**4** **(a)** Define *simple harmonic motion*.

.....

.....

..... [2]

**(b)** A tube, sealed at one end, has a circular cross-sectional area $A$ of $4.9 \times 10^{-4}\,m^2$. Some sand is put in the tube so that the total mass $M$ of the tube and its contents is 70 g. The tube floats upright in a liquid, as shown in Fig. 4.1.

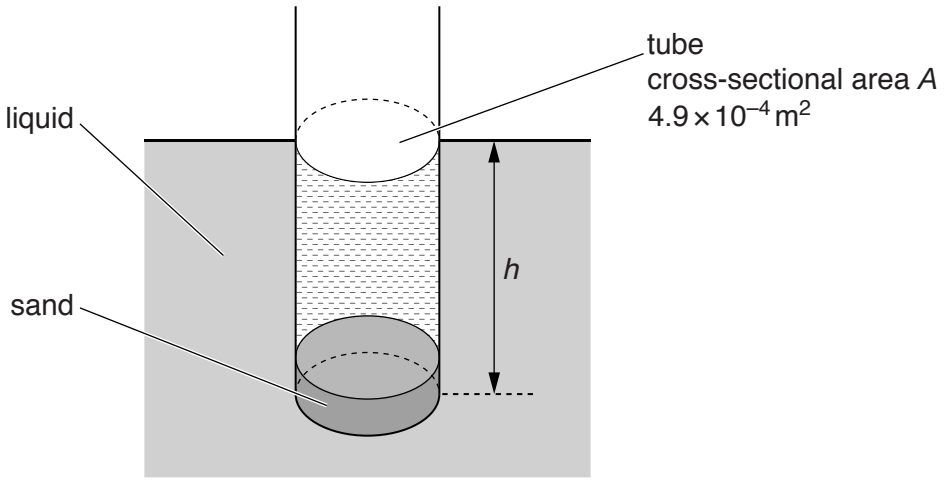


**Fig. 4.1**

The liquid has a density $\rho$ of $0.79\,g\,cm^{-3}$.

By reference to the liquid pressure exerted on the base of the tube, show that the distance $h$ of the base of the tube below the liquid surface is 18 cm. Explain your working.

[2]

**(c)** The tube in **(b)** is displaced vertically and then released. The variation with time $t$ of the distance $h$ is shown in Fig. 4.2.

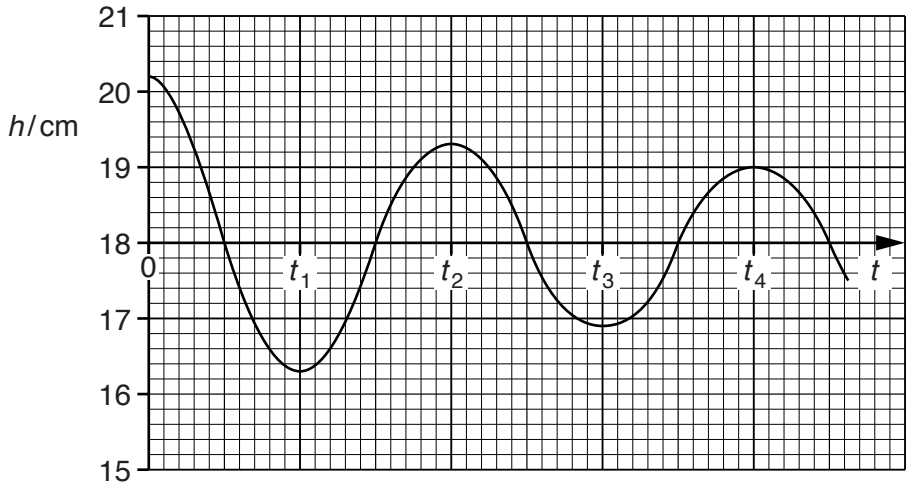


**Fig. 4.2**

The system oscillates with simple harmonic motion of angular frequency $\omega$ given by the expression

$$\omega^2 = \frac{\rho A g}{M}$$

where $g$ is the acceleration of free fall.

**(i)** Use data from **(b)** to determine

**1.** the time $t_1$,

$t_1$ = ..... s [3]

**2.** the time $t_3$.

$t_3$ = ..... s [1]

**(ii)** Determine the loss in total energy of the oscillating system between time $t = 0$ and time $t = t_4$.

loss in energy = .....J [3]