Lit 17

SECTION A

Answer **all** the questions.

1 This question is about notes produced by a flute.

A flute is an instrument that produces standing waves with displacement antinodes (A) at both ends. The nodes (N) and antinodes for the lowest note possible for a flute of length L are shown in Fig. 1.1.

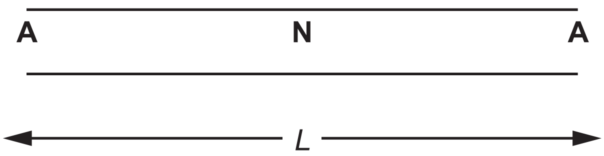

Fig. 1.1

(a) Explain how standing waves are formed in air.

...

...

...

...

...

...

... **[3]**

(b) Mark the antinodes and nodes on Fig. 1.2 for a note of **twice** the frequency of the note indicated in Fig. 1.1. Explain your answer.

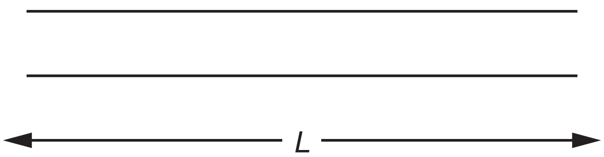

Fig. 1.2

...

...

... **[2]**

(c) The velocity of sound in air v is given by the equation $v = \sqrt{\frac{kp}{\rho}}$ where p is the pressure of the gas, ρ is the density of the gas and k is a constant.

Use the expression $pV = nRT$ and the expression for density, $\rho = \frac{m}{V}$, to show that $v = \sqrt{\frac{kRT}{M}}$ where $M = \frac{m}{n}$ is the mass of one mole of air.

[2]

(d) A flute of length L sounds a note of 262 Hz at a temperature of 293 K. Calculate the frequency of the note from the same length flute when the temperature of the air in the flute has increased to 303 K. The change in length of the flute caused by this temperature rise is negligible.

frequency at 303 K = ... Hz **[3]**

Section B

8 This question is about standing waves on guitar strings.

Fig. 8.1 shows a guitar whose strings are 0.65 m long.

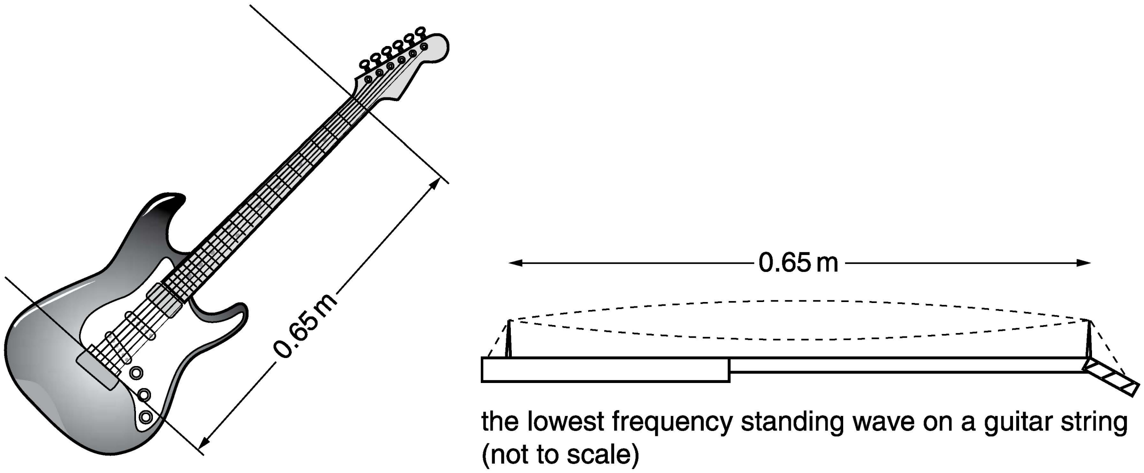

Fig. 8.1

(a) Explain why the wavelength of the standing wave shown in Fig. 8.1 is 1.3 m.

[1]

(b) The lowest frequency standing wave on the thickest guitar string is at 82 Hz. Show that the speed of the wave travelling along the string is about 100 m s^{-1}.

[2]

(c) (i) The speed *v* of waves along a string is given by the equation

$$v = \sqrt{\frac{T}{\mu}}$$

where *T* is the tension in the string, and μ is the mass of a metre length of the string.

Use this equation to calculate the tension *T* in the thickest guitar string where $\mu = 8.4 \times 10^{-3}\,\mathrm{kg\,m^{-1}}$.

tension = ... N **[2]**

(ii) All strings on the guitar have the same tension and length. Use the equation above to explain why the fundamental frequency of the thinnest string is higher than the fundamental frequency of the thickest string.

[1]

(d) Explain clearly how waves travelling along a string can produce standing waves on the string.

In your answer, you should use appropriate technical terms, spelled correctly.

