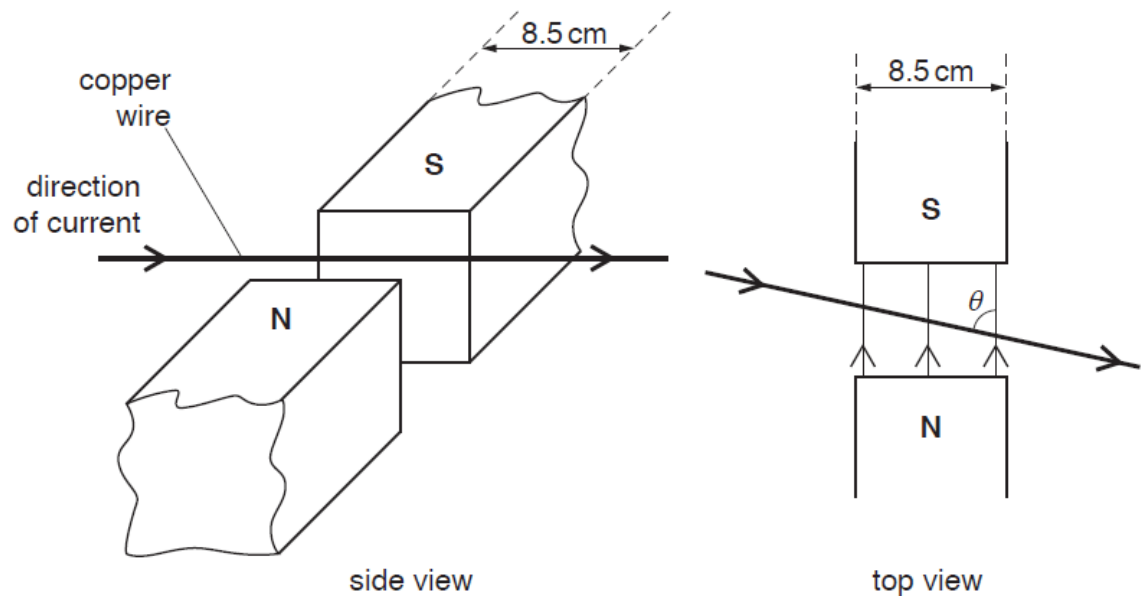


- 8 (a) A rigid copper wire is held horizontally between the pole pieces of two magnets, as shown in Fig. 8.1.



**Fig. 8.1**

The width of each pole piece is 8.5 cm. The uniform magnetic flux density  $B$  in the region between the poles of the magnets is 3.7 mT and is zero outside this region. The angle between the wire and the direction of the magnetic field is  $\theta$ . The current in the wire is in the direction shown on Fig. 8.1.

- (i) By reference to the side view of Fig. 8.1, state and explain the direction of the force on the magnets.

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

- (ii) The constant current in the wire is 5.1 A. For angle  $\theta$  equal to  $90^\circ$ , calculate the force on the wire.

force. = ..... N [2]

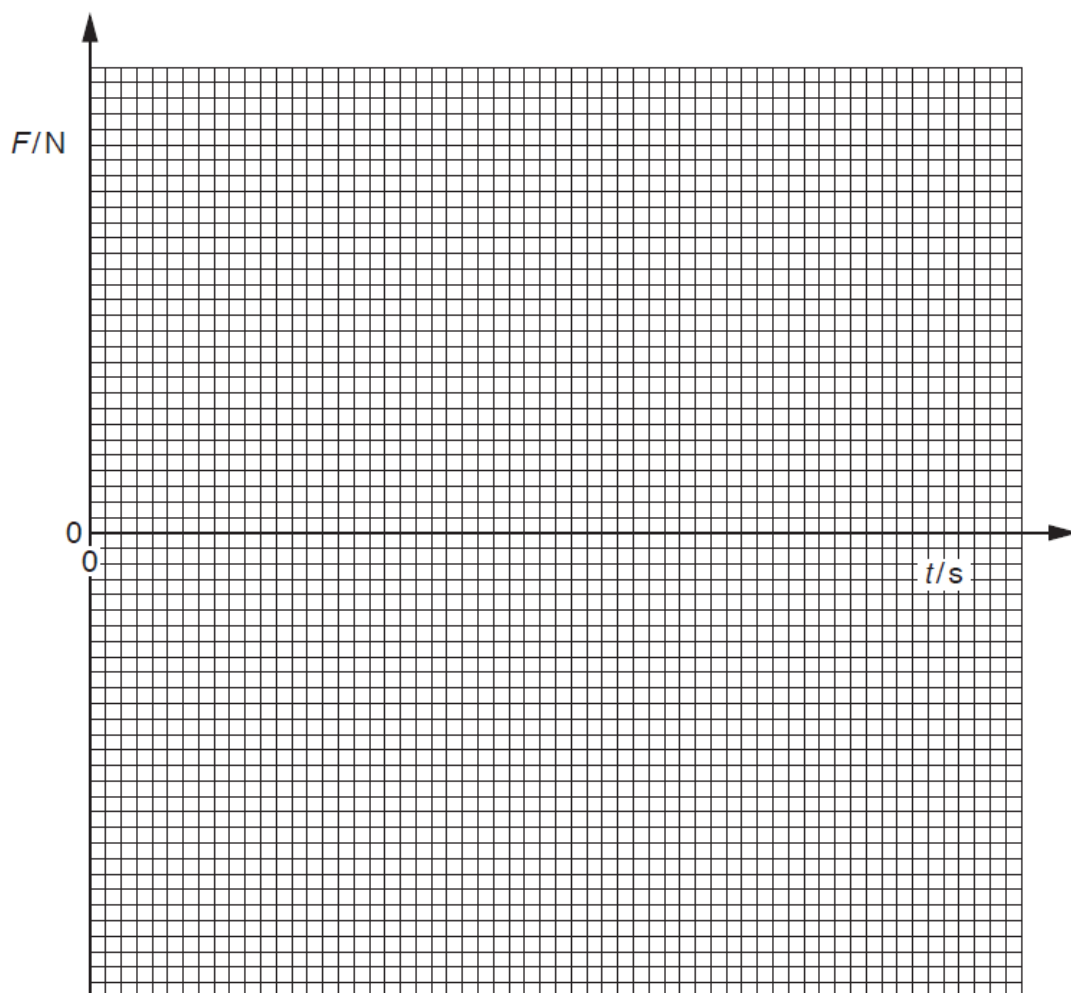
- (iii) The angle  $\theta$  is changed to  $60^\circ$ . Calculate the force on the wire.

