*See back cover for an English translation of this cover*

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91523M

915235

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

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Tohua tēnei pouaka mēnā KĀORE koe i tuhituhi i roto i tēnei pukapuka

# Ahupūngao, Kaupae 3, 2021

## 91523M Te whakaatu māramatanga ki ngā pūnaha ngaru

Ngā whiwhinga: Whā

| Paetae | Kaiaka | Kairangi |
|---|---|---|
| Te whakaatu māramatanga ki ngā pūnaha ngaru. | Te whakaatu māramatanga hōhonu ki ngā pūnaha ngaru. | Te whakaatu māramatanga matawhānui ki ngā pūnaha ngaru. |

Tirohia mēnā e rite ana te Tau Ākonga ā-Motu (NSN) kei runga i tō puka whakauru ki te tau kei runga i tēnei whārangi.

**Me whakamātau koe i ngā tūmahi KATOA kei roto i tēnei pukapuka.**

Tirohia mēnā kei a koe te Pukapuka Rauemi L3–PHYSMR.

Ki roto i ō tuhinga, whakamahia ngā whiriwhiringa tohutau mārama, ngā kupu, ngā hoahoa hoki, tētahi, ētahi rānei o ēnei, ki hea hiahiatia ai.

Me hoatu te wae tika o te Pūnaha Waeine ā-Ao (SI) ki ngā tuhinga tohutau, ki ngā tau tika o ngā tau tāpua.

Mēnā ka hiahia whārangi atu anō mō ō tuhinga, whakamahia te wāhi wātea kei muri o tēnei pukapuka.

Tirohia mēnā e tika ana te raupapatanga o ngā whārangi 2–17 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

Kaua e tuhi ki roto i tētahi wāhi kauruku whakahāngai (). Ka tapahia pea tēnei wāhi ina mākahia te pukapuka.

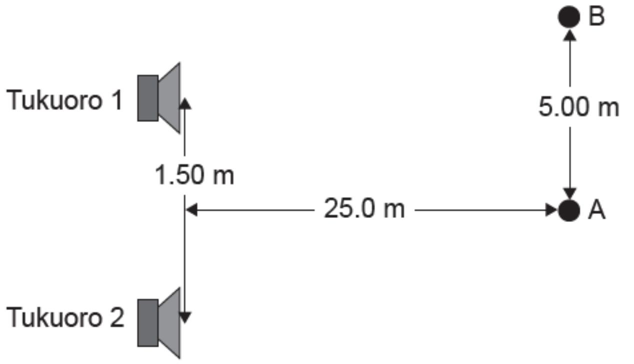
**ME HOATU RAWA KOE I TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.**

## TŪMAHI TUATAHI: TE INAKITANGA O NGĀ NGARU ORO

E rua ngā tukuoro e tūhono ana ki te pūwhakaputa tohu kotahi, kua tautuhia kia tōiriiri ngā tukuoro ki tētahi auau o te $8.95 \times 10^2$ Hz (e hāngai ana ki tētahi roanga ngaru o te 0.381 m i te hau takiwā). Ka mātua whakarite te kaiako ka honoa e ia ngā tukuoro ki ngā waea hiko kia tukutahi ai te putanga o tēnā, o tēnā.

Whakamahia ai e tētahi ākonga tana waea pūkoro hei ine i te kahaoro i te pūwāhi A, ā, he ōrite te tawhiti mai i ngā tukuoro e rua. Ka nekehia e ia te waea pūkoro ki B, me te kite ka mārire ake te oro, ā, ka kaha haere ake anō.

E whakaatu ana te hoahoa i raro i te whakatūtanga (kāore i te āwhatatia).




(a) Whakatauhia te tawhiti me neke te ākonga i te waea hei kimi i te pūwāhi **mārire tuatahi** i waenga i a A me B.

