3 (a) Define *simple harmonic motion*.

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…….. [2]

(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. 3.1. The tube has total mass m of 32 g and the area A of its cross-section is 4.2 cm^2.

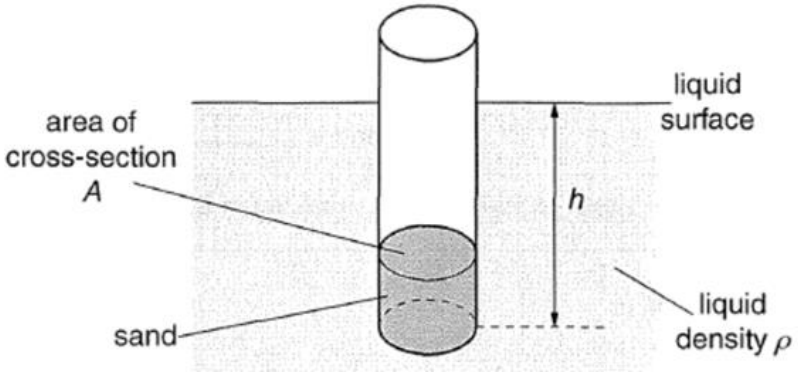

Fig. 3.1

The tube is displaced vertically and then released. For a displacement x, the acceleration a of the tube is given by the expression

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

where g is the acceleration of free fall.

The tube experiences damped oscillations in the liquid as shown in Fig. 3.2.

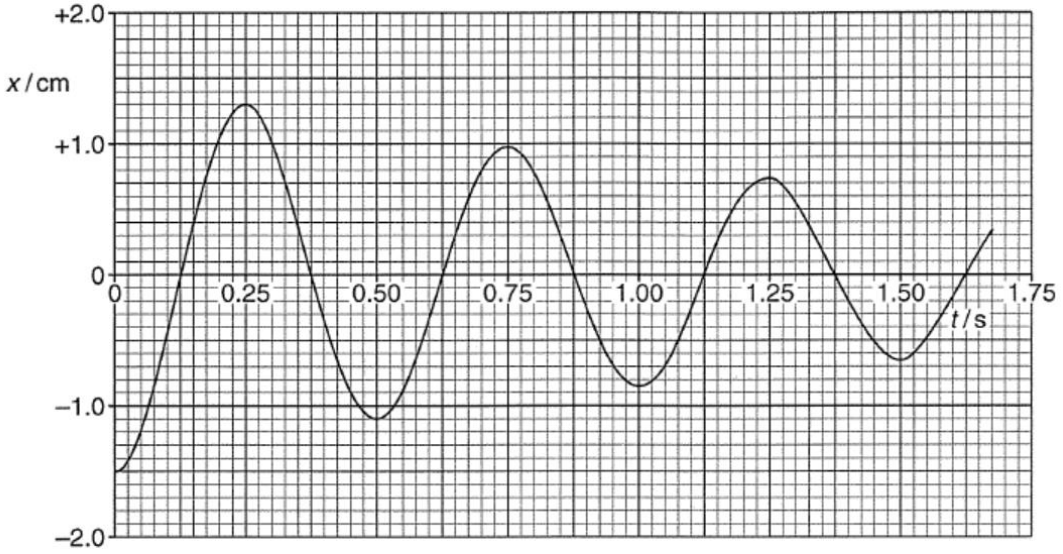

Fig. 3.2

(i) Determine the frequency of the oscillation.

frequency = …… Hz [1]

(ii) Determine the density of the liquid.

density = …… kg m^{-3} [3]

(iii) Determine the percentage loss of the energy of the oscillation during the first 1.50 s.

energy loss = …… % [3]

(iv) The tube is now placed in a liquid which is more viscous. It starts to oscillate from the same displacement at t = 0.00 s.

Explain in terms of energy changes why the amplitude of oscillation in this liquid decreases more over the same period.

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[Total: 11]