

- 8 (a) A rigid rectangular metal loop has resistance  $R$ . It has dimensions  $L$  and  $W$ , and moves with a constant speed  $v$  to the right, as shown in Fig. 8.1.

It enters a region of uniform magnetic field with field strength  $B$  directed into the page. The region extends a distance of  $3W$  in the horizontal direction.

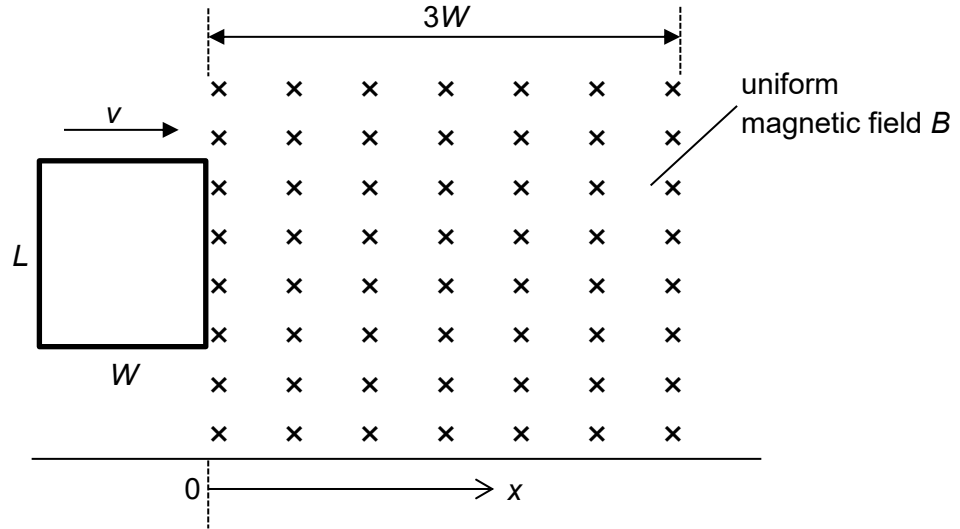
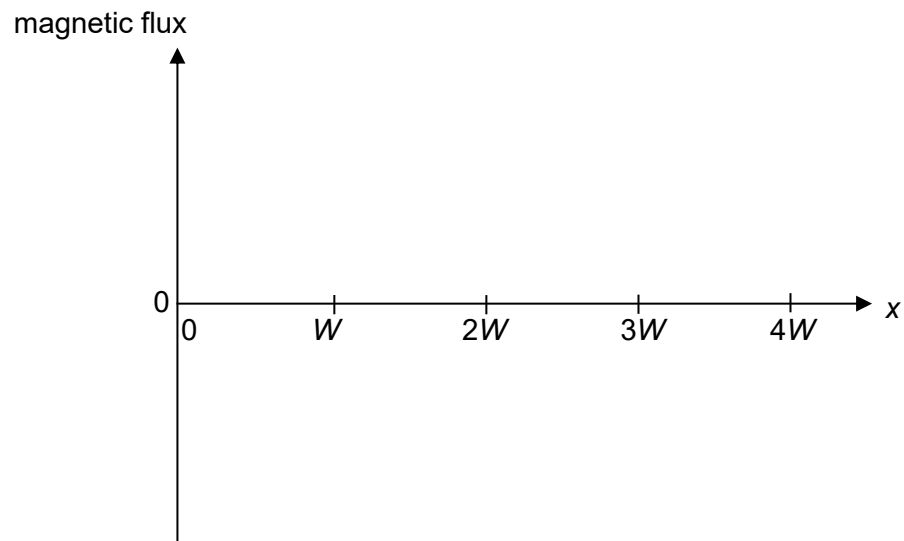


Fig. 8.1

Sketch for the entire duration from the point where the loop enters till it completely leaves the magnetic field,

- (i) the variation of the magnetic flux through the loop with horizontal distance  $x$  from the left edge of the uniform magnetic field.

