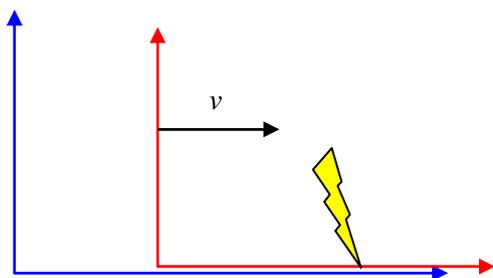
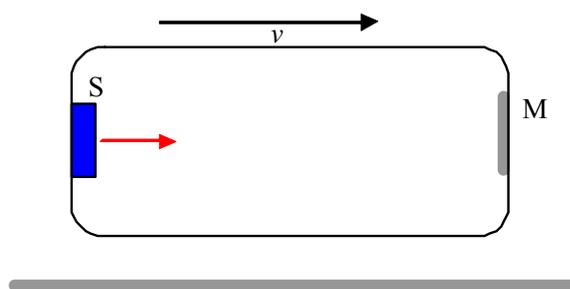


Extension Worksheet – Option H, Worksheet 1

- 1 Lightning strikes a point on the ground. An observer at rest on the ground sees light from the strike reach him when his clock reads $4.0 \mu\text{s}$. His position is 600 m from the point where lightning struck. State the time coordinate of the event ‘lightning strikes’ according to observers at rest on the ground. [2]
- 2 The diagram shows two inertial reference frames. Clocks in both frames were set to zero when the origins of the frames coincided.



- The red (right-hand) frame moves with speed $v = 30 \text{ ms}^{-1}$ relative to the blue (left-hand) frame. Lightning strikes at the position $x = 900 \text{ m}$ and at time $t = 6.0 \text{ s}$ according to observers on the ground (blue frame). Using a Galilean transformation equation determine the position and time of this event according to the observers in the red frame. [2]
- 3 For question 2, explain whether or not relativity would make any appreciable change to your answers. [2]
- 4 A box of proper length L moves with speed v relative to the ground.



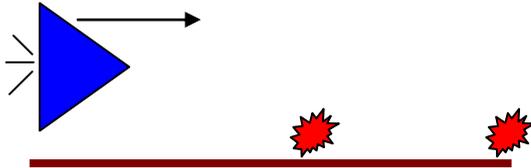
A ray of light is emitted from a source S towards a mirror M at the front of the box. The ray is reflected off the mirror and returns to S.

- a Define **proper length**. [1]
- b State whether the observer inside the box or the observer on the ground measures the proper length of the box. [1]
- c According to the observer inside the box, the light takes a time of 9.0 ns for the return trip from S to M and then back to S. Explain why this time interval is a proper time interval for the observer in the box. [2]

d The time interval for the observer on the ground is 12 ns. Calculate the length of the box according the ground observer. [3]

e According to the observer inside the box, the time for light to travel from S to M is the same as the time from M to S. State and explain whether the same is true according to the ground observer. [2]

5 Two explosions take place simultaneously on the ground according to observers on the ground. A rocket approaches the site of the explosions at relativistic speed.



By considering light from the explosions reaching an observer on the ground at the midpoint of the explosion positions, explain why the explosions are not simultaneous for the rocket observers, stating which one happened first. [4]