3

SUPERVISOR'S USE ONLY

91523M

915235

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Ahupūngao, Kaupae 3, 2018

91523M Te whakaatu māramatanga ki ngā pūnaha ngaru

2.00 i te ahiahi Rātū 20 Whiringa-ā-rangi 2018
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 2–21 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

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

TAPEKE

MĀ TE KAIMĀKA ANAKE

MĀ TE KAIMĀKA ANAKE

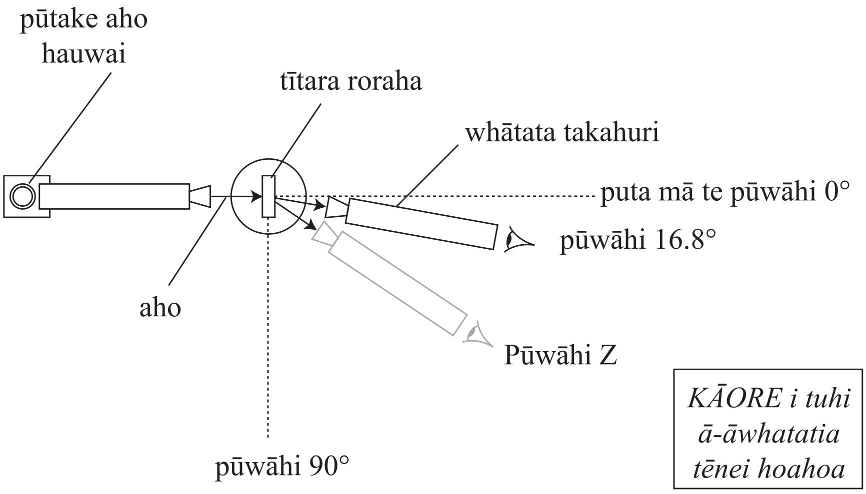
TŪMAHI TUATAHI

Ka whakaputa ngā pūmotu katoa i ngā roangaru taimau wehe kē o te aho e kīia ana he rārangi tūāwhiorangi e ahurei ana ki ia pūmotu. Ka whakaputa te hauwai i ngā rārangi aho ari e whā, e whakaaturia ana i raro.

Te Tūāwhiorangi Kitea o te Hauwai [1 nm = 1×10^{-9} m]

https://historyoftheatomictheory.wordpress.com/activity-hydrogen-spectrum/

Ka taea te aho mai i tētahi puna hauwai te hipa atu mā tētahi tītara roraha kia puta ai ko tētahi tauira whakararuraru. Ka taea te roangaru o ia rārangi tūāwhiorangi te whakatau mā te ine i te koki ki tōna mōrahi raupapa tuatahi.



KĀORE i tuhi ā-āwhatatia tēnei hoahoa

(a) Ko ngā rārangi o tētahi tītara roraha he 1.68×10^{-6} m te wehewehe haere.

Whakaaturia ko te roangaru o te rārangi tūāwhiorangi me tētahi mōrahi raupapa tuatahi o te 16.8° he 486 nm.

QUESTION ONE

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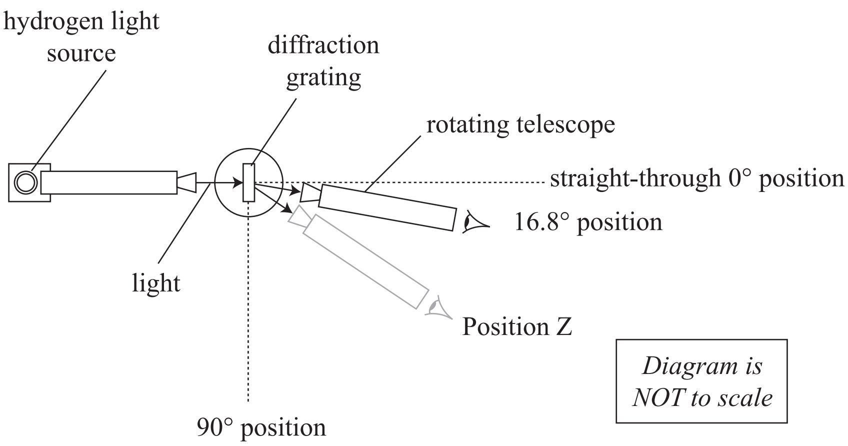
All elements emit a number of distinct fixed wavelengths of light known as spectral lines that are unique to each element. Hydrogen emits four visible light lines, as shown below.

