See back cover for an English translation of this cover

3

91523M

915235

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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Tohua tēnei pouaka mēnā KĀORE koe i tuhi kōrero ki tēnei pukapuka

Mātai Ahupūngao, Kaupae 3, 2022

91523M Te whakaatu māramatanga ki ngā pūnaha ngaru

Ngā whiwhinga: E whā

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki ngā pūnaha ngaru.	Te whakaatu i te hōhonu o te māramatanga ki ngā pūnaha ngaru.	Te whakaatu i te tōtōpū o te māramatanga ki ngā pūnaha ngaru.

Tirohia kia kitea ai 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.

I ō tuhinga, whakaatuhia kia mārama ngā whiriwhiringa tohutau, ngā kupu, ngā hoahoa hoki/rānei, ki ngā wāhi me pērā.

Me hoatu te wae tika o te Pūnaha o te Ao (SI), ki ngā whakautu tohutau, ki ngā tau tika o ngā tau tāpua.

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

Tirohia kia kitea ai e tika ana te raupapatanga o ngā whārangi 2 – 19 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

Kaua e tuhi ki tētahi wāhi e kitea ai te kauruku whakahāngai (⁘). Ka poroa pea taua wāhanga ka mākahia ana te pukapuka.

HOATU TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.

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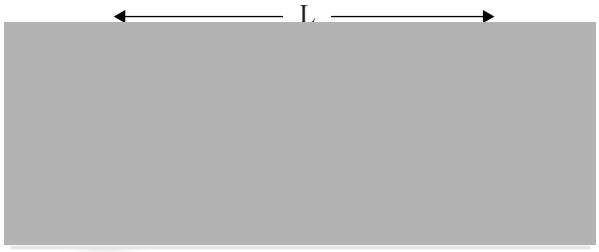
Kāore e whakaaetia ana kia tāruahia tētahi paku wāhanga o tēnei pukapuka ki te kore te Mana Tohu Mātauranga e mātua whakaae.

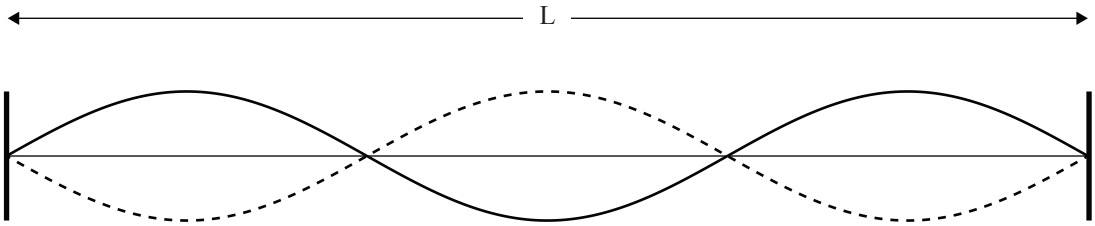
TE TŪMAHI TUATAHI: NGĀ NGARU TŪ

He rawe ki a Jane te whakatangi rakuraku.

Ka tākirikirihia ana e Jane te aho, e whakaaturia ana ki te hoahoa i raro tētahi o ngā hawarite tiori ka puta.



Te mātāpuna: www.dkfindout.com/us/music-art-and-literature/musical-instruments/guitar/



(a) Tuhia mai ko tēhea hawarite, ko tēhea (oro tāpiri) rānei e whakaaturia ana i te hoahoa i runga.

Tapaina ki te hoahoa he pona (N), he pūrahi (A) hoki, ka mutu, kia kaua e iti iho i te kotahi.

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

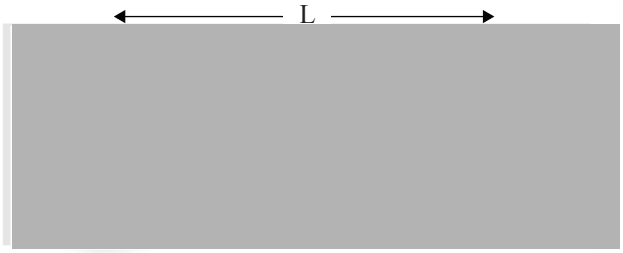
(b) Ko te 0.645 m te roa o te aho rakuraku. E 995 Hz te auau o te hawarite o te aho rakuraku, e whakaaturia ana i te hoahoa i runga.

