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 observer and passenger see the same speed which is c, speed of light.

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

3

$$l_v = l_o \sqrt{1 - \frac{(v^2)}{c^2}}$$
$$= 22 \sqrt{1 - \frac{(0.6c)^2}{c^2}}$$
$$= 22 \times \sqrt{(1 - 0.36)}$$
$$= 22 \times 0.8$$
$$l_v = 17.6 \text{ m}$$

$$l_v = l_o \sqrt{1 - \frac{v^2}{c^2}}$$
$$22 = l_o \sqrt{1 - \frac{(0.6c)^2}{c^2}}$$
$$22 = l_o \sqrt{(1 - 0.36)}$$
$$22 = l_o \times 0.8$$
$$l_o = \frac{22}{0.8}$$
$$l_o = 27.5 \text{ m}$$