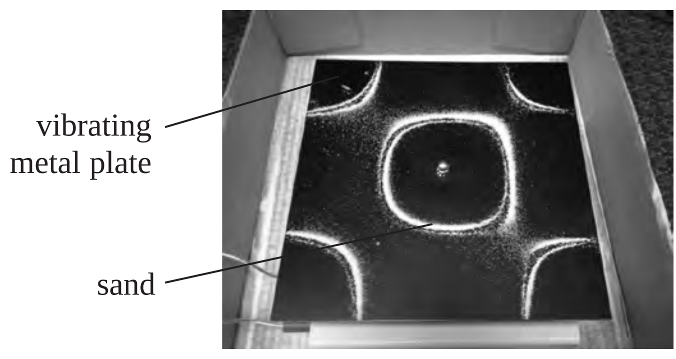
**6** Rosslyn Chapel is a 15th century chapel in Scotland. Inside the chapel, small sandstone cubes protrude from a number of arches. It has been suggested that carvings on these cubes bear a resemblance to standing wave patterns that can be produced on a vibrating metal plate.

A metal plate is made to vibrate and sand is scattered evenly across its surface. At a certain frequency the sand moves to produce the standing wave pattern shown below.




(Source: https://skullsinthestars.com/2013/05/02/physics-demonstrations-chladni-patterns/#jp-carousel-7353)

(a) Explain why the sand moves to different positions when a standing wave is formed on the plate.

**(3)**

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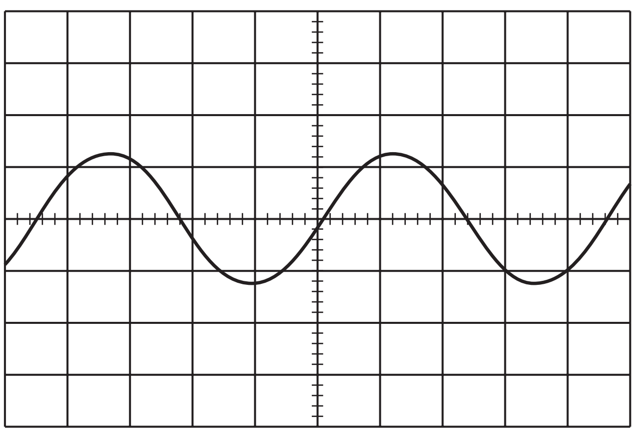
(b) The plate is set into movement by a vibration generator. The wavelength of the waves produced in the plate was estimated to be 0.32 m.

The signal applied to the vibration generator is shown on the oscilloscope trace below. The time base of the oscilloscope was set to $0.50\,\mathrm{ms\,div^{-1}}$.



The waves produced in the plate travel at a speed much less than the speed of sound in air.

Evaluate whether the data supports a value for the speed of waves in the plate that is much less than the speed of sound in air.

speed of sound in air = $340\,\mathrm{m\,s^{-1}}$

**(5)**

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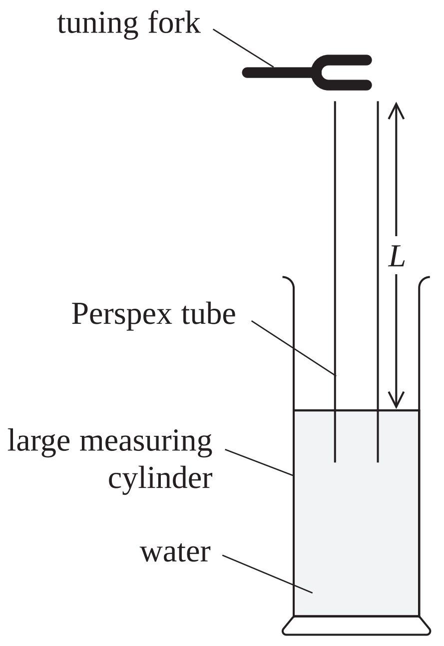
(c) The speed of sound in air can be determined by creating a standing wave in a column of air. The diagram shows a tuning fork just above the open end of a tube.




The tuning fork produces a sound wave of known frequency *f*. Several tuning forks are available, each with a different frequency.

A student adjusted the length *L* of the air column. A loud sound was heard when a standing wave was produced. A node was formed at the water surface, and an antinode was formed at the open end of the tube.

The student used values of *L* and *f* to determine a value for the speed of sound.

Describe a graphical method that the student could have used to determine a value for the speed of sound.

**(3)**

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**(Total for Question 6 = 11 marks)**