3

91523

915230

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

SUPERVISOR'S USE ONLY

Tick this box if there is no writing in this booklet

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.

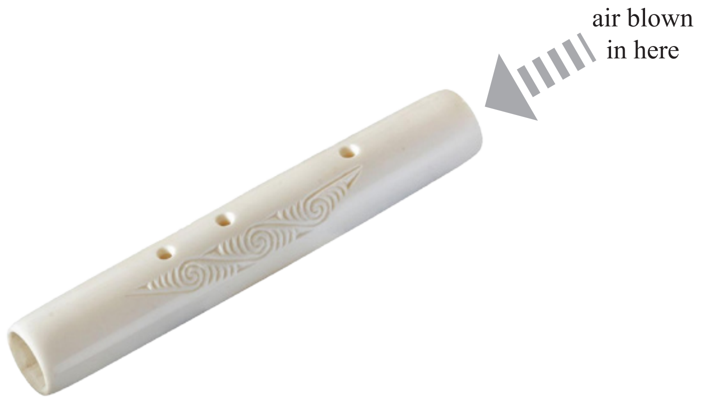
TOTAL

ASSESSOR'S USE ONLY

ASSESSOR'S USE ONLY

QUESTION ONE: THE KŌAUAU

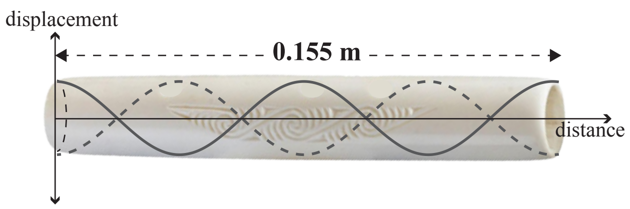
The speed of sound in air is 3.40×10^2 m s^{-1}.



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?

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

(c) Opening and closing holes in the kōauau can produce different notes. Manu opens the last hole and plays a note (the top two holes remain closed).

Explain how the frequency of the fundamental note played with the hole open compares to the frequency of the fundamental note played with the holes closed.

(d) Explain how a standing wave is produced in a kōauau (an open pipe).

ASSESSOR'S USE ONLY

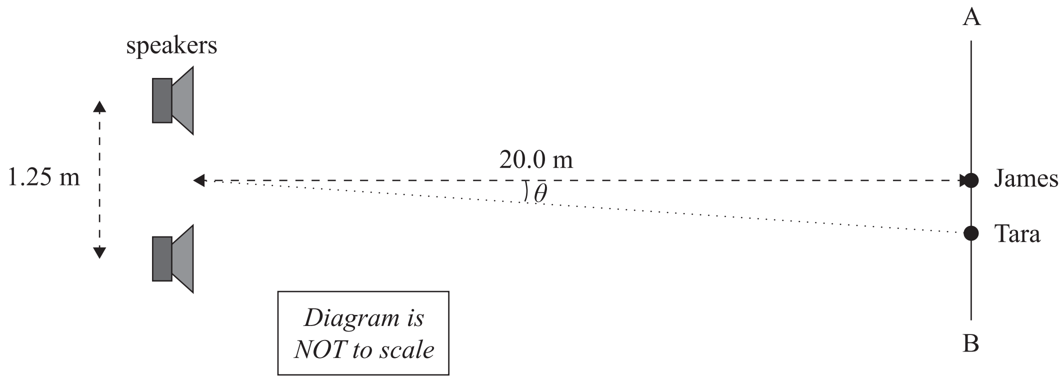
QUESTION TWO: SOUND WAVE INTERFERENCE PATTERNS

ASSESSOR'S USE ONLY

The speed of sound in air is 3.40×10^2 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 2.50×10^3 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.

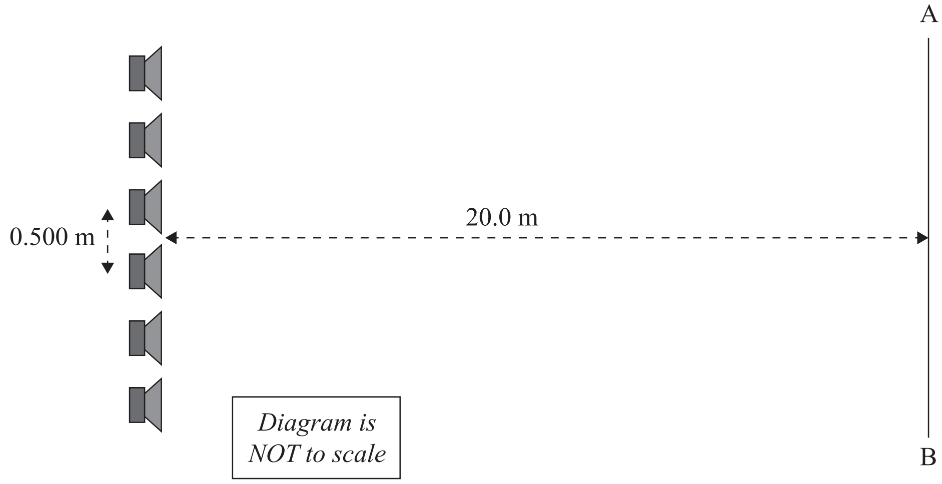
Calculate the angle, θ, that Tara makes with the central line.

