



RAN-2403080103022001

M.Sc. (Sem.-III) Examination October - 2025

(Physics) Paper: PH-532 (Basic 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 have their usual meaning.
- (3) Figures to the right indicate full marks.

Seat No.:

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Student's Signature

Q.1. Attempt any two out of the (a), (b) and (c) below.

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|---------|---|---|
| (a) (i) | Discuss basic nuclear properties and give the description of ;
(1) Charge and Mass (2) Nuclear Radius | 6 |
| (ii) | Find the radius of nuclide $^{238}_{92}\text{U}$. | 3 |
| (b) (i) | Define Binding energy of nucleus and draw and explain the characteristics of average binding energy per nucleon. | 6 |
| (ii) | Find binding energy of ^4_2He (in MeV). Given that $m_p = 1.00758u$,
$m_n = 1.00897u$ and $m_{\text{He}} = 4.0028 u$. | 3 |
| (c) (i) | Discuss even parity and odd parity according to mirror symmetry. | 3 |
| (ii) | Explain spin and iso - spin and discuss one method for the measurement of nuclear spin. | 6 |

Q.2. Attempt any two out of the (a), (b) and (c) below.

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|---------|---|---|
| (a) (i) | Define Radioactivity. Discuss basic parameters decay constant and activity of radioactive decay. | 4 |
| (ii) | Discuss parents and stable nuclei (end products) of four series. Mention their end products. Np^{237} Belongs to which natural radioactive decay series? | 5 |
| (b) (i) | What are the nuclear detectors? Divide the detectors according to their interactions with matter. | 4 |
| (ii) | Write short notes on semiconductor detector or solid state detector. | 5 |
| (c) (i) | Write short note on multiwire proportional counters | 5 |
| (ii) | Explain how heavy charged particle such as alpha particles interact with matter. | 4 |

Q.3. Attempt any two out of the (a), (b) and (c) below.

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|---------|--|---|
| (a) (i) | Describe rules for prediction of the angular momenta and parities of nuclear ground states by the shell model. | 7 |
| (ii) | Determine the ground-state J^π values of $^{16}_8\text{O}$. | 2 |
| (b) (i) | Discuss the nuclear rotational states of nuclei with example. | 5 |
| (ii) | What is magic numbers? Write their significance. | 4 |
| (c) (i) | Describe the Nilsson model and its role in understanding single-particle states in deformed nuclei. | 5 |

- (ii) What is the role of valence nucleons in determining the properties of a nucleus in the shell model? 4

Q.4. Attempt any two out of the (a), (b) and (c) below.

- (a) (i) Give the classification of elementary particles based on their interaction 5
(ii) Discuss the properties of hadrons. 3
- (b) (i) What is Gell-Mann Nishijima Scheme? Discuss its significance in context to the strangeness of the particles. 5
(ii) Explain color quantum number 3
- (c) (i) What is meant by pseudoscalar mesons and vector mesons? Argue why mesons have to be made up of a quark-antiquark pair 5
(ii) Determine whether the following reactions are allowed or forbidden 3
- $\rho + \rho \rightarrow \rho + \Lambda^0 + \bar{E}^0 + \Sigma^0$
 - $\gamma + n \rightarrow n + \pi^0$
 - $\rho + n \rightarrow \rho + \mu^- + \mu^+$