Tātaihia te tere o te oro mā te aho.

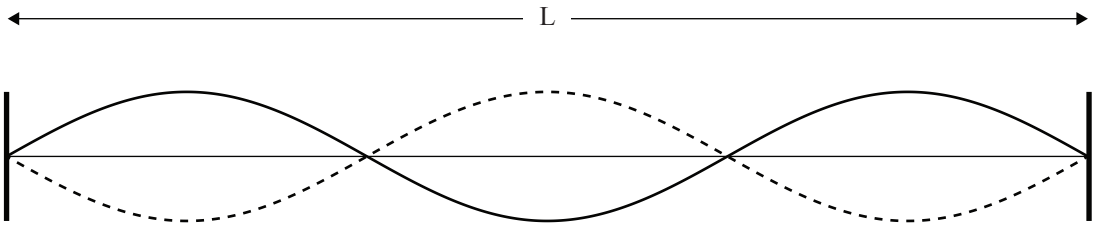
QUESTION ONE: STANDING WAVES

Jane enjoys playing the guitar.

When Jane plucks the string, one of the resonant harmonics that is produced, is shown in the diagram below.



Source: www.dkfindout.com/us/music-art-and-literature/musical-instruments/guitar/



(a) State which harmonic or (overtone) is shown in the diagram above.

Label at least one node (N) and one antinode (A) on the diagram.

If you need to redraw your response, use the diagram on page 15.

(b) The length of the guitar string is 0.645 m. The frequency of the harmonic, indicated in the diagram above, on the guitar string is 995 Hz.

Calculate the speed of sound through the string.

(c) I te wā e whakatangi ana a Jane i te oro 995 Hz i tana rakuraku, ka whakatika tana hoa, a Mele, i tana rakuraku mā te whakatangi i te oro kia ōrite ki tā Jane, kia ōrite hoki te tiori i te wā kotahi. Ka rongo rāua i ngā taki 5.00 Hz. Ka tautekatia e Mele te aho o tana rakuraku kia tere ake ai te rere o te oro i te aho, tae noa ki te wā kāore e rangona ngā taki.

- Tuhia mai te auautanga tuatahi o Mele.
- Whakamāramahia mai te pānga o te tauteka i te aho ki te auau o te oro i whakaputaina rā e Mele i tana rakuraku.

(d) Ka whakatangi hoki a Jane i te pūtōrino, e taea nei te whakatauira hei paipa tuwhera. Ka whakatangi a Mele i te pūtahoro, e taea nei te whakatauira hei paipa kua aukati i tētahi pito, ā, kua tuwhera i tērā atu pito.

Whakamāramahia mai te take kāore e taea e Mele te hawarite tuarua te whakaputa mā te pūtahoro, ahakoa e taea ana e Jane te hawarite tuarua te whakaputa mā tana pūtōrino.

(c) While Jane is playing the note of 995 Hz on her guitar, her friend Mele tunes her guitar by playing the same note as Jane with the same loudness at the same time. They hear beats of 5.00 Hz. Mele tightens her guitar string, so that sound travels faster in the string, until beats are no longer heard.

- State Mele's original frequency.
- Explain the effect tightening the string has on the frequency of the note that Mele was producing on her guitar.

(d) Jane also plays the flute, which can be modelled as an open pipe. Mele plays the clarinet, which can be modelled as a pipe which is closed at one end and open at the other end.

Explain why Mele cannot produce the second harmonic on the clarinet, whereas Jane is able to produce the second harmonic on her flute.

