2103000205021003
EXAMINATION FEBRUARY-MARCH 2024
BACHELOR OF SCIENCE (FIFTH SEMESTER)
PHYSICS-VIII (PH-508-ATOMIC AND NUCLEAR PHYSICS) - LEVEL 2

[Time: As Per Schedule] **[Max. Marks: 50]**

Instructions:
1. Fill up strictly the following details on your answer book
   a. Name of the Examination: **BACHELOR OF SCIENCE (FIFTH SEMESTER)**
   b. Name of the Subject: **PHYSICS-VIII (PH-508-ATOMIC AND NUCLEAR PHYSICS) LEVEL 2**
   c. Subject Code No: **2103000205021003**
2. Sketch neat and labelled diagram wherever necessary.
3. Figures to the right indicate full marks of the question.
4. All questions are compulsory.
5. All symbols used have their usual meaning.
6. Students are allowed to use a non-programmable scientific calculator.

Seat No:

Student's Signature

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

(1) What are the number of possible orientations of the electrons angular momentum vector L in magnetic field?

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

(3) Particles with anti-symmetric wave functions are called_____

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

(5) What are forbidden transitions?

(6) Write any two failures of liquid drop model

(7) What are magic numbers?

(8) Why beta-decay is called three body problem?

(9) Write Geiger-Nuttal law.

(10) Write general equation for electron capture.

Q.2 (Answer anyone in detail:) **7**

(1) Derive partial differential equation for the wave function ψ of the electron in hydrogen atom.

(2) Using radial part of the Schrodinger's equation obtain that the electron angular momentum $L = \sqrt{l(l+1)h}$

(B) Answer anyone: **3**

(1) Calculate magnitude of angular momentum L for an atomic electron in a p-state.
Plank's constant $h = 6.625 \times 10^{-34}\ J - S$

(2) Prove that the percentage difference between angular momentum L and maximum value of L_z for an atomic electron in a d-state is 18%

Q.3 (A) Answer anyone in detail: **7**

(1) Explain: How atoms interact with a magnetic field? Derive necessary equation of magnetic energy (U_m) of an atom when it is in a magnetic field.

(2) Discuss electron spin. Explain spin angular momentum and spin magnetic moment with proper equations.

(B) Answer anyone: **3**

(1) A beam of electron enters a uniform magnetic field of 1.52 T. Find the energy difference between electrons whose spins are parallel and antiparallel to the field. Bohr magneton $\mu_B = 9.274 \times 10^{-24} J/T$

(2) A spectrometer can resolve spectral lines in the region $\lambda = 578\ nm$, when separated by $\Delta\lambda = 0.0097\ nm$. Find the value of the external magnetic field required to confirm the normal Zeeman triplet. Mass of electron is $9.1 \times 10^{-31} kg$, charge of electron is $1.6 \times 10^{-19} C$

Q.4 (A) Answer anyone in detail: **7**

(1) With the analogy between nucleus and liquid drop, derive the semiempirical mass formula of the nucleus.

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

(B) Answer anyone: **3**

(1) Calculate the binding energy ${}^{81}_{36}Kr$ in Mev. Mass of the ${}^{81}_{36}Kr$ is 80.91661 amu, mass of proton and neutron are 1.007825 amu and 1.008665 amu respectively
Take 1 amu=931.49MeV.

(2) Calculate the volume energy term and surface energy term of ${}^{24}_{12}Mg$. Proportionality constants for volume energy term and surface energy terms are 15.5 MeV and 16.8 MeV respectively.

Q.5 (A) Answer anyone in detail: **7**

(1) Determine the kinetic energy of the alpha particles emitted in an α-decay in terms of total energy released in the decay.

(2) Write general equation of β^+ decay. Derive necessary condition for spontaneous emission of β^+ particle

(B) Answer anyone **3**

(1) ${}^{237}_{93}Np$ decays by α- particle emission. Kinetic Energy of the α- particle is 5.19 MeV. Calculate the velocity of the α- particle. $1eV = 1.6 \times 10^{-19}J$ and $1\ amu = 1.67 \times 10^{-27}kg$

(2) In the α- decay of Pu^{239}, the kinetic energy of the α- particle is 5.156 MeV. Calculate the total energy released in this decay.

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