3

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91523

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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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.

Not Achieved

TOTAL 05

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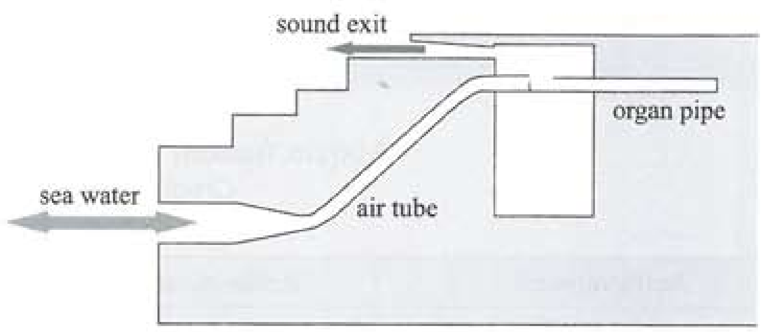
QUESTION ONE: THE SEA ORGAN

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/

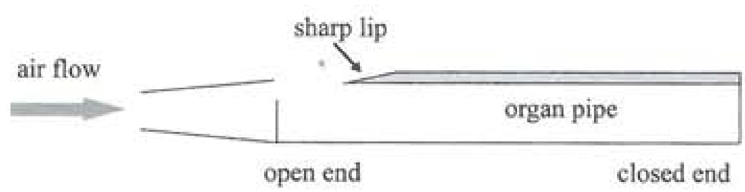
To produce a sound, the organ pipes must have air blown into them, so each organ pipe is connected to the top end of a tube, as shown in the diagram on the right.

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.



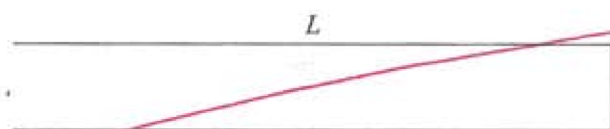
The diagram on the right shows the inside of an organ pipe.

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.



$L \cdot \frac{0.5}{2.6} = 1.3m$

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

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

This is because the frequency has to be ~~a certain~~ an exact, to be standing.
a node and an anti node has to occur

(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.

Because that would mean that the Length of the wave length which then change the frequency of the sound produced which affect the sounds that are heard.

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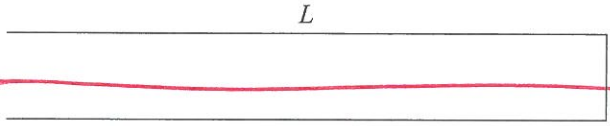
(d) The speed of sound in cold air is slower than it is in warm air.

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.



$v = f\lambda$

$\frac{v}{\lambda} = f$

warm air

$\frac{353}{2.6} = 135.769$

Cold air

$\frac{330}{2.6} = 126.923$

8.846 = difference

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N2

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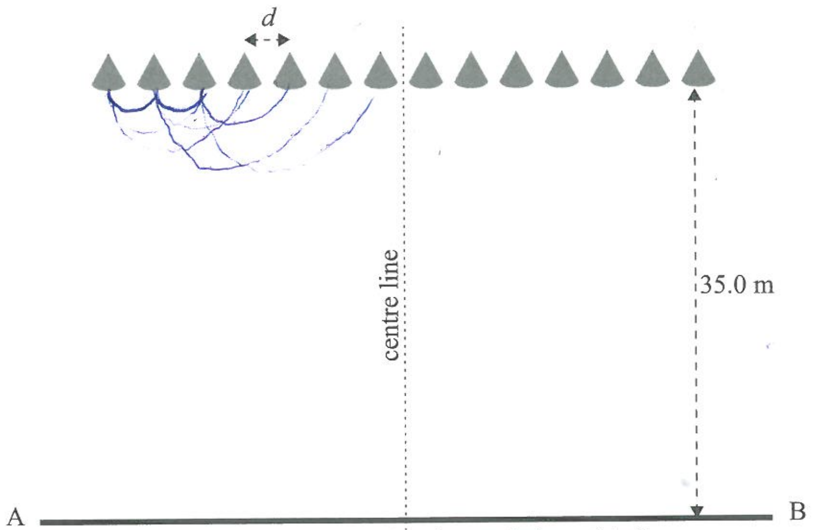
QUESTION TWO: INTERFERENCE

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.



interference pattern to be observed along this line

(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*.

~~K = ...m~~
~~d = ...~~ d = ?

$\frac{35 \times 0.6}{7.5} = 2.838$ m.

4

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

Because of multiple speakers producing waves the waves cross each other causing the interferences.

(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.

Some waves will be greater than others which means those sounds will be greater and less (constructive & destructive) in different places which means the sound will be different from how it was before.