The Visible Spectrum of Hydrogen [1 nm = 1×10^{-9} m]

https://historyoftheatomictheory.wordpress.com/activity-hydrogen-spectrum/

Light from a hydrogen source can be passed through a diffraction grating to form an interference pattern. The wavelength of each spectral line can then be determined by measuring the angle to its first order maximum.



(a) The lines on a diffraction grating are spaced 1.68×10^{-6} m apart.

Show that the wavelength of the spectral line with a first order maximum at 16.8° is 486 nm.

(b) Ka takahuria te whātata mai i te pūwāhi 16.8° ki te Pūwāhi Z, te wāhi o te rārangi tūāwhiorangi whai ake.

Tuhia te roangaru o tēnei rārangi. Whakamāramahia ō whakaaro whaitake.

(c) Tātaihia te tau mōrahi o ngā raupapa e kitea ana mō te rārangi 656 nm.

(d) Ka whakakapia te tītara roraha ki tētahi hae-huarua he 1.68×10^{-6} m te wehenga hae.

Whakaahuahia mai me te whakamārama i ngā huringa ka puta ki te wāhi, tīahoaho, me te whānui o ngā mōrahi mō te rārangi 656 nm.

MĀ TE KAIMĀKA ANAKE

ASSESSOR'S USE ONLY

(b) The telescope is rotated from the 16.8° position to Position Z, the location of the next spectral line.

State the wavelength of this line. Explain your reasoning.

(c) Calculate the maximum number of orders visible for the 656 nm line.

(d) The diffraction grating is replaced with a double-slit that has a slit separation of 1.68×10^{-6} m.

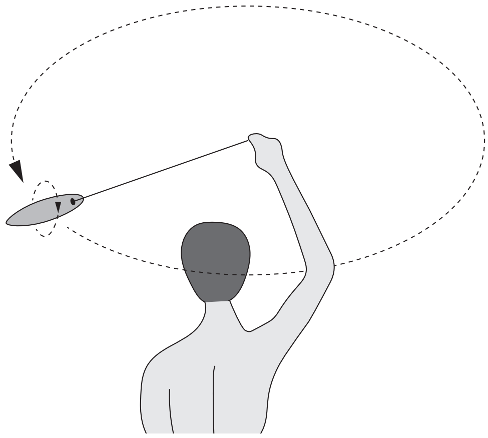
Describe and explain any changes that will occur to the location, brightness, and width of the maxima for the 656 nm line.

TŪMAHI TUARUA

MĀ TE KAIMĀKA ANAKE

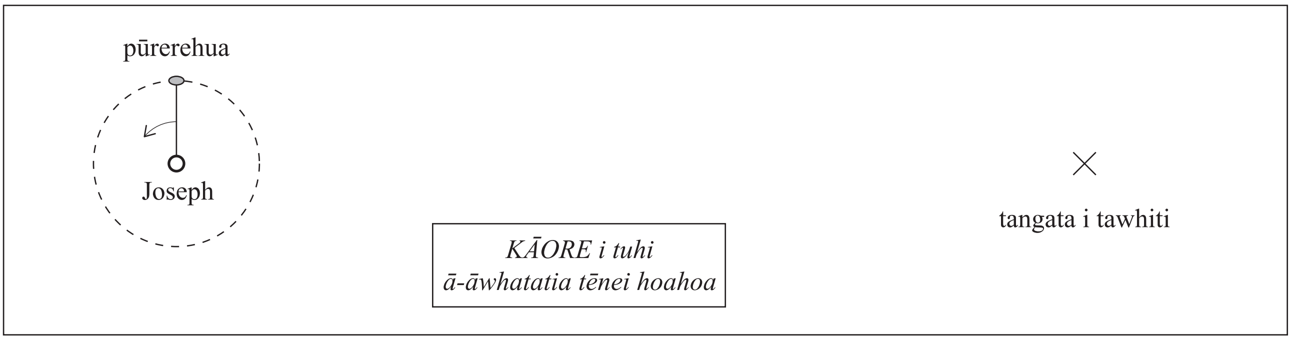
Te tere o te oro i te hau takiwā = 344 m s^{-1}

Ko te pūrerehua he papa rākau kua whakairohia, ā, kua tūhonoa ki tētahi tuaina. Ka taea te kōpiupiu haere i te māhunga hei whakaputa oro e rere tawhiti, e tātāu ana te hauoro. Ka taea e te kaiwhakatangi ngā huringa o te hauoro te whakahaere mā te kōpiupiu haere i te pūrerehua ki ngā tere rerekē.



