Written Examination Special Relativity F8066

Academic Year 2001–2002: 1 July 2002, 2-4 PM

Please read the following INSTRUCTIONS

A. Answer at most TWO questions. You may answer in english or in italian. A pass is obtained for one complete answer, and full marks for two complete answers.

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

C. On your answer paper, please rewrite and sign the pledge

"I swear on my honour that I have neither given nor received help during this examination."

---

1. The time intervals measured by two observers A, B differ by $\frac{25}{3} = 8.33\%$. What is their relative velocity? A third observer C sees A's velocity as $\vec{v}$ and B's velocity as $-\vec{v}$. What is v ?
Answer relative velocity $\frac{5c}{13}$, $v = \frac{c}{5}$.

2. Write out the transformations of the components of a **symmetric** contravariant tensor $A^{\alpha\beta}$ under a Lorentz boost with velocity v along the x-axis. Is the transformed tensor necessarily symmetric?
Answer $A^{\alpha\beta} = \frac{A^{\alpha\beta}+A^{\beta\alpha}}{2}$.....

3. Two snowballs of equal rest mass $m = 60\ gm$ are thrown together head-on, and fuse to form one snowball. If the velocity of each snowball was $v = 0.8c$, calculate

i)the velocity of the resultant snowball

ii)the rest mass of the resultant snowball
Answeri) zero ii) $M = 2\gamma m, \gamma = \frac{5}{3}, M = 200gm$

4. A spaceship moves with velocity $v = 3000\ km/s$. At what angle should an astronaut aboard the spaceship look in order to see light from the distant stars with null (zero) red shift?
Answer $\gamma(1 - \beta\cos\phi) = 1, \beta = 10^{-2}, \cos\phi = \frac{1}{200}$