



RAN-2303080102040005

M. Sc. (Sem. - II) Examination September - 2025

Physics (Paper - PH-424 - Elective 4) Nuclear and Particle Physics

Time: 3 Hours]
[Total Marks: 70
સૂચના : / Instructions

- (1) ઉપરોક્ત દર્શાવેલ વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fill up strictly the above details on your answer book
- (2) Symbols used in the question paper have their usual meanings.
- (3) Figures on the right indicate full marks of the question.
- (4) Students can use non-programmable scientific calculator.

Seat No.:

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Student's Signature

Q. 1. Attempt any Two. (18)

- a. i. What is a parity operator? Discuss types of parity and statistics associated with them. (05)
- ii. Even though neutron is not a charged particle, it has non-zero magnetic moment. Justify this statement. (02)
- iii. Discuss mass defect and binding energy of a nucleus in brief. (02)
- b. When do we get electric quadrupole moment for a nucleus? Derive an equation for the electric quadrupole moment of a nucleus. (09)
- c. i. Explain the charge symmetry and charge independence of nuclear forces. (06)
- ii. Which nucleus is more stable out of ${}^7_3\text{Li}$ and ${}^8_3\text{Li}$, given that $m_p = 1.007895 \text{ amu}$, $m_n = 1.008665 \text{ amu}$, $m({}^7_3\text{Li}) = 7.016003 \text{ amu}$ and $m({}^8_3\text{Li}) = 8.022486 \text{ amu}$? (03)

Q. 2. Attempt any Two. (18)

- a. How does the hyperfine splitting of spectral lines in an external magnetic field help to determine nuclear spin? Discuss the strong field cases. (09)
- b. Explain how to determine the nuclear spin using the following expression (09)

$$\Delta U = a\mu_1 \frac{F(F+1) - I(I+1) - J(J+1)}{2\sqrt{J(J+1) \cdot I(I+1)}}$$

- c. i. Draw the schematic diagram of the apparatus used by Purcell and others for NMR and explain its working. (06)
- ii. Explain microwave spectroscopy method. (03)

Q. 3. Attempt any Two. (18)

- a. Discuss how the extreme single particle shell model explains the occurrence of islands of isomerism within the atomic nuclei. (09)
- b. What significant evidence supports the existence of shell structure within atomic nuclei? How do these observations contribute to our understanding of Nuclear Physics and the behavior of nucleons? (09)

- c. i. Describe the use of semi-empirical binding energy formula to explain the phenomenon of alpha decay. (07)
- ii. How does the extreme single particle shell model predict and interpret the quadrupole moments of nuclei? (02)

Q. 4. Attempt any Two. (16)

- a. i. What are strange particles? What is strangeness quantum number? Discuss the significance of strangeness quantum number. (06)
- ii. Distinguish between quanta of forces and matter particles. (02)
- b. i. State and discuss CPT theorem. (06)
- ii. Convert 1 g into keV . (02)
- c. What is Gell-Mann Nishijima Scheme? Discuss its significance in context to the strangeness of the particles. (08)
