

M.Sc. DEGREE (C.S.S.) EXAMINATION, JUNE 2015**Fourth Semester**

Faculty of Science

Branch II : Physics – A – Pure Physics

PH 4C 12—NUCLEAR AND PARTICLE PHYSICS

(2012 Admission onwards—Regular/Supplementary)

(Common for all)

Time : Three Hours

Maximum Weight : 30

Part A*Answer any six questions.**Weight 1 each.*

1. Briefly describe magnetic moment of the nuclei.
2. Explain the meson exchange theory of nuclear force.
3. Reason out the general nature of the nucleon = nucleon potential.
4. Explain the collective model of the nucleus.
5. In the semi empirical mass formula, what is 'asymmetry energy' ?
6. What is the role of neutrino in β - decay ?
7. Explain what is meant by CPT theorem.
8. Briefly discuss about colour quantum numbers.
9. Illustrate with an example the conservation laws obeyed in a nuclear reaction.
10. Describe a set up for measuring the neutron scattering cross-section. What is the advantage of using a thin sample of the scatterer ?

(6 × 1 = 6)

Part B*Answer any four questions.**Weight 2 each.*

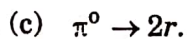
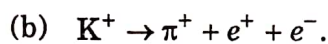
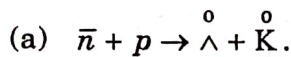
11. Two protons of kinetic energies E_{p_1} , and E_{p_2} , respectively collide and form a deuteron with kinetic energy E_D , positron of kinetic energy 0.04 MeV and a neutrino of energy Y eV. Obtain an equation to calculate the mass defect of the deuteron from the above.

Turn over

12. Consider the following decay $^{17}\text{F} \rightarrow ^{17}\text{O} + \beta^+ + \nu_e$. Find the maximum kinetic energy of the positron if the atomic masses of ^{17}F and ^{17}O are $17.0075 u$ and $17.0045 u$ respectively.

($m_e c^2 = 0.511 \text{ MeV}$ and $1 u$ is equivalent to 931.5 MeV).

13. The nucleus ^{12}N decays to ^{12}C with Q value 16.38 MeV . Calculate the maximum recoil energy of the daughter nucleus.
14. Find the speeds of alpha particles emitted with energies 2 MeV and 6 MeV .
15. Using semi-empirical mass formula show that a nucleus with mass number A and atomic number Z is unstable against symmetric fission if the relation $\frac{Z^2}{A} > 15$ is approximately satisfied.
16. Determine the type of interaction (strong, weak or electromagnetic) through the following processes can take place. Give reasons for your answer :



(4 × 2 = 8)

Part C

Answer all questions.
Weight 4 each.

17. (a) Describe an experiment to determine the nuclear radius and size.
(b) Write a note on quantum properties of nucleons.

Or

- (a) State the basic assumptions in the nuclear shell model and discuss the need for introducing a spin-orbit interaction.
(b) Explain why the shell model predictions of nuclear quadrupole moments are in poor agreement with experimental observations.
18. Elucidate the Bohr-Wheeler theory of nuclear fission.

Or

- (a) Give the quantum mechanical treatment of the deuteron.
- (b) Show that the mixing of the S and D states accounts for the magnetic moment of the deuteron.
19. (a) Obtain the expression for the rate of probability of β decay using Fermi's theory.
- (b) Explain how far the Fermi's theory has succeeded in explaining the experimental findings.

Or

Discuss schematically a nuclear fission reactor.

20. Describe the quark model of hadrons. Discuss the quark contents of baryon octet, baryon decuplet, pseudoscalar mesons and vector mesons. Briefly comment on coloured quarks and QCD.

Or

Explain the eight-fold way and SU (3) model for strong interaction. Discuss CPT invariance.

(4 × 4 = 16)