CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY

IV Semester of MSc Physics Examination May 2018

Course code & Name: PS952 Nuclear and Particle Physics

Date: 02-05-2018 Day: Wednesday Time: 10.00 am. To 10.30 am. Maximum Marks: 20

MCQ

Important Instructions:

- Tick the correct answer and it should be written in question paper itself.

Q – I Choose the correct answer for the following questions.		
1.	Deviation from Rutherford scattering formula for alpha particle scattering gives an estimation of a) Size of an atom b) Thickness of the target c) Size of the nucleus d) Half-life of alpha emitter.	
2.	The curve for B.E with fixed A as a function of Z is a) Straight line b) Parabola c) Circle d) Exponential curve	
3.	Non-zero quadrupole moment of deuteron indicates that a) Deuteron ground state is s-state-triplet b) Deuteron ground state is s-state-singlet c) Deuteron ground state is an admixture of s and p-states d) Deuteron ground state is an admixture of s and d-states	

4.	Neutron to Proton ratio for stable nuclei goes on increasing as Z-increases. This is due to a) Symmetry energy b) Pairing energy c) Surface energy d) Coulomb energy	
5.	Radius of nucleus varies as a) A b) A^2 c) $A^{1/3}$ d) A/Z	
6.	Deviation from spherical shape of nucleus is measured in terms of a) Magnetic moment of the nucleus b) Spin of the nucleus c) Quadrupole moment of the nucleus d) Parity of the nucleus	
7.	Consider Fermi theory of beta decay. The number of final state of electrons corresponding the momenta between p and p+dp is a) Independent of p b) Proportional to p^1dp c) Proportional to p^2dp d) Proportional to p^3dp	
8.	Magnetic moment of deuteron is not equal to the sum of neutron and proton. This is due to a) Spin dependence of nuclear forces b) Tensor characteristics of nuclear forces c) Spin-orbit parts of the nuclear forces d) Hard-core characteristics of nuclear forces.	
9.	Choose correct statement a) The decay of artificial radioactivity sample is not statistical in character. b) There is no difference between natural and artificial radioactivity except their origin c) Conservation laws like energy, angular momentum are violated by artificial radioactivity.	
10.	Which one of the following is a set of magic numbers a) 1,2,8,16,20,28 b) 2,8,16,20,28,50 c) 8,28,50,82,100,126 d) 2,8,20,28,50,82,126	

11.	The mean life of a radioactive sample with λ as a decay constant is a) $\ln 2/\lambda$ b) $e^{-\lambda}$ c) $1/\lambda$ d) None of the above	
12.	Which of the following is not a unit of radiation. a) Curie b) Becquerel c) Roentgen d) Newton	
13.	According to meson theory of nuclear forces a) A neutron emits a π^- meson and is converted into a proton b) A neutron emits a π^0 meson and is converted into proton c) A neutron emits a π^+ meson and is converted into proton d) A neutron cannot converted into proton.	
14.	The puzzle of magic numbers for nuclei was resolved by a) Introducing hard-core potential b) Introducing Yukawa potential for approximating the nuclear potential well c) Introducing a tensor character to nuclear forces d) Introducing spin-orbit force part to the nuclear potential.	
15.	Which of the following is not true for alpha decay a) There is pre-formation probability of alpha particle in the parent nucleus b) Alpha particle collides with nuclear surface many times. c) Quantum mechanical tunnelling is involved in the process d) Alpha particle kinetic energy equals the Q value of the decay.	
16.	The large pieces of the fission fragments are a) β^+ emitters b) β^- emitters c) alpha emitters d) Neutron emitters.	
17.	Which of the following is treated as a composite particle a) π-Mesons b) electron c) muon d) positron	
18.	Which particles don't participate in strong interaction? a) Leptons b) Hadrons c) Mesons d) Baryons.	

19.	Quarks can interacts via a) Strong interactions only b) Strong and weak interaction only c) All: strong, weak and electromagnetic d) Strong and electromagnetic interactions only	
20.	Hadrons can be divided into a) Photons and neutrons b) Muon and pions c) Mesons and baryons d) Tau and pion	

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Course code & Name PS952 Nuclear and Particle Physics

Date: 02-05-18 Day: Wednesday Time: 10.30 a.m. To 1.0 p.m. Maximum Marks: 50

Instructions:

1. **Section I and II must be attempted in SEPARATE ANSWER SHEET.**
2. Make suitable assumptions and draw neat figures wherever required.
3. Use of non-programmable calculator is allowed.
4. Show necessary calculations.

Section-I

Que. 2 Answer the following questions. Marks: 20

(a) Give the reasons for the non-occurrence of electrons in the nuclei (3)

(b) Why most of the odd-odd nuclei are unstable? (3)

(c) Calculate the binding energy of Lithium having A = 7 and Z = 3. Using this calculate B.E per nucleon. (M_{Li} = 7.016005 amu) (3)

(d) Calculate the ground state of ${}_8O^{15}$ nucleus according the shell model. (2)

(e) Mention necessary physical arguments supporting non-existence of an excited S-state of deuteron. (3)

(f) What are the differences between alpha decay and beta decay processes? (3)

(g) Give examples showing Lepton conservation in pion decay, muon decay and pair production. (3)

Section-II

Que. 3 Answer the following questions. Marks: 30

(a) Obtain the expression for B.E difference for mirror nuclei. (4)

(b) Using the semi-empirical mass formula, find the most stable Isobar for a nucleus having odd A. (The value of co-efficient: a_v = 0.01691 amu, a_s = 0.01911 amu, a_c= 0.00763 amu, a_a = 0.10175 amu and a_p = 0.012 amu) (4)

(c) Using the finite square well potential of depth V_0 and range R for the deuteron problem, obtain the condition which gives a relation between V_0 and R. (4)

(d) Predict the ground state spin and parity of the following nuclei: $_{19}K^{39}$ and $_{8}O^{18}$. (Write nuclear configuration of state occupied) (4)

(e) Show that $T_\alpha = Q\,(1-4/A)$ for $A>>4$. Here T_α is the kinetic energy of the alpha decay reaction, and Q = Q-value of the decay reaction. (4)

(f) Discuss Fermi theory of beta-decay process (only qualitatively, emphasizing the concepts involved). (4)

(g) Evaluate the quantum numbers T, T_3, B, S and Q for the neutron and π^+ particles. (3)

(h) Explain the concept of CP-invariance with example. (3)

Physical Constants:

Mass of Proton: 1.007825 units

Mass of Neutron: 1.008665 units

1 atomic unit = 931 MeV/c^2