MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAMINATION FOR BACHELOR BACHELOR OF SCIENCE (TELECOMMUNICATION AND INFORMATION TECHNOLOGY)

BACHELOR OF EDUCATION

SPH 202: MODERN PHYSICS

DATE: 26/9/2019 **TIME: 2:00 – 4:00 PM**

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

You may choose constants that you need among the following

Atomic mass unit u= 1.66 x10^{-27}Kg, Avogadro's number 6.022 x 10^{23}particles/mol, boltzmann's constant k_B = 1.38x10^{-23}J/K, Deutron mass m_d= 3.343x10^{-27}Kg,electron mass m_e= 9.109x10^{-31}Kg, electron volt eV=1.602 x10^{-19}J, charge e= 1.602x10^{-19}C, Gas constant R= 8.314J/K.mol, Gravitational constant G= 6.672x10^{-11}N.m^2/kg, neutron mass m_n=1.674x10^{-27}Kg, Permeability of free space $\mu_o = 4\pi\ x\ 10^{-7} T.m/A$, Permetivity of free space $\epsilon_o = 8.854\ x\ 10^{-12} C^2/N.m^2$. Plank's Constant $h = 6.626\ x\ 10^{-34} J.s$, ħ=1.054 x$10^{-34} J.s$, Proton mass $m_p = 1.672\ x10^{-27} Kg$, Rydberg constant $R_H = 1.097\ X\ 10^7 m^{-1}$, speed od light in a vacuum c = 2.997 x $\frac{10^8 m}{s}$, One light year(1Ly)is the diatance travelled by light in one year which is 9.4607 x 10^{12} Km

SECTION A

QUESTION ONE

a) A space ship of mass 12.0 x 10^{12} kg is to be accelerated to 0.96c.
   i) how much energy does this require? 4 marks
   ii) how many kilograms of matter would it take to provide this much energy? 4 marks

b) A spaceship flies by an observer with a speed of 0.95c, if its rest length is 80 m what does the observer measure as it bypasses her. 4 marks

c) A deuteron contains one proton and one neutron and has a mass of 3.013553u. Calculate the mass difference between the deuteron and the sum of masses of proton and neutron and determine its binding energy. 4 marks

d) Define the term red shift 2 marks

e) A stationary body explodes into three fragments of mass 0.65 kg, 0.43 kg and 0.12 kg that move apart at speeds of 0.65c, 0.78c and 0.99c respectively. Find the mass of the original body. 4 marks

f) Based on proton neutron ratio explain instability in nuclides. 2 marks

g) Give a reason as to why there is a gradual decrease in binding energy from 8.8 to 7.6MeV 2 marks

h) A radioactive sample contains 2.3 x 10^{16} atoms and has an activity of 6.0 x 10^{12}Bq. What is its half life? 4 marks

QUESTION TWO

a) i) Draw the set up for the Michelson interferometer 6 marks
   ii) Describe the features of the Michelson interferometer and explain how it works 6 marks

b) Derive the expression for Bohr total energy of the atom and for Bohr radius 8 marks

QUESTION THREE

a) i) Draw the set up for the Michelson–Morley experiment citing the modifications made to the Michelson interferometer 6 marks
   ii) Hence show that the time difference between horizontal and vertical beams is $\Delta t \approx \frac{LV^2}{C^3}$ 12 marks

b) State and explain the meaning of the Heinsenberg uncertainty principle 2 marks

QUESTION FOUR

a) Using a well drawn and described experiment, explain the concept of time dilation and show that $\Delta t = \gamma \Delta t_p$ 12 marks

b) Show that the

i) velocity of an electron in a hydrogen atom is given by 4 marks

$$v = \frac{e}{\sqrt{4\pi\varepsilon_o mr}}$$

ii) total energy in a hydrogen atom is

$E = -\frac{e^2}{8\pi\varepsilon_o r}$ 4 marks

QUESTION FIVE

a) Show that if proper length of an object is L_p and moving with speed of v in a direction parallel to its length, it contracts to $L = \frac{L_P}{\gamma}$ 7 marks

b) A girl travelling in a pickup tosses a ball vertically up when the car is at posion A, (**See Figure 1)** the ball landed back on the girl when the car is at position B. According to the girl, the path taken by the ball is a verticle line as shown at position A.

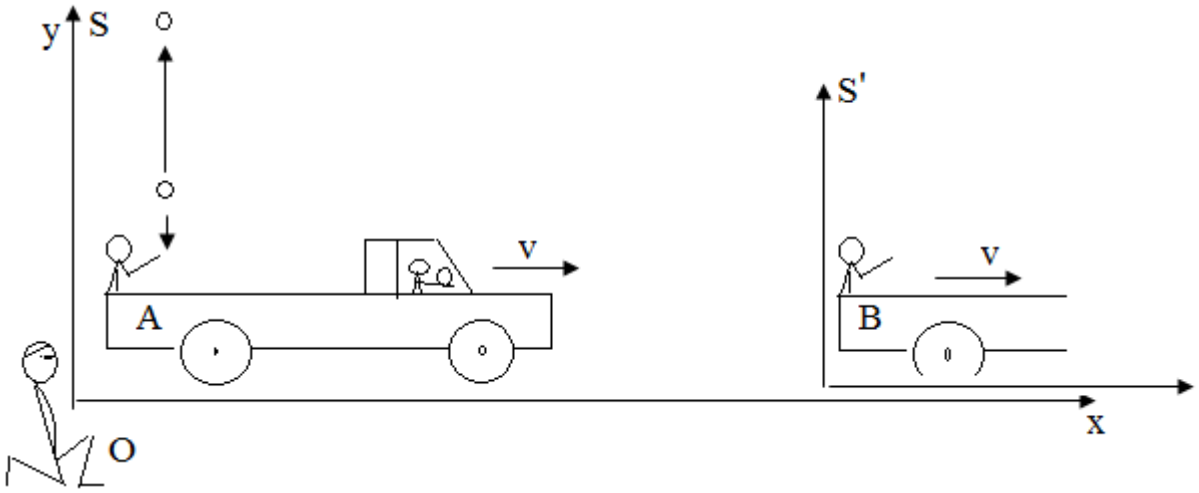

Figure 1

i) Draw what the stationary observer will record. 4 marks

ii) Frame S' is in motion at a speed of v (**Figure 1**), redraw the diagram making proper labeling and show that $X' = X - vt$ 4 marks

iii) Write down the Lorentz Transformation equation and state when they reduce to familiar classical equations 5 marks