force. = ..... N [2]

- (iv) The constant current in the wire is now changed to an alternating current of frequency 20 Hz and root-mean-square (r.m.s.) value 5.1 A.

The angle between the wire and the direction of the magnetic field is  $90^\circ$ .

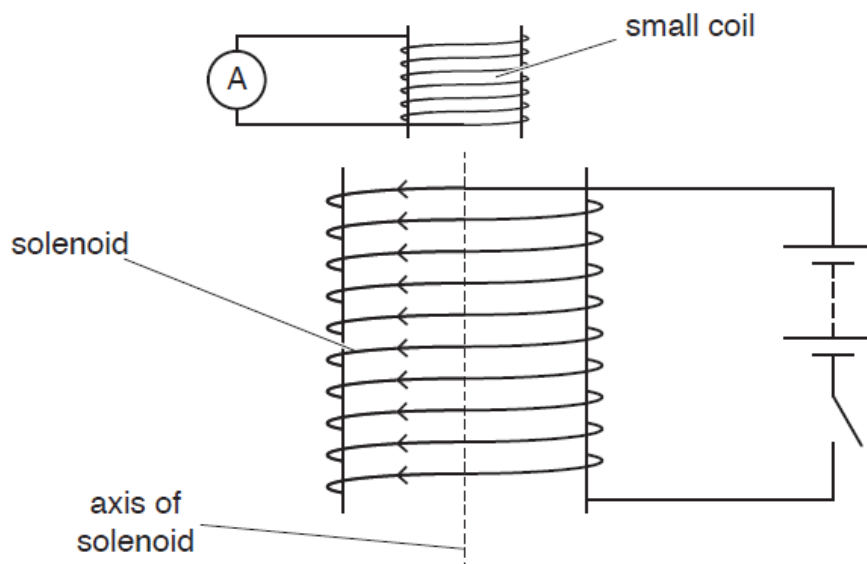
On Fig. 8.2, sketch a labelled graph to show the variation with time  $t$  of the force  $F$  on the wire for two cycles of the alternating current.



[3]

**Fig. 8.2**

**(b)** A solenoid is connected in series with a battery and a switch, as illustrated in Fig. 8.3.



**Fig. 8.3**

A small coil, connected to a sensitive ammeter, is situated near one end of the solenoid.

As the current in the solenoid is switched on, there is a changing magnetic field inside the solenoid.

- (i) State what is meant by a *magnetic field*.

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

- (ii) On Fig. 8.3, draw an arrow on the axis of the solenoid to show the direction of the magnetic field inside the solenoid. Label this arrow P. [1]

- (iii) When the switch is closed, a current flow in the solenoid. There is a current induced in the small coil. This induced current gives rise to a magnetic field in the small coil.

1. State *Lenz's law*.

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

2. Use Lenz's law to state and explain the direction of the magnetic field due to the induced current in the small coil. On Fig. 8.3, mark this direction with an arrow inside the small coil.

.....  
 .....

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

- (iv) The small coil has an area of cross-section  $7.0 \times 10^{-4} \text{ m}^2$  and contains 75 turns of wire. A constant current in the solenoid produces a uniform magnetic flux of flux density 1.4 mT throughout the small coil. The direction of the current in the solenoid is reversed in a time of 0.12 s.

Calculate the average e.m.f. induced in the small coil.

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

[Total: 20]

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