SEAT No._____

[57 & A-24]

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**Sardar Patel University**

**M Sc (Physics)- IV Semester Examination**

**PS04CPHY01 Nuclear and Particle Physics**

**Day and Date: Monday, 9th April 2018**

**Time: 10:00 am to 1:00 pm** **Max marks: 70**

**I Choose the best possible answer from the choices given below the questions** (8x1=8)

1. Weizsacker's mass formula predicts that
   (a) For odd A nuclei there can be only one stable isotope
   (b) For odd A nuclei there can be more than one stable isobars
   (c) For even A and even Z nuclei there can be only one stable isobars
   (d) All odd A and odd Z isotopes are stable

2. The Coulomb energy difference between the two mirror nuclei can be used to estimate
   (a) the BE of the nucleus (b) pairing energy of the nucleus
   (c) the nuclear size (d) nuclear charge distribution

3. Parity violation in weak decay is experimentally established by

   (a) Gammow-Teller experiment
   (b) Wu's experiment
   (c) Cabbibo experiment
   (d) Bohr & Mottleson experiment

4. The islands of isomerism is well explained by

   (a) Liquid drop model (b) Collective model
   (c) Single particle shell model (d) Statistical model

5. The anomalous magnetic moments of proton and neutron is understood by

   (a) The liquid drop model (b) Collective model
   (c ) charged pion cloud surrounding them (d) the atomic electron cloud

6. The beta decay transitions from $0^+ \rightarrow 0^+$ is allowed according to the

   (a) Fermi selection rule (b) Gammow-Teller selection rule
   (c ) By both the Fermi and G-T selection rules (c ) dipole selection rule

7. The exchange particles responsible for the colour interactions are

   (a) coloured gluons (b) photons
   (c) mesons (d) quarks

8. If B represents the baryon number and S represents the strangeness then B + S represents
   (a) Fermi number (b) Lepton number
   (c) Hadron number (d) Hypercharge

(P.T.O.)

**II Attempt any seven of the following short answer questions.** (7x2=14)

1. What does the spin-parity of the deuteron ground state equal to $1^+$ suggests? Explain.
2. Express the most general form of a tensor potential.
3. Explain very briefly the Fermi-Kurie plot.
4. Discuss the selection rules for electric and magnetic transitions in nuclei.
5. Explain the experimental basis for the single particle shell model?
6. Explain the Nordiem rule. Why is it required?
7. Explain the Geiger-Nuttel law with reference to alpha decay
8. Discuss briefly the gauge principle and its consequences.
9. Explain the basic concept of grand Unification theory.

III A. Based on the Liquid drop model, obtain the nuclear binding energy formula and explain each term. Compute the energy released by the fission of $^{235}U$ nucleus to $_{56}Ba^{141}$ and $_{36}Kr^{92}$. (6)

B. Discuss how the experimental magnetic moment of deuteron is accounted for? Then show that ground state of deuteron is an admixture of s and d- states. (6)

**OR**

B. Explain the various exchange forces of the two body nuclear interaction. Compute their contributions for the spin triplet and singlet states with different choices of angular momentum values.. (6)

IV A. Discuss in detail the experimental proof of the parity violation in $\beta$ – decay. (6)

B. Based on harmonic oscillator potential as the mean field nuclear potential, discuss the nuclear shell model. Explain the importance of the spin-orbit interaction. Using the single particle shell model determine the spin and parity of the ground state of 3Li7 nucleus. (6)

**OR**

B. Discuss how the alpha particle energy spectrum is analyzed. Based on quantum tunneling explain the alpha decay process of nucleus. (6)

V A. Show that the stopping power of heavy charged particle in matter depends mainly on its charge, mass and kinetic energy. Derive the relevant relationships. (6)

B. Discuss various types of nuclear reaction mechanisms. Explain the pre-equilibrium reaction mechanism through compound nuclear formation. (6)

**OR**

B. Explain briefly the therapeutic and diagnostic applications of nuclear physics. (6)

VI A. Describe the Gell-Mann's naïve SU(3) quark model for hadrons. Discuss its successes and failures. (6)

B. What is colour degrees of freedom for quarks? Why is it required? Discuss the properties of quantum chromodynamics (QCD) and compare them with that of QED. (6)

**OR**

B. Write short notes on i) Spontaneous symmetry breaking (6)
ii) Standard model of Particle Physics