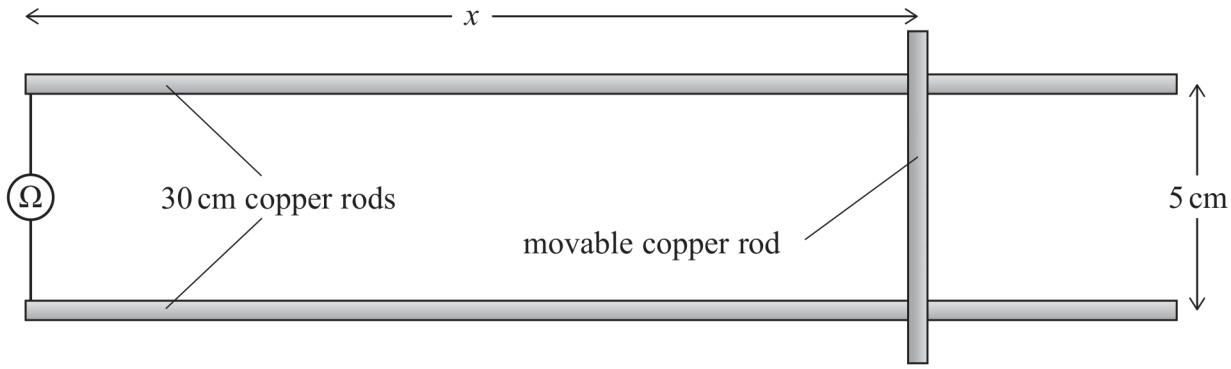
2 A student models a safety system used on a railway.

Two parallel 30 cm copper rods model the rails. These rods are fixed 5 cm apart and are connected to an ohmmeter.

A movable copper rod models the train. This rod completes the circuit with the ohmmeter, as shown.

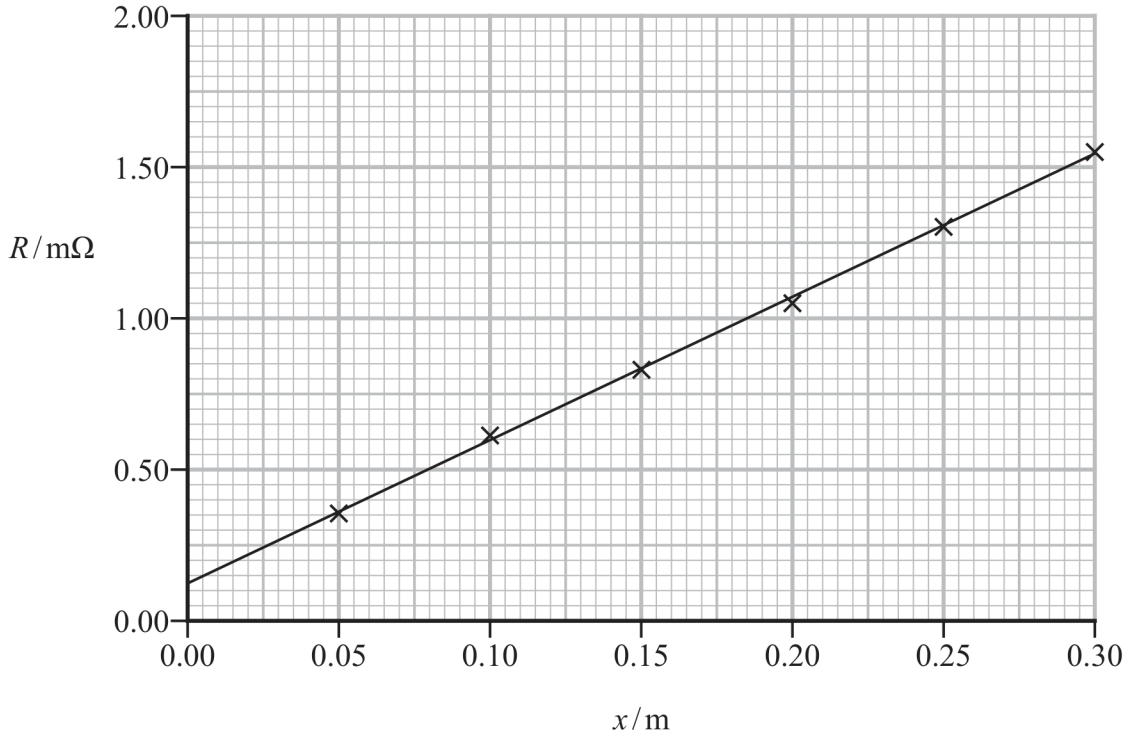


As the distance x varies, the resistance R of the circuit varies.

(a) Describe how the student could determine accurate values of x and R.

(4)

(b) The student measured values of x and corresponding values of R and plotted a graph of his measurements.



State why the line of best fit does not pass through the origin.

(1)

.....

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(c) The total length l of copper in the circuit is given by

$$l = 2x + 0.050\,\text{m}$$

The copper rods have a diameter of 3.0 mm.

Determine the resistivity of the copper.

(4)

Resistivity = ...

(d) The safety system of the railway estimates the position of a train on the track using a resistance measurement.

The rails become worn with continual use, so their cross-sectional area decreases.

Explain how the decrease in cross-sectional area affects the estimate of the position of a train.

(2)

(Total for Question 2 = 11 marks)