N1

QUESTION THREE: THE DOPPLER EFFECT

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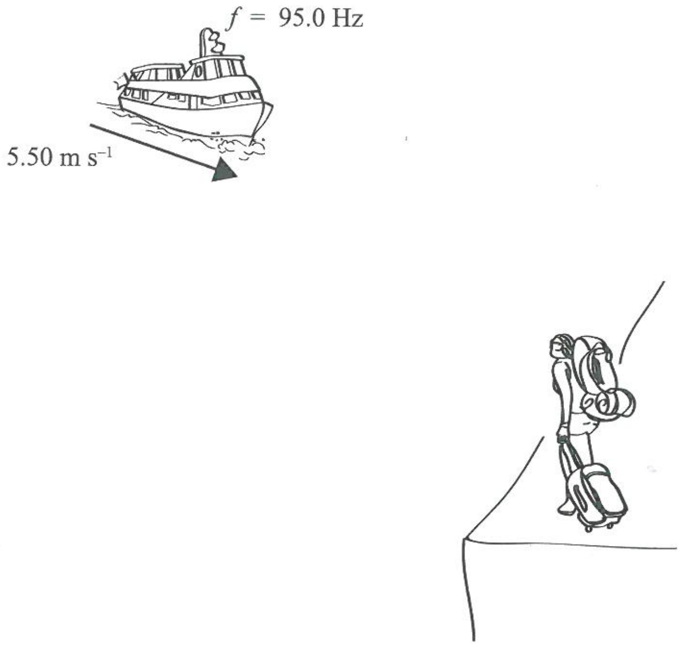
A tourist is watching a ferry boat coming towards her. The speed of the ferry is 5.50 m s^{-1}. The ferry sounds its horn, producing a note of frequency 95.0 Hz.

The speed of sound in the air over the water is 3.50 × 10^{2} m s^{-1}. (350 ms^{-1})



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

$$f' = f \frac{V_w}{V_w \pm V_s}$$

93.53

$f' =$ ~~[illegible] Hz~~

$$f' = 95 \times \frac{350}{350 + 5.5}$$

(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.

Because of the doppler effect. the sound comin towards the tourist ~~see~~ hears a slightly distorted version because the ferry boat is moving the speed is changed causing the waves to bunch up.

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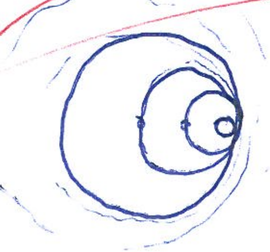
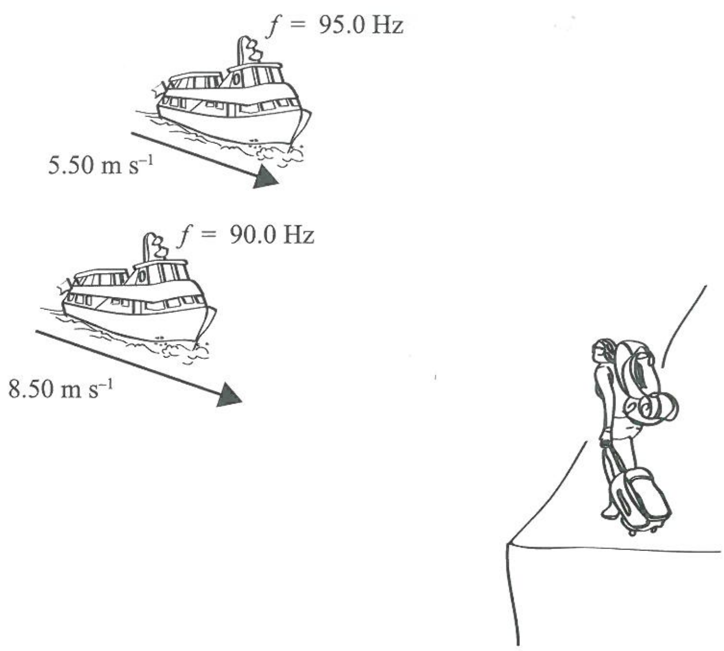


similair to this drawing how those in front will (decrease λ) hear a lower (f)



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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.

93.53.

$90 \times \frac{350}{350+8.5} = 87.86$

$= 5.66$ Hz

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

Beats are the difference in frequencies of 2 different frequencies (2 different sources of sounds) They resonate creating a beating sound which is how they're created.

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N2

Not Achieved exemplar for 91523 2014		Total score	05
Q	**Grade score**	**Annotation**	
1	N2	The answer to part (c) links length to wavelength and hence the frequency of the sound without saying whether longer pipes will produce longer or shorter standing waves, or higher or lower frequencies. In part (d), only the fundamental frequencies are found rather than the first overtone frequencies as required.	
2	N1	A supplied formula is has been used to find an approximate answer for the distance between the speakers. A more accurate method would have required finding the angle between antinodal lines and using $n\lambda = d\sin\theta$. The answers to parts (b) and (d) are too vague to convey understanding.	
3	N2	The frequency heard by an observer behind the boat is found, instead of an observer in front of the boat. The explanation for the Doppler effect correctly describes a decreased wavelength, but incorrectly attributes the changed wavelength to a speed change. The diagram shows some general understanding without being detailed enough to explain the situation described in the question. Beats are recognised as being due to waves having different frequencies, but does not link this to interference between the two waves, or describe oscillations in the amplitude heard by the tourist.	