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Reg. No. : .....

Name : .....

Sixth Semester B.Sc. Degree Examination, March 2020.

First Degree Programme under CBCSS

Physics

Core Course X

PY 1642 – NUCLEAR AND PARTICLE PHYSICS

(2013 Admission onwards)

Time : 3 Hours Max. Marks : 80

PART – A

Answer **all** the questions. Each question carries **1** marks.

1. Define unified atomic mass unit (u).
2. Write down the relation between nuclear radius and mass number.
3. Define half life of a radioactive isotope.
4. Write down the value of spin and binding energy of deuteron
5. Which particle is exchanged between the nucleons to exert nuclear force?
6. Write down the betatron condition for the orbit of electrons in a betatron
7. What is meant by elastic scattering in nuclear reactions?

8. Give any two differences between nuclear reactions and ordinary chemical reactions.

9. Nuclear fusion is known as thermonuclear reactions. Why?

10. What do you mean by cosmic rays?

(10 × 1 = 10 Marks)

PART – B

Answer **any eight** questions. Each question carries **2** marks.

11. What is meant by binding energy of a nucleus? Write the equation for binding energy.

12. Discuss the nuclear magnetic moment.

13. Mention any four conservation laws governing radioactive decay.

14. Write any four features of nuclear force inside a nucleus.

15. Briefly explain the working of Geiger-Muller counter.

16. Ordinary cyclotron cannot be used to accelerate electrons. Why?

17. What is meant by Q-value of a nuclear reaction?

18. Explain the term scattering cross section.

19. Explain Bohr and Wheeler's theory of nuclear fission.

20. Explain inertial confinement in fusion reactors.

21. Explain cascade theory of cosmic ray showers.

22. Find the density of ${}^{16}_{8}O$ nucleus. Given $u = 1.66 \times 10^{-27} kg$.

(8 × 2 = 16 Marks)

PART – C

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

23. Calculate the binding energy per nucleon in ${}^{12}_{6}C$. Masses of proton neutron and electron are $1.007276u, 1.008665u$ and $.00055u$ respectively. Atomic mass of ${}^{12}_{6}C = 12u$.

24. If 500μg of ${}^{131}I$ is injected in a patient, determine the activity immediately after injection. Half life of ${}^{131}I = 8.04$ days. Avogadro number $= 6.022 \times 10^{23}$ per gram mol.

25. The experimentally measured mass of π-meson is 140 MeV/c^2. Estimate the range of the nuclear force.

26. A Geiger-Muller counter wire collects 10^7 electrons per discharge. The average current in the circuit is $1.333 \times 10^{-11} A$. Find the counting rate per minute.

27. A cyclotron of maximum radius 0.25 m, accelerates protons in a 2.0 T magnetic field. Calculate the frequency needed for the applied alternating voltage.

28. The cross section of ${}^{113}Cd$ for capturing thermal neutrons is 21000 barns and its density is $8.64 g/cm^3$. What thickness of cadmium is needed to absorb 99.99 percent of an incident beam of thermal neutrons? Avogadro number $= 6.022 \times 10^{23}$ per gram mol.

29. Determine the product nucleus and Q-value in the reaction ${}^{27}_{13}Al(d,\alpha)$. Masses of ${}^{27}_{13}Al = 26.9901u$, mass of ${}^{25}_{12}Mg = 24.9936u$, mass of deuteron = $2.0147u$ and mass of $\alpha = 4.0039u$.

30. What is the energy releases when 1 kg of nuclear fuel is consumed if the fusion reaction ${}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}He$ is possible (Mass of ${}^{2}_{1}H = 2.0141u$, mass of ${}^{4}_{2}He = 4.0026u$.

31. The neutral pion at rest decays by $\pi^0 \rightarrow \gamma + \gamma$. Calculate the wavelength of gamma ray photon. Rest mass of $\pi^0 = 264 m_e$, where m_e is the mass of the electron.

(6 × 4 = 24 Marks)

PART – D

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

32. Explain the essential features of shell model of a nucleus. What are magic numbers? Give any four evidences for the existence of magic numbers.

33. Explain the origin of line and continuous beta ray spectrum and hence discuss the neutrino theory of beta decay.

34. Explain the working of a nuclear fission reactor. What is a fast breeder reactor?

35. Discuss the elementary particle quantum numbers and their conservation laws with examples.

(2 × 15 = 30 Marks)