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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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SUPERVISOR'S USE ONLY

Level 3 Physics, 2014

91523 Demonstrate understanding of wave systems

2.00 pm Tuesday 25 November 2014
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

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QUESTION ONE: THE SEA ORGAN

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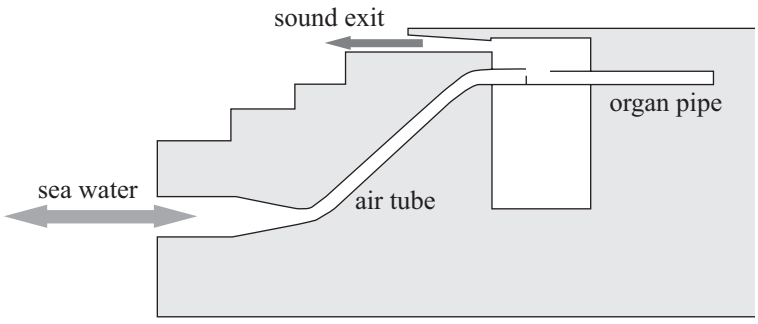
The Sea Organ in Zadar, Croatia, is a musical instrument that creates its musical notes through the action of sea waves on a set of pipes that are located underneath the steps shown in the picture. The sound from the pipes comes out through the regular slits in the vertical part of the top step.

http://travelforsomeday.wordpress.com/2012/03/06/the-sea-organ-morske-orgule-zadar-croatia/

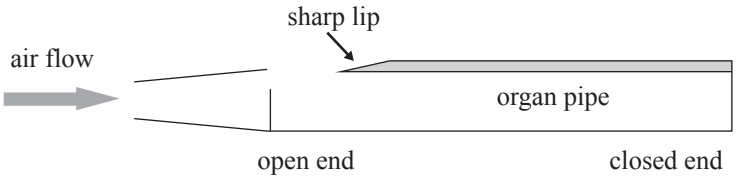
To produce a sound, the organ pipes must have air blown into them, so each organ pipe is connected to the top end of a tube, as shown in the diagram on the right.

The action of the waves pushes water in and out of a tube, creating a flow of air at the upper end of the tube.



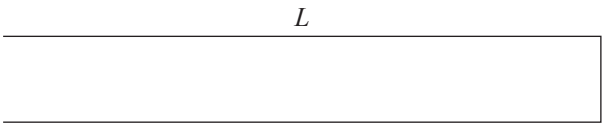
The diagram on the right shows the inside of an organ pipe.

These organ pipes have one closed end.



(a) Calculate the length, L, of an organ pipe, with one closed end, that produces a fundamental standing wave of wavelength 2.60 m.

You may find the diagram on the right useful.



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(b) Air is driven against a sharp lip, producing oscillations in the air, with a range of frequencies.

Explain why not all frequencies produce standing waves in the pipe.

(c) The Sea Organ contains organ pipes of several different lengths.

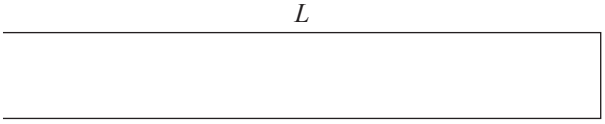
Explain why the differences in length of the organ pipes affect the sounds that are heard.

(d) The speed of sound in cold air is slower than it is in warm air.

Calculate the difference between the 3rd harmonic frequency (1st overtone) heard in summer (35°C), and the 3rd harmonic frequency heard in winter (–2°C).

Speed of sound in air at 35°C = 353 m s^{-1}
Speed of sound in air at –2°C = 330 m s^{-1}

You may find the diagram on the right useful.



