

(6 pages)

MAY 2016

P/ID 40010/PPHK

Time : Three hours

Maximum : 100 marks

PART A — (10 × 2 = 20 marks)

Answer ALL questions.

1. Explain why di-proton or di-neutron nuclei do not exist.
2. Write a short note on Mass parabola.
3. What you mean by pair production?
4. Explain salient properties of the nuclear forces.
5. Explain why it is not possible to have a $0^+ \rightarrow 0^+$ in γ -transition.
6. What is meant by helicity of neutrino?
7. Write a short note on super allowed transitions.
8. Expand the given nuclear reaction $^{13}\text{C}(p, X)^{10}\text{B}$ and find the unknown particle (X).

9. Write short note on Quark and gluons.
10. Determine the charges of the u and d quarks from the quark structure of a neutron.

PART B — (5 × 6 = 30 marks)

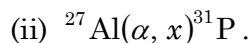
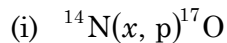
Answer ALL questions.

11. (a) Explain the charge independence and the spin dependence of nuclear forces.

Or

- (b) Outline Yukawa's meson exchange theory of nuclear forces.

12. (a) Expand the following reactions and determine the Q-values.



Or

- (b) Prove that the nuclear reaction cross-section varies inversely proportional to the velocity of the incident neutron for low energy neutrons.

13. (a) Discuss the Liquid drop model based on the Bohr-Wheeler theory of fission.

Or

- (b) Discuss the salient features of Nuclear Shell Model. Predict the ground state J^π of ^{15}N .

14. (a) Describe the Fermi and Gamow-Teller transitions in Beta decay and explain the allowed and forbidden transitions with suitable examples.

Or

- (b) Write notes on :
- (i) Internal conversion
 - (ii) Nuclear Isomerism

15. (a) Discuss the classification of Fermions and Bosons.

Or

- (b) What is Isospin? Write a note on conservation of Isospin.

PART C — (5 × 10 = 50 marks)

Answer ALL questions.

16. (a) Derive an expression for the binding energy of a deuteron, as a function of the depth and width of the potential.

Or

- (b) Explain the concept of scattering length and effective range in the study of low energy neutron-proton scattering and derive an expression for scattering cross section in terms of scattering length and effective range.

17. (a) Discuss briefly the various types of the direct reactions with suitable examples.

Or

- (b) Describe the Breit-Wigner dispersion formula for σ_r (the reaction cross section) and σ_s (the scattering cross section) for spin-less neutrons.

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18. (a) Discuss the Nuclear Shell Model and present the nuclear energy level scheme, with a suitable potential. Explain how the $\vec{L} \cdot \vec{S}$ interaction helps us to reproduce the magic number?

Or

- (b) (i) Discuss the salient features of the collective model.
- (ii) Find the total angular momentum and parity for the ground state of $^{33}\text{S}_{16}$ nucleus from the single particle shell model. Also, determine the magnetic moment and the electric quadrupole moment of $^{33}\text{S}_{16}$ nucleus. ($R_0 = 1.2 \text{ fm}$).
19. (a) Discuss the Fermi's theories of beta decay and explain the continuous beta spectrum.

Or

- (b) (i) What are the selection rules for gamma decay? Illustrate with examples.
- (ii) Determine the multipolarities in gamma decay using angular correlation techniques.

20. (a) What is CP invariance? Combined operation of charge and space or simultaneous reversal of charge and position coordinate on the particle.

Or

- (b) (i) What do you mean by SU(3) group?
(ii) Write down the weight diagram for the baryon octet.
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