Written Examination Special Relativity F8066

Academic Year 2007–2008, 8 July 2008, 2.30-4.30 PM

Please read the following INSTRUCTIONS

A. Answer at most TWO questions. You may answer in english or in italian.

B. You may not use notes or textbooks, but the course notes are available for consultation at the front desk.

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1. A stick of proper length l sits at rest in frame S, lying in the $x-y$ plane at an angle $\theta = \arctan(3/4)$ with the x axis. Another frame S' moves with velocity v along the positive x axis of S. In S' the stick is angled at 45° with respect to the x' axis.
(a) What is v?
Ans. $\gamma = \frac{\tan\theta'}{\tan\theta} = \frac{4}{3}$, $v = \frac{\sqrt{7}}{4}c$
(b) What is the length l' of the stick as measured is S'?
Ans. $l' = \frac{3\sqrt{2}}{5}l$.

2. In an inertial frame two particles are shot out simultaneously from a given point, with equal speeds v, in orthogonal directions. What is the speed of each particle relative to the other?
Ans. $\gamma(u) = \gamma^2(v), \quad u = v\sqrt{2 - \frac{v^2}{c^2}}$

3. Argue that the set of all Lorentz boosts is a group (the direction of the x and x' remaining the same). What are the physical meanings of the identity and the inverse of an element in this group? Is this group abelian? Given a pair of consecutive transformations corresponding to velocities v_1 and v_2, what is the velocity corresponding to the composition of the two transformations? Justify all answers.