TE TŪMAHI TUARUA: TE WHAKARARURARU

E mātaihia ana e Vincent ngā tauira whakararuraru ka hangā e ngā tītara roraha. Kei a ia tētahi huinga tītara roraha e rerekē ana ngā āputa hāpara. Ka whitikia e Vincent tētahi taiaho whero mā ngā tītara, ā, ka mātakitaki ia i te tauira i puta rā ki te mata e āhua tawhiti ana.

(a) Whakaahuatia te pānga o te whakapiki ake i te tawhiti, *d*, i waenganui i ngā hāpara (ka ōrite tonu te whānui o ngā hāpara) ki te tauira hihi ka puta ki te mata.

(b) Ka whakamahi a Vincent i te tītara roraha hei mātai i te aho kahurangi mai i tana taiaho hou. Ka whakamahi ia i tētahi tītara e 6.00×10^5 ngā rārangi i ia mita. Ka kite ia i tētahi raupapa kōiraira e muramura ana, koia rā te mōrahi. Ka ine ia i tētahi koki e 54.0° i waenganui i te tuatoru o ngā kōiraira pūaho (te tuatoru o ngā raupapa mōrahi) me te kōiraira o waenga e muramura ana.

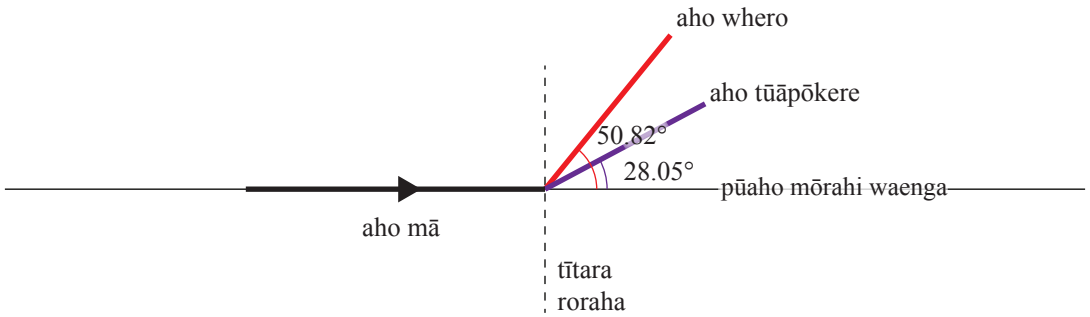
Tātaihia te auau o te aho e mātakitakingia ana e ia.

(c) Kātahi ka whitikia e Vincent tētahi aho mā mā taua tītara roraha tonu e 6.00×10^5 ngā rārangi i ia mita. Ka kite ia i te mā o te rārangi pūrahi o waenga, ā, ka whakaputaina e ia raupapa tētahi tūāwhiorangi whānui.

Whakamāramahia mai ngā kitenga e rua mā te whakamahi i tō mōhio ki ngā kano me te roa o ngā ngaru o te aho.

(d) I te wā e mātaihia ana te pānga o te whiti i tētahi aho mā mā te tītara roraha, ka āta ine a Vincent i te koki 28.05º mō te aho tūāpōkere mai i te pūaho mōrahi o waenga. Ka inea ai e ia he koki 50.82º mō te aho whero **e ōrite ana te raupapa**.

$\lambda_{\text{whero}} - \lambda_{\text{tūāpōkere}} = 2.54 \times 10^{-7}$ m



Tātaihia te roa o te ngaru o te aho whero.

Tīmatahia tō whakautu mā te tautuhi i te āhuatanga pātahi ki te aho whero me te aho tūāpōkere i te whārite $n\lambda = d\sin\theta$.

QUESTION TWO: INTERFERENCE

Vincent is studying interference patterns formed by diffraction gratings. He has a set of diffraction gratings with different slit spacings. Vincent shines a red laser through the gratings, and observes the pattern formed on a screen that is some distance away.

(a) Describe the effect on the pattern of fringes that are formed on the screen when the distance, d, between slits increases (the width of the slits remain the same).

