

A level Physics B

H557/01 Fundamentals of physics

Question Set 37

1

This question is about loud annoying oscillations set up in the volume of air in a car when it travels at a specific speed with the sunroof partially open.

The oscillations are driven by a series of eddies that form in the air-flow above the sunroof aperture. Two of the eddies are shown in **Fig. 1.1**.

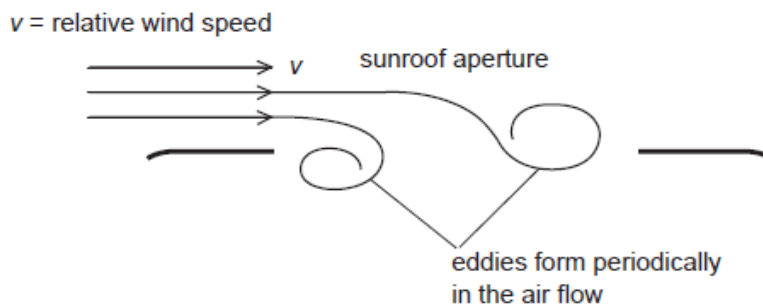


Fig. 1.1

The frequency of eddy production f is given by the equation $f = cv$ where v is the relative speed of the air flow and c is a constant.

Fig. 1.2 shows the $f = cv$ proportionality and **Fig. 1.3** shows how the sound level in the car varies with speed v .

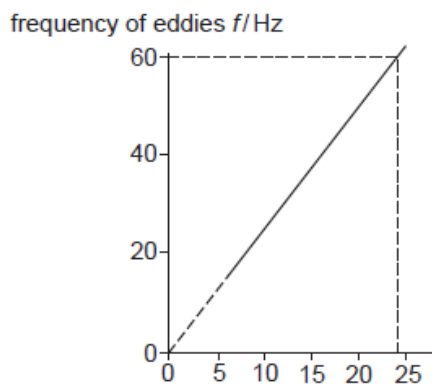


Fig. 1.2

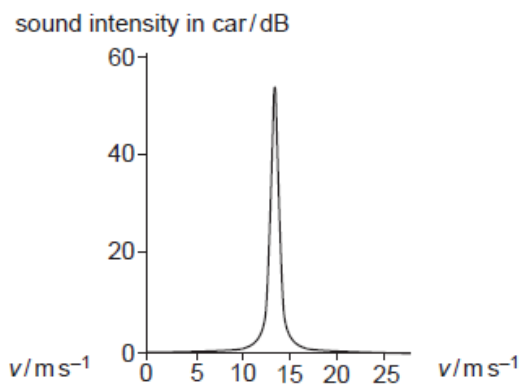


Fig. 1.3

- (a) (i) Use **Fig. 1.2** and **Fig. 1.3** to estimate a value for the frequency f of the loud oscillation. Make your method clear.

$f = \dots\dots\dots \text{Hz}$ [2]

- (ii) State the evidence that shows there is a resonant oscillation happening in this example

(b) The resonant frequency f of an enclosed volume of air V , with an aperture area A , is given by:

$$f = \frac{u}{2\pi} \sqrt{\frac{A}{VL}}$$

Calculate the resonant frequency f of oscillation of the air in a car with an open sunroof.

Where: $u = 340 \text{ ms}^{-1}$ the speed of sound in air

and for this car:

$L = 0.14 \text{ m}$ the effective length of air mass oscillating in the aperture.
 $A = 0.18 \text{ m}^2$
 $V = 3.2 \text{ m}^3$

$f = \dots\dots\dots \text{ Hz}$

[2]

Total Marks for Question Set: 6

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