7 The plan view of a train braking system is illustrated in Fig 7.1. The train carriage is mounted on a rectangular metal frame ABCD of length L and width w. The effective resistance of the frame is R.

The train carriage is initially moving at a constant speed along the rails.

A uniform magnetic field B is directed perpendicularly into the ground over a rectangular region of length L. Line P denotes the start of this region while line Q denotes the end of the region.

After passing through the magnetic field, the train speed is expected to be reduced to a very low value after which brakes can be applied to stop it completely. Air resistance and friction may be neglected.

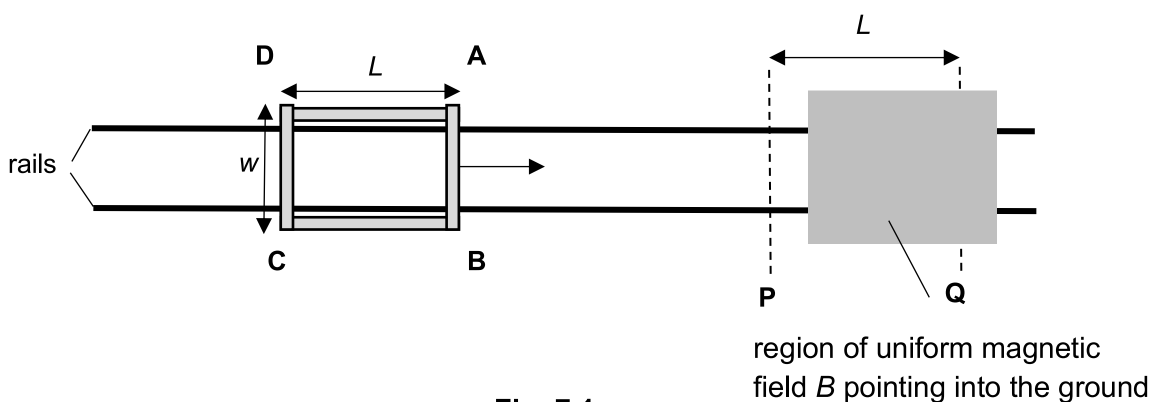

Fig. 7.1

(a) Show that as the frame enters the region of magnetic field, the e.m.f. induced in it, E, is given by $E = Bwv$ where v is the speed of the train carriage. Explain your working clearly.

[2
]

(b) **(i)** Explain why the train carriage slows down as AB moves through the magnetic field from P to Q.

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.... [3]

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(ii) The graph in Fig 7.2 shows the velocity of the train carriage as it moves through the magnetic field, from the instant AB crosses line P to the instant CD crosses line Q.

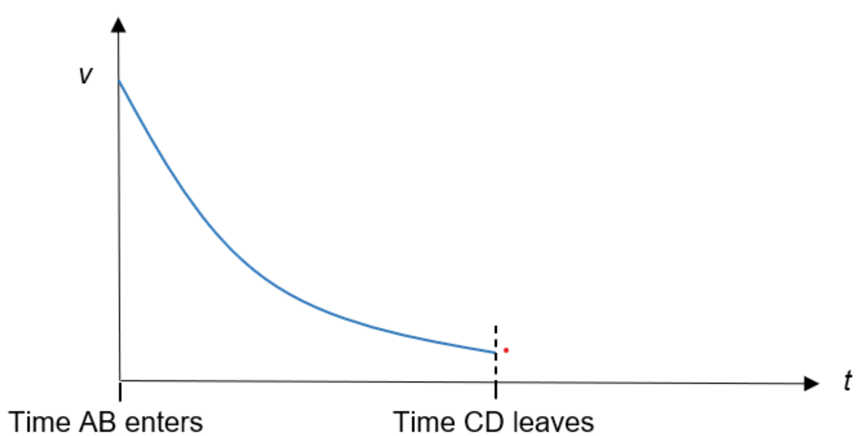

Fig. 7.2

The length of the magnetic field is now reduced by *moving Q closer to P* so that the distance PQ is now smaller than *L*.

Sketch on Fig 7.2 the new variation of the velocity of the train carriage with time as it passes through the magnetic field from the instant AB crosses line P to the instant CD crosses line Q. [3]

[Total: 8]