UNIVERSITY OF SRI JAYEWARDANEPURA

B. Sc. General Degree Second Year Course Unit Examination – Oct/Nov, 2018.

PHY 207 1.0 / PHY 257 1.0 / PHY 302 1.0 / PHY 327 1.0

- Special Theory of Relativity

Time : One hour

Answer all questions

Assume, velocity of Light (c) = 3×10^8 ms^{-1}

01. Write down the **two** main Einstein's Postulates in Special Theory of Relativity (STR).

Obtain the following relativistic time equation, starting from the above Postulates in STR.

$$t^1 = \gamma\, t \ , \quad \text{where, } \gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} ; \text{ (Symbols have their usual meanings)}$$

An alpha particle and a beta particle, which are created in a particle accelerator, travel a total distance of 10.0 m between two detectors in 50 ns and 40 ns respectively, as measured in the laboratory frame.

(*a*) What is the lifetime of the alpha particle as measured in its own frame?

(*b*) What is the lifetime of the alpha particle as measured in the frame of the beta particle?

02. Derive an expression for the length contraction ($l_2 = l_1\sqrt{1 - v^2/c^2}$) starting from the relativistic time equation (Symbols have their usual meanings).

A star known as Alfa-Centauri is about 4.0 light years (1 light year = 9.4608 x 1015m) distant from the Earth. If suppose a rocket from the Earth is to reach it in five years, how fast would it have to go?

What is the length of the trip (from the Earth to Alpha-Centauri) according to an observer in the rocket?

03. **Derive** the equation,

$$E^2 - p^2\ c^2 = m_o^2\ c^4,$$

starting from the Einstein's energy equation, $E = m\,c^2$. (Symbols have their usual meanings)

Hence, **obtain** the equation,

$$m = \gamma\ m_o, \quad \text{where, } \gamma\ = \left(1 - \frac{v^2}{c^2}\right)^{-1/2};$$

for **mass variation** in relativistic dynamics. (Symbols have their usual meanings)

A proton is accelerated to a velocity 0.95c by using a particle accelerator. Rest mass of the proton is 1.67×10^{-27} kg. **Calculate** the mass of the moving proton.

04. What is meant by the **Doppler Effect** in Relativity for a moving light source?

You are given the following mathematical equation for the Doppler effect,

$f_o = \dfrac{f_s}{\gamma\ \left(1 - \beta\ \cos\theta\right)}$. Where $\gamma\ = 1/\sqrt{1-\beta^2}$, $\beta = \dfrac{v}{c}$ and other symbols have their usual meanings.

A spacecraft moves towards the Earth with a constant velocity $c/2$ as viewed from the Earth's frame. The spacecraft emits light of wave length λ as measured in its own frame. The wave length of the light as seen by an observer on the Earth is 6000 $\mathring{A}$. (1 $\mathring{A}$ = 10^{-10} m)

Find the value of λ.

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