



Senior Math Circles

Wednesday, February 8, 2017

Problem Set 1

- Suppose the frame \acute{S} moves to the left at a speed of $\frac{c}{2}$ ms^{-1} relative to S .
 - If P has co-ordinates $\begin{bmatrix} 2 \\ 3 \end{bmatrix}$ in S , then what are its co-ordinates in \acute{S} ?
 - If Q has co-ordinates $\begin{bmatrix} 3 \\ 4 \end{bmatrix}$ in \acute{S} , then what are its co-ordinates in S ?
 - What is the path of $T = \alpha x$ when viewed from \acute{S} ?
- When high energy cosmic ray protons enter the earth's upper atmosphere they interact with it and produce muons. This interaction occurs at 10^4m , and the muons move towards the earth's surface at $0.994c$ ms^{-1} .
 - How long do the muons take to reach the earth's surface?
 - according to an earth observer?
 - according to the muons?
 - Suppose that the muon surface density is 10^2 per m^2 per second at 10^4 m and the muon half life is 2.10^{-6}s .
 - What density would the earth observer expect to record at the earth's surface if she knows no SR?
 - What is the true value of the density at the earth's surface?
- What speed would Bob have to travel in the twin problem so that when he returns, after 10 years of travel, Dave is twice as old as Bob is. Assume that they are both 30 at the start of the exercise and neglect accelerations.
- How fast would you have to move a 30m long pole to make it just fit inside a 5m long shed?
- What is the largest length, L, of pole that can be made to fit inside a 100m long barn if the pole can be moved at $0.9999c$ ms^{-1} ?