Ka whakaputaina e te pūrerehua tētahi orotahi i te 2.00×10^2 Hz i i te wā e whiua amio haerehia ana e Joseph me te houanga o te 1.00 s me te tere o te 6.28 m s^{-1}. Kei te pū o te porowhita a Joseph.

Hoahoa A



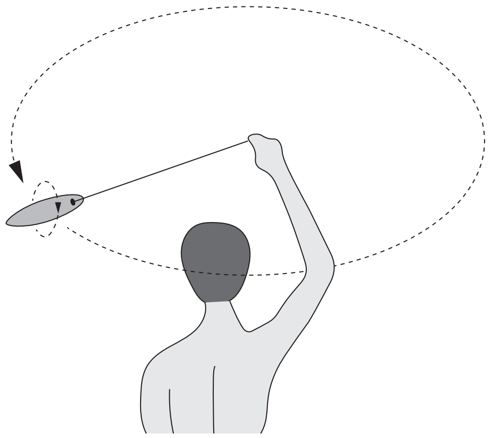
(a) Whakaahuahia mai ngā huringa ki te oro ka rongohia e tētahi tangata i tawhiti, i te wā e huri amio ana te pūrerehua.

ASSESSOR'S USE ONLY

QUESTION TWO

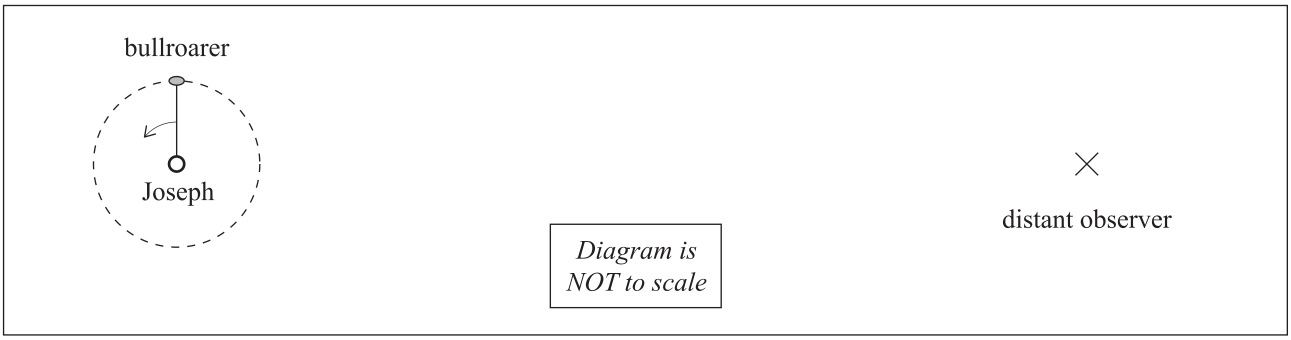
Speed of sound in air = 344 m s^{-1}

A bullroarer is a carved piece of wood attached to a string. It can be swung around the head to create sounds that travel long distances and fluctuate in pitch. The user can control the changes in pitch by swinging the bullroarer around in a circle at different speeds.



The bullroarer emits a note at 2.00×10^2 Hz as Joseph swings it in a circle with a period 1.00 s and speed 6.28 m s^{-1}. Joseph is at the centre of the circle.

Figure A



(a) Describe changes in sound that will be heard by a distant observer, as the bullroarer moves around the circle.

MĀ TE KAIMĀKA ANAKE

(b) Ina tae atu te pūrerehua ki te pūwāhi e whakaaturia ana i te Hoahoa A i te whārangi 6:

(i) Tātaihia te roangaru o ngā ngaru oro ka rongo a Joseph.

