RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
First Year – Semester II Examination – February / March 2019

PHY 1104 – MODERN PHYSICS

Time: One (01) hour

Answer two questions only.
The use of non-programmable calculator is permitted.

1. Using Lorentz- Einstein transformation equations,

a) Show that an object contracts to a length, $L = L_0/\gamma$, when it moves with a speed v in a direction parallel to its length. Assume that it has a proper length L_0 when it is at rest. What is γ ?

(06 Marks)

b) Explain what is meant by proper time t_0 and then state the equation for the *time dilation effect.*

(06 Marks)

c) A spaceship travels with a speed v = 0.7 c ($\gamma = 1.40$) with respect to the Earth. A person on the Earth throws a ball in a projectile. Assume that the motion of the spaceship is in horizontal direction with respect to the person. (Assume that the acceleration due to gravity is $g = 10\ \text{ms}^{-2}$).

i. If a ball has a maximum vertical displacement of 20 m, what is the time duration of the projectile motion of the ball as measured by an observer inside the spaceship?

(07 Marks)

ii. If the horizontal component of the projected velocity is $10\ \text{ms}^{-1}$, find how far away from the person, the ball hits the ground as seen by the observer inside the spaceship.

(06 Marks)

Contd.

2. Using Lorentz- Einstein transformation equations,

a) Show that the Lorentz velocity transformation equations along x and y directions are given by,

$$U'x = \frac{Ux - v}{1 - \frac{v}{c^2}Ux}$$

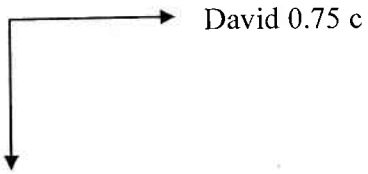
$$U'y = \frac{Uy/\gamma}{1 - \frac{v}{c^2}Ux}$$

Hence state the Lorentz velocity transformation equations along the z direction.

(10 Marks)

b) Write the **inverse** velocity transformation equation along the z direction. (05 Marks)

c) Two motorcycle riders named David and Emilli are racing at relativistic speeds as given in the figure. Find how fast Emilli recedes over David's right shoulder as seen by David.



(10 Marks)

3.

a) State the postulates of Bohr's theory of the hydrogen atom. (03 Marks)

b) Derive an expression for the radius of the n^{th} Bohr orbit of the hydrogen atom. (07 Marks)

c) Obtain an expression for the total energy of an electron in the n^{th} orbit of the hydrogen atom in terms of the absolute constants. (05 Marks)

d) What are the energy (in Joules) and the wavelength (in meters) of the line in the spectrum of Hydrogen that represents the movement of an electron from $n = 4\ to\ n = 6$ Bohr orbits? In what part of the electromagnetic spectrum do we find this radiation?
(h= 6.626×10^{-34} Js, c =2.998×10^{8} ms^{-1}) (10 Marks)

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