

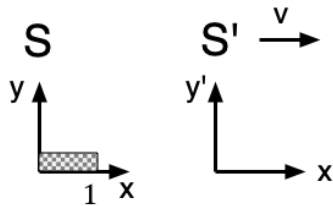
Feb. 23, 2021

### Modern Physics: Test # 1

No books, notes, google or any references! You may use a calculator.

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1. A meter stick is at rest in frame S and lies along the  $x$ -axis. A frame  $S'$  moves in the positive  $x$  direction with respect to S with speed  $v$  as seen by an observer in S.
  - (a) What is the length of the meter stick as observed in frame  $S'$ ?
  - (b) Draw a space-time diagram in frame  $S'$  showing the world lines for both ends of the meter stick.
  - (c) Use the Lorentz Transformation to prove that the meter stick as measured by an observer in frame  $S'$  is as you claim.



2. A pion ( $m_{\pi}c^2 = 0.135 \text{ GeV}$ ) has a *kinetic* energy of  $0.135 \text{ GeV}$  in the laboratory and travels a distance of  $30 \text{ m}$  before decaying. How long did the pion live in its rest frame?
3. An excited nucleus (mass  $m^*$ ) at rest in the laboratory decays to its ground state (mass  $m$ ) plus a gamma ray. In terms of  $m^*$  and  $m$ , what is the gamma ray energy?