

RAN-2103000206021003

T.Y.B.Sc. (Semester-VI) Examination March - 2026
Physics P-VIII (Old Course) (Phy-608)
(Atomic and Nuclear Physics)

Time: 2 Hours]
[Total Marks: 50

સૂચના : / Instructions (1) ઉપરોક્ત દર્શાવેલ વિગતો ઉત્તરવહી પર અવશ્ય લખવી. Fill up strictly the above details on your answer book. (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.	Seat No.: Student's Signature
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- Q-1. Answer in short as directed :- 10**
- 1) Due to which phenomenon, the fine-structure doubling of spectral lines arise?
 - 2) What is the total angular momentum of a closed sub shell?
 - 3) What are the possible value of total angular momentum of electron with $l = 1$
 - 4) How an ionic bond is formed?
 - 5) What is meant by rotational energy states?
 - 6) Name two gases commonly used in GM counters?
 - 7) What are dynodes in PM tube?
 - 8) Which gas is filled in the proportional counter for detecting slow neutrons?
 - 9) Name the quanta of force in gravitational interactions.
 - 10) Give decay mode of free neutron.
- Q-2. A) Attempt any one of the following :- 07**
- 1) Explain in detail variations in size and ionization energies of atoms in periodic table from quantum theory of atomic structure,
 - 2) Explain in detail the total angular momentum and its quantization.
- B) Attempt any one of the following :- 03**
- 1) What is the atomic number Z of the element for that wavelength of $K\alpha$ X-ray line is 0.180 nm ? (Take Rydberg constant $R = 1.097 \times 10^7 \text{ m}^{-1}$)
 - 2) The term symbol of the ground state of sodium is $3^2 \times S_{1/2}$ and that of the first excited state is $3^2P_{1/2}$. List the possible quantum numbers n, l, j and m_l of the outer electron in each case.
- Q-3. A) Attempt any one of the following :- 07**
- 1) Explain in detail the rotational energy levels and rotational spectra of molecules. Derive formula for frequency of rotational spectra.

- 2) Explain electronic spectra of molecules and discuss fluorescence and phosphorescence.

B) Attempt any one of the following :-

03

- 1) The equivalent force constant of HCl molecule is 470 N/m, estimate the energy difference between the lowest and first excited vibrational state of HCl.
(Reduced mass of HCl is 1.615×10^{-27} kg.
(Planck's constant $h = 6.625 \times 10^{-34}$ J - s)
- 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 about Cerenkov counters. Mention its advantages and limitations.

B) Attempt any one of the following :-

03

- 1) U^{235} undergoes fission producing fission fragments having total kinetic energy of 180 MeV inside an ionization chamber. Calculate the resultant pulse height, if capacitance of ionization chamber is 100 pF. Energy required to create one ion-pair is 35 eV.
- 2) An α -particle of energy 5.48 MeV is completely stopped in an ionization chamber. What is the pulse height in an external resistance of $1\text{ M}\Omega$? Energy required to produce an ion-pair is 35 eV and the capacitance of the chamber is 50 pF.

Q-5. A) Attempt any one of the following :-

07

- 1) Explain in detail four fundamental interactions among particles with suitable examples.
- 2) What are mesons? Explain production and decay modes for mesons, π - mesons, K - mesons and η -meson.

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 $h = 6.625 \times 10^{-34}$ 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.