(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 2.50×10^3 Hz.

ASSESSOR'S USE ONLY

(c) James and Tara find six identical speakers and line them up 0.500 m apart (see diagram below). They play a 2.50×10^3 Hz frequency sound through all speakers. They then walk along the line (A to B) parallel to the speakers, as before.



Describe and explain the difference in the loud and quiet sound pattern they hear as they walk along the line, compared to when there were only two sources of sound.

(d) Explain the effect on the spacing of loud and quiet spots along the line AB if James and Tara played a higher frequency sound through the speakers.

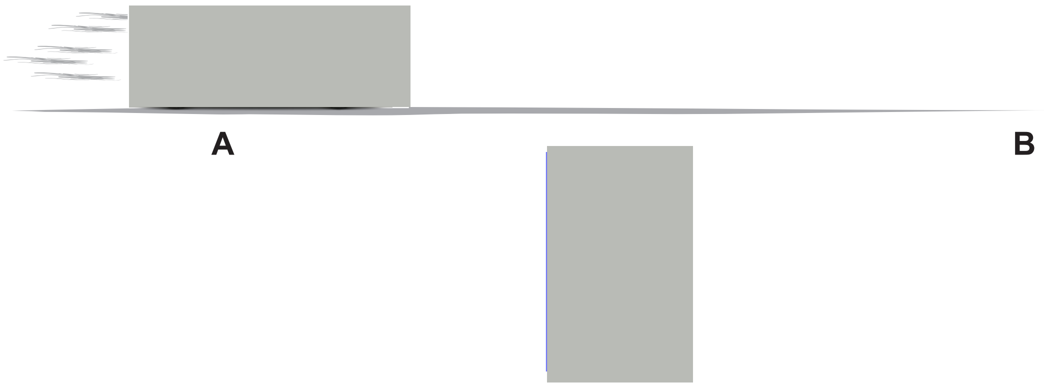
ASSESSOR'S USE ONLY

QUESTION THREE: A DOPPLER EXPERIMENT

The speed of sound in air is 3.40×10^2 m s^{-1}.

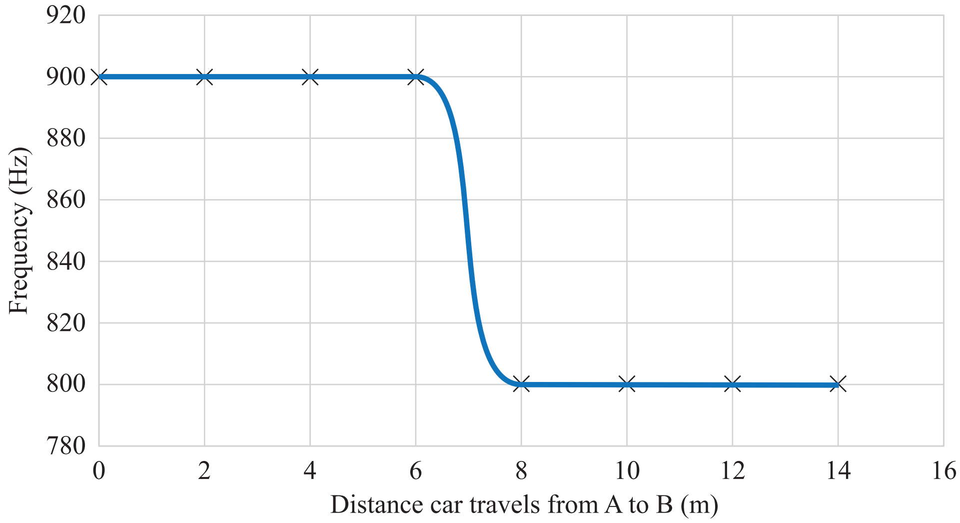
Lily and Dave are conducting an experiment to measure the frequency of the sound produced by a car horn as it travels past a stationary observer.

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/
and 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.

(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.

ASSESSOR'S USE ONLY

(c) Using the information from the previous page, calculate the constant speed of the car that Lily is driving.

(d) After Lily passes point B, she decides to accelerate away from Dave, who remains in the same position.

Using your knowledge of the Doppler effect, explain how and why the frequency that Dave hears changes during this time.

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

ASSESSOR'S USE ONLY

91523