EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE - 2005/2006

SECOND SEMESTER (REPEAT)

(MARCH/APRIL 2008)

PH 205 RELATIVITY

Time: 01 hour.

Answer ALL Questions

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1. Given two frames S and S', where frame 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 transformations, show that the velocity components of the particle in frame S' are given by,

$$U'_x = \frac{U_x - V}{\left(1 - \frac{VU_x}{c^2}\right)}, \qquad U_y' = \frac{U_y}{\gamma\left(1 - \frac{VU_x}{c^2}\right)}, \qquad U'_z = \frac{U_z}{\gamma\left(1 - \frac{VU_x}{c^2}\right)}.$$

Then show that, $U_x = \dfrac{U'_x + V}{\left(1 + \frac{VUx'}{c^2}\right)}$.

where the symbols have their usual meanings.

A space ship is launched from earth and maintains a uniform velocity of $0.9c$ in the horizontal direction where c is the velocity of the light which equals to $3\times10^8\, ms^{-1}$. The space ship subsequently launches a small rocket in the forward direction with the speed of $0.9c$ relative to the space ship. What is the speed of the small rocket relative to the Earth?

2. Write down the expression for the relativistic mass and relativistic momentum of a particle with clear symbolic definition.

   i. Show that the Energy-Momentum equation of a particle is given by,
   $$E^2 - p^2c^2 = m_0{}^2c^4.$$
   ii. Show that the quantity $E^2 - p^2c^2$ is invariant.
   iii. A particle of rest mass m_0 is traveling, so that its total energy is just twice of its rest mass energy. It collides with a new particle. Show that the rest mass of the new particle is $\sqrt{6}m_0$.