

D3APH2002

(2 Pages)

Name.....

Reg. No.....

**THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2021  
(Regular/Improvement/Supplementary)**

**PHYSICS  
FPHY3C10: NUCLEAR AND PARTICLE PHYSICS**

**Time: 3 Hours**

**Maximum Weightage: 30**

**Part A: Short answer questions. All questions can be answered. Each carries one weightage.  
(Ceiling 6 weightage).**

1. Briefly explain Yukawa's theory of nuclear forces.
2. Write selection rules of allowed nuclear decays. Give an example.
3. Plot the splitting of the nuclear levels based on spin-orbit interaction.
4. What is meant by the dead time of G-M counter?
5. Mention the uses of semiconductor detectors.
6. Why is statistics of counting essential in the case of nuclear events like radioactive transformation.
7. Compare the voltage-sensitive type and charge-sensitive type preamplifiers.
8. Explain the need for color quantum number in describing quarks.

**Part B: Essay questions. All questions can be answered. Each carries six weightage.  
(Ceiling 12 weightage).**

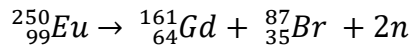
9. Discuss the general characteristics of nuclear forces in detail.
10. Discuss the Fermi's theory of beta decay.
11. What are magic numbers? Describe the shell model of the nucleus and indicate how the model explains the existence of magic numbers.
12. Discuss the quark model with experimental evidence.

**Part C: Problems. All questions can be answered. Each carries four weightage.  
(Ceiling 12 weightage).**

13. Obtain an expression for scattering length. Comment on its sign.
14. Obtain the ground state spins and parity of the following nuclei:  ${}^7\text{Li}$ ,  ${}^{17}\text{O}$ ,  ${}^{23}\text{Na}$ ,  ${}^{27}\text{Al}$ , and  ${}^{58}\text{Ni}$ .

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

15. Calculate the energy released in the fission:



Masses of  ${}^{250}_{99}\text{Eu}$ ,  ${}^{161}_{64}\text{Gd}$ ,  ${}^{87}_{35}\text{Br}$  and neutron are 250.0849 amu, 160.9286 amu, 86.9220 amu and 1.008665 amu respectively.

16. What spin and parities would you predict for the ground state of  ${}^{15}_8\text{O}$  and  ${}^{17}_8\text{O}$ ? Justify your answer on the basis of shell model.

17. An ionization chamber is connected to an electrometer of capacitance 0.5pF and voltage sensitivity of 4 divisions per volt. A beam of  $\alpha$ -particle causes a deflection of 0.8 divisions. Calculate the number of ion pairs required and the energy of the  $\alpha$ - particles. Given that one ion pair requires energy of 35eV and  $e = 1.6 \times 10^{-19}$  Coulomb.

18. Give the quark structure of the following particles.

(a) proton                      (b)  $\Omega^-$                       (c)  $\pi^+$                       (d)  $\text{K}^+$                       (e)  $\mu^-$

19. A particle X decays at rest weakly as follows.  $X \rightarrow \pi^0 + \mu^+ + \gamma_e$ . Determine the following properties of X. (a) Charge; (b) Baryon number; (c) Lepton number; (d) Isospin; (e) Strangeness; (f) Spin; (g) Boson or Fermion and (h) identify X.