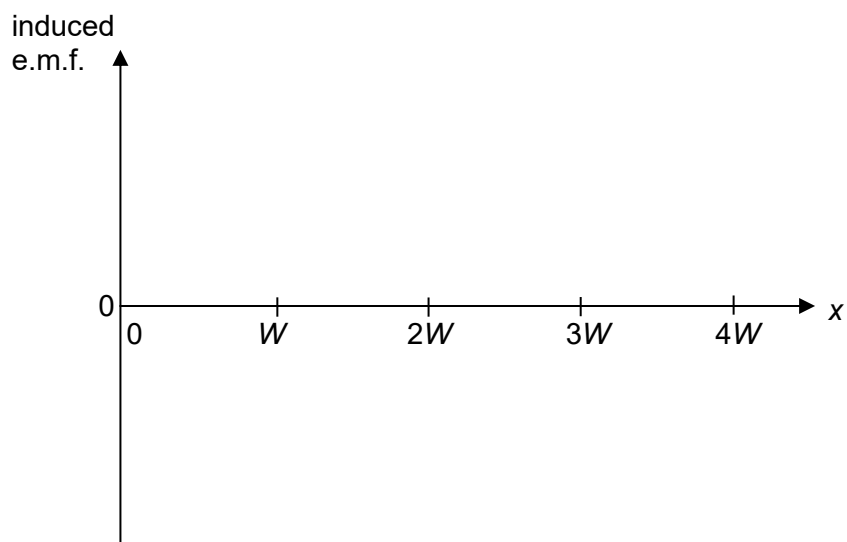
Include in your sketch, an appropriate expression for the maximum magnetic flux, in terms of  $B$ ,  $L$ ,  $W$ ,  $v$  and  $R$  where appropriate.



[2]

- (ii) the variation of the induced electromotive force (e.m.f.) in the loop with distance  $x$ .

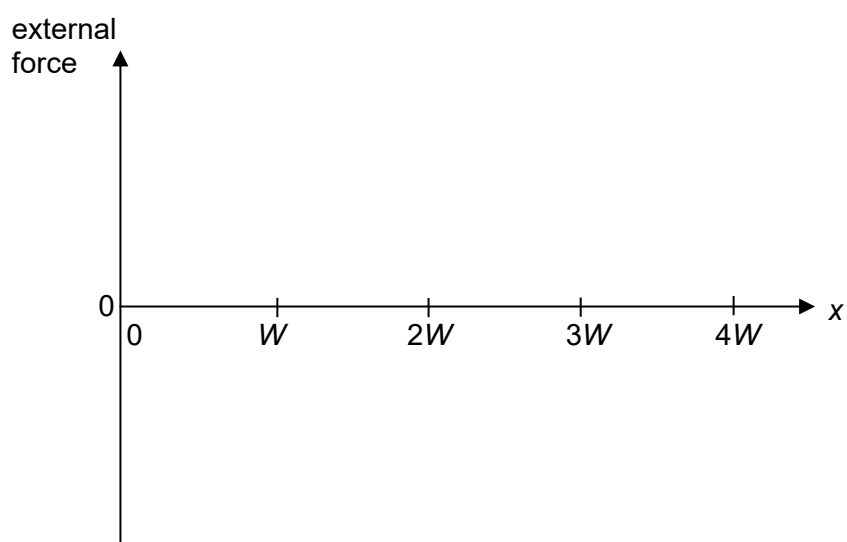
Include in your sketch, an appropriate expression for the maximum induced e.m.f., in terms of  $B$ ,  $L$ ,  $W$ ,  $v$  and  $R$  where appropriate.