(b) Vincent uses the diffraction grating to study blue light from his new laser. He uses a grating with 6.00×10^5 lines per metre. He sees a series of bright dots that are the maxima. He measures an angle of 54.0° between the third bright dot (third order maxima) and the central bright dot.

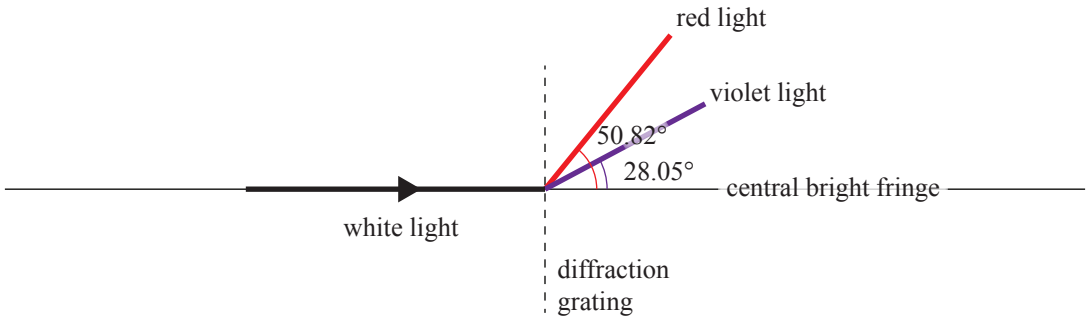
Calculate the frequency of light that he is observing.

(c) Vincent next shines white light through the same diffraction grating of 6.00×10^5 lines per metre. He notices that the central antinodal line is white, and each of the orders produces a complete spectrum.

Explain both observations using your knowledge of colours and wavelengths of light.

(d) While studying the effect of shining white light through the diffraction grating, Vincent carefully measures an angle of 28.05º for the violet light from the central bright fringe. He then measures an angle of 50.82º for the red light of the **same order**.

$\lambda_{red} - \lambda_{violet} = 2.54 \times 10^{-7}$ m



Calculate the wavelength of the red light.

Begin your answer by identifying what is common to both red light and violet light in the equation $n\lambda = d \sin\theta$.

TE TŪMAHI TUATORU: TE PĀNGA DOPPLER

Te tere o te oro i te hau takiwā = 3.40×10^2 m s^{-1}

E rua ngā motokā pirihimana e ōrite ana te auau (7.50×10^2 Hz) o ngā tangi whakatūpato. Ko tētahi e tū ana, ko tērā atu motokā pirihimana e whakatata atu ana ki a Emma e tū ana i te paeara.

(a) Whakatairitea te hauoro o te oro ka rangona e Emma ki te hauoro o te oro ka rangona e te kaihautū o te motokā i a ia e whakatata atu ana i tana motokā ki a Emma, e tangi nei te tangi whakatūpato.

(b) Ka whakatangihia te tangi whakatūpato o te motokā e tū ana me tō te motokā e whakatata atu ana ki a Emma. E 8.50 Hz te rerekē o te auau ka rangona e Emma i te auau tūturu (e motuhenga ana).

