

Reg. No. :

Name :

Sixth Semester B.Sc. Degree Examination, April 2023

First Degree Programme under CBCSS

Physics

Core Course X

PY 1642 : NUCLEAR AND PARTICLE PHYSICS

(2018 Admission Onwards)

Time : 3 Hours

Max. Marks : 80

SECTION – A

Very short answer type questions. Answer all questions.

1. What is meant by mass defect in a nucleus?
2. What do you mean by nuclear isotones?
3. What is meant by internal conversion?
4. Write any two differences between radioactivity and chemical reaction.
5. Define half-life of a radioactive isotope.
6. Define Q-value of a nuclear reaction.
7. What is meant by pair production?
8. What is the function of control rods in a nuclear reactor?

P.T.O.

9. Nuclear fusion is known as thermonuclear reactions. Why?
10. What are fermions and bosons?

SECTION – B

(10 × 1 = 10 Marks)

Short answer type questions. Answer any **eight** questions. Each question carries **2** marks.

11. Write a note on Yukawa's Meson theory of nuclear forces.
12. Discuss the nuclear magnetic moments of a proton and neutron.
13. What is meant by binding energy of a nucleus? Write the equation for binding energy.
14. Write down the semi-empirical mass formula for binding energy of a nucleus and mention the name of each energy terms.
15. Write a note collective model of nucleus.
16. Give any two limitations of liquid drop model of nucleus.
17. Derive the radioactive decay law $N = N_0 e^{-\lambda t}$.
18. What is meant by a compound nucleus? Give an example.
19. What is the advantage of synchrotron over ordinary cyclotron.
20. Explain the working of GM counter.
21. Explain Bohr and Wheeler's theory of nuclear fission.
22. What are the major hazards of nuclear power plant?

(8 × 2 = 16 Marks)

SECTION – C

Answer any **six** questions. Each question carries 4 marks.

23. The radius of Uranium ($^{238}_{92}\text{U}$) nucleus is 7.44 fermi. Estimate the radius of Nitrogen ($^{14}_7\text{N}$) nucleus.
24. Calculate the binding energy of the last neutron in $^{23}_{11}\text{Na}$. Mass of $^{23}_{11}\text{Na} = 22.9898u$, atomic mass of $^{23}_{11}\text{Na} = 21.9944u$, mass of neutron = $1.0087u$.
25. The activity of 2.00 mg of radon is 310 Ci. What will be its activity after one week? Half life of radon is 3.8 days.
26. Find the probability that a particular nucleus of Cl-38 will decay in any 1.00 s period. (Half life = 37.2 minutes)
27. Find the Q-value of the following reaction $^1_1\text{H} + ^3_1\text{H} \rightarrow ^2_1\text{H} + ^2_1\text{H}$ and state whether the reactions are exothermic or endothermic. The atomic masses of ^1_1H , ^2_1H , and ^3_1H are respectively 1.0078 u, 2.0141 u and 3.0160 u.
28. A ^3_2He nucleus at rest absorbs a thermal neutron (almost at rest) by the following reaction. $^3_2\text{He} + ^1_0\text{n} \rightarrow ^3_1\text{H} + ^1_1\text{H}$ $Q = 0.763\text{MeV}$
Calculate the kinetic energy of the two final product particles.
29. Determine the magnetic field intensity needed in a 1 km radius synchrotron for 400 GeV protons. Use the relativistic mass.
30. A nuclear reactor containing U-235 is operating at a power output of 2 W. Calculate the number of fissions per second if 200 MeV of energy is produced in the fission of single uranium nucleus.

31. Check whether the following reaction $\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$ is allowed on the basis of conservation laws of charge, electron lepton number and muon lepton numbers.

(6 × 4 = 24 Marks)

SECTION – D

Answer any **two** questions. **Each** question carries **15** marks.

32. Write a short note on the following properties of nucleus:
- (a) Composition (b) Size (c) Quadrupole moment (d) Spin and magnetic moment
33. Explain the essential features of shell model of a nucleus. What are magic numbers? Give any four evidences for the existence of magic numbers.
34. Explain the origin of line and continuous beta ray spectrum and discuss the neutrino theory of beta decay.
35. Explain the classification of elementary particles and give their properties.

(2 × 15 = 30 Marks)