NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Level 3 Physics, 2016

91523 Demonstrate understanding of wave systems

2.00 p.m. Tuesday 15 November 2016
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

ASSESSOR'S USE ONLY

QUESTION ONE: PAN FLUTES

Assume the speed of sound in air is 343 m s^{-1}.

A pan flute is a musical instrument made of a set of pipes that are closed at one end. Maria produces different frequency notes by blowing air across the top of different pipes.

Maria is producing the fundamental frequency (first harmonic) in one pipe.

(a) On the diagram below draw the standing wave Maria is producing in the pipe.

Label the displacement nodes and antinodes.

(b) Maria blows across one pipe and a fundamental frequency of 350 Hz is produced. A second pipe produces a fundamental frequency of 395 Hz.

Explain which pipe is longer.

Maria blows air across one of her pipes and it produces a third harmonic with a frequency of 762 Hz. At the same time, her friend Sophie blows air across a similar pipe and also produces a third harmonic. They both hear a sound of 764 Hz, which is the average of the two frequencies. The sound varies in loudness, at a frequency of 4.00 Hz.

(c)   State the name of this phenomenon, and explain how it causes Maria to hear a variation in loudness.

(d)   Calculate the length of Sophie's pipe.

QUESTION TWO: A RADIO CONTROLLED PLANE

Mike is flying his radio controlled plane. The plane flies towards him at constant speed, and then away from him with constant acceleration, as shown in the diagram below.

The plane is producing a constant frequency of 185 Hz.

Assume the speed of sound in air is 343 m s^{-1}.

X

Y

constant speed   *constant acceleration*
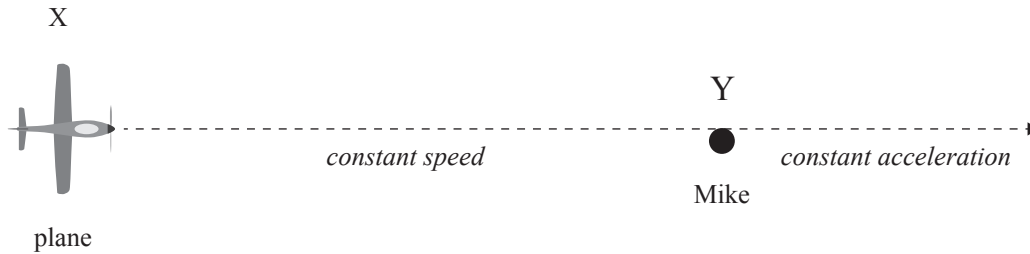
Mike

plane

(a)   Describe and explain the frequency of the sound Mike hears when the plane is at position X.

(b)   Describe the frequency of the sound Mike hears when the plane is at position Y.

(c) Describe and explain the frequency of the sound Mike hears as the plane gradually accelerates away from him.

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(d) Calculate the speed of the plane when the sound waves being produced behind it have a wavelength of 2.00 m.

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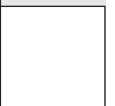
QUESTION THREE: DIFFRACTION GRATINGS

Moana is doing an experiment in the laboratory. She shines a laser beam at a double slit and observes an interference pattern on a screen. The diagram below shows the experiment. Moana measures the distance between adjacent bright spots (maxima) and finds they are 0.0100 m apart.

The slits are 1.28×10^{-4} m apart.

The screen is 2.10 m from the slits.
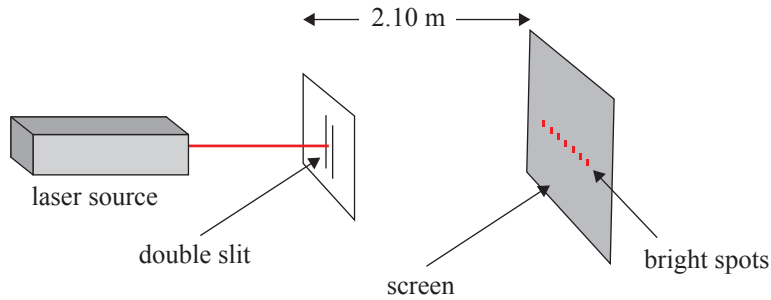
(a) Show that the wavelength of the laser light is 6.10×10^{-7} m.

Moana replaces the double slit with a diffraction grating in the same position. The diffraction grating has 500 lines per mm.

(b) Calculate the angle between the central antinodal line and the first antinodal line.

(c) Explain what would happen to the distance between the bright spots on the screen if the laser source is changed to one with a shorter wavelength.

(d)   Moana then shines white light through a diffraction grating. The pattern she sees is shown below.

Explain the pattern Moana observes.

Your explanation should include:

- why the centre of the pattern is white

- why there is a coloured spectrum on each side

- why there are dark regions between the white and coloured regions.

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