Ser. No. EDU 132/18

GARISSA UNIVERSITY

UNIVERSITY EXAMINATION 2017/2018 ACADEMIC YEAR ONE SECOND SEMESTER EXAMINATION

SCHOOL OF BIOLOGY AND PHYSICAL SCIENCES

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: PHY: 122e

COURSE TITLE: MODERN PHYSICS

EXAMINATION DURATION: 3 HOURS

DATE: 19/04/18 **TIME: 09.00-12.00 PM**

INSTRUCTION TO CANDIDATES

- **The examination has SIX (6) questions**
- **Question ONE (1) is COMPULSORY**
- **Choose any other THREE (3) questions from the remaining FIVE (5) questions**
- **Use sketch diagrams to illustrate your answer whenever necessary**
- **Do not carry mobile phones or any other written materials in examination room**
- **Do not write on this paper**

This paper consists of FOUR (4) printed pages ***please turn over***

You may find the following constants useful

Magnitude of the charge of electron (e)	1.6 x 10^{-19}C
Rest mass of an electron Me	9.11 x 10-31Kg
Rest mass of proton Mp	1.67 x 10^{-27}Kg
Atomic mass unit, u	931.5MeV
Velocity of light, c	3.0 x 10^{8} m/s
Planks constant, h	6.26 x 10^{-34}Js
Stefan's constant, δ	5.67 x 10^{-8}W/m^{2}K^{4}
Wein's constant	2.898 x 10^{-3}mK
1 eV	1.6 x 10^{-19}J
Sun's diameter	1.4 x 10m

QUESTION ONE (COMPULSORY)

(a) When in Michelson Morley experiment no fridge shift was observed, it was concluded that the speed of light in free space is the same regardless of any motion of the observer.

i. What was the reason to arrive at this conclusion? **[2 marks]**

ii. Is this conclusion one of the postulates of the special theory of relativity? **[1 mark]**

iii. State any other postulates. **[2 marks]**

(b) Two spaceships are moving in the same direction with a relative speed of 0.5c. If the speed of one of the spaceships (slower one) is 0.9c as measured by an observer on earth, find the speed of the other spaceship with respect to the observer on earth. **[4 marks]**

(c) i. Differentiate between fusion and fission. **[2 marks]**

ii. A radioactive elements has half life of 1620 years. Find its radioactivity constant (λ) in seconds and hence or otherwise how long would it take 10gm to reduce to 8gm. **[4 marks]**

(d) i. State two implications of Bohr's postulates. **[2 marks]**

In the Bohr model of hydrogen atom the speed of the electron in its orbit is given as

1. $$v = \frac{e}{\sqrt{4\pi\varepsilon_0 r^2 mr}}$$

ii. Show that the magnitude of the potential energy of the electron is two times its kinetic energy.

[4 marks]

(e) Sodium has a work function of 2.3 eV. Calculate its threshold frequency and maximum velocity of Photoelectrons produced when the sodium is illuminated by light of wavelength 5 x 10^{-7}m.

[4 marks]

QUESTION TWO

(a) i. Define time dilation. **[1 mark]**

ii. A spaceship flies past earth with speed of 0.89C about (2.97×10^8 m/s). A high intensity signal light blinks on and off each pulse lasting 2×10^{-6}s. At a certain instant the ship appears to an observer to be directly overhead at an altitude of 1000km and to be travelling perpendicular to the line of sight. What is the duration of each light pulse as measured by this observer and how far does the ship travel relative to earth during each pulse **[4 marks]**

(b) Sunlight arrives at the earth at the rate of about 1.4kW/m^2 when the sun is directly overhead. The average radius of the earth's orbit is about 1.5×10^{11} m and the radius of the sun is 7×10^8m. From this, figures find the surface temperature of the sun on the assumption that it radiates like a blackbody. **[6 marks]**

(c) In photoelectric effect the kinetic energy of the electrons emitted from the metal surface depends on the frequency of the radiation and not intensity of radiation. Explain **[4 marks]**

QUESTION THREE

(a) State the two postulates of special relativity. Hence explain their implications. **[4 marks]**

(b) Briefly explain the Heisenberg's uncertainity principle. The position and momentum of a 1keV electron are simultaneous determined. If its position is located to within 1A, what is the percentage of uncertainity in its momentum **[5 marks]**

(c) i. State Weins distribution law **[1 mark]**

ii. Radiation from a spectrum corresponding to that of a black body at 2.5K is doppler shifted to longer wavelength. Find the wavelength at which the energy density is maximum. **[3 marks]**

ii. Define a muon. **[2 marks]**

QUESTION FOUR

(a) i. Define work function of a metal. **[2 marks]**

ii. A photon in the light of frequency 2×10^{15} Hz falls on a material whose work function is 2.28eV. Find the energy of the photon and threshold frequency of the material. **[6 marks]**

(b) μ mesons are created by the cosmic ray particles at an altitude of about 8500m from the sea level. Their mean lifetime measured at rest is 2×10^{-6}s. In its lifetime it can travel a distance of only 600m with its speed of 0.998c. But these μ mesons reach the earth in abundance. Explain this meson paradox from the frame of reference of meson by use of Lorentz – Fitzgerald contraction **[4 marks]**

(c) Find the momentum of a 1MeV electron. **[3 marks]**

QUESTION FIVE

(a) i. Derive de Broglie wavelength formula for moving bodies. **[3 marks]**

ii. Find the de Broglie wavelengths of a 46g golf ball with a velocity 0f 30m/s **[3 marks]**

(b) i. Define nuclear binding energy. Plot a variation curve showing nuclear binding energy against the atomic mass. Explain its shape. **[2 marks]**

ii. Calculate the binding energy per nucleon for helium nucleus whose atomic number is 2 and mass number .4. **[4 marks]**

(c) Discuss the Davisson-Germer experiment stating clearly what its results demonstrate **[3 marks]**

QUESTION SIX

(a) Define gravitational red shift and find its value Δv in terms of the mass M and radius R of the star for a proton of frequency v emitted from the star. **[5 marks]**

(b) i. Define the half life of a radioisotope. **[2 marks]**

ii. The half life of the sodium isotope ${}_{11}Na^{24}$ is 15 hours. What fraction of it will remain un decayed after 50 hours. **[3 marks]**

iii. Explain how energy is released during nuclear fusion. **[3 marks]**

(c) State the applications of emitted radiations. **[2 marks]**