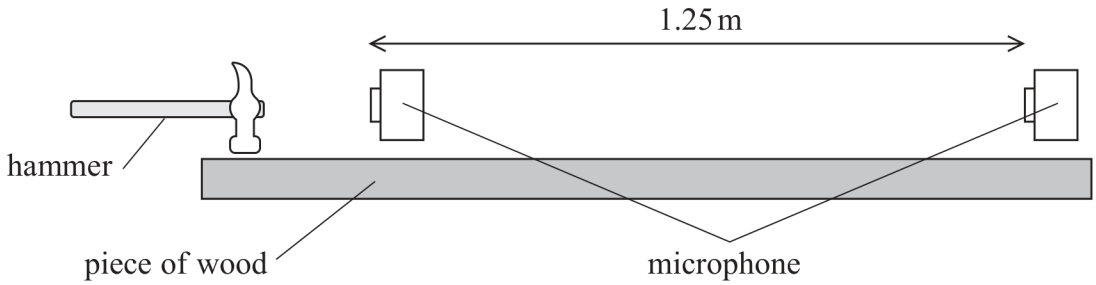
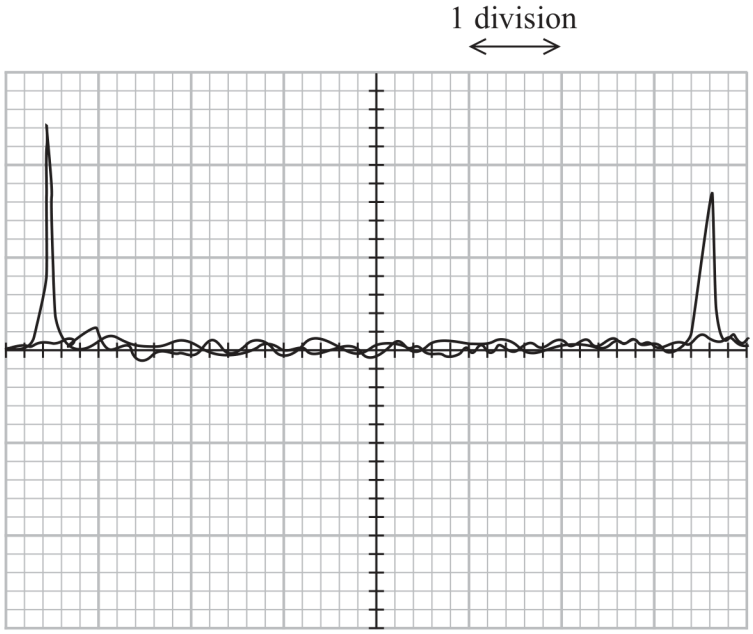
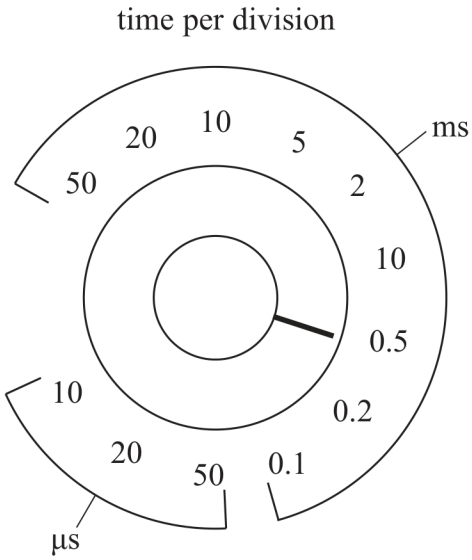
5 A student carried out an experiment to compare the speed of sound in air and the speed of sound in wood. The student used a long piece of wood, a hammer and two microphones, as shown.



The microphones were connected to a 2-beam oscilloscope. The student hit the wood with a metal hammer producing a sharp sound that travelled through the air. The oscilloscope traces produced by the microphones and the time per division dial are shown.





(a) (i) Determine the speed of sound in air.

distance between microphones = 1.25 m

(4)

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Speed of sound = ... $m\,s^{-1}$

(ii) The student then attached the microphones to the piece of wood so they detected the sound passing along the wood. The distance between the microphones was 1.25 m.

The student adjusted the dial on the oscilloscope to 20 µs per division to display the traces from the microphones. A teacher commented that this was not the correct setting.

Justify the teacher's comment.

The piece of wood is made of oak. The speed of sound in oak is approximately 4000 $m\,s^{-1}$.

(3)

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(b) The student tried the same experiment using a rubber hammer. The rubber hammer compressed as it hit the wood making a sound that lasted for a longer time.

Explain the effect that using the rubber hammer had on the accuracy of the time determined.

(2)

(c) The student was given the following equation and data to find a value for the speed of sound in oak.

$$v = \sqrt{\frac{E}{\rho}}$$

Young modulus E of oak = 11.2 GPa ± 0.5 GPa
Density ρ of oak = 650 kg m^{-3} with an uncertainty of 3%

Assess which of these values was the more significant source of uncertainty in the value of the speed of sound.

(2)

(Total for Question 5 = 11 marks)