UNIVERSITY OF SRI JAYEWARDANEPURA

B.Sc. General/Special Degree Third Year Course Unit Examination –

October, 2017.

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.

$$t_2 = t_1 \frac{1}{\sqrt{1 - v^2/c^2}}$$ (Symbols have their usual meanings)

How many times will the half-life of an unstable particle increase, compared its stationary value, if it moves with a velocity of *0.99 c* ?

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

A solid cube has each side a while at rest. It is now set into motion with velocity kc where k is a constant and c is the velocity of light, along the direction of the base diagonal.

What is its volume as seen by a stationary observer ?

03. Derive the expression, $E^2 = m_o{}^2 c^4 + p^2\, c^2$, starting from the equation, $E = m\,c^2$ (symbols have their usual meanings).

Hence, obtain the equation, $m = \dfrac{m_o}{\sqrt{1-\dfrac{v^2}{c^2}}}$ for **mass variation** in relativistic dynamics. (Symbols have their usual meanings)

If $M = m/m_o$ and $\beta = \dfrac{v}{c}$, sketch the variation of M vs β.

For a particle of the rest mass m_0, relativistic mass m, rest energy E_0 and total relativistic energy E, prove the following relations;

(*a*) $v = \dfrac{c\sqrt{(E+E_0)(E-E_0)}}{E}$

(*b*) $v = \dfrac{c\sqrt{(m+m_0)(m-m_0)}}{m}$

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.

In Astronomy, Astronomical Charts display "**actual**" colour and **speed of stars** in the Universe. Such charts indicate the colours of the stars observed on the Earth. However, indicating their "actual" colours and speeds seems beyond common sense.

Write down your views on the basis on which above information are included in Astronomical Charts.

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