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UNIVERSITY EXAMINATIONS 2022/2023

THIRD YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR
OF SCIENCE IN PHYSICS

SPH 3351: ATOMIC PHYSICS

DATE: APRIL 2023

TIME: 2 HOURS

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

- State any two successes of the Borh atomic theory. (2 Marks)
- The wavelength of an electromagnetic radiation is 121.6nm. find the energy in Electron-Volts. (5 Marks)
- Consider an electron in the P orbital of a one electron system. Determine the possible values of L, S and J and hence write the term symbols for the microstates. (5 Marks)
- Define the fine structure. (2 Marks)
- The lowest 2p term for sodium (Na=11) has a doublet splitting of 17.2cm^{-2} and a quantum defect of 0.884. using the Landle formula find the effective atomic number (z) (5 Marks)
- Find the energy required to remove an electron from the K-shell of cadmium (z=48) (5 Marks)
- Differentiate between Zeeman and Stack effects. (2 Marks)
- Calculate the g-value for the state 3F_2 . (4 Marks)

QUESTION TWO (20 MARKS)

- a) For the Balmer series of the Hydrogen atom, find the lowest and the highest energies hence show that it does not overlap with the Lyman series. (8 Marks)
- b) For the term 4F , find all the possible values of L, S and J and write the term symbols for all the possible microstates. (8 Marks)
- c) Prove that the state $^2P_{3/2}$ cannot exist. (4 Marks)

QUESTION THREE (20 MARKS)

- a) For the sodium atom ($Z=11$)
- Write the electronic configuration (1 Mark)
 - Calculate the values of L, S and J and write the term symbol for the ground state. (4 Marks)
 - If the valence electron was excited to the state 4^2D show all the possible transition routes that the electron can use to fall back to ground state. (5 Marks)
 - On an energy level diagram indicate the possible transitions. (4 Marks)
 - State the number of spectra line that could be observed from the transitions. (1 Mark)
- b) Explain the two processes that lead to production of X-rays clearly showing how the continuous and the sharp X-ray spectra are produced. (5 Marks)

QUESTION FOUR (20 MARKS)

- a) Predict the splitting of 3P_1 when the atom is in an external magnetic field of 4T. (12 Marks)
- b) Find the minimum magnetic field needed for the normal Zeeman effect to be observed in a spectral line of 400 nm wavelength when a spectrometer of resolution 0.001 nm is used. (8 Marks)