



NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES

DEPARTMENT OF PHYSICS

2024_2 EXAMINATION

COURSE CODE: PHY 303
COURSE TITLE: SPECIAL RELATIVITY
CREDIT UNIT: 2
TIME ALLOWED: (2 HRS)

INSTRUCTION: *Answer question 1 and any other three questions*

QUESTION 1

- (a) Write the Galilean transformation for the measurement made by two object in s and s' frames (7marks)
- (b) Differentiate between inertia and non-inertia frames (5marks)
- (c) Define the momentum of four vector and write its formular (5marks)
- (d) Write clearly the Einstein's mass energy equation (5marks)
- (e) State the meaning of a group (3marks)

QUESTION 2

- (a). Given the Maxwell's equation $\nabla^2 \epsilon = \epsilon_0 \mu_0 \frac{d^2 \epsilon}{dt^2}$, write out the Cartesian coordinate system of the electric field vector E and further express its x-component (5marks).
- (b) Define the term Galilean invariance in transformation (4marks)
- (c) Assuming that the rest radius of earth is $6400km$ and its orbital speed about the sun is $30km^{-1}$, how much does earths diameter appear to be shortened to an observer on the sun, due to earths orbital motion? (6marks)

QUESTION 3

- (a) Explain the Emission theories in the Michelson morley experiment (5marks)
- (b) Write the time dilation formula and define its terms (4marks)

(c) (i) what is mean life time **(2marks)**

(ii) The mean lifetime of muons at rest is found to be about $2.2 \times 10^{-6}s$, while the mean lifetime in a burst of cosmic rays is found to be $1.5 \times 10^{-5}s$, what is the speed of these cosmic ray muons? **(4marks)**

QUESTION 4

(a) Explain numerically what is meant by the rest energy of 1kg of water (or any other substance)? **(4marks)**

(b) Write clearly the Einstein's mass energy equation and explain its terms **(4marks)**

(c) An electron has kinetic energy equal to its rest energy. Show that the energy of a photon which has the same momentum as this electron is given by $E_\gamma =$

$$\sqrt{3}E_0, \text{ where } E_0 = m_e c^2 \text{ (7marks)}$$

QUESTION 5

(a)- Write the quantitative statement of conservation of charge and define the terms **(5marks)**

(b) Define the term relativistic invariance **(3marks)**

(b)- Find the wavelength shift in the Doppler effects for the sodium line 589nm emitted by a source moving in a circle with a constant speed $0.05c$ observed by a person fixed at the center of the circle. **(7marks)**