MAASAI MARA UNIVERSITY

SUPPLEMENTARY/SPECIAL EXAMINATIONS
2018/2019 ACADEMIC YEAR
SECOND YEAR SECOND SEMESTER

SCHOOL OF SCIENCE
BACHELOR OF SCIENCE

COURSE CODE: PHY 212
COURSE TITLE: MODERN PHYSICS1

DATE: 24.4.2019 **TIME: 8.30AM – 10.30AM**

INSTRUCTIONS TO CANDIDATES

1. Answer Question **ONE** and any other *two* questions
2. *Question one carries 30 marks while each of the others carries 20 marks*
3. *Credit will be awarded for clear explanations and illustrations.*

*This paper consists of **5** printed pages. Please turn over.*

Physical constants

Electron charge = 1.6×10^{-19}C; proton charge= $+1.6 \times 10^{-19}$C

Mass of electron $m_e = 9.11 \times 10^{-31}$kg

Speed of light c = 3.0×10^{8} m/s; Avogadro constant $N_a = 6.023 \times 10^{23}$ /mol

Planck's constant h = 6.63×10^{-34}Js; Stefan constant $\sigma = 5.670 \times 10^{-8}$wm^{-2}k^{-4}

Rydberg constant, $R_{hc} = 1.097 \times 10^{7}$m^{-1}; Mass of proton $M_p = 1.67 \times 10^{-27}$kg

Rest energy of electron E_e = 0.511MeV; one atomic mass unit, u = 1.66×10^{-27}kg

One electron volt, 1eV = 1.60×10^{-19}J; mass of neutron $m_n = 1.675 \times 10^{-27}$kg

1 curie = 3.7×10^{10}decay/s; a.m.u = 931.5MeV

QUESTION ONE (30MKS)

a. State the two postulates of relativity **(2mks)**

b. Assuming that the tungsten filament of a bulb is a blackbody , determine its peak wavelength if its temperature is 2900K **(3mks)**

c. Show that for $V \ll C$, relativistic kinetic energy $K = \frac{mC^2}{\sqrt{1-\frac{U^2}{C^2}}} - mc^2$ reduces to $\frac{1}{2}mu^2$ **(4mks)**

d. X-rays of wavelength λ_o =0.200 000nm are scattered from a block of material. The scattered x-rays are observed at an angle of 45^0 to the incident beam

   i. Calculate the wavelength of the x-rays scattered at this angle **(3mks)**

   ii. Compute the fractional change in the energy of a photon in the collision **(4mks)**

e. The speed of an electron is measured to be 5.00×10^3m/s to an accuracy of 0.003%. Find the minimum uncertainty in determining the position of this electron **(4mks)**

f. (i)Define the term binding energy **(2mks)**

(ii) Calculate the deuteron's binding energy in MeV, if it consists of a proton and a neutron, (m_d = 2.014102u, m_p=1.007825u and $m_{n=}$ 1.008665u) **(3mks)**

g. State Bohr's correspondence principle **(2mks)**

h. Briefly explain the Ultraviolet catastrophe **(3mks)**

QUESTION TWO (20MKS)

a. Explain briefly the following:
   i. Heisenberg energy –time uncertainty principle **(3mks)**
   ii. De Broglie wavelength **(3mks)**

b. Explain why wave properties of a baseball are not observable **(3mks)**

c. The Balmer series for the hydrogen atom corresponds to the electronic transitions that terminate in the state with quantum number n=2
   i. Find the longest wavelength photon emitted in the Balmer series and determine its frequency and energy **(6mks)**
   ii. Find the shortest wavelength photon emitted in the same series (2marks)

d. State three failures of the Bohr model of atom **(3mks)**

QUESTION THREE (20MKS)

a. State three consequences of relativity **(3mks)**

b. State TWO reasons why modern Physics is studied. **(2mks)**

c. A sodium surface is illuminated with light of wavelength 0.300μm. the work function for sodium is 2.46eV. Calculate:
   i. The energy of each photon in electron volts **(3mks)**
   ii. The maximum kinetic energy of the ejected photoelectron **(2mks)**
   iii. The cut-off wavelength for sodium **(2mks**

d. Starting from definition of relativistic momentum ,$F = \frac{dp}{dt}$ show that relative kinetic energy is expressed as $K = \frac{mc^2}{\sqrt{1-\frac{u^2}{c^2}}} - mc^2$ **(8mks)**

QUESTION FOUR (20MKS)

a. Explain briefly the following:
   i. Pauli exclusion principle **(2mks)**
   ii. Nuclear fusion **(2mks)**
   iii. Nuclear fission **(2mks)**

b. The half life of the radioactive nucleus $^{226}_{88}Ra$ is 1.6×10^3 year. If a sample initially contains 3.00×10^{16} such nuclei, determine;
   i. The initial activity in curies **(4mks)**
   ii. The number of radium nuclei remaining after 4.8×10^3 year (3marks)
   iii. The activity at this later time **(2mks)**

c. Determine whether the following reaction can occur based on the law of conservation of baryon number $p + n \rightarrow p + p + n + \bar{p}$ **(2mks)**

d. If the spacing between certain planes in a crystal of calcite is 0.314nm; find the grazing angle at which the third order interference will occur for x-rays of wavelength 0.0700nm **(3mks)**

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