

# Relativistic Electrodynamics

## RED.3

1. The earth and sun are 8.3 light-minutes apart. Ignore their relative motion for this problem and assume they live in a single inertial frame, the Earth-Sun frame. In this frame, two events  $A$  and  $B$  occur at  $t = 0$  on the earth and at 2 minutes on the sun respectively. Find the time difference between the events according to an observer moving at  $u = 0.8c$  from Earth to Sun. Repeat if observer is moving in the opposite direction at  $u = 0.8c$ .  
[2 marks]
2. A muon has a lifetime of  $2 \times 10^{-6}s$  in its rest frame. It is created 100km above the earth and moves towards it at a speed of  $2.97 \times 10^8 m/s$ . In the rest frame of the Earth, how far does it travel before it decays?  
[2 marks]
3. An observer  $S$  who lives on the  $x$ -axis sees a flash of red light at  $x = 1210m$ , then after  $4.96\mu s$ , a flash of blue at  $x = 480m$ . Use subscripts R and B to label the coordinates of the events.
  - (a) What is the velocity relative to  $S$  of an observer  $S'$  who records the events as occurring at the same place?
  - (b) Which event occurs first according to  $S'$  and what is the measured time interval between these flashes?  
[2 marks]
4. A body of rest mass  $m$  moving at speed  $v$  approaches an identical body at rest. Find  $V$ , the speed of a frame in which the total momentum is zero.  
[2 marks]
5. A rod of length  $L_0$  is at rest in the frame  $S_0$  at an angle  $\Theta_0$  with respect to the  $x_0$  axis. The frame  $S_0$  moves relative to the frame  $S$  in the standard configuration and with speed  $v$ .
  - (a) Determine the length of the rod as measured by an observer stationary in  $S$ .
  - (b) Determine the angle  $\Theta$  the rod makes with the  $x$  axis in  $S$ .  
[2 marks]