

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

The velocity of the light will travel at the speed of light for the passenger but take longer to travel as seen by the rail worker.

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

$$\begin{aligned}
 L_v &= L_0 \sqrt{1 - \frac{v^2}{c^2}} \\
 &= 22 \sqrt{1 - \frac{(0.6c)^2}{c^2}} \\
 &= 22 \sqrt{1 - 0.6^2} \\
 &= 22 \sqrt{1 - 0.36} \\
 &= 22 \sqrt{0.64} \\
 &= 22 \times 0.8 \\
 &= 17.6 \text{ m}
 \end{aligned}$$