(ii) Whakamāramahia mai he aha e rerekē ai te roangaru o ngā ngaru oro ka rongo i te tangata i tawhiti ki aua roangaru ka rongo a Joseph.

(c) Me āta tohu ki te hoahoa kei te Hoahoa A ke te whārangi 6, ngā pūwāhi e rua o te pūrerehua e ōrite ana te ine a te tangata i tawhiti me tā Joseph ine i te auau ōrite.

Whakamāramahia mai he aha i ōrite ai te auau i ēnei pūwāhi ki tērā ka inea e Joseph.

ASSESSOR'S USE ONLY

(b) When the bullroarer is at the position shown in Figure A on page 7:

(i) Calculate the wavelength of the sound waves that Joseph will hear.

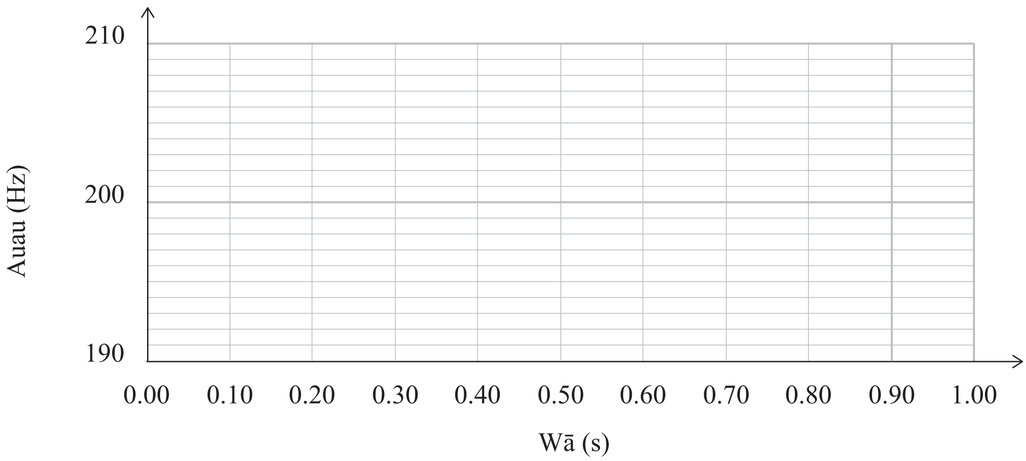
(ii) Explain why the sound waves observed by the distant observer will not have the same wavelength that Joseph experiences.

(c) Clearly mark on the diagram in Figure A on page 7, the two positions of the bullroarer at which the distant observer will measure the same frequency as Joseph.

Explain why the frequency at these points is the same as what Joseph would measure.

(d) Tātaihia ngā auau mōrahi me te mōkito ka inea e tētahi tangata i tawhiti i te hurihanga kotahi o te pūrerehua.

Whakamahia ko ēnei hei tātuhi i tētahi kauwhata o te rerekētanga o te auau ki te wā mai i te pūwāhi e whakaaturia ana i te Hoahoa A kei te whārangi 6.

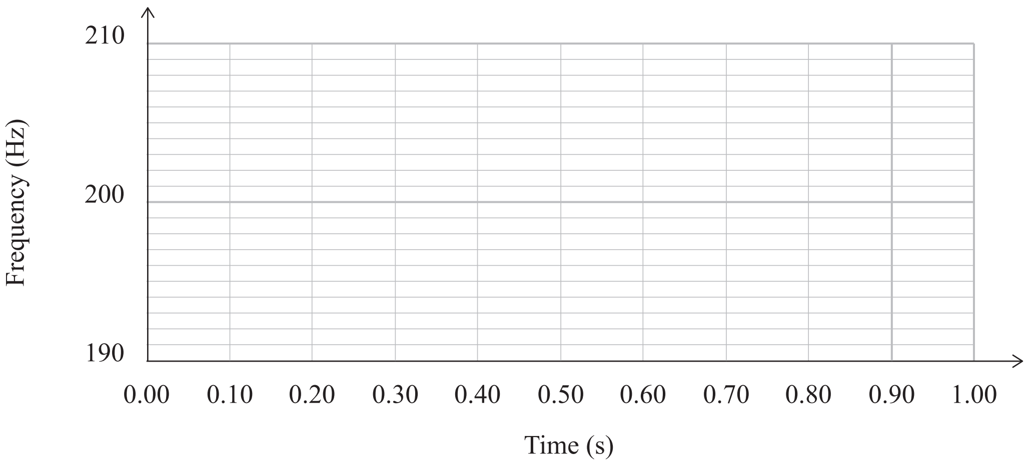


Ki te hiahia koe ki te tuhi anō i tō urupare, whakamahia te tapawhā kei te whārangi 18.

