MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

P.O. Box 972-60200 – Meru-Kenya.
Tel: +254(0) 799 529 958, +254(0) 799 529 959, +254 (0)712 524 293
Website: www.must.ac.ke Email: info@mucst.ac.ke

UNIVERSITY EXAMINATIONS 2022/2023

THIRD YEAR, SECOND SEMESTER SPECIAL/SUPPLEMENTARY EXAMINATION
FOR DEGREE OF BACHELOR OF SCIENCE IN PHYSICS

SPH 3351: ATOMIC PHYSICS

DATE: AUGUST 2023 **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) State the four quantum numbers of the vector model. (4 Marks)

b) An atom of hydrogen emits a photon with Energy € of 10.2 eV. Determine the wave number for this photon. (4 Marks)

c) Using the vector model explain fine structure of hydrogen. (5 Marks)

d) State any three drawbacks of the Borh model of the atom. (3 Marks)

e) Determine the maximum number of electrons that can be accommodated in an atom with the 3S orbital as the highest energy level orbital. (5 Marks)

f) An X-ray tube has a current 8 mA when the accelerating potential is 120kV. Calculate the maximum speed of the electrons as they strike the target. (5 Marks)

g) Differentiate between Zeeman effect and Stack Effects. (2 Marks)

h) State the 2 characteristics of spin quantum number. (2 Marks)

QUESTION TWO (20 MARKS)

a) Given that for the Bohr atomic model, the energy of the electron in the n^{th} orbit is given by $E_n = \frac{mZ^2e^4}{8\varepsilon_0^2h^2n^2}$ Derive the equation for the wave number of the photon emitted when an electron falls from a higher energy level to a lower energy level. (8 Marks)

b) For the ^3D term find all the possible states and write term symbols. (8 Marks)

c) Determine the frequency of First member of the Balmer series. (4 Marks)

QUESTION THREE (20 MARKS)

a) Calculate the Rydberg denominations for the first term value of the principal series of sodium given that the wave number of the transition is 16973.7 cm^{-1} and R_{Na}=109734cm^{-1} (10 Marks)

b) The ratio of the first ionization potential of sodium to that of Hydrogen 2:5. Calculate the effective nuclear charge of sodium atom as far as the 3s electron is concerned. (10 Marks)

QUESTION FOUR (20 MARKS)

a) The mass absorption coefficient of iron is 0.4 $g\ Cm^{-1}$ for X-rays of wavelength $1.2 \times 10^{-12}m$. If the density of Iron is 2.4 gcm^{-3}, find:

i. Linear attenuation coefficient of iron for this wavelength. (4 Marks)

ii. The half value layer (4 Marks)

iii. The depth of iron at which the intensity of the X-rays will 10% of the original. (6 Marks)

b) An X-ray tube has accelerating potential of 36KeV. Find the highest frequency present in the radiant from this X-ray tube. (6 Marks)