



RAN-2103000206021003

T. Y. B. Sc. (Sem. - VI) Examination September - 2025

Physics (Paper - VIII) Atomic and Nuclear Physics

Time: 2 Hours]

[Total Marks: 50

સૂચના : / Instructions

(1)

નીચે દર્શાવેલ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fill up strictly the details of signs on your answer book

Name of the Examination:

T. Y. B. Sc. (Sem. - VI)

Name of the Subject :

Physics (Paper - VIII) Atomic and Nuclear Physics

Subject Code No.: 2103000206021003

Seat No.:

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Student's Signature

- (2) Question paper carries total five questions. Numbers on right indicate full marks of the question.
- (3) Draw neat diagram wherever necessary.
- (4) Symbols used in paper have their conventional meanings.

Q. 1. Answer in short as directed:

(10)

1. What is total angular momentum of a closed subshell?
2. An element is positioned at 3th period and 6th group of periodic table.
How many electrons does it have in outermost orbit?
3. Why is it impossible for a $2^2P_{5/2}$ state to exist?
4. What are the possible values of $\vec{j}$ for $j = \frac{3}{2}$ state.
5. In formation of covalent bonds in atom why do only outermost orbit electrons be involved?
6. What is meant by scintillation efficiency?
7. Which detector provides visual trajectory of a charged particle?
8. Which gas is filled in the proportional counter for detecting slow neutrons?
9. Are all nucleons fermions? Justify your answer.
10. What is pair annihilation?

Q. 2. a. Attempt any one of the following: (07)

1. Explain spin-orbit coupling and hence the fine-structure doubling of spectral lines.
2. Explain X-ray spectra. Find the relation between frequency of K_{α} X-rays and atomic number Z .

b. Attempt any one of the following: (03)

1. Discuss why the spins of electrons in hydrogen molecules must be antiparallel.
2. Find the possible quantum numbers n, l, j and m_j of electron having term symbols (a) $3^2S_{1/2}$ and (b) $3^2P_{1/2}$

Q. 3. a. Attempt any one of the following: (07)

1. Explain formation and stability of hydrogen molecule using concept of wave functions.
2. Explain in detail the rotational energy levels and rotational spectra of molecules. Derive formula for frequency of rotational spectra.

b. Attempt any one of the following: (03)

1. An element has a K_{α} x-ray line of wavelength 0.180 nm. Find the atomic number of the element. (take $R = 1.097 \times 10^7 m^{-1}$)
2. In carbon monoxide (CO) molecule the $J=0 \rightarrow J=1$ absorption line occurs at a frequency of 1.15×10^{11} Hz. What is the bond length of the CO molecule? (Reduced mass of CO molecule is 1.14×10^{-26} kg)

Q. 4. a. Attempt any one of the following: (07)

1. Explain in detail principle, construction and working of Tandem accelerator.
2. Explain in detail Photomultiplier tube with scintillation detector and electronic circuitry.

b. Attempt any one of the following: (03)

1. A current of 2.9×10^{-12} A is produced in an ionization chamber when 100 α -particles enter per second into it. If 30 eV energy is required to create one ion pair then find the energy of incident α -particle.
2. A Geiger counter consists of a 50 mm diameter grounded tube with a wire of 25 μ m diameter at +700 V in the centre. What is the electric field at the tube wall?

Q. 5. a. Attempt any one of the following: (07)

1. Explain classification of elementary particles. Discuss about quanta of force and matter particles.
2. What are leptons? Explain production and decay modes for leptons.

b. Attempt any one of the following: (03)

1. Mean lifetime of Λ -baryon is 2.63×10^{-10} s. Determine its decay width. Take value of $h = 6.625 \times 10^{-34}$ J_{-s}.
2. Find the value dimensionless coupling constant for electromagnetic interaction. (Take $e = 1.6 \times 10^{-19}$ C, $\epsilon_0 = 8.854 \times 10^{-12}$ SI, $h = 6.626 \times 10^{-34}$ J_{-s})
