MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

P.O. Box 972-60200 – Meru-Kenya.
Tel: +254 (0)799529958, +254 (0)799529959, +254 (0)712524293
Website: www.must.ac.ke Email: info@must.ac.ke

UNIVERSITY EXAMINATIONS 2019/2020

THIRD YEAR SPECIAL/SUPPLEMENTARY EXAMINATIONS FOR BACHELOR OF EDUCATION SCIENCE AND BACHELOR OF SCIENCE (PHYSICS OPTION)

SPH 3351: ATOMIC PHYSICS

DATE: JANUARY 2021 **TIME: 2 HOURS**

INSTRUCTIONS: Answer question **One** and any other **two** questions

QUESTION ONE (30 MARKS)

a) State any three assumptions of the Bohr Atomic theory (3 marks)
b) State the two quantum numbers introduced by the vector model to explain fine structure and spectra of multi electron atoms (2mark)
c) An atom of hydrogen emits a photon with Energy (E) of 1.55 eV. Determine the wave number for this photon (4 marks)
d) Using the vector model explain why spectral lines of hydrogen split into more lines that are close together under high resolution spectrometry (5 marks)
e) State any three drawbacks of the Sommerfeld relativistic model of the atom (3 marks)
f) Determine the maximum number of electrons that can be accommodated in an atom with the 2P orbital as the highest energy level orbital (5 marks)
g) An X-ray tube has a current 2 mA when the accelerating potential is 60kV. Calculate the maximum speed of the electrons as they strike the target (5 marks)
h) Explain how the stack effect occurs (4 marks)

QUESTION TWO (20 MARKS)

a) In the hydrogen atom, excited electrons fall to energy level of principal quantum number 3. Determine the frequencies of highest energy spectral line (4 marks)
b) With aid of a well labeled energy level diagram show the first three spectral series of Hydrogen (8 marks)

c) 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 frequency of the photon emitted when an electron falls from a higher energy level to a lower energy level (8 marks)

QUESTION THREE (20 MARKS)

a) Show that the intensity of X-rays at a depth x while passing through a material is given by $I = I_0e^{-\mu x}$; μ is the linear attenuation coefficient of the material (9 marks)

b) The mass absorption coefficient of Iron is $0.6\ g\ Cm^{-1}$ for X-rays of wavelength $3.2 \times 10^{-10}m$. If the density of Iron is $3.2\ gcm^{-3}$, Find:

i. Linear attenuation coefficient of iron for this wavelength (3 marks)

ii. The half value layer (3 marks)

iii. The depth of iron at which the intensity of the X-rays will 40% of the original (5 marks)

QUESTION FOUR (20 MARKS)

a) Show the distribution of electrons in an atom in the energy level n=2 using all the quantum numbers of the vector model and use this information to determine the maximum number of electrons that can be accommodated in the 2P orbital (10 marks**)**

b) An element Q has atomic number 11.

i. Show its electronic configuration (1 marks)

ii. Determine the multiplicity of the state (5 marks)

iii. Write the atomic term symbol for the state (4 marks)