KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN PHYSICS AND BACHELOR OF SCIENCE IN CHEMISTRY

COURSE CODE: SPC 222

COURSE TITLE: MODERN PHYSICS

DURATION: 2 HOURS

DATE: 10/05/2022 **TIME: 9:00AM-11:00AM**

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other **TWO** (2) Questions.
- Question **ONE** carries **30 MARKS** and the remaining carry **20 MARKS** each.
- ALL Symbols have their usual meaning

QUESTION ONE (30MARKS)

a) Define the following terms (2mks)

i) Time dilation

ii) Blackbody radiation

b) State two postulates of special relativity principle (2mks)

c) Briefly outline the Lorentz tranformations for a frame moving along the x-direction with a relative velocity,v (3mks)

d) Two observers, A on earth and B in a spacecraft whose speed is $2x10^8$m/s, both set their watches to the same time when the spacecraft is abreast of the earth. How much time must elapse by A's reckoning before the watches differ by 1s? (3mks)

e) Ultraviolet light of wavelength 350nm and intensity $1w/m^2$ is directed at a potassium surface. Find the maximum K.E of the photoelectrons given that the work function of potassium is 2.2eV (3mks)

f) i) X-rays of wavelength $10x10^{-12}$m are scattered from a target. Find the wavelength of x-rays scattered through 45^o (3mks)

ii) state any three uses of x-rays (3mks)

g) Differentiate between

i) Pauli's exclusion principle and the uncertainity principle (2mks)

ii) Nuclear fission and nuclear fussion (2mks)

iii) Alpha and Beta decay (2mks)

h) Define halflife. Show that the halflife of a radioactive material is given by

$$T_{1/2} = \frac{0.693}{\lambda}$$

(3mks)

i) State two types of elementary particles (2mks)

QUESTION TWO (20MARKS)

a) A meter stick appears only 60cm to an observer. What is its relative speed? How long does it take to pass the observer? (5mks)

b) Show that the comton effect is given by $\lambda' - \lambda = \lambda_c(1 - \cos\phi)$ (10mks)

c) Find the de Broglie wavelength of 46-g golf ball with a velocity of 30m/s. What is the physical meaning? (5mks)

QUESTION THREE (20MARKS)

a) Show that for massles particles (m_o=0), the relation between their energy and mass is that E=Pc (10mks)

b) Briefly describe how X-rays are produced (5mks)

c) Deduce the Wein's law from Planck's law (5mks)

QUESTION FOUR (20MARKS)

a) Show that in the limit $h \to 0$, the average value of energy of an oscillator is kT (10mks)

b) Explain the Rutherford's model of an atom. Show that E=$\frac{-e^2}{8\pi\varepsilon_o r}$ (10mks)

QUESTION FIVE (20MARKS)

a) With a well labelled diagram,,show that a change in path difference λ for Mitchelson and Moley experiment produces a fringe shift of unity (15mks)

b) Deduce the Stefan's law from Planck's law (5mks)