Indian Institute of Technology Guwahati

Tutorial-2 PH131: Modern Physics Due on :14 October 2025

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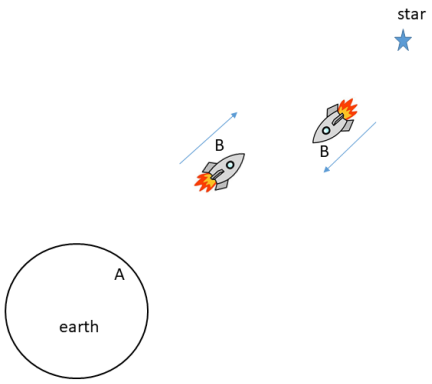
1. A π^+ meson is created in the atmosphere at a height 200km from the ground when primary cosmic ray is incident. It descends vertically at a speed 0.99c. It then disintegrates after 2.5×10^{-8} sec of its creation as measured from the frame of reference of the π^+ meson. At what height from the ground the π^+ meson is observed to disintegrate from earth?

2. A and B are twins and each of the two is 20 years old. B sets off on a rocket at a constant velocity of 0.95c (c being the velocity of light in vacuum) to a distant star. After exploring the star for a very short duration B then gets back home on earth.



   As measured by A the total period of absence of B is 40 years. What is the time of absence as per B's clock? Is this entire experiment symmetrical with respect to the frames of reference of the two twins? If not why.

3. A bullet train has a total length (as measured from the frame of reference of the train itself) of 450 metres. An observer standing on a railway platform is measuring the length of the bullet train when the train is traveling with a constant velocity at speed equal to 400 km/hour. Obtain the amount by which the length of the train appears to get shortened as per the observer on the platform. (Hint: As in this case $\beta^2 \ll 1$, hence expand γ binomially and retain upto the second term).

4. The spaceship Enterprise goes to a planet in a star system far away with a speed of 0.9c, spends 6 months on the planet, and comes back with a speed of 0.95c. The entire trip takes 5 years for the crew.
   (a) How far is the planet according to Earth observers?
   (b) How long did it take the crew to get to the planet?
   (c) How long did the entire trip take for the Earth observers?