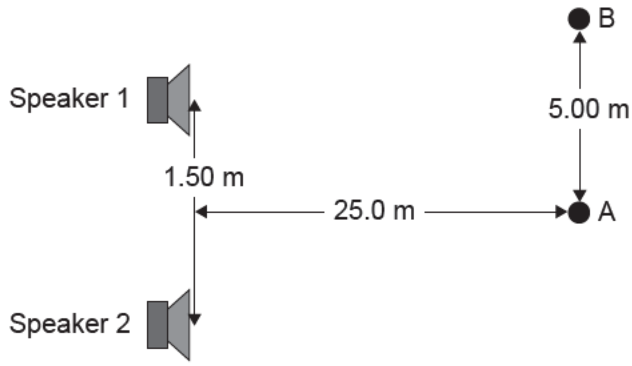
(b) Whakamāramahia he pēhea te huri o te kahaoro nā te inakitanga ina neke te waea mai i A ki B.

## 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 $8.95 \times 10^2$ 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) Whakamāramahia te rerekētanga i waenga i te tauira o ngā oro rarahi me te ririki ka rongo te ākonga i a ia ka hīkoi i AB mēnā he tawhiti atu ngā tukuoro tētahi i tētahi.

Homai ētahi take mō tō whakautu.

(d) Kei te hiahia anō te kaiako ki te whakaatu i ngā taki. Ina puta i te Tukuoro 1 tētahi oro i te auau o te $8.95 \times 10^2$ Hz, ka tūhono ia i te Tukuoro 2 kia ōrite te kaha o te oro ki te auau o te $8.90 \times 10^2$ Hz.

(i) Whakamāramahia te take ka rongo ngā ākonga i tētahi tangi ka rerekē haere tonu te kahaoro, ā, ka whakatau i te auau o te taki.

(ii) Whakaahuahia ngā huringa ki te auau o ngā taki ka rongo i ngā ākonga i te āta whakapikitanga haere a te kaiako i te auau o te Tukuoro 2 mai i te $8.90 \times 10^2$ Hz ki te $9.00 \times 10^2$ Hz.

Ka noho te Tukuoro 1 ki tētahi auau o te $8.95 \times 10^2$ Hz.

(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 $8.95 \times 10^2$ Hz, she connects Speaker 2 so that it makes an equally loud sound of frequency $8.90 \times 10^2$ 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 $8.90 \times 10^2$ Hz to $9.00 \times 10^2$ Hz.

Speaker 1 remains at a frequency of $8.95 \times 10^2$ Hz.

## TŪMAHI TUARUA:  NGĀ NGARU TŪ

He 341 m $s^{-1}$ te tere o te oro i te hau takiwā.

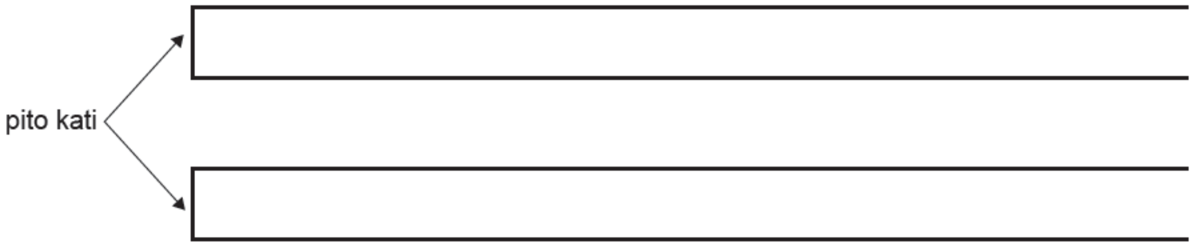
https://en.wikipedia.org/wiki/Didgeridoo#/media/File:Didgeridoo_street_player-2.jpg

(a) Ka hangaia e Marc he didgeridoo mai i tētahi paipa kirihou he 1.20 m te roa. Ka tōiriiritia e Marc ōna ngutu ki te paipa, kia tōiriiri ai te hau i roto i te ngongo, me te ārai i te ngongo i te pito e pupuhi ana ia, kia kati ai tētahi pito, ā, ka huaki tētahi pito.

