

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 light beam will travel slower for the observer than the passenger.

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

$$L = L_0 \sqrt{1 - \frac{v^2}{c^2}} = 22 \sqrt{1 - \frac{(1.8 \times 10^8)^2}{(3 \times 10^8)^2}}$$

60% of  $3 \times 10^8 = 1.8 \times 10^8$   
 $= 180000000$

$$= \frac{3.24 \times 10^{16}}{9 \times 10^{16}}$$

$$22 = L \sqrt{1 - 0.36}$$

$$22 = L \times 0.8$$

$$L = \frac{22}{0.8}$$

= 27.5m observed by rail worker.

$$= 22 \times \sqrt{1 - 0.36}$$

$$22 \times 0.8$$

$$= 17.6m$$