7 **(a)** State what is meant by *simple harmonic motion.*

.....

.....

.....[2]

(b) A spring hangs vertically from a fixed point. A copper plate is attached to the free end of the spring, as illustrated in Fig. 7.1.

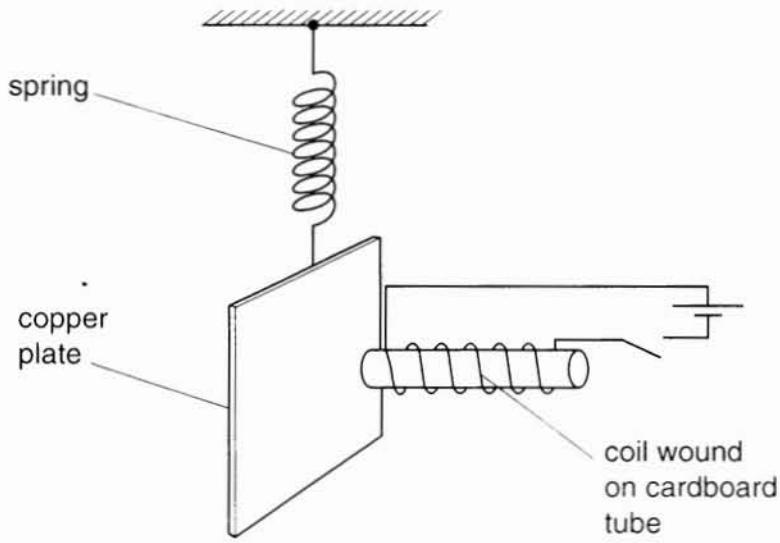

Fig. 7.1

One end of a coil of wire, wound on a cardboard tube, is placed near to the copper plate.

The copper plate is displaced vertically and then released. The variation with time t of the vertical displacement y of the plate is shown in Fig. 7.2.

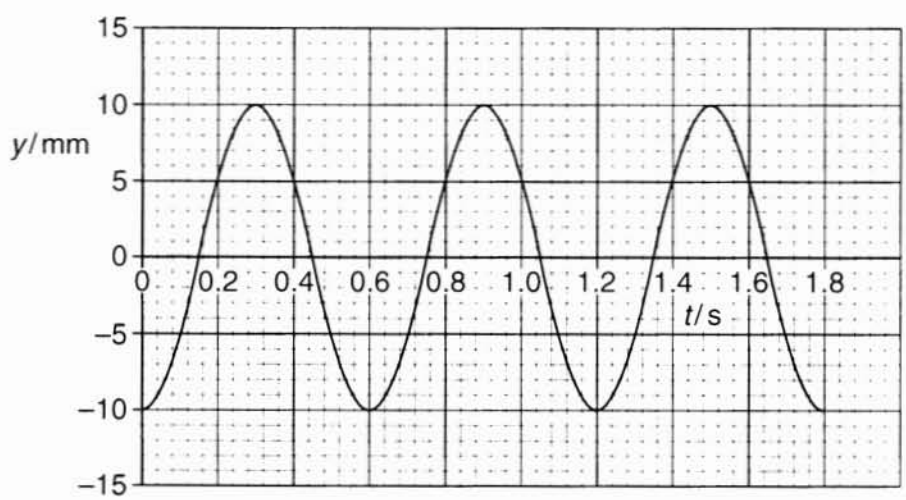

Fig. 7.2

The copper plate undergoes simple harmonic motion. The mass m of the oscillating copper plate is 320 g.

(i) Determine the frequency f of oscillation of the plate.

frequency = ... Hz [1]

(ii) Show that the total energy E_T of the oscillations is given by

$$E_T = 2\pi^2 m f^2 a^2,$$

where a is the amplitude of vibration of the plate.

[2]

(iii) Use the expression in **(ii)** to calculate the energy of the oscillations.

energy = ... J [2]

For Examine Use

(c) At time $t = 1.8\,s$, the current in the coil in **(b)** is switched on. The variation with time t of the subsequent oscillations of the plate is shown in Fig. 7.3.

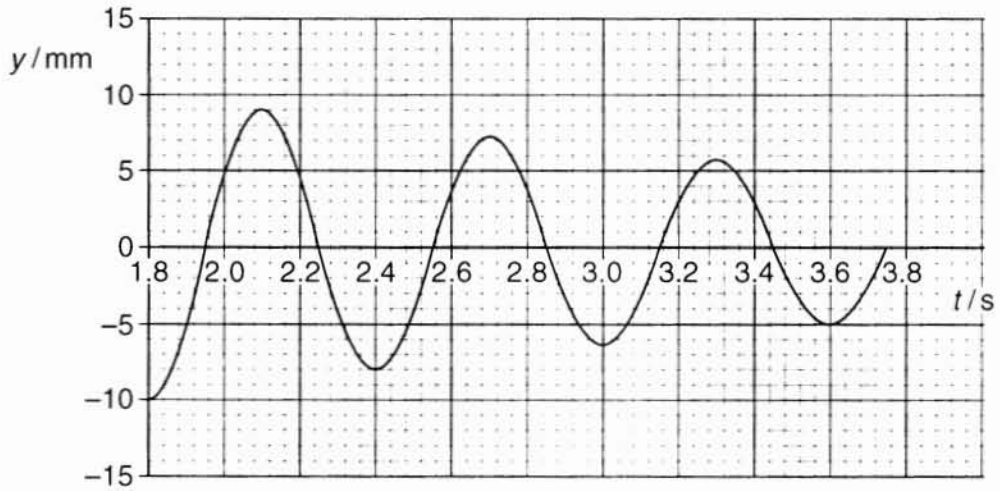

Fig. 7.3

(i) State and explain whether the damping of the plate is light, heavy or critical.

.....

.....

..... [2]

(ii) **1.** State Faraday's law of electromagnetic induction.

.....

.....

..... [2]

2. Use Faraday's law to explain why the oscillations are damped.

.....

.....

.....

..... [3]

(iii) Use the expression in **(b)(ii)** to calculate the loss of energy of the oscillations during the first 1.8 s after the current has been switched on.

For Examiner's Use

energy = ... J [3]

(d) State and explain the effect on the oscillations in **(c)** of inserting an iron core into the coil.

.....

.....

.....

..... [3]

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