RAN-2103000205021003

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

Physics : Paper VIII (PH-508)

Atomic and Nuclear Physics

Time: 2 Hours] **[Total Marks: 50**

સૂચના : / Instructions

(૧) **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) Which quantum number describes the quantization of electron energy in the hydrogen atom?

(2) What are the possible values of magnetic quantum number ?

(3) Why can't we think of the electron as moving around the nucleus in any conventional sense?

(4) What are forbidden transitions?

(5) Particles with symmetric wave functions are called_____.

(6) What are isobars?

(7) Write any two failures of liquid drop model.

(8) What is electron capture?

(9) What is quantum mechanical tunneling effect in case a decay?

(10) What is induced radioactivity?

Q. 2 (A) Answer anyone 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 in detail about the space quantization of orbital angular momentum.

(B) Answer anyone: **[03]**

(1) Calculate magnitude of 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 *f*-state.

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

(1) Discuss electron probability density and explain actual probability of finding electron in hydrogen atom.

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

(B) Answer anyone: **[03]**

(1) Find the normal Zeeman splitting of the line 643.8 nm in a magnetic field of 0.5T.

(mass of electron is $9.1 \times 10^{-31}\, kg$ and charge of electron is $1.6 \times 10^{-19}\, C$)

(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 anyone in detail: **[07]**

(1) Explain in detail about the volume energy term (B_1) and surface energy term (B_2) about the nucleus.

(2) Write basic assumptions, Achievements and failures of the shell model.

(B) Answer anyone: **[03]**

(1) Binding energy of $^{70}_{30}Zn$ is 620.4 MeV. Find mass of $^{70}_{30}Zn$ nucleus.
Take: 1 amu = 931.47 MeV, Mass of a proton M_p = 1.007276 amu and
Mass of a neutron M_n =1.008665 amu

(2) Find the value of Coulomb energy term for $^{28}_{14}si$. Proportionality constants for Coulomb energy term is 0.7 MeV

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

(1) Write general equation for α -decay. Derive equation of disintegration energy in α -decay.

(2) Prove that β^- decay occurs When the mass of parent atom M(Z) is greater than that of the daughter atom M(Z+1)

(B) Answer anyone: **[03]**

(1) Po^{212} decays by α-particle emission. Energy of the α-particle is 9 MeV. Calculate the total energy liberated during the decay.

(2) Calculate the height of the potential barrier faced by an α-particle inside the $^{252}_{98}Cf$ nucleus. Take $\varepsilon_0 = 8.85 \times 10^{-12}$ $\frac{c^2}{N - m^2}$ and constant $R_0 = 1.2\ fm$

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