EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE - 2009/2010

SECOND SEMESTER (PROPER/REPEAT)

(April 2012)

PH 205 RELATIVITY

Time: 01 hour.

Answer ALL Questions

You may find the following data useful.

Velocity of light in vacuum (c) = 3×10^8 m/s

Plank's constant (h) = 6.62×10^{-34} J s

1 eV=1.6×10^{-19} J

1) State Einstein's postulates of Special Theory of Relativity. Hence, deduce Lorenz's Transformation Equations for position and time in two inertial frames of reference.

(a) One event occurs at the origin of an inertial frame S at time t=0. Another event occurs at a point $x=9 \times 10^8$ m, $y=z=0$ at time $t=4$ s relative to the same frame S. Find the velocities (relative to S) of inertial frames in which the two events are

I. simultaneous;

II. recorded at the same point in space.

(b) If the mean lifetime of a muon when it is at rest is 2.2×10^{-6} s, find the average distance it will travel in vacuum with velocity 0.99c before decay. Compare with the distance calculated classically.

2) If the relativistic total energy of a particle is given by $E = mc^2$, then show that $\frac{E^2}{c^2} - p^2$ is invariant; where p is the momentum of the particle and c is the velocity of light. You may consider the relativistic mass of a particle moving with velocity u as $m = \frac{m_0}{\sqrt{1-(u^2/c^2)}}$; where m_0 is the rest mass of the particle.

(a) A particle of rest mass m_0 is travelling so that its total energy is just twice its rest mass energy. It collides with a stationary particle of rest mass m_0 to form a new particle. Show that the rest mass of the new particle is $\sqrt{6}\, m_0$.

(b) If De Broglie's wavelength is given by $\lambda=h/p$, then

I. show that the rest mass of photon is zero.

II. Calculate the De Broglie's wavelength of a pion having rest mass 140 MeV/c^2 and total energy 420 MeV.