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

For Examiner's Use

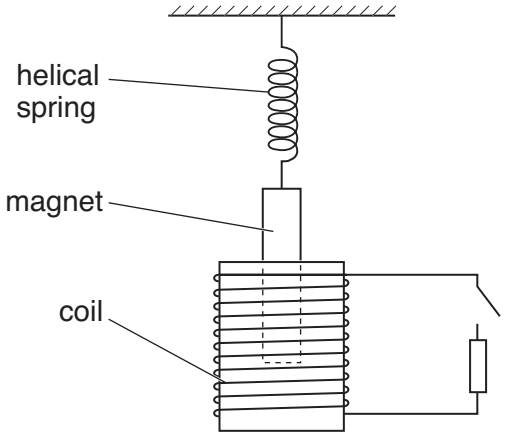

Fig. 3.1

One pole of the magnet is situated in a coil of wire. The coil is connected in series with a switch and a resistor. The switch is open.

The magnet is displaced vertically and then released. As the magnet passes through its rest position, a timer is started. The variation with time t of the vertical displacement y of the magnet from its rest position is shown in Fig. 3.2.

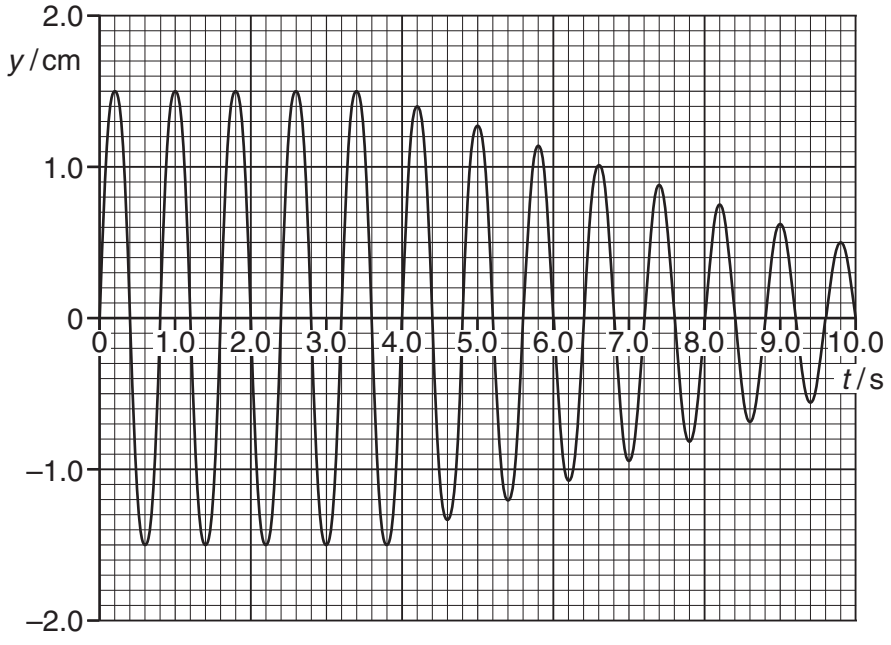

Fig. 3.2

At time t = 4.0 s, the switch is closed.

For Examiner's Use

(a) Use Fig. 3.2 to

(i) state the evidence for the magnet to be undergoing free oscillations during the period $t = 0$ to $t = 4.0\,s$,

.....

.....[1]

(ii) state, with a reason, whether the damping after time $t = 4.0\,s$ is light, critical or heavy,

.....

.....

.....[2]

(iii) determine the natural frequency of vibration of the magnet on the spring.

frequency = ... Hz [2]

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

.....

.....

.....[2]

(ii) Explain why, after time $t = 4.0\,s$, the amplitude of vibration of the magnet is seen to decrease.

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.....

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.....[4]