91523

915230

NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

3

SUPERVISOR'S USE ONLY

Tick this box if you have NOT written in this booklet

Level 3 Physics 2021

91523 Demonstrate understanding of wave systems

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 2–11 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

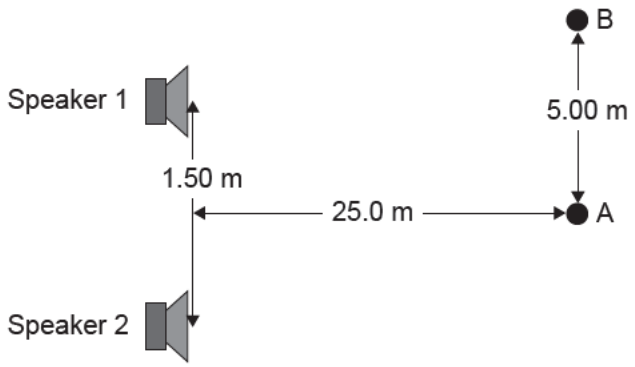
YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

QUESTION ONE: SUPERPOSITION OF SOUND WAVES

Two loudspeakers are connected to the same signal generator ,which is set to make the loudspeakers vibrate at a frequency of 8.95×10^2 Hz (corresponding to a wavelength of 0.381 m in air). The teacher makes sure that she wires the speakers so that they move in phase.

A student uses her phone to measure the sound intensity (loudness) at point A, which is equally distant from both speakers. She moves the phone towards B, noting that the sound gets quieter and then louder again.

The diagram below shows the set-up (not to scale).



(a) Determine the distance the student will have to move the phone to find the **first quiet** point between A and B.

(b) Explain how superposition causes the sound intensity to change when the phone is moved from A to B.

(c) Describe the difference in the pattern of loud and soft sounds the students would hear as they walk along AB if the speakers were further apart.

Give reasons for your answer.

(d) The teacher also wants to demonstrate beats. With Speaker 1 making a sound of frequency 8.95×10^2 Hz, she connects Speaker 2 so that it makes an equally loud sound of frequency 8.90×10^2 Hz.

(i) Explain why the students hear a note that regularly changes in loudness, and determine the frequency of this beat.

(ii) Describe the changes to the frequency of beats the students will hear as the teacher slowly increases the frequency of Speaker 2 from 8.90×10^2 Hz to 9.00×10^2 Hz.

Speaker 1 remains at a frequency of 8.95×10^2 Hz.

QUESTION TWO: STANDING WAVES

https://en.wikipedia.org/wiki/Didgeridoo#/media/File:Didgeridoo_street_player-2.jpg

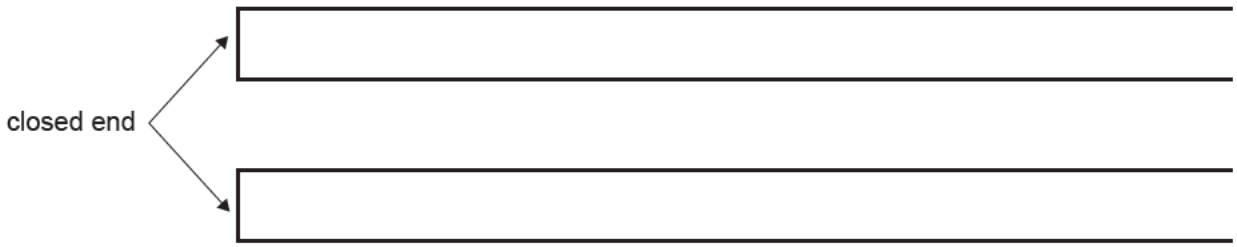
The speed of sound in air is 341 m s^{-1}.

(a) Marc makes a sort of didgeridoo using a piece of plastic drainpipe 1.20 m long. Marc vibrates his lips against the pipe, making the air vibrate in the tube, and also blocking the tube at the end he is blowing into, so that one end is closed while the other end is open.

Calculate the wavelength of the lowest note that Marc can make with his didgeridoo.

(b) Some of the richness in the tone of the didgeridoo is caused by the presence of overtones.

In the space below, label the positions of displacement nodes (N) and antinodes (A) that the first two overtones will produce.



If you need to redraw your response, use the diagram on page 8.

State how the frequencies of these overtones relate to the lowest (fundamental) frequency of the pipe.

(c) Although Marc's lips vibrate at many frequencies, the pipe resonates only at certain frequencies.

Explain how the sound waves travel in the pipe to produce only these natural, resonant frequencies.

(d) As Marc keeps blowing into the pipe, the air warms up, and so the speed of sound in the pipe increases.

Explain how this will affect the resonant frequencies of the sound that the pipe produces.

QUESTION THREE: DOPPLER EFFECT AT THE RACE TRACK

Susan is watching a Formula 1 car race. As the cars go past, she hears the familiar sound of the engine change due to the Doppler effect.

The speed of sound in air at the track is 341 m s^{-1}.

www.abc net.au/news/2020-04-27/formula-1-season-may-resume-in-austria-july-without-spectators/12190752

(a) A car is approaching Susan at a speed of 44.4 m s^{-1} and Susan hears an engine at a frequency of 6.50×10^2 Hz.

Show that the frequency that would be heard by the driver is 5.65×10^2 Hz.

(b) Explain why the motion of the car causes Susan to hear a different frequency to that which the driver hears.

(You may add to the diagram below to support your answer).

(c) After the car has passed Susan, and is moving directly away from her, Susan hears an engine frequency of 5.00×10^2 Hz. Susan wants to know whether the car is still travelling at 44.4 m s^{-1}.

By assuming that the true frequency of the engine has not changed, determine whether the car has changed speed.

(d) Susan knows that as the car accelerates, the frequency of the sound produced by the engine increases.

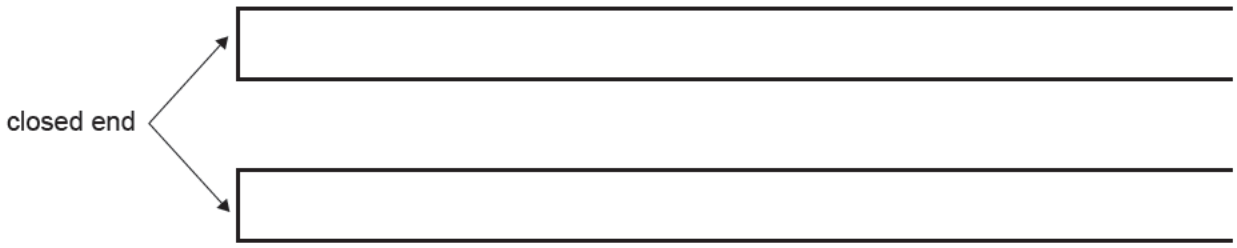
After the car has passed Susan, it accelerates away with an increase in engine frequency of 10%.

When the car's speed has increased by 10%, will the frequency Susan hears be higher (due to the higher revs) or lower (due to the Doppler effect)?

Justify your answer using equations or simple calculations.

SPARE DIAGRAM

If you need to redraw your response to Question Two (b), use the diagram below. Make sure it is clear which answer you want marked.



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

QUESTION NUMBER

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

QUESTION NUMBER

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

QUESTION NUMBER

91523