Tātaihia te roanga ngaru o te oro tino mārū ka taea e Marc te whakatangi mā tana didgeridoo.

(b) Ko te reka o te tangi o te didgeridoo ka ahu mai i ngā ororunga.

Ki te wāhi i raro, tapaina ngā pūwāhi o ngā pona (node) (N) me ngā pūmōrahi (antinode) (A) nekeneke ka puta i ngā ororunga tuatahi e rua.




*Ki te hiahia koe ki te tuhi anō i tō urupare, whakamahia te hoahoa kei te whārangi 14.*

Tuhia he pēhea te pānga o ngā auau o aua ororunga ki te auau tino mārū (taketake) o te paipa.

## QUESTION TWO: STANDING WAVES

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

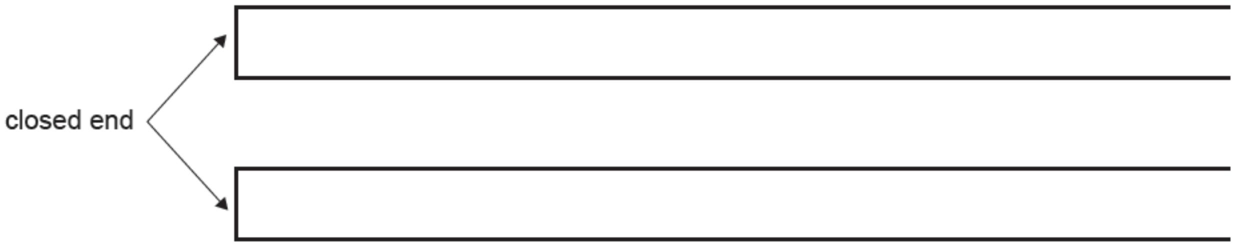
https://en.wikipedia.org/wiki/Didgeridoo#/media/File:Didgeridoo_street_player-2.jpg

(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 15.*

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

(c) Ahakoa ka tōiriiri ngā ngutu o Marc i ngā auau maha, ka tiori (resonate) anake te paipa i ētahi auau ake.

Whakamāramahia he pēhea te rere a ngā oro ngaru i te paipa kia puta ai aua auau tūturu, tiori.

(d) I a Marc e puhapuha haere i te paipa, ka mahana haere te hau, ā, kia tere haere ake te oro i roto i te paipa.

Whakamāramahia mai ka pēhea te whai pānga o ngā auau tiori ki te oro ka puta i te paipa.

(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.

## TŪMAHI TUATORU: TE PĀNGA DOPPLER I TE ARA REIHI

Kei te mātakitaki a Susan i tētahi reihi motukā Formula 1. I te hipatanga o ngā motukā, ka rongo ia i tētahi oro me tōna mōhio ko te huringa o te oro mīhini tērā nā te pānga Doppler.

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

Ko te tere o te oro i te hau takiwā i te ara reihi he 341 m $s^{-1}$.

(a) Kei te whakatata atu tētahi motukā ki a Susan i te tere o te 44.4 m $s^{-1}$ ka rongo a Susan i tētahi mīhini kei te auau o te $6.50 \times 10^2$ Hz.

Me whakaatu ko te auau ka rongohia e te kaitaraiwa he $5.65 \times 10^2$ Hz.

(b) Whakamāramahia te take nā te neke o te waka ka rongo a Susan i tētahi auau rerekē ki tērā e rongo ana te kaitaraiwa.

(Ka āhei koe ki te tāpiri tuhituhi ki te hoahoa i raro hei tautoko i tō tuhinga).

## QUESTION THREE: DOPPLER EFFECT AT THE RACE TRACK

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

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 $s^{-1}$.