[3]

[Total: 9]

Section B

8 This question is about the interference of microwaves.
Two students set up the apparatus shown in Fig. 8.1.

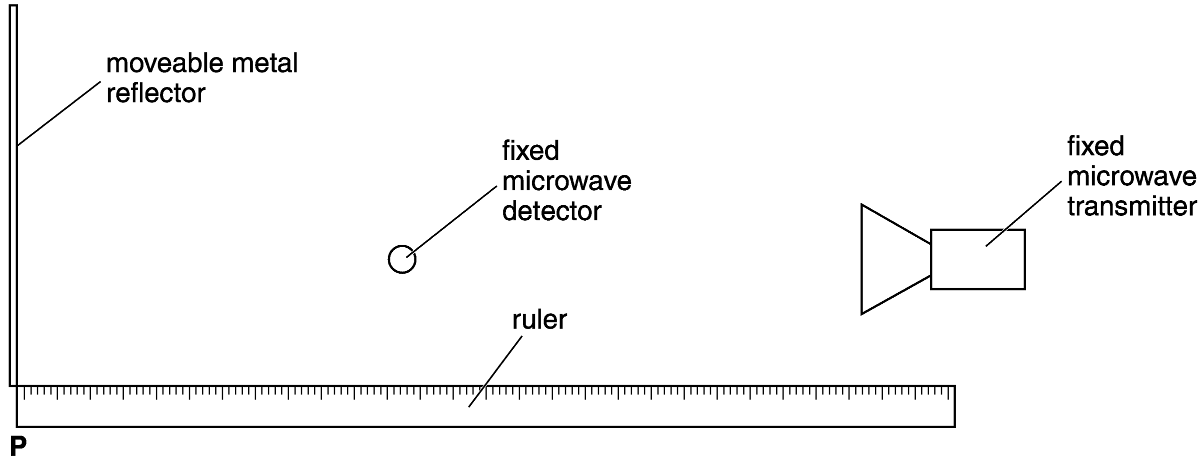

Fig. 8.1

(a) It is observed that when a metal reflector is placed at point **P**, the signal received by the detector falls.
Explain why this happens.

[2]

(b) The reflector is moved slowly towards the microwave detector. The graph of Fig. 8.2 shows how the signal strength at the detector varies for different positions of the reflector.

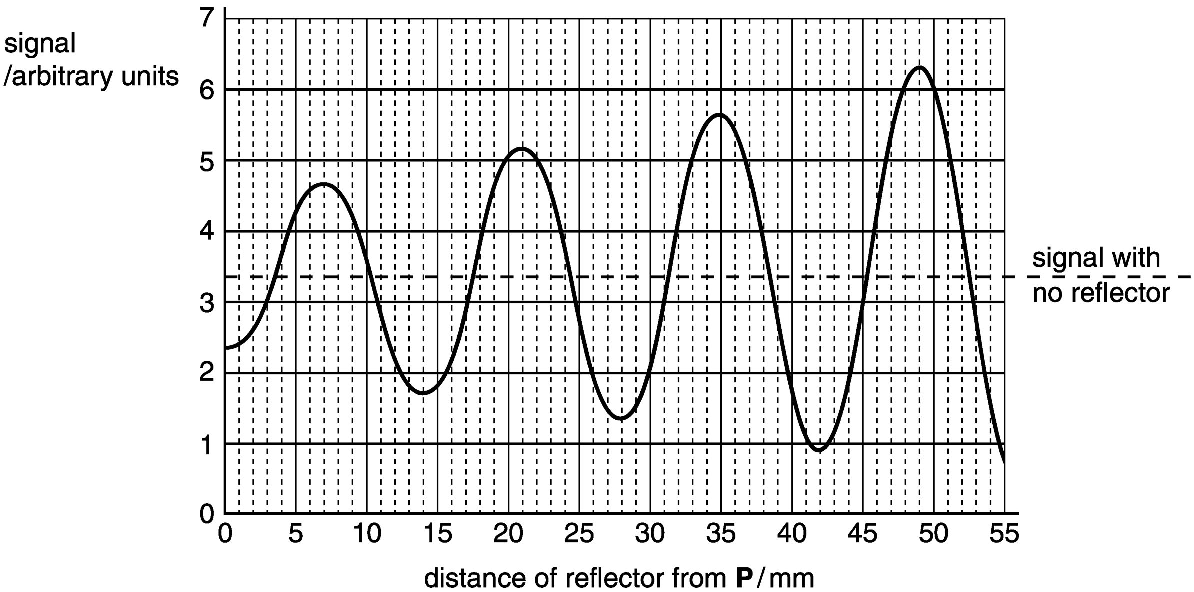

Fig. 8.2

The line of dashes shows the strength of the signal **before** the metal reflector is put at point **P**.

(i) Explain why the signal varies between maxima and minima as the reflector is moved towards the detector.

[2]

(ii) Use information from Fig. 8.2 to calculate the wavelength of the microwaves.
Make your working clear.

wavelength = ... mm **[2]**

(c) The experiment is now repeated with the transmitter closer to the detector. The detector remains fixed in the same place, and the reflector is again moved slowly towards it, starting at **P** as before.
Explain one feature of the results in Fig. 8.2 that would remain the same, and one feature that would change.

In your answer you should use appropriate technical terms spelled correctly.

[4]

[Total: 10]