

C 31290

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Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2017

(CUCSS)

Physics

PHY 3C 10—NUCLEAR AND PARTICLE PHYSICS

(2012 Admissions)

Time : Three Hours

Maximum : 36 Weightage

Section A

Answer all questions.

Each has weightage 1.

1. If stable nuclei have equal number of proton and neutron whereas the heavy nuclei have excess of neutron. Explain why ?
2. Explain the general nature of the nucleon-nucleon potential.
3. Explain briefly the electron scattering technique used for nuclear radius determination.
4. What is asymmetry energy in the semi empirical mass formula ?
5. Explain CPT theorem.
6. Briefly explain why deuteron has a ground state S state and cannot have any excited S state.
7. Describe the magic numbers. How the magic number can be explained with the help of the shell model for a nucleus ?
8. Derive an expression for Q-value of a nuclear reaction. Show that an exothermic reaction is possible even when the reacting nuclei have no energy.
9. Describe about the source of energy in the core of our sun.
10. Briefly explain the characteristic nature of energy spectrum of beta particles.
11. Describe the quarks and their properties.
12. Mention the interacting and mediating particles in each of the basic forces of nature. What is the spin of the mediating particles ?

(12 × 1 = 12 weightage)

Turn over

Section B

Answer any **two** questions.

Each has weightage 6.

13. Discuss the Effective range theory of n-p scattering and obtain a relation between scattering length, effective range and deuteron binding energy.
14. Describe Gamow's theory of alpha decay. Discuss how the theory explain Geiger Nuttal law.
15. Give an evidence in favour of a shell structure in a nuclei. State main assumptions in the shell model of the nuclei and describe its success.
16. (a) Give detail information about the formation of mesons or baryons with the help of quark model.
(b) Describe the eight color gluons and their matrices.

(2 × 6 = 12 weightage)

Section C

Answer any **four** questions.

Each has weightage 3.

17. Using the harmonic-oscillator shell model, describe the expected configurations for the ground states of the light stable nuclei with $A \leq 4$, specify also their total L, S, J and T quantum numbers and parity.
18. The simplest model for low lying states of nuclei with N and Z between 20 and 28 involves only $f_{7/2}$ nucleons. Using this model predict the magnetic dipole moment of ${}^{41}_{20}\text{Ca}_{21}$ and ${}^{41}_{21}\text{Sc}_{20}$.
19. Consider the following high energy reactions or particle decays :
 - (i) $\pi^- + p \rightarrow \pi^0 + n$.
 - (ii) $\pi^0 \rightarrow \gamma + \gamma + \gamma$.
 - (iii) $\pi^0 \rightarrow \gamma + \gamma$.
 - (iv) $p + \bar{p} \rightarrow \gamma$. Indicate for each case :
 - (a) Allowed or forbidden.
 - (b) Reason if forbidden.
 - (c) Type of interaction if allowed.

20. The half life of ${}_{13}\text{Al}^{28}$ is 2.3 min and that of ${}_{11}\text{Na}^{23}$ is 15 hrs. Obtain a value for the ratio of the number of aluminium atoms to sodium atoms remaining after 12 min. At what time will this ratio be unity ?
21. Explain why a baryon of spin 1 and antibaryon of electric charge +2 cannot exist according to quark model.
22. In the scattering experiment using alpha particles of energy 7.68 MeV and the target materials are gold and aluminium. Calculate the distance of the closest approach in both cases.

(4 × 3 = 12 weightage)