

- 3 A hollow tube, sealed at one end, has a cross-sectional area A of 24 cm^2 . The tube contains sand so that the total mass M of the tube and sand is 0.23 kg .

The tube floats upright in a liquid of density ρ , as illustrated in Fig. 3.1.

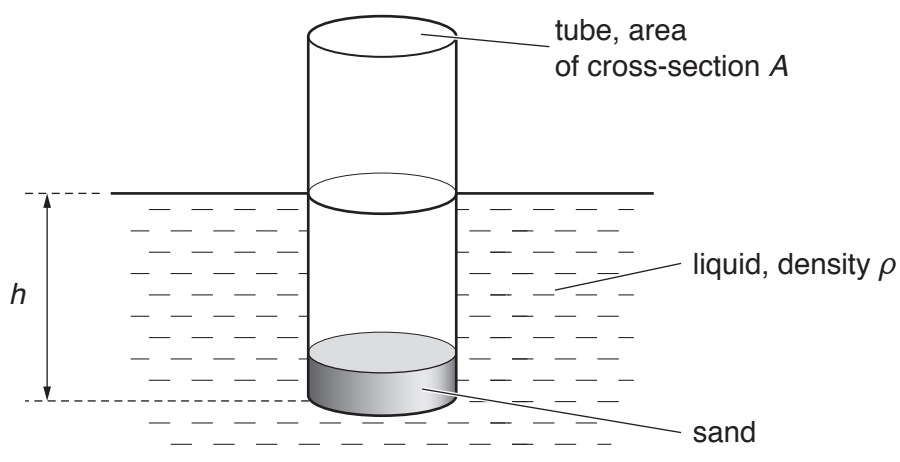


Fig. 3.1

The depth of the bottom of the tube below the liquid surface is h .

The tube is displaced vertically and then released. The variation with time t of the depth h is shown in Fig. 3.2.

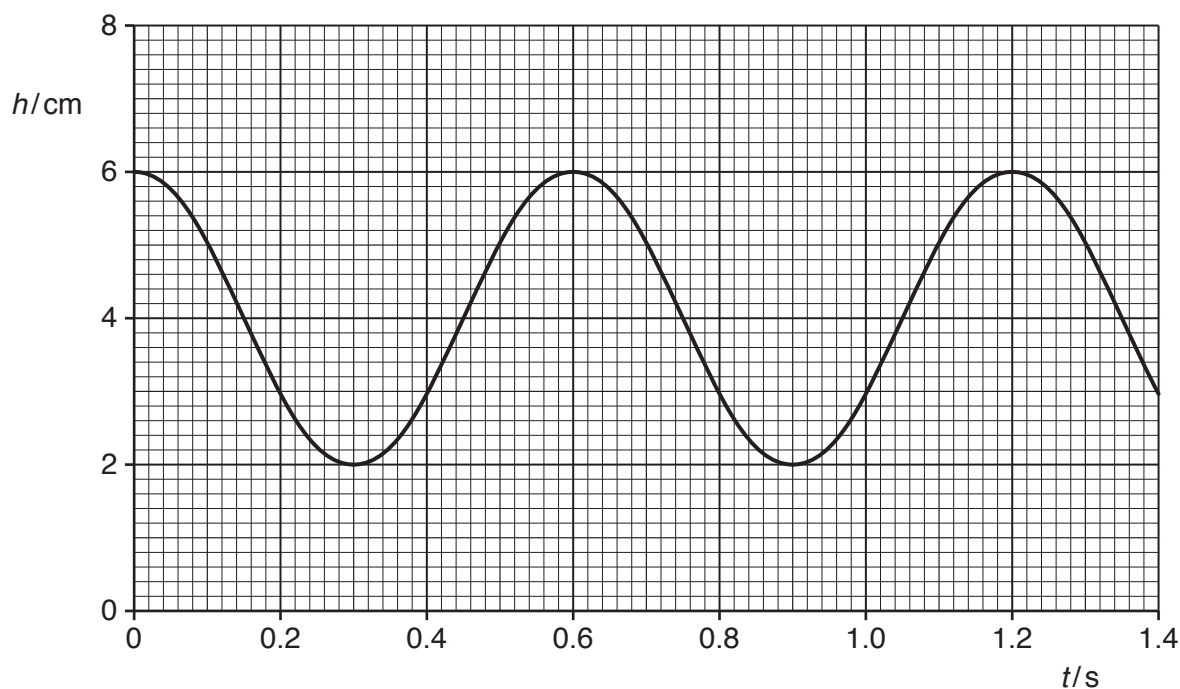


Fig. 3.2

- (a) Determine:
- (i) the amplitude, in metres, of the oscillations

amplitude = m [1]

- (ii) the frequency of oscillation of the tube in the liquid

frequency =Hz [2]

- (iii) the acceleration of the tube when h is a maximum.

acceleration =ms⁻² [2]

- (b) The frequency f of oscillation of the tube is given by the expression

$$f = \frac{1}{2\pi} \sqrt{\left(\frac{A\rho g}{M}\right)}$$

where g is the acceleration of free fall.

Calculate the density ρ of the liquid in which the tube is floating.

$\rho =$ kg m⁻³ [2]

- (c) The oscillations illustrated in Fig. 3.2 are undamped. In practice, the liquid does cause light damping.

On Fig. 3.2, draw a line to show light damping of the oscillations for time $t = 0$ to time $t = 1.4$ s. [3]

[Total: 10]