2 A bar magnet of mass 180 g is suspended from the free end of a spring, as illustrated in Fig. 2.1.

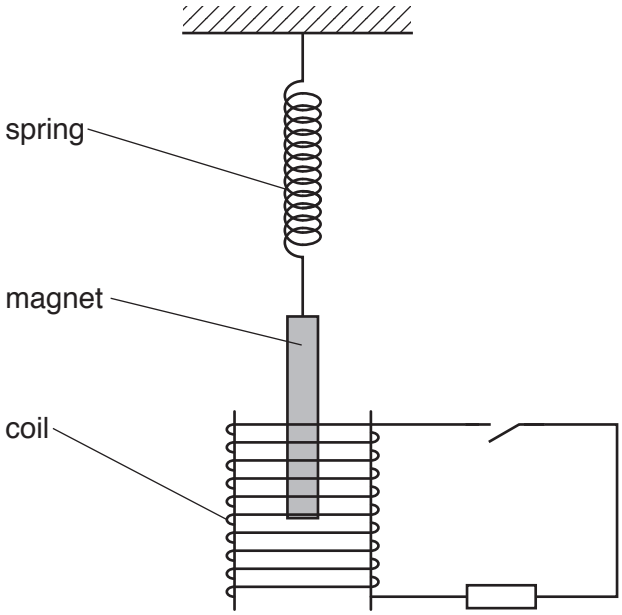

Fig. 2.1

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 $t = 3.0$ 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. 2.2.

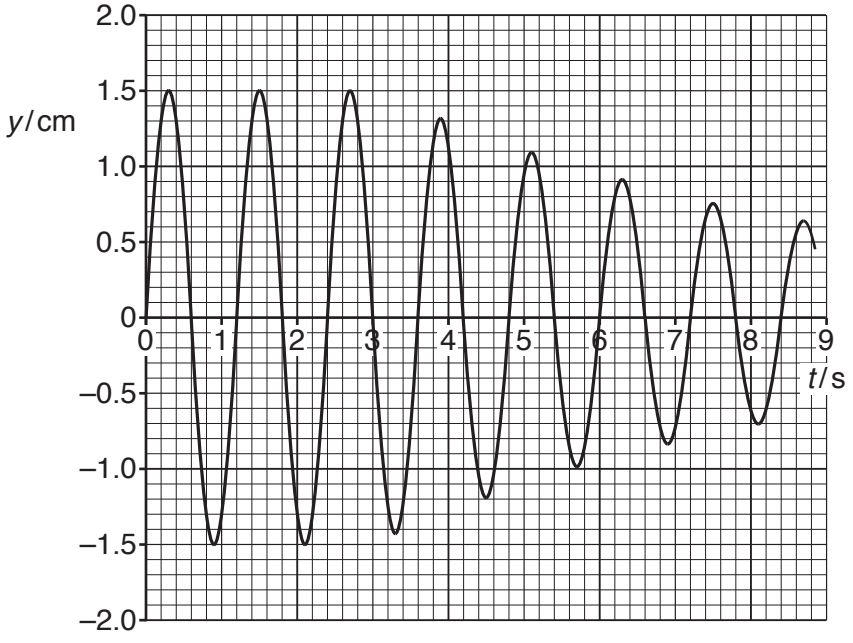

Fig. 2.2

(a) Determine, to two significant figures, the frequency of oscillation of the magnet.

frequency = ... Hz [2]

(b) State whether the closing of the switch gives rise to light, heavy or critical damping.

.....[1]

(c) Calculate the change in the energy ΔE of oscillation of the magnet between time $t = 2.7\,s$ and time $t = 7.5\,s$. Explain your working.

ΔE = ... J [6]

[Total: 9]

[Turn over