

Question 19 (4 marks)

In one of Einstein's famous thought experiments, a passenger travels on a train that passes through a station at 60% of the speed of light. According to the passenger, the length of the train carriage is 22 m from front to rear.

- (a) A light in the train carriage is switched on. Compare the velocity of the light beam as seen by the passenger on the train and a rail worker standing on the station platform. 1

One of Einstein's basic tenets was that the speed of light remains constant in any frame of reference, therefore it is observed to be the same for both passenger & worker

- (b) Calculate the length of the carriage as observed by the rail worker on the station platform. 3

It will appear shorter to the rail worker due to Lorentz-Fitzgerald length contraction

$$l_v = l_0 \sqrt{1 - \frac{v^2}{c^2}} \quad \begin{matrix} v = 0.6c \\ v^2 = 0.6^2 c^2 \end{matrix}$$

$$= 22 \sqrt{1 - 0.6^2}$$

$$= 17.6 \text{ m}$$

Length of the carriage as observed by the rail worker on the station platform is 17.6m