3 A liquid is contained in a U-shaped tube of uniform internal diameter and occupies a length L within the tube. When the tube is moved horizontally and then stopped, the liquid subsequently oscillates within the tube as shown in Fig. 3.1.

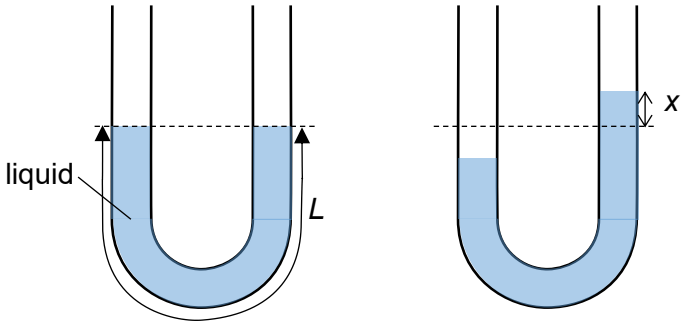

Fig. 3.1

The displacement of the liquid surface from the equilibrium is x and the acceleration a of the liquid surface in the tube is given by:

$$a = \frac{-2gx}{L}$$

where g is the acceleration of free fall.

(a) Explain, with reference to the acceleration of the liquid surface, why the motion of the liquid surface is a simple harmonic oscillation.

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.....[2]

(b) The length of the liquid within the tube, L, is 0.40 m. Determine the period of oscillation of the liquid surface.

period of oscillation = ... s [2]

(c) The oscillation of the liquid is lightly damped. Describe the subsequent motion of the liquid surface.

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.....[2]

(d) On the axes in Fig. 3.2 below, sketch graphs to show the variation with time of the kinetic energy and potential energy of the liquid in the U-shaped tube. You should show the variation over **one** period T of the oscillation. Label the kinetic and potential energy as E_k *and* E_p respectively. No numerical values are needed on the axes.

Fig. 3.2

[2]

(e) The U-shaped tube is now made to oscillate horizontally at various frequencies by an external driving force. At one particular frequency, the amplitude of oscillation of the liquid surface is at a maximum. Explain why this phenomenon occurs.

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