MĀ TE KAIMĀKA ANAKE

(d) Calculate the maximum and minimum frequencies that a distant observer will measure during one revolution of the bullroarer.

Use these to draw a graph of the variation of frequency against time starting from the position shown in Figure A on page 7.



If you need to redraw your response, use the box on page 19.

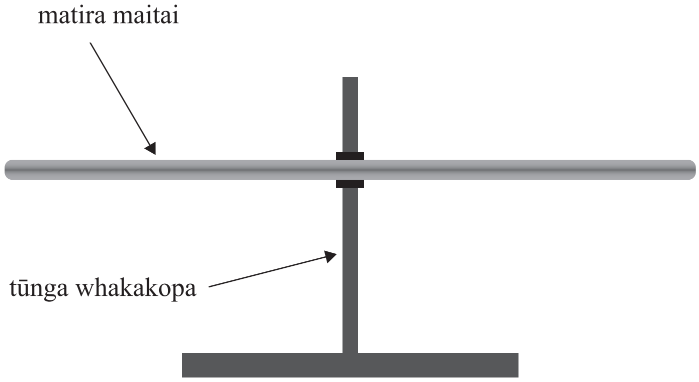
ASSESSOR'S USE ONLY

MĀ TE KAIMĀKA ANAKE

TŪMĀHI TUATORU

Te tere o te oro i te hau takiwā = 344 m s^{-1}

Kei te hiahia a Clara ki te tūhura i ngā āhuatanga o tētahi matira maitai he 0.400 m te roa. E mārō ana te whakakopa o te matira ki waenganui, ā, e wātea ana ngā pito ki te tōiriiri. Ka haua te matira kia puta ai tētahi ngaru tū pou taketake.



(a) Me whakaatu ko te roangaru o te ngaru he 0.800 m.

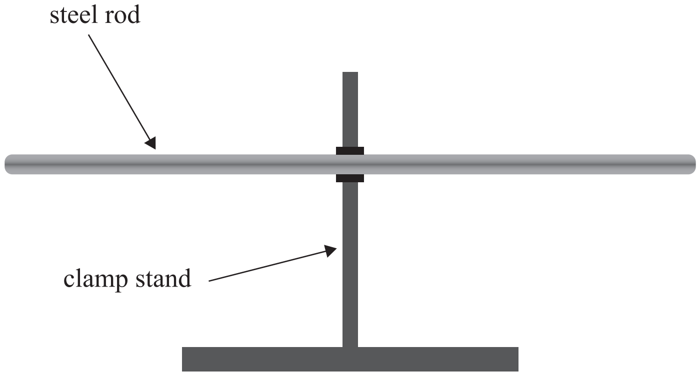
Me whakauru he hoahoa ki tō tuhinga.

QUESTION THREE

ASSESSOR'S USE ONLY

Speed of sound in air = 344 m s^{-1}

Clara wants to investigate the properties of a 0.400 m length of solid steel rod. The bar is clamped rigidly at the centre, and the ends are free to vibrate. The rod is struck in such a way as to produce a fundamental longitudinal standing wave.

