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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**

**2019\_1 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)**What is an inertial frame of reference? ***(2 marks)***

Is earth an inertial frame? Briefly explain ***(2 marks)***

**b)** A rod of length 100 cm, when the rod is in a satellite moving with a velocity 0.5c with respect to the earth, what is the length of the rod as measured by an observer ***(i)*** in the satellite and ***(ii)*** In the laboratory on earth***? (5 marks)***

**c)** i) What is the Galilean transformation? ***(2 marks)***

ii) What are the limitations of Galilean transformation? Briefly explain. ***(4 marks)***

d) At what speed does a clock move if it runs at a rate which is one-half the rate of a

clock at rest? ***(5 marks)***

**e)** Prove that momentum of a body of rest mass mo and total energy T is  ***(5 marks)***

**QUESTION 2**

***a)*** A man in a boat moving at constant speed of 60m/h relative to the shore throws an object in the forward direction with a speed of 30km/h. What is the speed of the object as measured by an observer at rest at the shore? ***(5marks)***

***b)*** How fast must an electron move in order that its mass equals the rest mass of the proton? ***(5 marks)***

***c)*** i) State the Einstein’s definition of simultaneity ***(2.5 marks)***

ii) Give a consequence of the definitions ***(2.5 marks)***

**QUESTION 3**

**a)** If the kinetic energy of a body is twice its rest mass energy, find its velocity. ***(6 marks)***

**b)** A passenger in a train moving at 35km/h looks out and sees a man standing on the

platform of the station at t = t’ = 0. Twenty seconds after, the man on the platform

determines that a bird flying in the same direction as the train is 800m away.

What is the average speed of the bird as determined by the passenger? ***(4.5 marks)***

**c)** State three properties of Lorentz Transformation that you know ***(4.5 marks)***

**QUESTION 4**

**a)** An atomic clock is placed in a jet airplane. The clock measures a time interval of 3600s when the jet moves with speed 400ms-1. How much larger a time interval does not an identical clock held by an observer at rest on the ground measure? ***(5 marks)***

**b)** An observer at rest with respect to the ground observes a particle of mass m1 = 3kg moving

along the x-axis with a velocity us =3m/s. It approaches a second particle of mass m2 = 1kg

moving with velocity u2 = -3m/s along the same axis. After head-on collision, he finds that

the velocity of m2 is u2’ = -3m/s along the x-axis. What are the momenta before and after the

collision as seen by a moving observer walking with a velocity of 2m/s relative to the ground

along the x-axis? ***(10 marks)***

**QUESTION 5**

1. In a Michelson-Morley experiment, an interferometer with arms of 11m and sodium light of

5900A was used. If the velocity of the earth through ether is 3 x 104ms-1, calculate the expected total fringe shift when the apparatus is rotated through 900. ***(5 marks)***

**b)** If the laws of physics are the same for two observers in uniform relative motion, why do they get different answers when they calculate physical quantities? Explain briefly, perhaps with an example. ***(5 marks)***

**c)** At what speed should a clock be moved so that it may appear to lose, 1 minute in each

hour? ***(5 marks)***