9 **(a)** Define *magnetic flux linkage*.

....

....

.... [2]

(b) A solenoid of diameter 6.0 cm and 540 turns is placed in a uniform magnetic field as shown in Fig. 9.1.

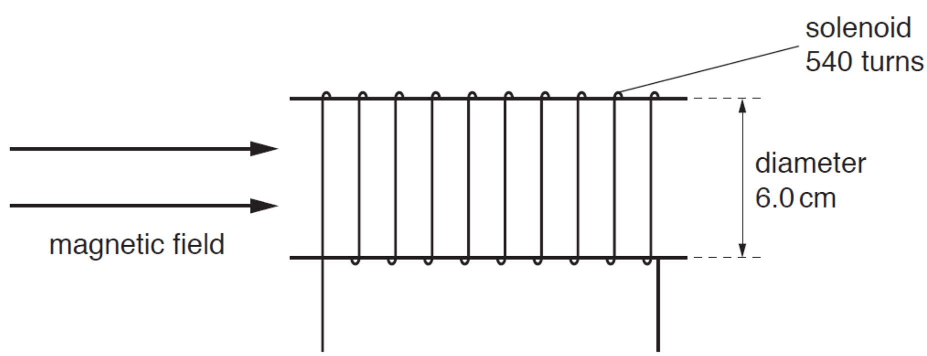


Fig. 9.1

The variation with time t of the magnetic flux density is shown in Fig. 9.2.

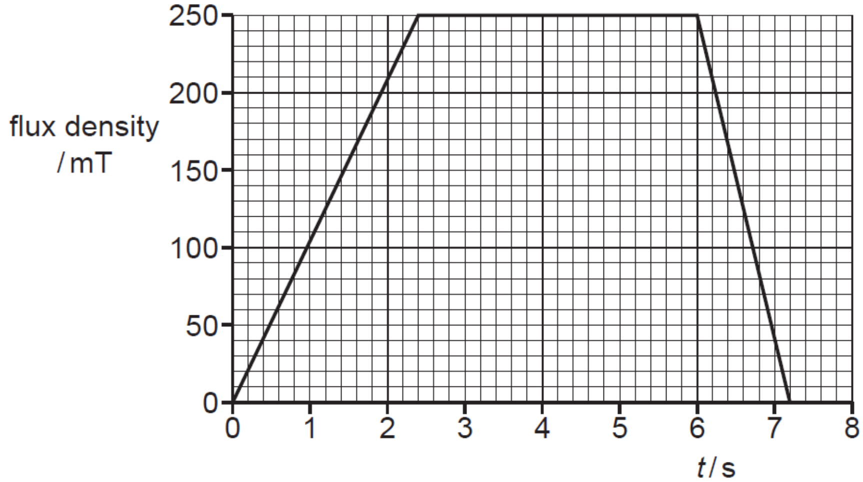


Fig. 9.2

Calculate the maximum magnitude of the induced electromotive force (e.m.f.) in the solenoid.

e.m.f. = ... V [3]

Question 9 continues on the next page.

(c) A thin copper sheet X is supported on a rigid rod so that it hangs between the poles of a magnet as shown in Fig. 9.3.

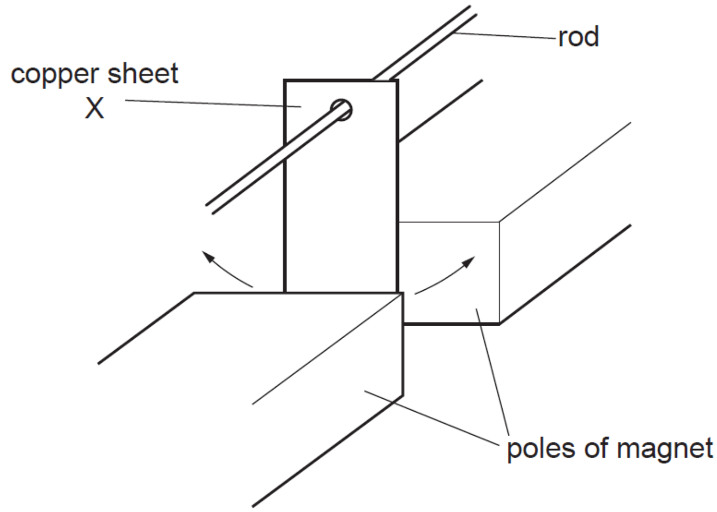


Fig. 9.3

Sheet X is displaced to one side and then released so that it oscillates. A motion sensor is used to record the displacement of X.

