**3** A bar magnet of mass 250 g is suspended from the free end of a spring, as illustrated in Fig. 3.1.

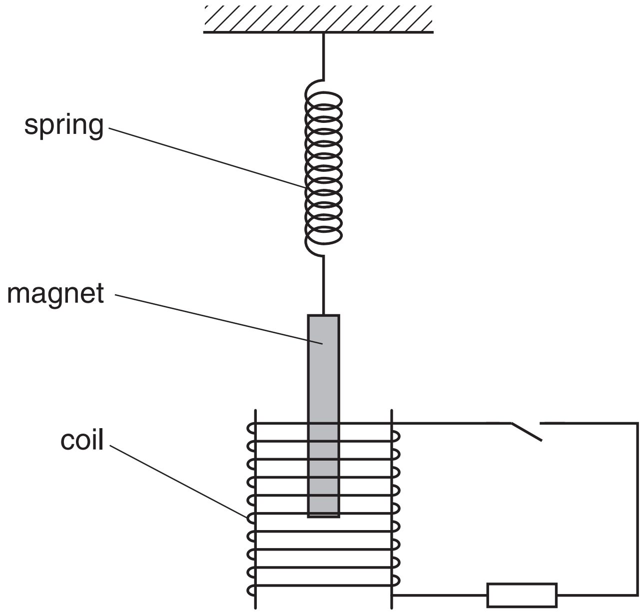


**Fig. 3.1**

The magnet hangs so that one pole is near the centre of a coil of wire.

The coil is connected in series with a resistor and a switch. The switch is open.

The magnet is displaced vertically and then allowed to oscillate with one pole remaining inside the coil. The other pole remains outside the coil.

At time $t = 0$, the magnet is oscillating freely as it passes through its equilibrium position. At time $t = 6.0\,\text{s}$, the switch in the circuit is closed.

The variation with time $t$ of the vertical displacement $y$ of the magnet is shown in Fig. 3.2.

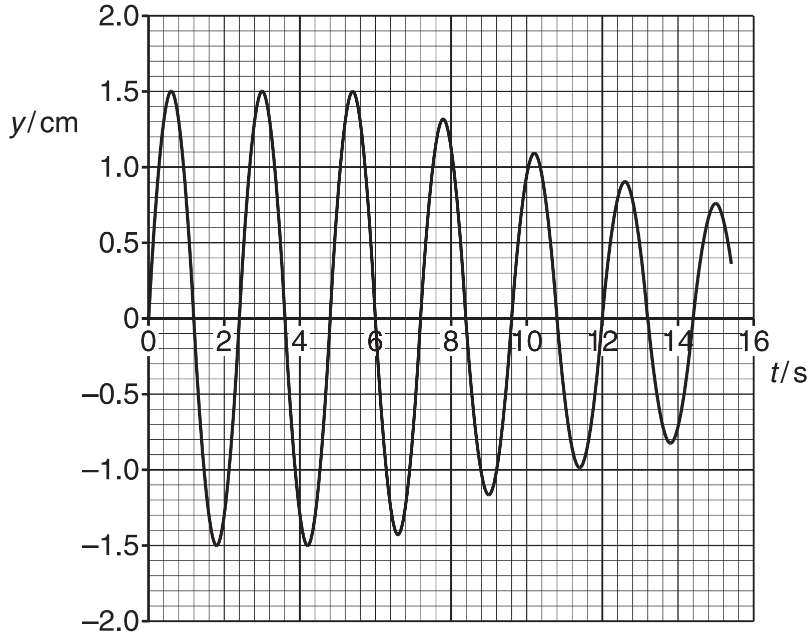


**Fig. 3.2**

**(a)** For the oscillating magnet, use data from Fig. 3.2 to calculate, to two significant figures,

**(i)** the frequency $f$,

$f$ = .................................................... Hz [2]

**(ii)** the energy of the oscillations during the time $t = 0$ to time $t = 6.0$ s.

energy = ...................................................... J [3]

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

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**(ii)** Use Faraday's law and energy conservation to explain why the amplitude of the oscillations of the magnet reduces after time $t = 6.0\,\text{s}$.

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[Total: 10]