4 A U-tube contains liquid, as shown in Fig. 4.1.

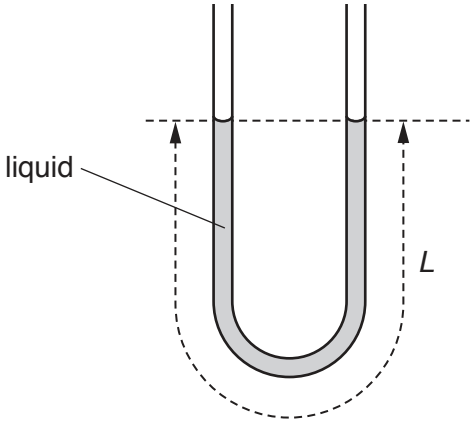

Fig. 4.1

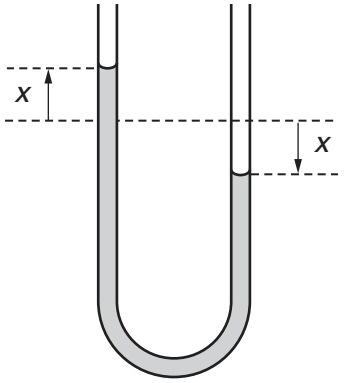

Fig. 4.2

The total length of the liquid column is L.

The column of liquid is displaced so that the change in height of the liquid level from the equilibrium position in each arm of the U-tube is x, as shown in Fig. 4.2.

The liquid in the U-tube then oscillates such that its acceleration a is given by the expression

$$a = -\left(\frac{2g}{L}\right)x$$

where g is the acceleration of free fall.

(a) Show that the liquid column undergoes simple harmonic motion.

[2]

(b) The variation with time t of the displacement x is shown in Fig. 4.3.

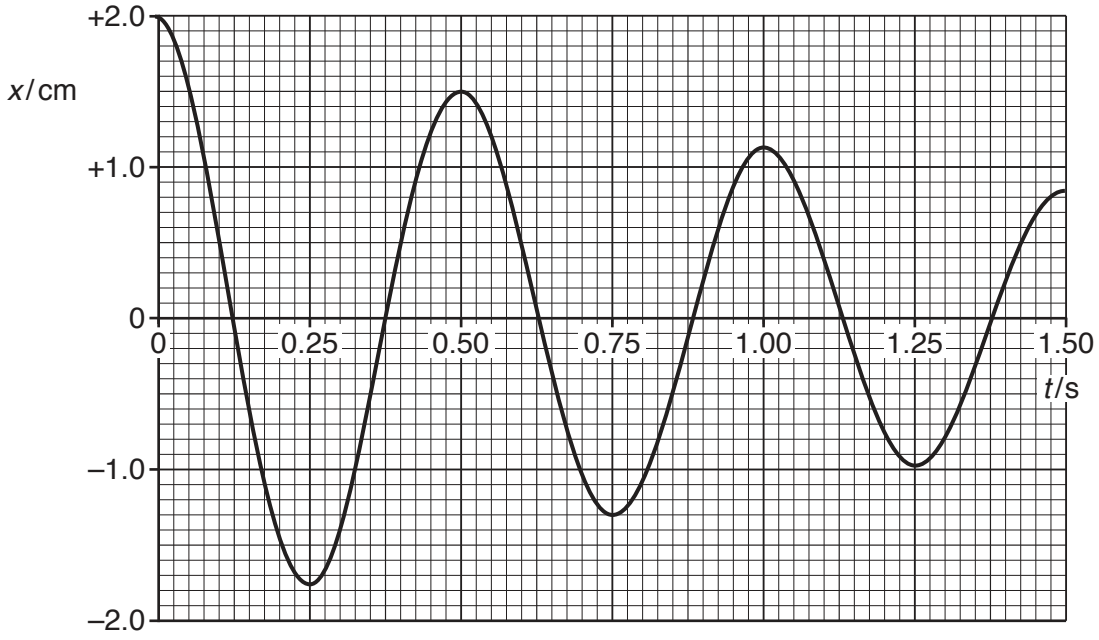

Fig. 4.3

Use data from Fig. 4.3 to determine the length L of the liquid column.

L = ... m [3]

(c) The oscillations shown in Fig. 4.3 are damped.

(i) Suggest one cause of this damping.

.....

.....[1]

(ii) Calculate the ratio

$$\frac{\text{total energy of oscillations after 1.5 complete oscillations}}{\text{total initial energy of oscillations}}$$

ratio = ... [2]

[Total: 8]

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