QUESTION TWO: INTERFERENCE

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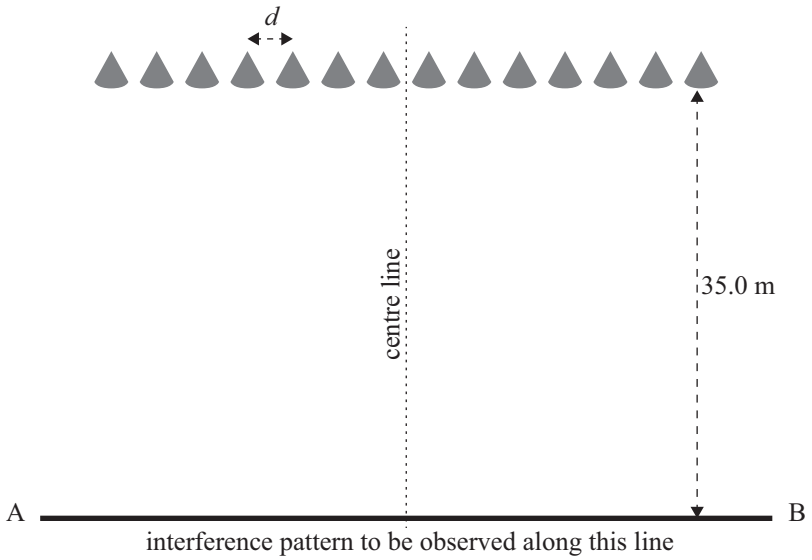
The diagram shows a series of speakers connected together, and to a frequency generator producing a single frequency. The speakers act like a diffraction grating.



(a) The sound wave source is producing a note of wavelength 0.600 m.
The distance between the speakers and the line AB is 35.0 m.
When a person walks along the line AB, the distance between two loud positions is 7.40 m.

Calculate the separation of the speakers, *d*.

(b) Explain how the path difference of the waves causes positions of constructive and destructive interference along the line AB.

(c) Explain the effect on the interference pattern of reducing the distance between the speakers.

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(d) The frequency generator is now set so that several different frequencies are emitted by each speaker.

Explain how the sound heard by someone walking along AB would differ from that described in part (b) of this question.

QUESTION THREE: THE DOPPLER EFFECT

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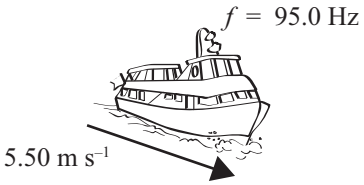
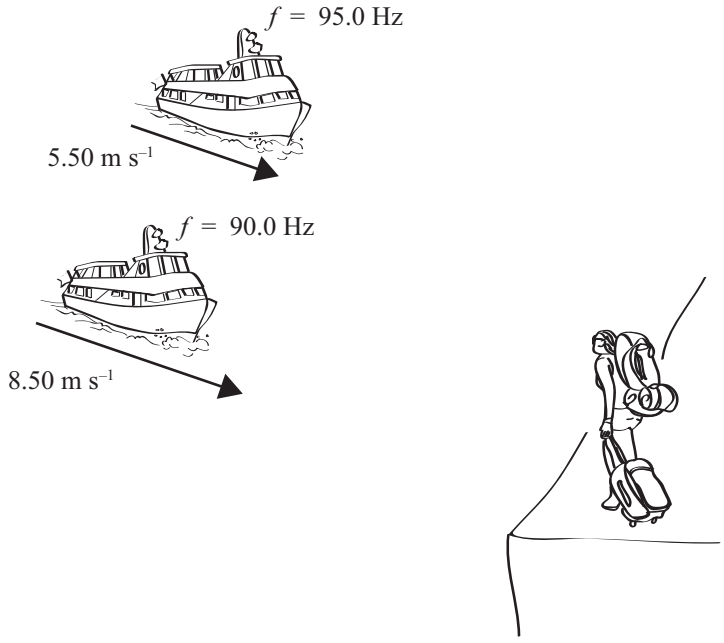
A tourist is watching a ferry boat coming towards her. The speed of the ferry is 5.50 m s^{-1}. The ferry sounds its horn, producing a note of frequency 95.0 Hz.

The speed of sound in the air over the water is 3.50×10^2 m s^{-1}.



(a) Calculate the frequency of the note that the tourist hears.

(b) Explain why the sound of the horn heard by the tourist does not have the same pitch as the sound emitted by the horn.



(c) A second ferry, which is overtaking the first, also sounds its horn, producing a note of frequency 90.0 Hz. For a few moments, both ferries are the same distance from the tourist, quite close together, and both are sounding their horns. The tourist hears beats.

(i) Calculate the frequency of the beats that are heard by the tourist.

(ii) Describe what beats are, and explain how they are created.

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

QUESTION NUMBER

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