5 **(a)** A metal rod is accelerated uniformly from rest in a uniform magnetic field as shown in Fig. 5.1.

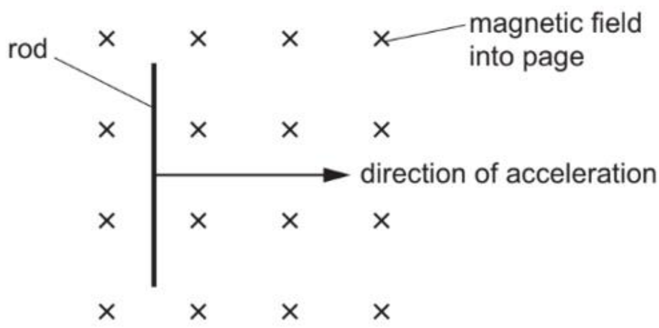


Fig. 5.1

The rod has length l and the flux density of the magnetic field is B.

An electromotive force (e.m.f.) is induced in the rod. The variation with time t of the induced e.m.f. E is shown in Fig. 5.2.

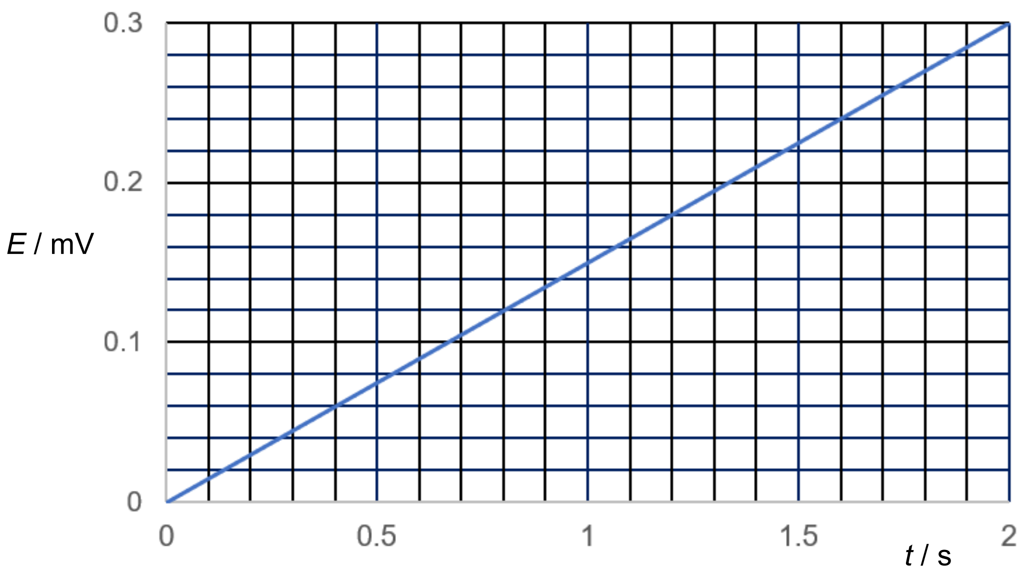


Fig. 5.2

(i) Explain how Fig. 5.2 shows that the acceleration of the rod is uniform.

....

....

.... [2]

[Turn over

(ii) The same metal rod in **(a)** is now placed on a pair of smooth conducting rails with a resistor *R* connected to the rails on a flat surface as shown in Fig. 5.3. The rod is pulled on the rails at a steady speed *v* from the left to the right.

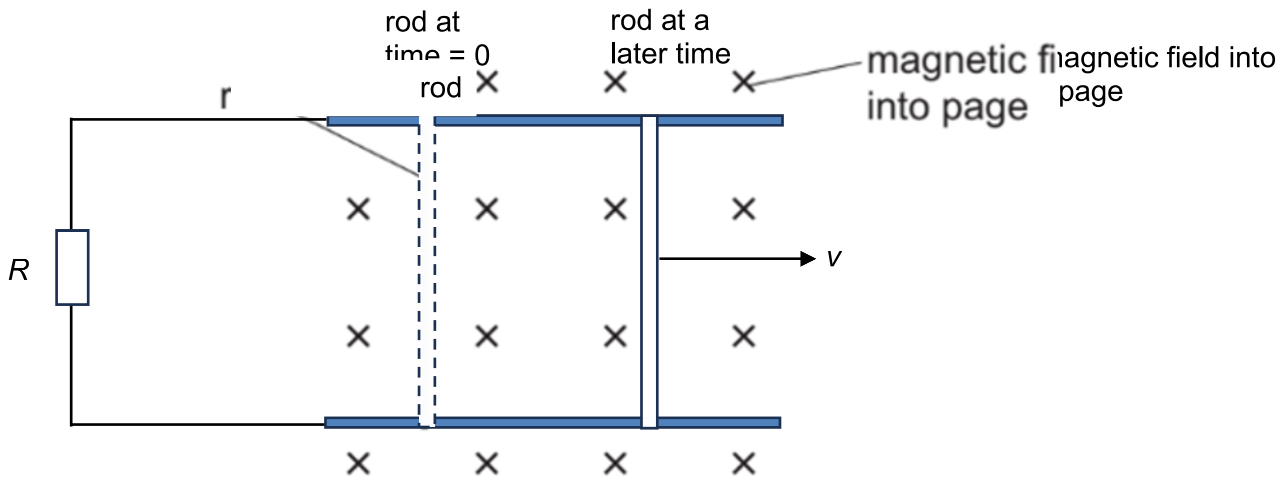


Fig. 5.3

Explain in terms of energy changes, why external work is needed to keep the speed of the rod constant.

