6 (a) The plan view (from top down) of a train braking system is illustrated in Fig 6.1. The train carriage of mass *m* 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 speed (exit speed) after which brakes can be applied to stop it completely. You may assume that friction is negligible.

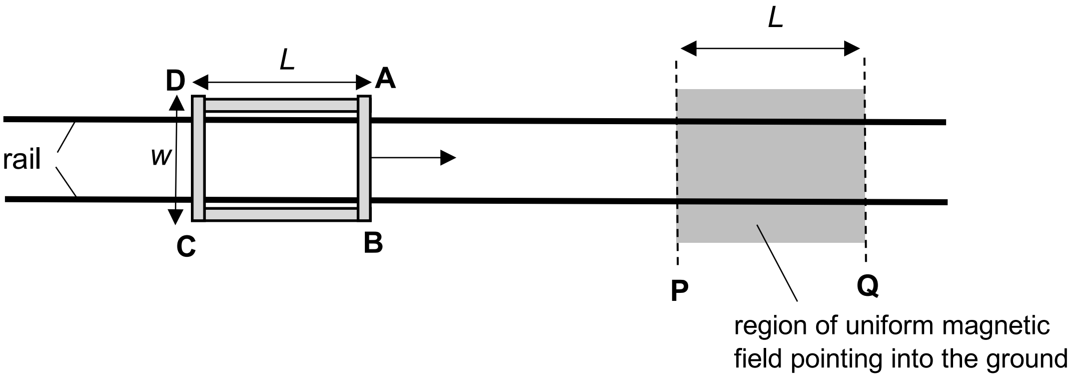

Fig 6.1

(i) Define *magnetic flux density.*

....

....

....

....[2]

(ii) Explain how the train carriage is slowed down as AB moves through the magnetic field from P to Q.

....

....

....

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

....

....[3]

(iii) Show that the braking force acting on the frame is given by $F = \frac{B^2 w^2 v}{R}$ where v is the speed of the train carriage. Explain your working clearly.

[4]

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

(b) The graph in Fig 6.2 shows the speed 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.

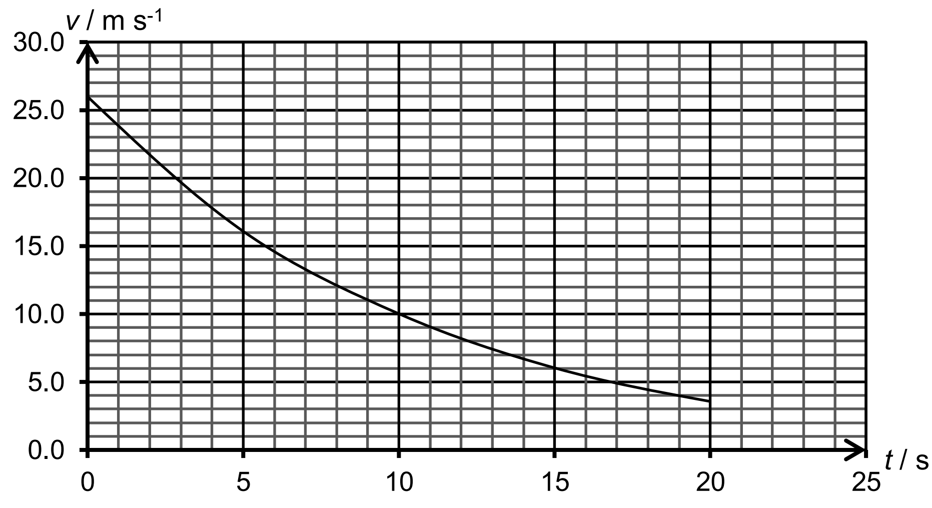

Fig 6.2

(i) Use Fig 6.2 to estimate the distance PQ.

distance PQ = ... m [2]

(ii) Discuss how increasing the region of magnetic field (distance between P and Q) would affect, if at all, the exit speed of the train after passing through it.

....

....

.... [2]

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN