Indian Institute of Technology Guwahati

Tutorial-3 | PH131: Modern Physics | Due on: 21 October 2025

---

1. The Earth and Alpha Centauri are 4.3 light years apart. Ignoring their relative motion, assume that events A and B occur at t = 0 on Earth and at 1 year on Alpha Centauri, respectively, as observed from earth.
   (a) What is the time difference between the events according to an observer moving at β= 0.98 from Earth to Alpha Centauri?
   (b) What is the time difference between the events according to an observer moving at β= 0.98 from Alpha Centauri to Earth?
   (c) What is the speed of a spacecraft that makes the trip from Alpha Centauri to Earth in 2.5 years according to the spacecraft clocks?
   (d) What is the trip time for the observer on Earth?

2. In an intergalactic race, team A is moving at speed 0.8c relative to the finish line. They notice that a faster team B passes them at a speed 0.9c. Team B observes another team C to pass them at a speed 0.95c. What are the speeds of teams B and C relative to the finish line?

3. A super-ball has the property that when it hits a wall with a given speed relative to the wall, it bounces back with the same speed in the opposite direction relative to the same wall. What do you measure the speed of the bounced ball to be if you throw it at speed v towards a wall which is moving towards you at speed v_w?

4. Consider the tale of a physicist who is ticketed for running a red light and argues that because he was approaching the intersection, the red light was Doppler shifted and appeared green. How fast would he have been going? Consider the wavelengths of red and green light to be 650 nm and 530 nm, respectively.