....

....

....

....

.... [2]

(b) An alternating current I in a resistor of resistance 400 Ω varies with time t according to

$$I = 3.5 \sin(40\pi t)$$

where I is in A and t is in s.

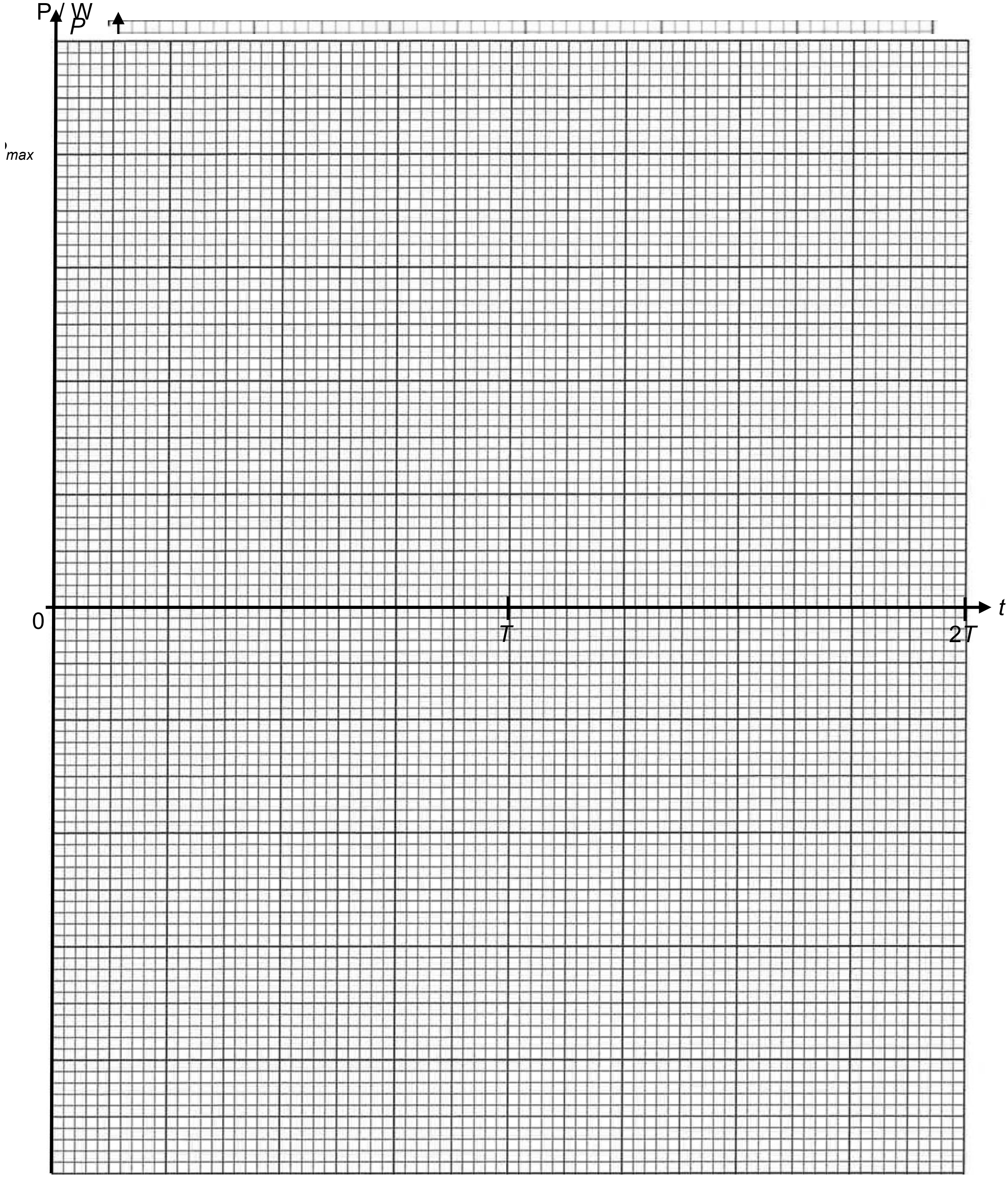
(i) Calculate the period T period of the alternating current.

T = ………………………………. s [1]

(ii) Calculate the mean power P transferred in the 400 Ω resistor.

P = ………………………………. W [2]

(iii) On Fig. 5.4, show the variation with time t of the power P transferred in the resistor for two periods of the alternating current. P_{max} is the maximum power transferred in the resistor.



[3]

[Total: 10]