7 **(a)** State the origin of the upthrust acting on a body in a fluid.

.....

.....

..... [2]

For Examiner's Use

(b) A tube, sealed at one end, has a uniform area of cross-section A. Some sand is placed in the tube so that it floats upright in a liquid of density ρ, as shown in Fig. 7.1.

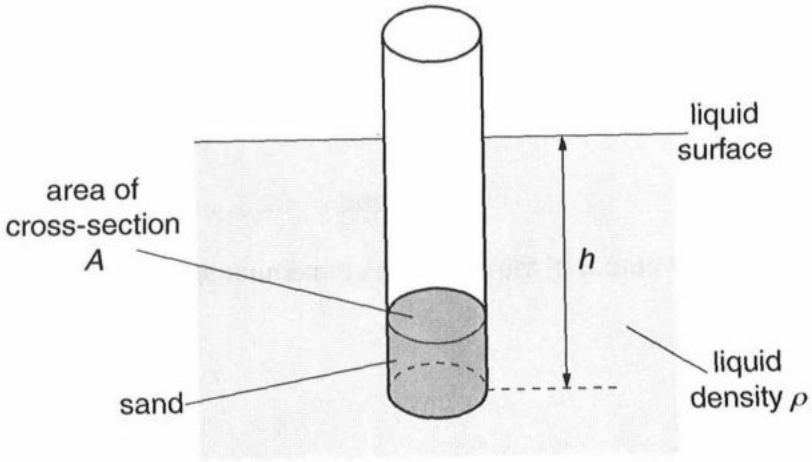

Fig 7.1

The total mass of the tube and the sand is m.
The tube floats with its base a distance h below the surface of the liquid.

Derive an expression relating m to h, A and ρ. Explain your working.

[3]

(c) The tube in **(b)** is displaced vertically and then released.
For a displacement x, the acceleration a of the tube is given by the expression

For Examiner's Use

$$a = -\left(\frac{\rho A g}{m}\right)x$$

where g is the acceleration of free fall.

(i) Explain why the expression leads to the conclusion that the tube is performing simple harmonic motion.

.....

.....

.....

..... [3]

(ii) The tube has total mass m of 32 g and the area A of its cross-section is $4.2\,\text{cm}^2$.
It is floating in liquid of density ρ of $1.0 \times 10^3\,\text{kg m}^{-3}$.

Show that the frequency of oscillation of the tube is 1.8 Hz.

[3]

(d) The tube in **(b)** is now placed in a different liquid.

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The tube oscillates vertically. The variation with time t of the vertical displacement x of the tube is shown in Fig. 7.2.

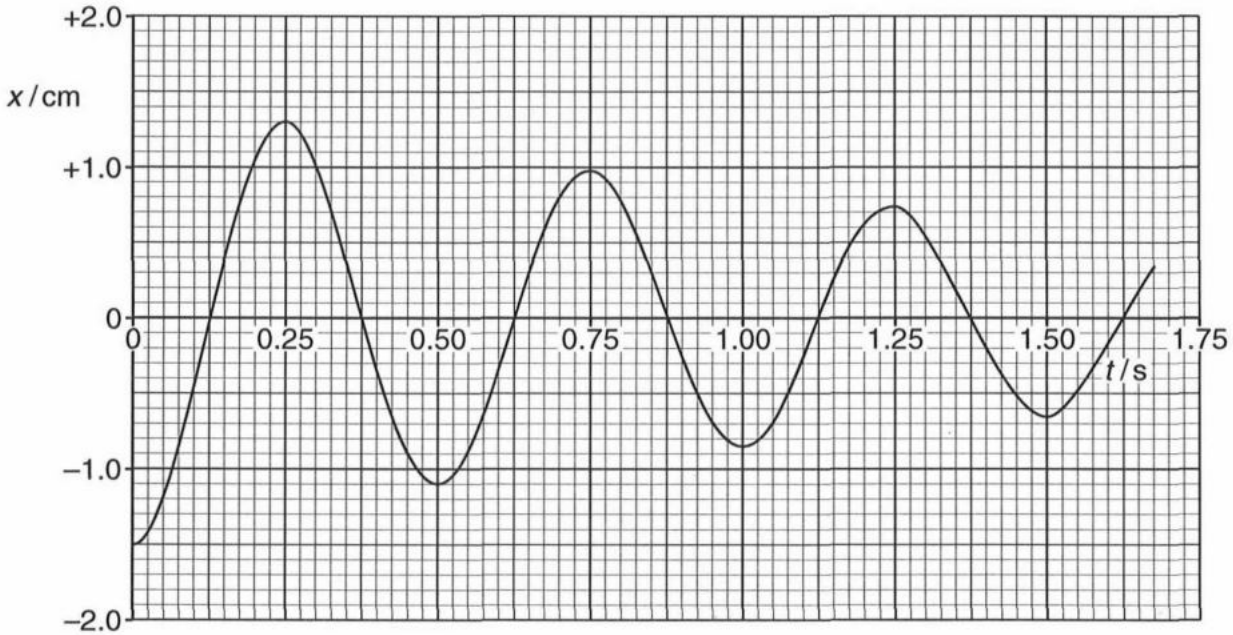

Fig. 7.2

(i) Use Fig. 7.2 to

1. determine the frequency of oscillation of the tube,

frequency = ... Hz [2]

2. calculate the density of the liquid.

density = ... $kg\,m^{-3}$ [2]

(ii) **1.** Suggest two reasons why the amplitude of the oscillation decreases with time.

For Examiner's Use

1. .....

.....

2. .....

.....

[2]

2. Calculate the decrease in energy of the oscillation during the first 1.0 s.

decrease = ... J [3]