RAN-2103000205021003

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T. Y. B. Sc. (Sem. - V) Examination March - 2023

Physics : Paper - VIII (PH - 508)

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. - V)**

Name of the Subject :

☛ **Physics : Paper - VIII (PH - 508) Atomic and Nuclear Physics**

Subject Code No.: **2103000205021003**

Seat No.:

Student's Signature

(2) Figures to the right indicate total marks carried by the question.
(3) All symbols used have their usual meaning.
(4) Students are allowed to use a non-programmable scientific calculator.

Q. 1. Answer in brief: **[10]**

(1) What are the possible values of principal quantum number ? What does it describe?

(2) What are the possible values of magnetic quantum number m_l of an electron whose orbital quantum number is $l = 4$?

(3) Unit of the gyromagnetic ratio is _____.

(4) What are the possible values of magnetic spin quantum number(m_s)?

(5) Unit of Planck's constant h and unit of _____ are same.

(6) Write any two similarities between liquid drop and nucleus.

(7) Give two achievements of the shell model.

(8) Why α particles are deflected by electric and magnetic fields?

(9) How are atomic number and atomic mass number change during β decay?

(10) Why β decay is called isobaric transformation?

Q. 2. (A) Answer any one in detail: **[07]**

(1) Explain how three quantum numbers n, l and m_l are obtained as a natural consequence of solving Schrodinger's equation for hydrogen atom.

(2) Explain quantization of angular momentum direction. How the uncertainty principle prohibits the angular momentum vector from having a definite direction in space.

(B) Answer any one: **[03]**

(1) Calculate electron angular momentum L for orbital quantum number $l = 3$.
Take value of Planck's constant $h = 6.625 \times 10^{-34}\, J - s$

(2) Find the percentage difference between angular momentum L and the maximum value of L_z for an atomic electron in a p-state.

Q. 3. (A) Answer any one in detail: **[07]**

(1) What is Zeeman effect? Explain splitting of spectral line in normal Zeeman effect.

(2) Explain in detail about radiative transitions.

(B) Answer any one: **[03]**

(1) Zeeman components of a 500 nm spectral line are 0.0116 nm apart when the magnetic field is 1.00 T. Find the ratio e/m for the electron from these data.

(2) Calculate the value of Bohr magneton. Mass of electron is $9.1 \times 10^{-31} kg$, charge of electron is $1.6 \times 10^{-19}\, C$ and Planck's constant $h = 6.625 \times 10^{-34}\, J - S$.

Q. 4. (A) Answer any one in detail: **[07]**

(1) Discuss the shell model of the nucleus.

(2) Derive the semiempirical mass formula of the nucleus.

(B) Answer any one: **[03]**

(1) Calculate the contribution of Coulomb energy and surface energy terms of ${}^{236}_{92}U$. Proportionality constants for Coulomb energy term and surface energy terms are 0.7 MeV and 16.8 MeV respectively.

(2) Calculate the binding energy of an α-particle in MeV. Mass of the α-particle is 4.0028 amu, mass of proton and neutron are 1.00758 amu and 1.00897 amu. Take 1 amu = 931.5 MeV.

Q. 5. (A) Answer any one in detail: **[07]**

(1) What is the range of alpha particle? Explain Geiger-Nuttal law in detail.

(2) Explain in detail about applications of radioactivity.

(B) Answer any one: **[03]**

(1) Rutherford bombarded 7.7 MeV α-particles from Po^{214} on ${}^{14}_{7}N$ to initiate the nuclear reaction ${}^{14}_{7}N\,(a, p)\,{}^{17}_{8}O$. Find the height of Coulomb barrier faced by α-particles.

$\varepsilon_0 = 8.85 \times 10^{-12}\ \dfrac{C^2}{N - m^2}$ and constant $R_0 = 1.2\,fm$.

(2) Find the energy released in the of α-decay of ${}^{238}_{92}U$:

${}^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He + Q$

Give : M (${}^{238}_{92}U$) = 238.050786 amu,

M (${}^{234}_{90}Th$) = 234.043583 amu

M (${}^{4}_{2}He$) = 4.002603 amu

1amu = 931.5 MeV