Relativistic Mechanics

Tutorial Sheet 1

Q.1 Show that space-time interval $x^2 + y^2 + z^2 - c^2t^2$ is invariant under Lorentz transformations.

Q.2 A train whose length is 150 meter when at rest has to pass through a tunnel of length 125 meter. The train is moving with uniform speed of 2.4×10^8 m/sec towards the tunnel. Find the length of the train and that of the tunnel as observed by an observer (i) at the tunnel (ii) at the train. Ans: (i) 90m, 125m (ii) 75m, 150m

Q.3 Show that the circle, $x^2 + y^2 = a^2$ in frame S appears to be an ellipse in frame S' which is moving with velocity v relative to S.

Q.4 Calculate the percentage contraction of a rod moving with a velocity of 0.8c in a direction inclined at 60° to its own length.

Ans: 8.4 %

Q.5 The mean life time of a meson is 2×10^{-8} sec. Calculate the mean life of meson moving with a velocity 0.8 c. Ans: 3.33×10^{-8} sec

Q.6 A clock measures proper time. With what speed a clock should move relative to an observer so that it may appear to go slow by 4 minutes in a day? Ans: 2.32×10^7 m/sec

Q.7 What is the length of a meter stick moving parallel to its length when its mass is 3/2 times of its rest mass. Ans: 0.667 m

Q.8 Two particles come toward each other, each with speed 0.9c, with respect to laboratory. What is their relative speed? Ans: .994 c

Q.9 A particle is moving with 90%of the velocity of light. Compare its relativistic mass with its rest mass. Also calculate percentage increase in its mass.

Q.10 If the kinetic energy of body is twice its rest mass energy, find its velocity. Ans: 2.829×10^8 m/sec.

Q.11 Calculate the rest mass, relativistic mass and momentum of a photon having energy 5 eV. Ans: $p = 2.67 \times 10^{-27}$ kg-m/sec, $m = 8.9 \times 10^{-36}$kg, $m_0 = 0$