

# Astronomy 2 – Special Relativity

## Tutorial Question for week 7

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### Question

[ This question will probably be more straightforward *after* Monday's lecture than before. ]

Take two cars, moving along the  $x$ -axis at a speed  $v$ , separated by 1 km in their frame. The lead car passes first a checkpoint and then, 0.5 km further on, a traffic policeman.

Sketch a Minkowski diagram of these events, indicating at least the worldlines of the cars, the checkpoint and the policeman, and marking the events ①, the lead car passing the checkpoint, ②, the position of the second car at the same time as ① in the cars' frame, ③, the position of the second car at the same time as ① in the checkpoint frame, ④, the second car reaching the checkpoint, and ⑤, the first car reaching the policeman. [ It will probably help if you choose the frames such that event ① has coordinates  $x_1 = t_1 = x'_1 = t'_1 = 0$ , but if you want to do it another way, that's fine. ]

Give expressions for the coordinates of these events (in either  $S$  or  $S'$  as appropriate), in terms of the speed  $v$ .

Give an expression for the interval  $s_{45}^2$  between events ④ and ⑤, and calculate numerical values for this in the cases (i)  $v = 1/2$ , (ii)  $v = 3/5$  and (iii)  $v = 4/5$ . In each of the three cases, state, with an explanation, whether it is possible for the traffic policeman to signal to the checkpoint to lower a barrier before the second car arrives.

[ Optional, non-assessed, extra: draw Minkowski diagrams for the three cases (i), (ii) and (iii), which illustrate the answers you obtain above. This might illuminate both the answer to this question, and the pole-in-the-barn problem. ]