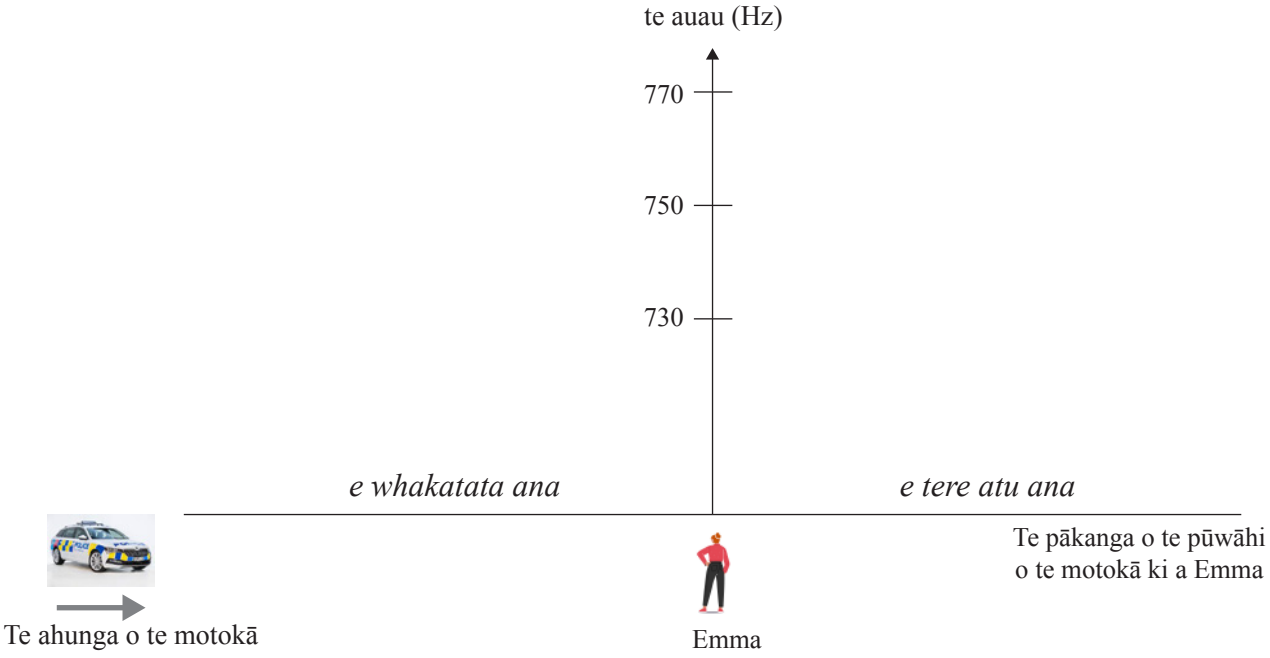
Whakaaturia mai kua 3.81 m s^{-1} te tere o te motokā pirihimana e whakatata atu ana.

(c) Kei te tino pātata te tū a Emma ki te taha o te rori i te wā ka whakatata atu te motokā pirihimana ki a ia, ā, ka pūmau tonu te tere o te motokā i te wā ka hipa i a ia.

Mā te tātai i te auau o te oro ka rangona e Emma i te wā e tere atu ana te motokā pirihimana i a ia, huahuatia mai tētahi kauwhata o te auau ki te pūwāhi mā te whakamahi i ngā tuaka kua tuhia ki raro iho nei hei whakaatu i te panonitanga o te auau o te oro ka rangona e Emma i te wā ka:

- whakatata atu te motokā pirihimana ki a ia mai i tawhiti
- tere atu te motokā pirihimana i a ia ki tawhiti.

Te kauwhata o te auau ki te pūwāhi



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www.vectorstock.com/royalty-free-vector/ginger-hair-woman-back-view-female-character-vector-39949834

(d) Whakamāramahia mai te take mō te āhua o te kauwhata kua tuhia e koe.

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

I ō tuhinga, kōrero mai mō te āhua o te kauwhata i te motokā e:

- whakatata atu ana ki a Emma
- hipa ana i a Emma.

Whakaurua he kōrero mō te rōnaki o te kauwhata ka whakatata atu ana, ka hipa ana hoki te motokā, e tangi ana te tangi whakatūpato, i a Emma.

QUESTION THREE: DOPPLER EFFECT

Speed of sound in air = 3.40×10^2 m s^{-1}

Two police cars have identical sirens of frequency 7.50×10^2 Hz. One of them is stationary while the other police car is approaching Emma, who is standing on the kerb.

(a) Compare the pitch of the note that Emma hears to the pitch of the note the driver of the car hears, as his car approaches her with its siren on.

(b) The stationary car, as well as the car approaching Emma, sound their sirens. The frequency heard by Emma differs from the true (actual) frequency by 8.50 Hz.

