) Which of the following property is possessed by Nuclei just below Magic Nuclei?

  (a) Excited states (b) Isomerism (c) Large life time (d) all of them

(3) The three β –decay process are _____ transitions.
  (a) Isobaric (b) Isotopic (c) Isometric (d) Isothermal

(4) A free neutron outside a nucleus undergoes a _____ - decay.
  (a) β^- (b) β^+ (c) Electron-capture (d) none of them

(5) Electrons losses energy in medium due to two processes - _____ and Bremsstrahlung radiations.
  (a) ionization (b) absorption (c) adsorption (d) elastic

(6) There can be below two possibilities for fine structure of α - particle spectrum.
  1. The parent has multiple excited states and daughter has one ground state
  2. The parent and daughter has simultaneous multiple excited states
  3. The parent and daughter has only one ground state
  4. The parent has one ground state and daughter has multiple excited states
  (a) 1 & 2 (b) 2 & 3 (c) 3 & 4 (d) 4 & 1

(7) Hyper charge is conserved in _____ nuclear interactions.
  (a) Electroweak (b) strong (c) Electromagnetic (d) all of these

(8) _____ and _____ are characterized by strangeness number.
  (a) Bosons, Mesons (b) Hyperons, Mesons
  (c) Hyperons, Keoans (d) Fermions, Bosons

Q.2 Attempt any Seven of the followings: [14]
(1) Explain Nordheim's rule for odd Z – odd N Nuclei.
(2) Discuss exchange forces between proton and neutron in brief.
(3) Discuss in brief Q-values in the three β-decay processes.
(4) With schematic diagram of a tank containing hydrogeneous material, explain experimental detection of neutrino.
(5) Explain inverse β-decay process and for what study it is used?

(6) Explain very briefly the Fermi-Kurie plot.

(7) Discuss the classification of elementary particles.

(8) Briefly discuss the idea of Grand Unification theory.

(9) What is compound nucleus? Write a nuclear reaction where in compound nucleus is formed.

Q.3(a) Describe the experimental information of deuteron nucleus. Solve the Schrodinger [6] wave equation for two body problem in the centre of mass system. Discuss the shape of the ground state wave function for deuteron.

Q.3(b) Discuss successes and failure of single particle shell model. Explain how collective [6] model overcomes the shortcoming of single particle shell model.

OR

Q.3(b) How Magnetic moment of deuteron is a mixture of 96% $^3S_1$ and 4% $^3D_1$ states? [6] Explain.

Q.4(a) Explain the Fermi theory of β-decay by deriving and discussing the equation of [6] transition probability.

Q.4(b) With the potential energy curve explain in details the theoretical explanation of [6] alpha disintegration.

OR

Q.4(b) Write a short note on electromagnetic transitions in nuclei. [6]

Q.5(a) Explain the interaction of heavy charged particles with matter and derive the [6] equation for the energy loss.

Q.5(b) Write a note on interaction and slowing down of neutrons in matter. [6]

OR

Q.5(b) Explain in detail the solar fusion having proton-proton cycle and CNO cycle. [6]

Q.6(a) Discuss Conservation laws of elementary particles with at least two examples for [6] each. Examine the following Interaction. (Allowed/Forbidden)
(a) $K^- + K^- + p^+ \rightarrow \Omega^- + K^+ + K^0$　　(b) $\pi^+ \rightarrow \mu^+ + v + K^-$
(c) $\pi^+ \rightarrow \mu^+ + v + \bar{v}$　　　　　　　　(d) $\Lambda \rightarrow p + \pi^-$

Q.6(b) Discuss the SU(3) symmetry for baryons and mesons. [6]

OR

Q.6(b) Discuss the Standard model of quarks and the quark structure for baryons and [6] mesons. Calculate the charge and spin for proton and neutron from their quark structures.

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