Section B

Answer **two** questions from this Section in the spaces provided.

7 **(a)** A mass undergoes simple harmonic motion.

(i) State, for the motion of the mass, what is meant by

1. the *displacement*,

.....

..... [1]

2. the *amplitude*.

.....

..... [1]

(ii) State, by reference to displacement, what is meant by *simple harmonic motion*.

.....

.....

..... [2]

(b) The bob of a simple pendulum undergoes simple harmonic motion, as illustrated in Fig. 7.1.

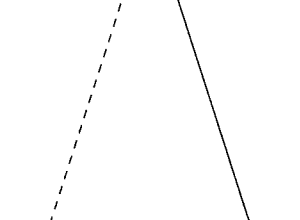

Fig. 7.1

A block of wood, floating in water, undergoes vertical oscillations, as illustrated in Fig. 7.2.

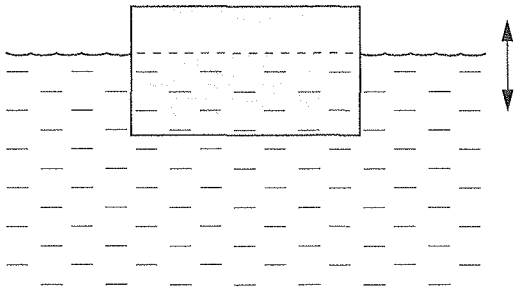

Fig. 7.2

For each system, describe the restoring force that gives rise to the oscillations.

simple pendulum .....

.....

.....

floating block .....

.....

.....

[4]

(c) A uniform strip of steel is clamped at one end. A metal block of mass M is fixed to the strip, a distance L from the clamp, as illustrated in Fig. 7.3.

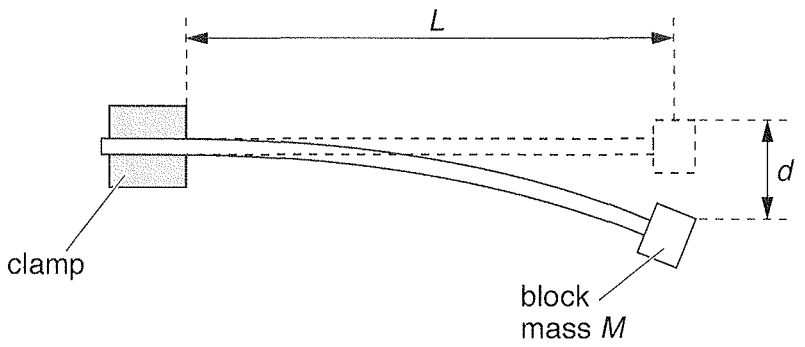

Fig. 7.3

The mass causes the end of the steel strip to be depressed by a distance d.

Explain why part of the strip is compressed and part of the strip is extended.

.....

.....

.....

..... [3]

(d) The free end of the strip in **(c)** is given a small vertical displacement and then released.

The variation with displacement x from the equilibrium position of the acceleration a of the end of the strip is given by the expression

$$a = -\frac{CE}{L^3 M}x$$

where C is a constant for the strip and E is a constant for the material of the strip.

Show that the end of the strip is undergoing simple harmonic motion.

.....

.....

.....

..... [2]

(e) The constant E for steel is $2.0 \times 10^{11}\,\text{N m}^{-2}$.
When a mass M of 150 g is clamped to the steel strip so that the distance L on Fig. 7.3 is 0.80 m, the variation with time t of the depression d of the end of the strip is shown in Fig. 7.4.

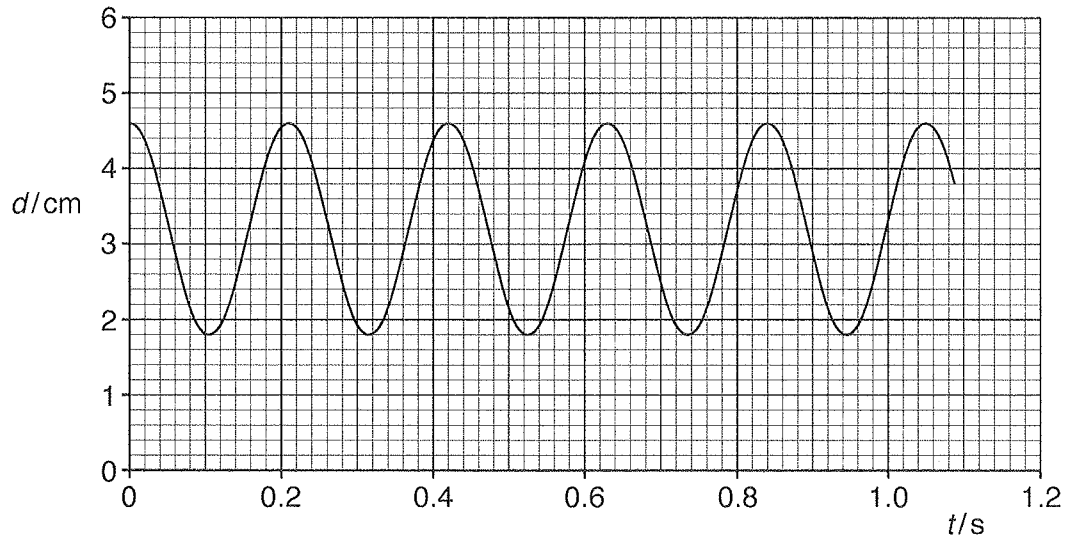

Fig. 7.4

Use Fig. 7.4 and the expression in **(d)** to determine

(i) the angular frequency ω of the oscillations,

ω = ... rad s^{-1} [2]

(ii) the value (without the unit) of the constant C for this strip.

value of C = ... [2]

(f) A strip of aluminium has the value of C calculated in **(e)(ii)**.
The constant E for aluminium is $7.1 \times 10^{10}\,\text{N m}^{-2}$.

Using data given in **(e)** and the expression in **(d)**, calculate the mass, positioned on the aluminium strip such that $L = 0.80\,\text{m}$, so that the steel and the aluminium strips have the same frequency of oscillation.

mass = ... kg [3]