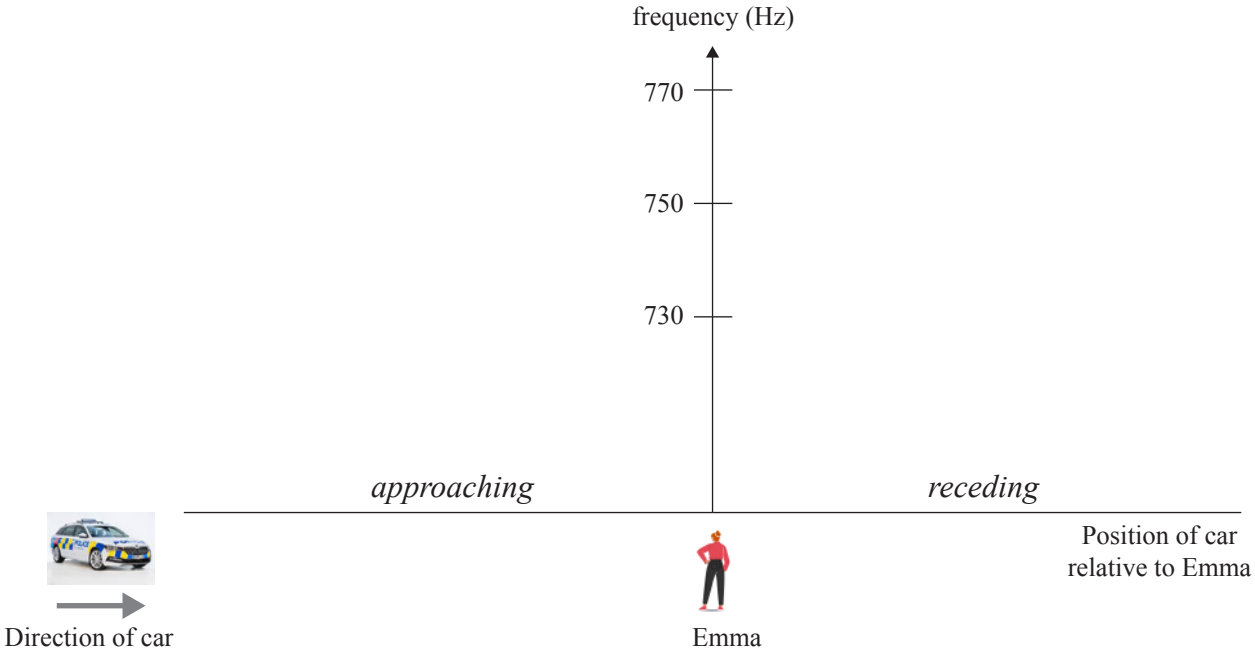
Show that the speed of the approaching police car is 3.81 m s^{-1}.

(c) Emma is standing very close to the side of the road as the police car approaches her, and then goes past her at a constant speed.

By calculating the apparent frequency of the sound that Emma hears when the police car goes away from her, sketch a graph of frequency against position using the axes drawn opposite above to show how the frequency of the sound that Emma hears changes as:

- the police car approaches her from a distance
- the police car recedes from her into the distance.

Graph of frequency against position



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www.vectorstock.com/royalty-free-vector/ginger-hair-woman-back-view-female-character-vector-39949834

(d) Explain the reason for the shape of the graph you have drawn.

If you need to redraw your response, use the diagram on page 15.

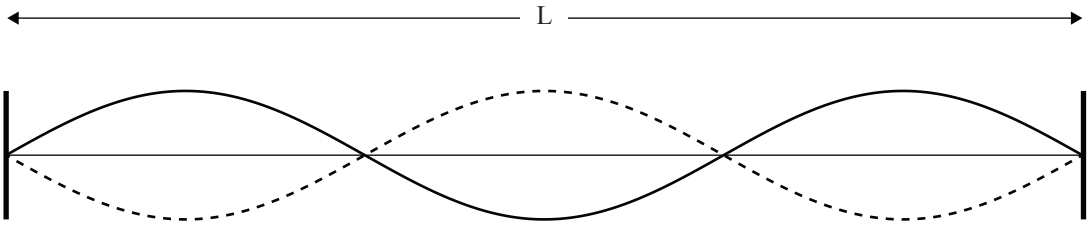
In your answer comment on the shape of the graph as the car:

- approaches Emma
- goes past Emma.

