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Reg. No. : .....

Name : .....

Fourth Semester M.Sc. Degree Examination, October 2023

Physics with Specialization in Nano Science/Physics with Specialization in Space Physics

PHNS 541/PHSP 541 : NUCLEAR AND PARTICLE PHYSICS

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 75

SECTION – A

Answer any **five** questions. **Each** question carries **3** marks.

1. State the main propositions of Yukawa's theory of nuclear forces.
2. Explain the concept of scattering length. Give its simple geometrical interpretation.
3. What are stripping reaction? Explain what happens in a stripping reaction involving a deuteron.
4. Differentiate between nuclear fission and fusion reactions. Give one example each.
5. Briefly list the details of any one method for confining a plasma in a tokamak.
6. Explain the CNO cycle.
7. What are the two main types of particle accelerators and what are the two main modes of their operation.
8. Outline the unification scheme identified for the weak and the electromagnetic interaction.

(5 × 3 = 15 Marks)

P.T.O.

SECTION – B

Answer **three** questions. **Each** question carries **15** marks.

9. (a) Explain the liquid drop model and develop the Semi-empirical mass formula for the finding energy.

   (b) Illustrate how any two of the experimentally determined characteristics of the deuteron point to the possibility of non central nuclear forces. How in non-centrality taken into account.

Or

10. (a) Briefly delineate the experimental results that led to the formulation of the optical model for nuclear reactions. Give the main features of this model.

    (b) What are resonance reactions? Derive and explain the Brait - Wigner formula.

11. (a) Explain the four factor formula in terms of the four factors that enter it.

    (b) Give the steps of the P.P. chain. Establish that nuclear fusion needs to be invoked for explaining energy production in stars and also that it is sufficient for the same.

Or

12. (a) What is the laws on criterion? What is its significance in the context of nuclear fusion?

    (b) Explain the principle of inertial confinement fusion. How is fusion achieved so in practice?

13. (a) Explain the working principle of a cyclotron. Illustrate that the same cyclotron can be used to accelerate ions of a different mass and charge.

    (b) Explain the working of any one type of semiconductor detector. Use a schematic circuit diagram.

Or

14. (a) Characterize weak decays in terms of the quantities conserved / not conserved in them. Use suitable examples.

    (b) Delineate the salient features of GUT.

(3 × 15 = 45 Marks)

SECTION – C

Answer any **three** questions. **Each** question carries **5** marks.

15. Derive an expression for and hence evaluate the maximum energy for S wave n-p scattering in the centre of mass frame in terms of the range of the nuclear force.

16. Determine the Q values for the reaction $12C(\alpha, x)^{16}O$, $M(\alpha) = 4.0015\,amu$; $M\left(^{16}O\right) = 15.995\,amu$.

17. ^{235}U undergoes fission yielding ^{141}Ba and ^{92}Kr. Given that $M\left(^{235}u\right) = 233.04278$; $M\left(^{141}Ba\right) = 140.9129$; $M\left(^{92}Kr\right) = 91.8972$; $M(n) = 1.00866$ determine approximately the kinetic energy of the ^{141}Ba nucleus.

18. A star has a luminosity of $10^{26}\,W$. The star is burning hydrogen to produce helium by fusion in its core via the reaction $4\,^1H \rightarrow {}^4_2He + 2e^+ + 2\gamma e$.

    Estimate the number of neutrinos emitted by the star per second. $M(H) = 1.0073\,amu$. $M(4He) = 4.0015\ amu$.

19. For a medium of refractive index 1.5 determine the minimum kinetic energy of protons that may be detected by a cherenkov detector employing the medium.

    Take $M\left(P^+\right) = 1\,amu$.

20. Setup the weight diagram $(I_3 - Y)$ plot for the baryon octet.

(3 × 5 = 15 Marks)