

# 3

91523



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## Level 3 Physics 2020

### 91523 Demonstrate understanding of wave systems

2.00 p.m. Wednesday 2 December 2020  
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of wave systems.	Demonstrate in-depth understanding of wave systems.	Demonstrate comprehensive understanding of wave systems.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

**You should attempt ALL the questions in this booklet.**

Make sure that you have Resource Booklet L3–PHYSR.

In your answers use clear numerical working, words, and/or diagrams as required.

Numerical answers should be given with an SI unit, to an appropriate number of significant figures.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

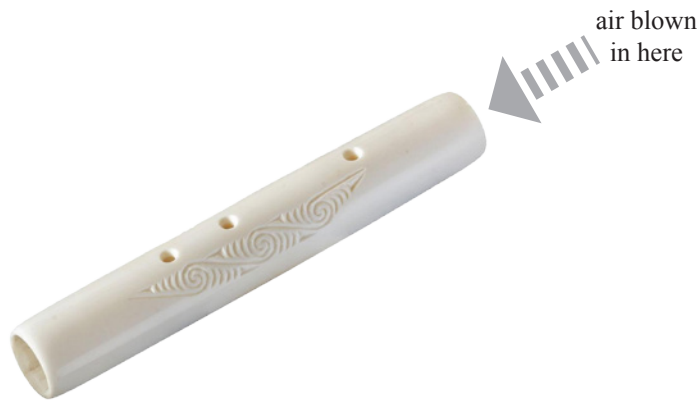
**YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.**

**TOTAL**

ASSESSOR'S USE ONLY

## QUESTION ONE: THE KŌAUAU

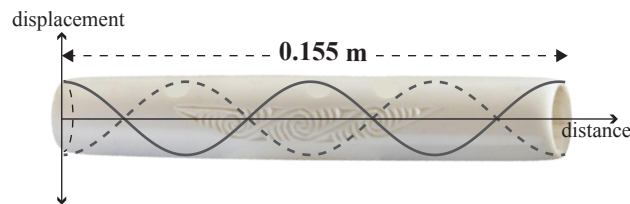
The speed of sound in air is  $3.40 \times 10^2 \text{ m s}^{-1}$ .



<https://allgoods.co.nz/product/499557>

A Māori kōauau is a short flute carved from bone. This instrument can be modelled as an open pipe of length 0.155 m.

On one occasion Manu covers all the holes and plays a note that has the following displacement standing wave pattern for one of its harmonics.



(a) Which harmonic is shown in the diagram above?

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(b) Calculate the frequency of the standing wave above.

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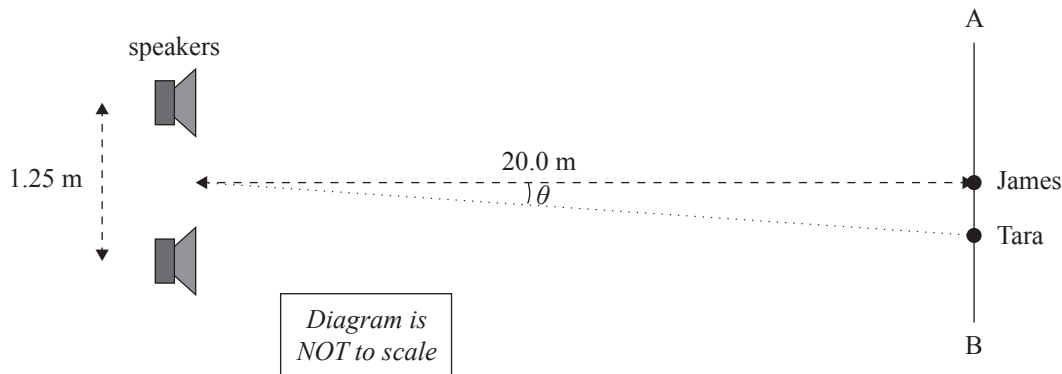


**QUESTION TWO: SOUND WAVE INTERFERENCE PATTERNS**

The speed of sound in air is  $3.40 \times 10^2 \text{ m s}^{-1}$ .

James and Tara take two portable speakers out on the school field and place them 1.25 m apart. They send a signal via their computer to play a frequency of  $2.50 \times 10^3 \text{ Hz}$  out of both speakers at the same time.

They walk along a line (A to B) parallel to the speakers, 20.0 m away, as shown below. They notice a regular series of loud and quiet spots along the line and decide to investigate the pattern.



- (a) James stands along the central line and Tara stands on the first adjacent loud spot along the line.

Calculate the angle,  $\theta$ , that Tara makes with the central line.

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- (b) The distance between A and B is 10 metres.

Calculate the total number of loud spots the students could hear along this line while both speakers are producing the same frequency of  $2.50 \times 10^3 \text{ Hz}$ .

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### QUESTION THREE: A DOPPLER EXPERIMENT

The speed of sound in air is  $3.40 \times 10^2 \text{ m s}^{-1}$ .

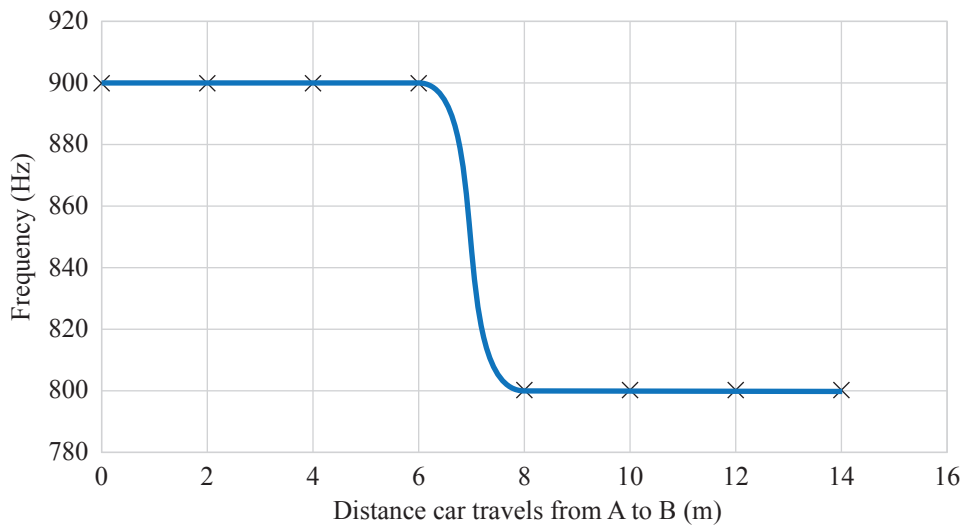
Lily and Dave are conducting an experiment to measure the frequency of the sound produced by a car horn as it travels past a stationary observer.

Lily drives her car from point A to point B directly past (and very close to) Dave who is recording the frequency of the sound waves, as shown below.



adapted from: [www.cleanpng.com/png-2-15-toyota-corolla-2-14-toyota-camry-car-2-19-toy-6336589/](http://www.cleanpng.com/png-2-15-toyota-corolla-2-14-toyota-camry-car-2-19-toy-6336589/)  
and [www.aliexpress.com/item/32589231539.html](http://www.aliexpress.com/item/32589231539.html)

Using the data recorded, Dave was able to plot the frequency he observed on a graph.



- (a) Using the graph, state the frequency Dave hears as the car travels **towards** him.

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- (b) By considering the motion of the sound waves from the car horn, give reasons why Dave's meter detects a change in frequency as the car approaches him, and then goes past him.

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