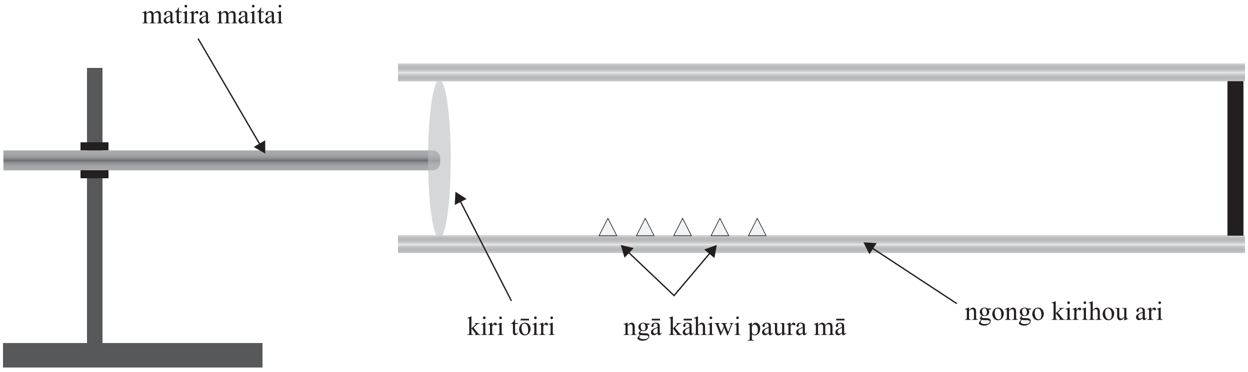


(a) Show that the wavelength of the wave is 0.800 m.

A diagram should be included in your answer.

E mau ana ki tētahi pito o te matira ko tētahi kiri tōiri ka nekeneke haere noa i roto i tētahi ngongo kirihou purata. E katia ana tētahi atu pito o te ngongo kirihou. Ki te taha raro o te ngongo kirihou purata ko ngā puehu paura mā.

Ina patua te matira matai, ka whakapukepuke mai ngā paura mā kia $\frac{\lambda}{2}$ ngā wehenga. Ka tōiriiri tonu te matira maitai ki te auau taketake.

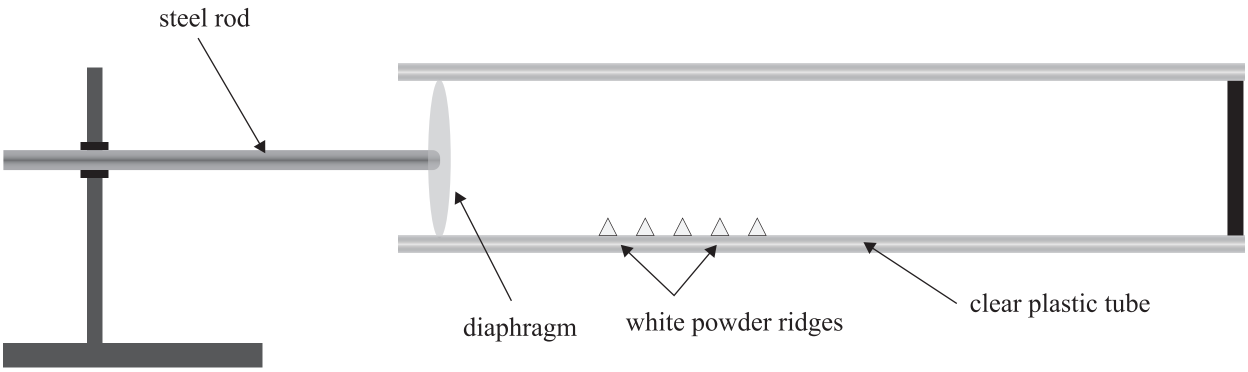


(b) He ōrite te auau o ngā tōiriiri i roto i te hau i te ngongo ki te auau o ngā tōiriiri kei te matira maitai.

Whakamāramahia mai he aha i tika ai tēnei mō te auau, engari kaua mō te roangaru o ngā tōiriiri e rua.

One end of the rod is attached to a diaphragm that can move freely inside a clear plastic tube. The clear plastic tube is closed at the opposite end. On the bottom of the clear plastic tube is a fine white powder.

When the steel rod is struck, the white powder forms into ridges that are $\frac{\lambda}{2}$ apart. The steel rod still vibrates at the fundamental frequency.



(b) The frequency of vibrations in the air in the tube is the same as the frequency of the vibrations in the steel rod.

Explain why this is true for the frequency, but not for the wavelength of the two vibrations.

MĀ TE KAIMĀKA ANAKE

(c) Ka inea e Clara ngā kāhiwi kia 2.30×10^{-2} m te wehenga tētahi i tētahi.

Tātaihia te tere o te oro i te matira.

(d) Ka whakatikahia te tūnga whakakopa, ā, ka patua te matira kia puta ai he ngaru tū o te hawarite tuarua i roto i te matira.

Whakamāramahia mai te pānga o tēnei ki te hau i roto i te ngongo.