A second thin copper sheet Y replaces sheet X. Sheet Y has the same overall dimensions as X but is cut into the shape shown in Fig. 9.4.

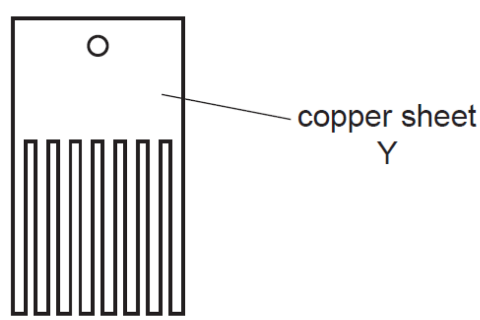


Fig. 9.4

The motion sensor is again used to record the displacement.

The graph in Fig. 9.5 shows the variation with time t of the displacement s of each copper sheet.

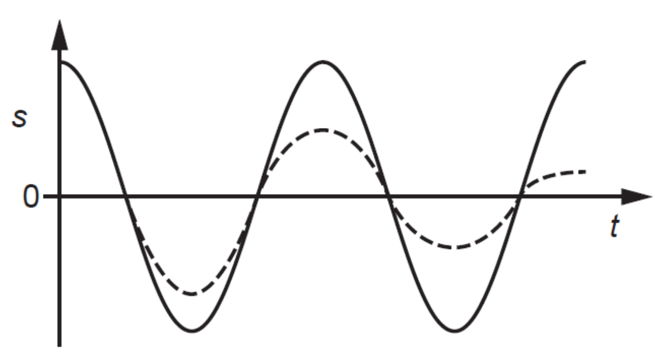


Fig. 9.5

(i) State the name of the phenomenon illustrated by the gradual reduction in the amplitude of the dashed line.

……………………………………………………………………………………………... [1]

(ii) Deduce which copper sheet is represented by the dashed line. Explain your answer using the principles of electromagnetic induction.

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………………... [4]

(d) The output potential difference (p.d.) of an alternating power supply is represented by

$$V = 320 \sin(100\pi t)$$

where V is the p.d. in volts and t is the time in seconds.

The power supply is connected to resistor R of resistance 120 Ω and an ideal diode in the circuit shown in Fig. 9.6.

