D3APH2102 (2 Pages) Name............................
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# THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2022
**(Regular/Improvement/Supplementary)**

## PHYSICS
## FPHY3C10: NUCLEAR AND PARTICLE PHYSICS

**Time: 3 Hours** **Maximum Weightage: 30**

**Part A: Short answer questions. Answer *all* questions. Each carries *one* weightage.**

1. What are the constraints to measure nuclear radius?
2. Give a brief account of exchange force model.
3. What is the role of neutrino in β- decay?
4. Explain the concept of confined quarks.
5. Draw the beta ray spectrum and explain why it is continuous.
6. State the limitations of shell model.
7. Give a simple theory of deuteron structure.
8. Explain the collective model of the nucleus.

**(8 × 1 = 8 weightage)**

**Part B: Essay questions. Answer any *two* questions. Each carries *five* weightage.**

9. Obtain the expression for phase-shift and scattering cross section in the case of low energy n-p scattering.
10. State the basic assumptions in the nuclear shell model and discuss the need for introducing spin-orbit interaction. Explain why the shell model prediction of the nuclear quadrupole moments is in poor agreement with experimental observations.
11. Explain the construction, working and characteristic curve of GM counter. Mention its applications.
12. Explain the eight fold way and SU(3) model for strong interaction. Discuss CPT invariance.

**(2 × 5 = 10 weightage)**

**(P.T.O.)**

**Part C: Problems. Answer any *four* questions. Each carries *three* weightage.**

13. Calculate the maximum energy available to the electrons in the decay of $Na^{24}$. Why are beta particles of this energy not observed experimentally?

14. What is internal conversion? A nucleus which can decay through both gamma ray emission and internal conversion has a life time of 8.7 ps and its probability for gamma emission is $\lambda_{\gamma}= 4.1\times 10^{10} s^{-1}$. Find the probability for internal conversion for this nucleus.

15. A sample of uranium emitting α-particles of energy 4.08 MeV, is placed near an ionization chamber. Assuming that only 10 particles per sec enter the chamber, calculate the current produced.

16. Determine the threshold energy for the reaction $\alpha + {}^{14}_{7}N \rightarrow p + {}^{17}_{8}O$.

    Nuclear masses are $M_{\alpha}$ = 4.002603 u; $M_{N^{14}}$ = 14.003074 u; $M_{O^{17}}$ = 16.999131 u; $M_P$ = 1.0078254 u.

17. What spin, parity and isospin would the shell model predict for the ground state of $B^{13}$ , $C^{13}$ and $N^{13}$?

18. A particle X decays at rest weakly as follows $X \rightarrow \pi^0 + \mu^+ + \nu_\nu$. Determine the following properties of X.

    $(a)$ Charge; $(b)$ Baryon number; $(c)$ Lepton number; $(d)$ Isospin; $(e)$ Strangeness $(f)$ spin; $(g)$ boson or fermion ; $(h)$ Identify X.

19. Give the quark structure of the following particles.

    $(a)$ Proton $(b)$ $\Omega^-$ $(c)$ $\pi^+$ $(d)$ $K^+$ $(e)$ $\mu^-$ $(f)$ $\Lambda^0$.

**(4 × 3 = 12 weightage)**