[2]

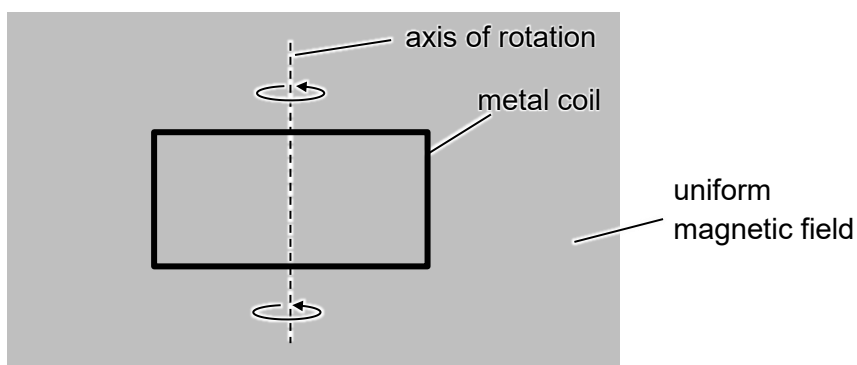
- (iii) the variation of the external force applied to the loop to keep  $v$  constant with distance  $x$ .

Include in your sketch, an appropriate expression for the maximum external force applied, in terms of  $B$ ,  $L$ ,  $W$ ,  $v$  and  $R$  where appropriate.



[2]

- (b) Fig. 8.2 shows a simple generator where a metal coil rotates at a constant angular velocity about a vertical axis in a uniform magnetic field.



**Fig. 8.2**

- (i) State Faraday's law of electromagnetic induction.

.....  
 ..... [2]

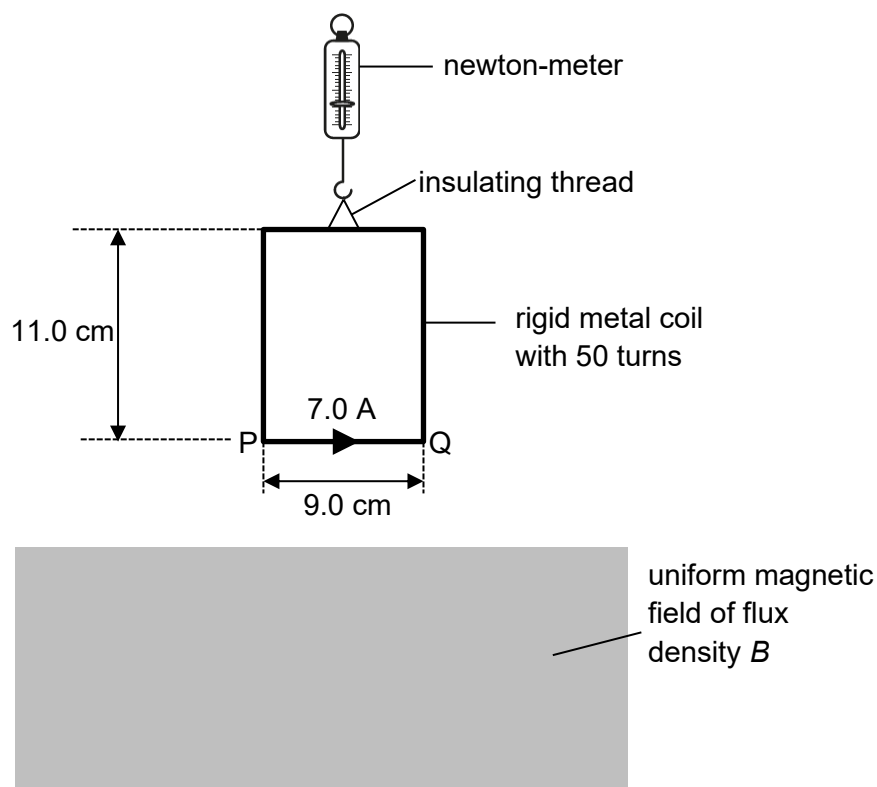
- (ii) State two factors that affects the magnitude of the maximum induced e.m.f.

.....  
 .....  
 ..... [2]

- (iii) Explain why the e.m.f. induced is sinusoidal.