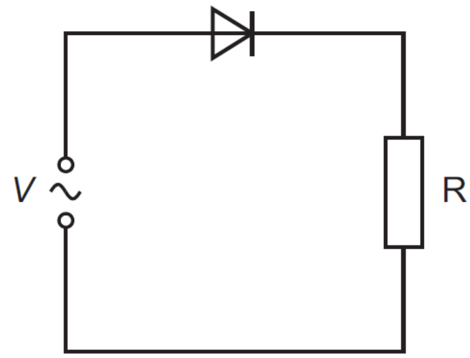


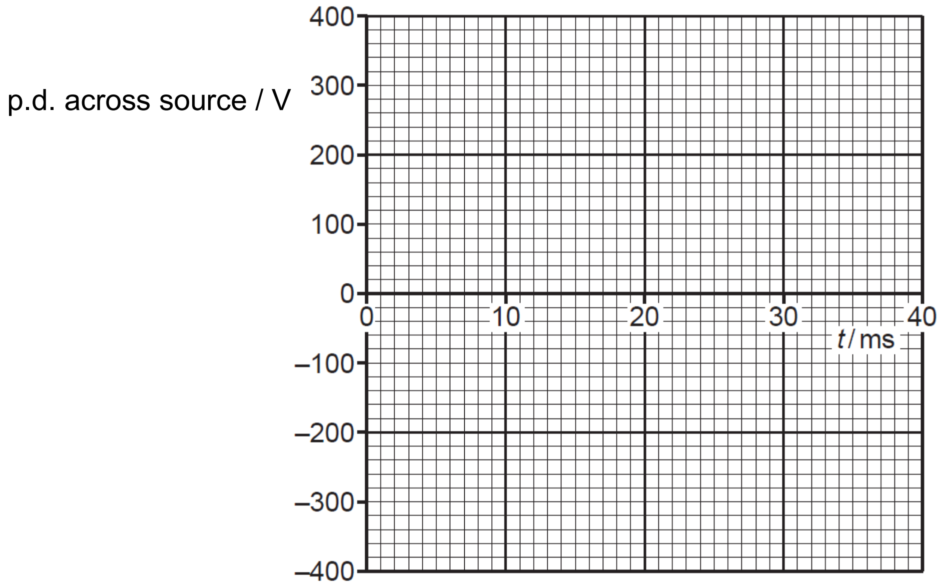
Fig. 9.6

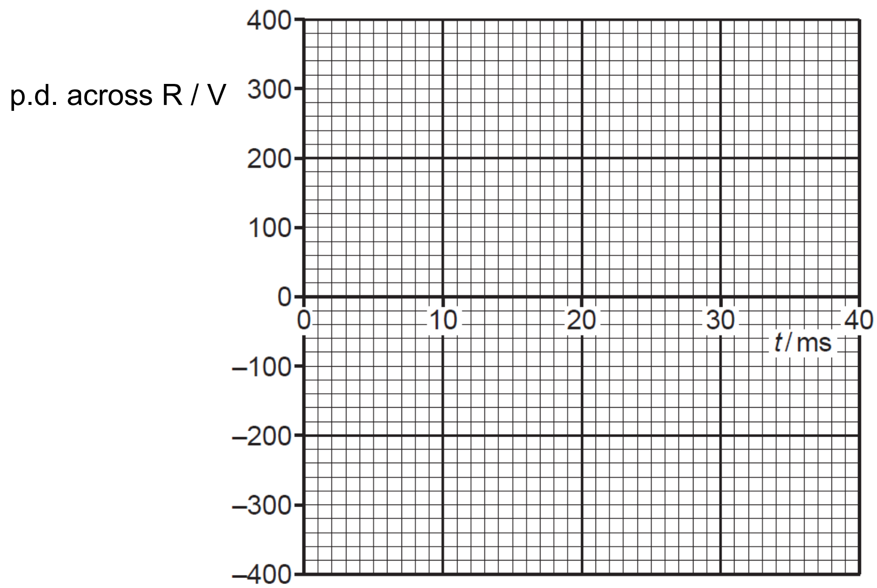
(i) Sketch on Fig. 9.7, from time t = 0 to time t = 40 ms.

1. the variation with time t of the p.d across the source,

2. the variation with time t of the p.d across the R,

3. the variation with time t of the p.d across the diode.


p.d. across source / V
400
300
200
100
0
–100
–200
–300
–400
0
10
20
30
40
t / ms


p.d. across R / V
400
300
200
100
0
–100
–200
–300
–400
0
10
20
30
40
t / ms

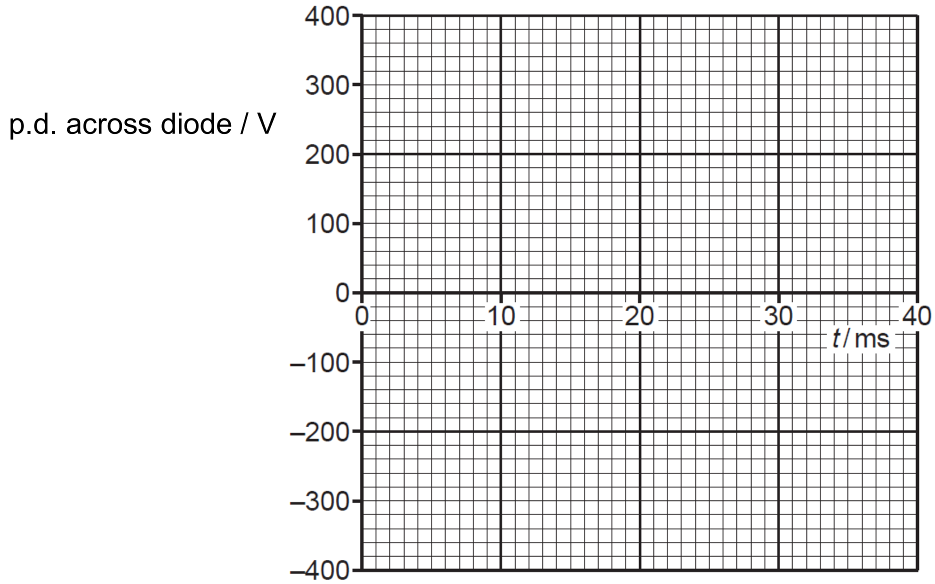


Fig. 9.7

[5]

(ii) Determine the average power dissipated in the resistor R.

power = ……………………………W [2]

(iii) Define the *root-mean-square (r.m.s.) current.*

……………………………………………………………………………………………..

……………………………………………………………………………………………..

…………………………………………………………………………………………… [1]

(iv) Determine the r.m.s current in the resistor R.

r.m.s current = …………………………….A [2]

[Total: 20]

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