EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE 2004/05 (REPEAT) (OCT/NOV. 2006)

SECOND SEMESTER

PH 205 RELATIVITY

Time: 01 hour.

Answer ALL Questions.

You may use the following information useful:

Rest mass of proton $m_p = 1.673 \times 10^{-27} kg$

Velocity of light $c = 3 \times 10^8 ms^{-1}$

01. State the fundamental postulates of the special theory of relativity and deduce Lorentz transformation equations from them.

Given two frames S and S' where S' is moving at uniform velocity V in the positive xx' direction relative to frame S. A particle in frame S has velocity $U = \{u_x, u_y, u_z\}$. Using appropriate Lorentz transformation equations show that the velocity components of the particle in frame S' are given by

$$u_x' = \frac{u_x - V}{\left(1 - \frac{Vu_x}{c^2}\right)} \qquad u_y' = \frac{u_y}{\gamma\left(1 - \frac{Vu_x}{c^2}\right)} \qquad u_z' = \frac{u_z}{\gamma\left(1 - \frac{Vu_x}{c^2}\right)}$$

where the symbols have their usual meanings.

A spacecraft A is moving with a speed of $2.80 \times 10^8 ms^{-1}$ relative to the earth. A second spacecraft B, moving in the same direction as that of A, has a speed of $1.00 \times 10^8 ms^{-1}$ relative to the spacecraft A. Calculate the speed of B relative to the earth.

02. (a) Classically we consider a mass of the object is a constant factor, but in special theory of relativity this is not true. State the expression for the relativistic mass and explain clearly each symbol that you use.

Calculate the relativistic energy and momentum of a proton which is moving with a speed of $2.4 \times 10^8 ms^{-1}$.

(b) An external force $\underline{F}$ is applied on a particle where $\underline{F} = \frac{d\underline{p}}{dt}$, derive an expression for its kinetic energy.

(c) Derive the Energy-Momentum equation of the particle given by $E^2 - p^2c^2 = m_0c^4$, where the symbols have their usual significance.