.....  
 .....  
 .....  
 .....  
 ..... [3]

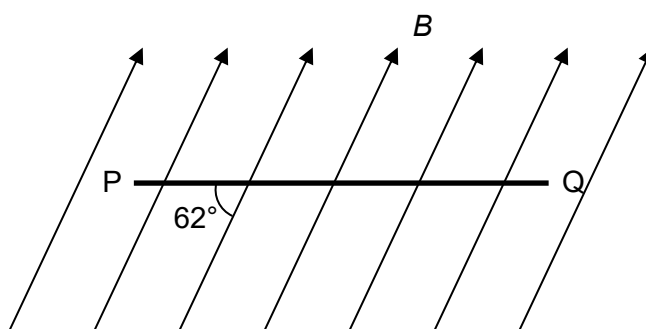
- (c) A rigid metal coil with 50 turns measuring 11.0 cm by 9.0 cm is suspended from a sensitive newton-meter, as shown in Fig. 8.3. The metal coil is initially above a region of uniform magnetic field of flux density  $B$ .



**Fig. 8.3**

The coil is connected to a power supply so that there is a current of 7.0 A in the direction indicated in Fig. 8.3.

The coil is then slowly lowered at a constant speed into the uniform magnetic field until all of side PQ enters the field. The magnetic field lines are in the horizontal plane and at an angle of  $62^\circ$  to PQ. The top view is shown in Fig. 8.4.



**Fig. 8.4 (top view)**

When side PQ of the coil first enters the magnetic field, the reading on the newton-meter changes by 0.35 N.

- (i) Determine the magnetic flux density  $B$ .

$$B = \dots\dots\dots \text{ T} \quad [2]$$

- (ii) State and explain if the change in the reading on the newton-meter is an increase or decrease from its initial value before the coil enters the magnetic field.

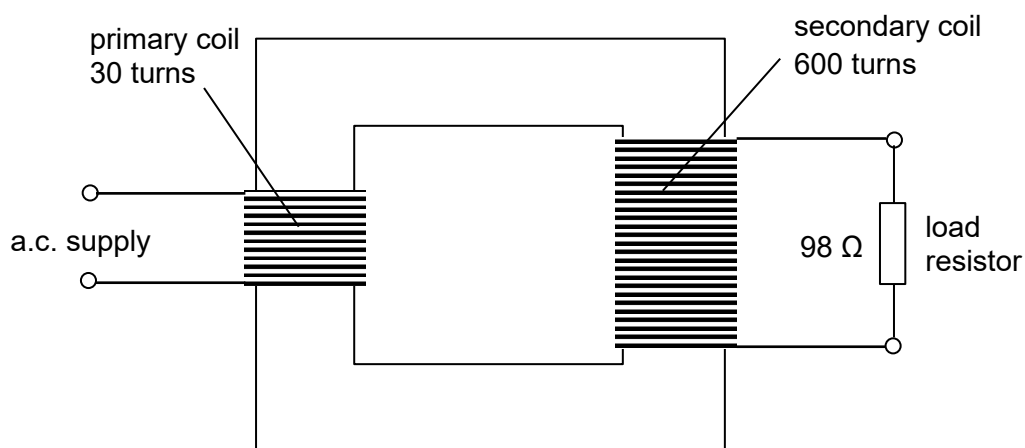
.....  
 ..... [1]

- (iii) The rigid coil is slowly lowered further so that the vertical sides start to enter the magnetic field.

State what additional motion will be observed.

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

- (d) An alternating current (a.c.) supply is connected to a laminated iron-cored transformer. The transformer consists of a primary coil of 30 turns and a secondary coil of 600 turns, as shown in Fig. 8.5.



**Fig. 8.5**

The a.c. supply is a sinusoidal alternating voltage of peak value 102 V. The output from the transformer is connected to a load resistor of resistance  $98\ \Omega$ .

- (i) Suggest why the iron core is laminated.

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

- (ii) Calculate the peak value of the output potential difference.

peak output potential difference = ..... V [1]

- (iii) Calculate the root-mean-square (r.m.s.) current in the load resistor.

r.m.s. current = ..... A [1]