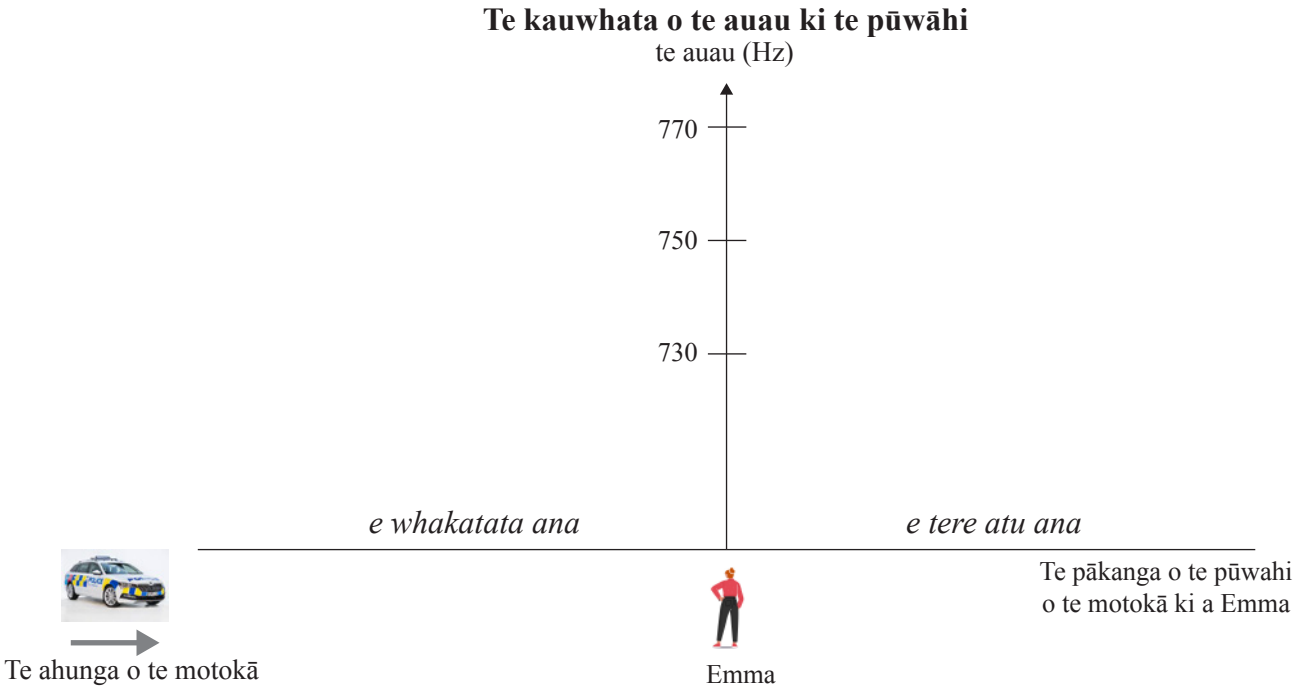
Include a comment on the gradient of the graph as the car, with its siren sounding, approaches and goes past Emma.

HE HOAHOA WĀTEA

Ki te hiahia koe ki te tā anō i tō urupare ki te Tūmahi Tuatahi (a), whakamahia te hoahoa i raro nei. Kia mārama te tohu i te tuhinga ka hiahia koe kia mākahia.