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

Show that the frequency that would be heard by the driver is $5.65 \times 10^2$ 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) I muri i te hipatanga o te motukā i a Susan, ā, kei te whakatawhiti atu mai i a ia, ka rongo a Susan i te auau o te mīhini o te $5.00 \times 10^2$ Hz. Kei te hiahia a Susan ki te mōhio mēnā he 44.4 m $s^{-1}$ tonu te tere o te motukā.

Me kī kāore i rerekē te auau tūturu o te mīhini, me whakatau mēnā kua rerekē te tere o te motukā.

(d) Kei te mōhio a Susan ina whakatere haere ake te motukā, ka piki anō te auau o te oro ka puta i te mīhini.

I muri i te hipatanga o te motukā i a Susan, ka whakatere ake me te piki o te auau o te mīhini o te 10%.

Ina heke te tere o te motukā mā te 10%, ka teitei ake te auau ka rongo a Susan (nā ngā huringa nui ake o te mīhini), iti ake rānei (nā te pānga Doppler)?

Parahautia tō whakautu mā ngā whārite, ngā tātaitanga māmā rānei.

(c) After the car has passed Susan, and is moving directly away from her, Susan hears an engine frequency of $5.00 \times 10^2$ 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.

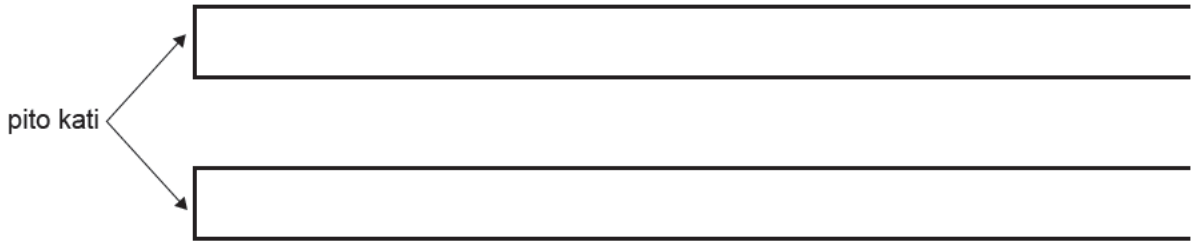
After the car has passed Susan, it accelerates away with an increase in engine frequency of 10%.

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.

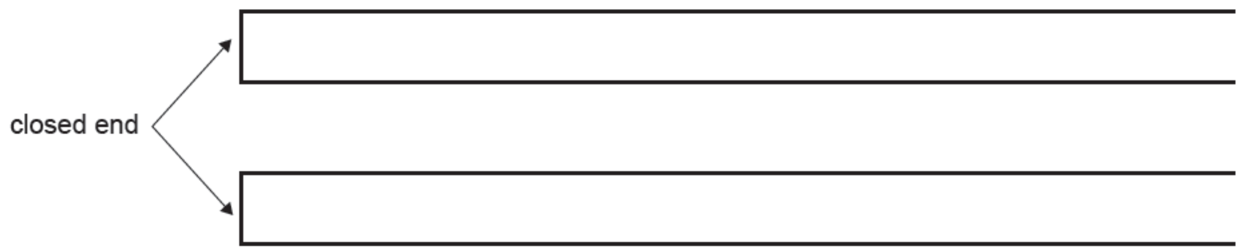
## HE HOAHOA TĀPIRI

Ki te hiahia koe ki te tātuhi anō i tō urupare ki te Tūmahi Tuarua (b), whakamahia te hoahoa i raro nei. Kia mārama te tohu ko tēhea te tuhinga ka hiahia koe kia mākahia.



**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.



**He whārangi anō ki te hiahiatia.**
**Tuhia te (ngā) tau tūmahi mēnā e tika ana.**

TAU TŪMAHI

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

QUESTION NUMBER

*English translation of the wording on the front cover*

# Level 3 Physics 2021

## 91523 Demonstrate understanding of wave systems

Credits: Four

91523M

| 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–PHYSMR.

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 – 17 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.**