Oxford Cambridge and RSA

A Level Physics A

H556/03 Unified physics

Question Set 5

1 **(a)** A loudspeaker mounted on a bench is emitting sound of frequency 1.7 kHz to a microphone. Fig. 5.1 shows an illustration of the bulk movement of the air at one instant of time.

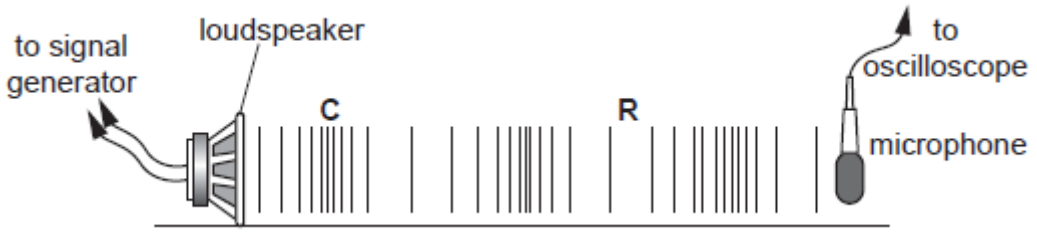

Fig. 5.1

The maximum displacement of the air particles from their mean positions is 2.0×10^{-6} m.

The speed of sound in air at 17 °C is 340 m s^{-1}.

(i) On Fig. 5.2, sketch the sinusoidal variation of the displacement of the air with distance between **C** and **R**.

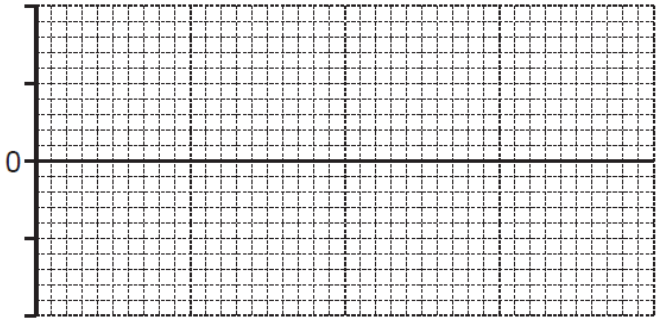

Fig. 5.2

1 Label the axes and include sensible scales.
2 On Fig. 5.2, mark one point where air particles are moving at maximum speed. Label it **X**.
3 On Fig. 5.2, mark one point where air particles are moving at maximum speed but travelling in the opposite direction to the air particles in **2**. Label it **Y**.

[4]

(ii) Calculate

1 the maximum speed v_{max} of the oscillating particles in the sound wave

v_{max} = ... m s^{-1} **[2]**

2 the root mean square speed $c_{r.m.s.}$ of the air molecules in the room.
The molar mass of air is 2.9×10^{-2} kg mol^{-1}.

$c_{r.m.s.}$ = ... m s^{-1} **[2]**

(b)* Students are given the equipment in Fig. 5.1 together with a metre rule. They are also given a second loudspeaker connected to the same signal generator at 1.7 kHz. They are asked to design an experiment where they would need to take just **one** measurement and be able to determine the value of the speed of sound.

They set up the experiment in two different ways as shown in Fig. 5.3(a) and (b).

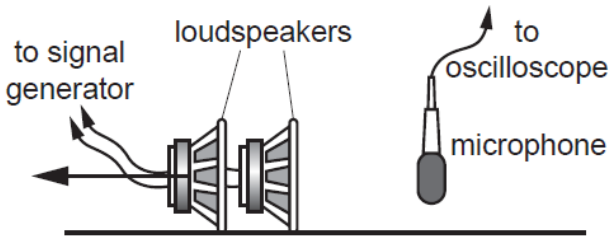

Fig. 5.3(a)

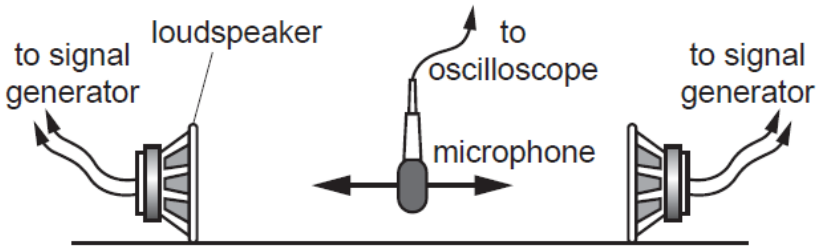

Fig. 5.3(b)

In method **(a)** the microphone is fixed and one loudspeaker is moved to the left as shown in Fig. 5.3(a).
In method **(b)** the microphone is moved to the left or to the right with the loudspeakers fixed a certain distance apart as shown in Fig. 5.3(b).

Describe and explain how both methods can be used to accurately determine the speed of sound. In your description, discuss how the uncertainty in the value for the speed of sound can be minimised in one of the methods, without using any other apparatus. **[6]**

Total Marks for Question Set 5: 14

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