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**NATIONAL OPEN UNIVERSITY OF NIGERIA**

**PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA**

**FACULTY OF SCIENCES**

**DEPARTMENT OF PURE AND APPLIED SCIENCE**

 **2018\_2 SEMESTER 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)(i) Explain what you understand by the term inertial reference frame of reference.**4 marks**

(ii) Show that Newton’s second law of motion is invariant under Galilean transformation.**6 marks**

(b)(i)A swimmer can swim with a speed $c$ in the still water of a lake. In a stream in which the speed of the current is $v$ (which, we assume, is less than$c$), the swimmer can also swim with a speed $c$ relative to the water in the stream. Suppose the swimmer swims upstream a distance $L$ which is equal to the width of the stream and then returns downstream to the starting point. Find the time taken to make the round trip and compare it with the round trip time taken to swim straight across the stream. **8 marks**

(ii) The equation of an electromagnetic wave in free space is given as

$$\frac{∂^{2 }E\_{x}}{∂x^{2}}+\frac{∂^{2}E\_{x}}{∂y^{2}}+ \frac{∂^{2}E\_{x}}{∂z^{2}}= \frac{1}{c^{2}}\frac{∂^{2}E\_{x}}{∂t^{2}}$$

Show that this equation is not invariant under Galilean transformation.**7 marks**

**QUESTION 2**

 (a) A sample of radioactive material at rest in the laboratory ejects two electrons in opposite directions. One of the electron has a speed of 0.6c and the other has a speed of 0.7c, as measured by a laboratory observer. According to classical velocity transformations, what will be the speed of one electron as measured from the other **4 marks**

(b) A man in a boat moving at constant speed of 50km/h relative to the shore throws an object in the forward direction with a speed of 20.5km/h. What is the speed of the object as measured by an observer at rest at the shore. **4 marks**

 (c)(i) In a Michelson-Morley experiment, the lengths of the arms of the interferometer was

 found to be $11 m$ and the wavelength of light used was$ 6000 Å$. Calculate the total

 expected fringe shift when the apparatus is rotated through$ 90°$. Take the orbital speed of

 the earth to be $3×10^{4}ms^{-1}$. **4 marks**

 (ii) Briefly discuss two viewpoints that were suggested to retain the ether concept. **3 marks**

**QUESTION 3**

a. Observer O’ moving with a speed of 0.8c relative to a space platform, travels to a x-century which, at a distance of 4 light years, is the nearest star to the

 platform. When he reaches the space platform, compare his age with that of

his twin brother O, who has stayed on the platform. **8marks**

b. A passenger in a train moving at 20km/h looks out and sees a man standing

 on the platform of the station at t = t’ = 0. Twenty five seconds after, the man on the platform determines that a bird flying in the same direction as the train is 750m away. What is the average speed of the bird as determined

 by the passenger. **7marks**

**QUESTION 4**

a. Calculate the energy of an electron in joules and electrons – volts

 [hints: Eo = moc2, 1ev = 1.6×10-19J] (8 marks)

b. Calculate the velocity of a proton whose kinetic energy is 200Mev. (7 marks)

**QUESTION 5**

(a) Calculate the momentum of a 1Mev electron. [Hints: E2 = (pc)2 + Eo2] **3 marks**

(b) An observer at rest with respect to the ground observes the following collision. A particle

 mass M1= 1kg moving with velocity U1 = 4m/s along the axis approaches a second

 particle of mass M2 = 1kg moving with velocity U2= -3m/s along the X- axis. After a

 head on collision the ground observer finds that M2has a velocity U2 = 3m/s along the

 X- axis. Find the velocity U1 of M1 after collision. **4 marks**

 (c)(i) Write down the components of the electric and magnetic fields $\vec{E}^{'}$ and $\vec{B}^{'}$ in the $S^{'}$ frame

 in terms of the components $\vec{E}$ and $\vec{B}$ in the $S$ frame, where both frames are inertial.

 **4 marks**

 (ii) Find the magnetic field of a point charge in uniform motion. **4 marks**