**PHY102A**
**PROBLEM SHEET 6, PART 2**

**(1)** Consider two frames of reference : a boy standing on a horizontal road, call him A and a person on a passing truck, call him B. The boy puts two crackers on the road, at a distance $l$ apart, along the length of the road. (The truck's length according to the boy is greater than $l$). As the truck passes by with constant speed $v$, the crackers explode simultaneously as seen by the boy, and leave two marks on the truck. The boy says that the distance between the marks is $l$, in his frame. He can then calculate the distance between the marks that should be seen by B. Calculate this distance. Now repeat the whole analysis from the point of view of B. What is the distance between the marks as seen by B ? Is it different from that predicted by the boy ? If so, what is the resolution of this paradox ? (HInt : B sees the crackers at a distance different from the boy.)

**(2)** A truck and a tunnel both have proper length $l$. The truck comes into the tunnel with speed $v$. A torch is kept at the front end of the truck. There is an activator at the far end of the tunnel that switches on the torch as the front end of the truck passes the far end of the tunnel. A deactivator is kept at the back end of the truck that deactivates the torch as the back of the truck passes the near end of the tunnel. From the frame of the tunnel, the truck is contracted and hence the deactivator will deactivate the torch and it will not light. From the truck frame, the tunnel is contracted so that the torch will light before the deactivator works. Will the torch light or not ?

**(3)** A car with proper length $l$ moves at speed $\frac{c}{3}$ w.r.t the ground. A boy slides a block along the length of the car, from the back to the front at speed $\frac{c}{4}$ w.r.t the car. Assume that the car floor is frictionless. How much time does the block take to go from the back to the front in the car frame and in the ground frame. What distance will the block have covered in the car frame and in the ground frame when it just hits the wall.

**(4)** Consider two events which have coordinates $(x_1, t_1)$ and $(x_2, t_2)$ in the frame of A and $(x'_1, t'_1)$ and $(x'_2, t'_2)$ in the frame of B, where A and B are observers with B moving with constant speed $v$ w.r.t A. Using Lorentz transformation, show that

$$c^2 (t_2 - t_1)^2 - (x_2 - x_1)^2 = c^2 \left(t'_2 - t'_1\right)^2 - \left(x'_2 - x'_1\right)^2$$