(c) Clara measures the ridges to be 2.30×10^{-2} m apart.

Calculate the speed of sound in the rod.

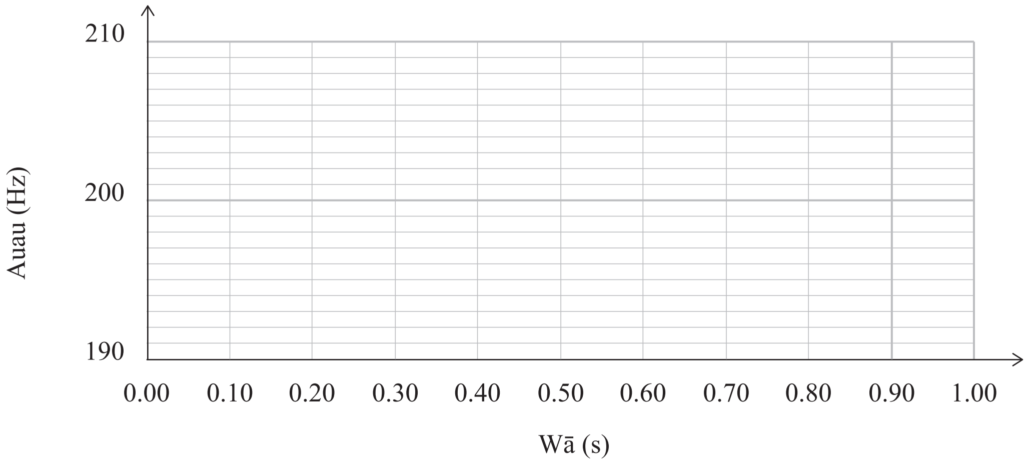
(d) The clamp stand is adjusted and the steel rod is struck in such a way as to produce a standing wave of the second harmonic in the rod.

Explain the effect this will have on the air inside the tube.

ASSESSOR'S USE ONLY

HE HOAHOA TĀPIRI

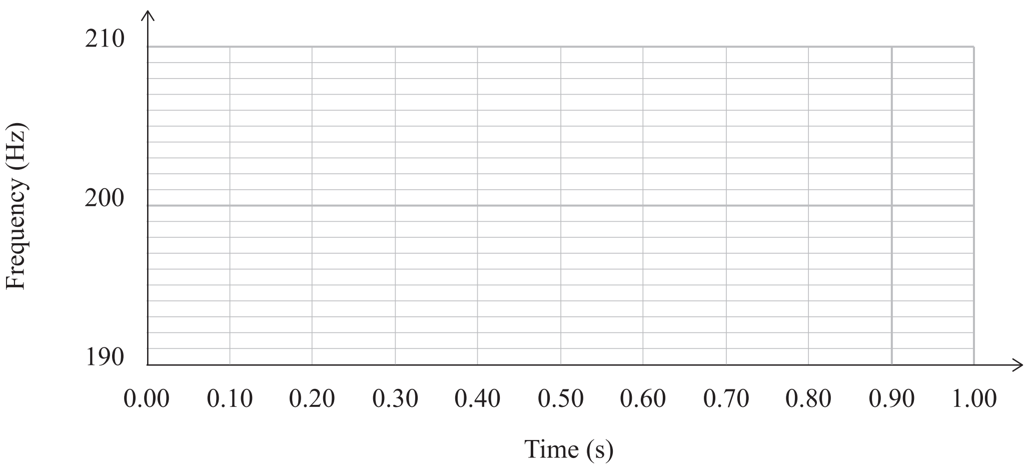
Ki te hiahia koe kia tuhia anō tō urupare ki te Tūmahi Tuarua (d), tuhia ki ngā tuaka i raro nei. Kia mārama te tohu ko tēhea te tuhinga ka hiahia koe kia mākahia.



SPARE DIAGRAMS

ASSESSOR'S USE ONLY

If you need to redraw your response to Question Two (d), draw it on the axes 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

MĀ TE KAIMĀKA ANAKE

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

QUESTION NUMBER

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English translation of the wording on the front cover

Level 3 Physics, 2018

91523 Demonstrate understanding of wave systems

2.00 p.m. Tuesday 20 November 2018
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–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 – 21 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.