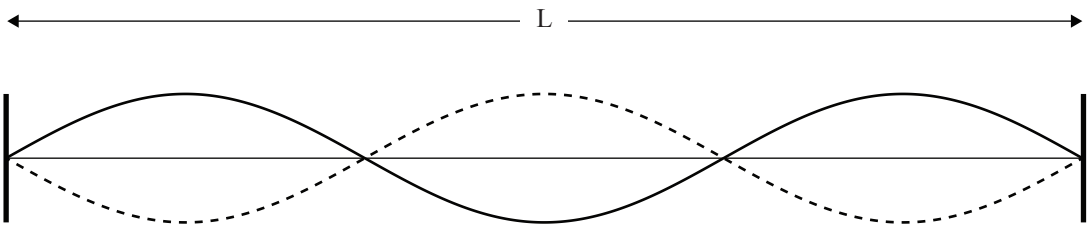


Ki te hiahia koe ki te tā anō i tō urupare ki te Tūmahi Tuatoru (c), whakamahia te hoahoa i raro nei. Kia mārama te tohu i te tuhinga ka hiahia koe kia mākahia.

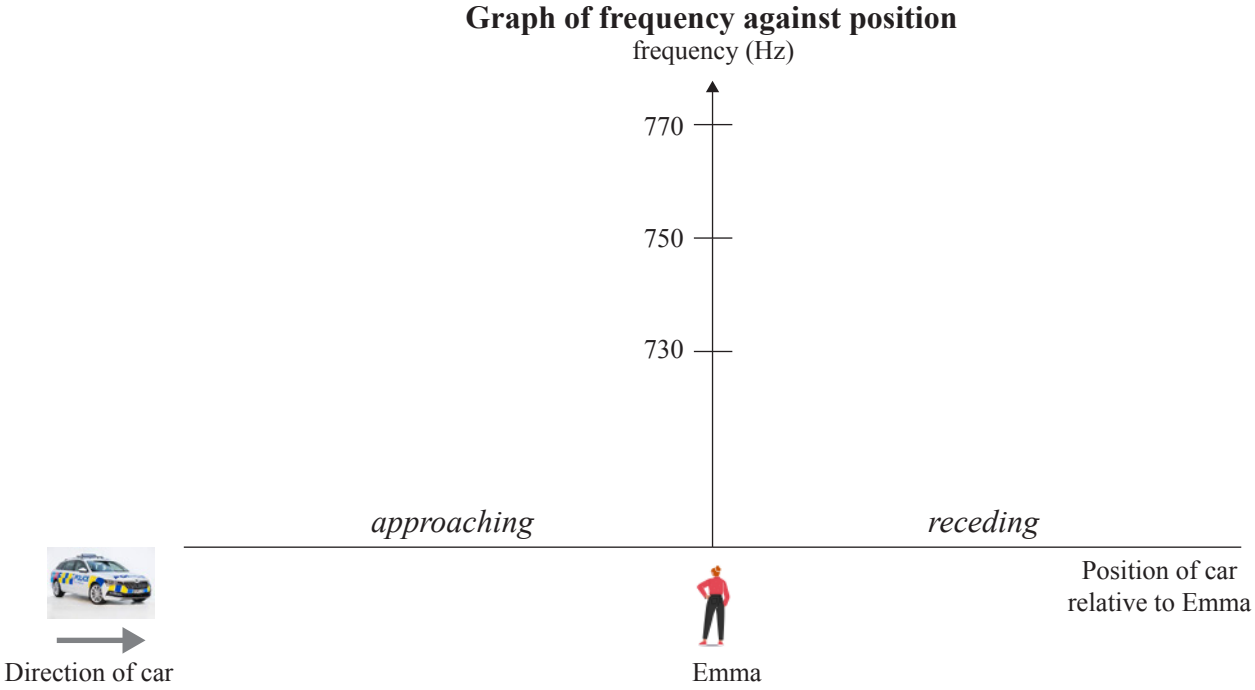


SPARE DIAGRAMS

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



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



He whārangi anō ki te hiahiatia.
Tuhia te tau tūmahi mēnā e hāngai ana.

TE TAU TŪMAHI

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

QUESTION NUMBER

He whārangi anō ki te hiahiatia.
Tuhia te tau tūmahi mēnā e hāngai ana.

TE 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 2022

91523M 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 – 19 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.