

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 beam as seen by the train passenger is faster than the velocity seen by the observer

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

$$l_v = l_0 \sqrt{1 - \frac{v^2}{c^2}}$$

$$l_v = 22 \times \sqrt{1 - \frac{(3.0 \times 10^8)^2 \times 60\%}{(3.0 \times 10^8)^2}}$$

$$\therefore l_v = 22 \times \sqrt{1 - \frac{324 \times 10^{16}}{9 \times 10^{16}}} \rightarrow (3.24 \times 10^{16})$$

$$\therefore l_v = 17.6 \text{ m}$$

$$\text{length observed} = 17.6 \text{ m}$$