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N – 1312

Reg. No. : .....

Name : .....

Sixth Semester B.Sc. Degree Examination, April 2022

First Degree Programme under CBCSS

Physics

Core Course X

PY 1642 – NUCLEAR AND PARTICLE PHYSICS

(2018 & 2019 Admission)

Time : 3 Hours

Max. Marks : 80

SECTION – A

Very short answer type questions. Answer **all ten** questions of **1** mark each

1. What is meant by the saturation of nuclear forces?
2. Give the expression for nuclear magneton.
3. What do you mean by collective model of nucleus?
4. What is meant by internal conversion?
5. Define rutherford (rd), a unit of radioactivity.
6. What is meant by nuclear transmutation?
7. What is meant by photoelectric effect?
8. What is nuclear fission?
9. What is tokamak?
10. What do you mean by resonance particles?

(10 × 1 = 10 Marks)

P.T.O.

SECTION – B

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

11. What is meant by nuclear quadrupole moment? Give its value for a perfect spherical distribution nuclear charge.
12. What is meant by binding energy of a nucleus? Write the equation for binding energy.
13. Give any four properties of nuclear force inside a nucleus.
14. Give four evidences for the existence of magic numbers.
15. Write down the semi-empirical mass formula for binding energy of a nucleus and mention the name of each energy terms.
16. What are the achievements of Shell model of nucleus?
17. Mention any four conservation laws governing radioactive decay.
18. What do you mean by electron capture? Give an example.
19. What is meant by a compound nucleus? Give an example
20. What do you mean by scattering cross section?
21. Why electrons cannot be accelerated in ordinary cyclotron?
22. Explain the working of scintillation detector.
23. Explain chain reaction.
24. What is meant by a breeder reactor?
25. Give the function of moderator in a nuclear reactor? Write down two examples for moderators.
26. Write a short note on strange particles.

(8 × 2 = 16 Marks)

SECTION – C

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

27. Calculate the binding energy per nucleon in $^{16}_{8}O$. Masses of hydrogen atom and neutron are 1.0078 u and 1.0087 u respectively. Atomic mass of $^{16}_{8}O = 15.995u$

28. Find the density of ${}^{14}_{7}N$ nucleus. Given $1u = 1.66 \times 10^{-27} kg$ and $R_0 = 1.2 \times 10^{-15} m$.

29. Polonium isotope ${}^{210}_{84}Po$ is unstable and emits a 5.30 *MeV* alpha particle. The atomic mass, of ${}^{210}_{84}Po$ is 209.9829 *u* and that of ${}^{4}_{2}He$ is 4.0026*u*. Identify the daughter nuclide and find its atomic mass.

30. Activity of 1g of radium-226 is 1 Ci. Calculate its half-life? (Avogadro number $= 6.023 \times 10^{23} mol^{-1}$)

31. Find the Q-value of the following reaction ${}^{12}_{6}C + {}^{12}_{6}C \rightarrow {}^{20}_{10}Ne + {}^{4}_{2}He$ and state whether the reactions are exothermic or endothermic. The atomic masses of ${}^{12}_{6}C$, ${}^{20}_{10}Ne$ and ${}^{4}_{2}He$ are respectively 12.000 *u*, 19.9924 *u* and 4.0026 *u*.

32. The Q-value of the reaction ${}^{23}_{11}Na(n,\alpha){}^{20}_{9}F$ is –5.4 MeV. Determine the threshold energy of the neutrons for this reaction. Mass of *n* = 1.008665 *u*, mass of ${}^{23}_{11}Na = 22.9898\ u$

33. Consider the fusion reaction ${}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{1}H + {}^{1}_{1}H$; $Q = 4.03\,MeV$ in which the deuteron and proton are essentially at rest. What is the kinetic energy of the tritium nucleus?

34. The voltage across 'Dees' of a cyclotron is 25 kV. How many revolutions do protons make to reach a kinetic energy of 20 MeV?

35. Determine the magnetic field intensity needed in a 1 km radius synchrotron for 400 GeV protons. Use the relativistic mass.

36. Small power stations in remote areas make use of energy from the radioactive decay of Po-210 to Pb-206. This nucleus is alpha emitter with an energy of 5.3 MeV with a half life of 138 days. Calculate power in watts per gram of Po-210.

37. The quark composition of neutron is *udd*. Show that this composition gives, the required charge, baryon number and strangeness of the neutron.

38. Check whether the following reaction $p^+ + p^+ \rightarrow \lambda^0 + K^0 + p^+ + \pi^+$ is allowed on the basis of conservation laws of charge, baryon number and strangeness.

(6 × 4 = 24 Marks)

SECTION – D

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

39. Explain the following:

    (a) Cyclotron

    (b) Synchrotron

40. Explain liquid drop model of a nucleus and arrive at the semi-empirical mass formula.

41. Discuss the Gamow's theory of alpha decay.

42. Discuss different types of nuclear reactions with examples and the conservation laws governing these reactions.

43. Explain the working of a nuclear fission reactor with the function of different parts. What is a fast breeder reactor?

44. Explain the different elementary particle quantum numbers and their conservation laws with examples.

(2 × 15 = 30 Marks)
