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90520

905200

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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 3 Physics, 2009

90520 Demonstrate understanding of wave systems

Credits: Four
9.30 am Tuesday 24 November 2009

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 answer ALL the questions in this booklet.

For each numerical answer, full working must be shown. The answer should be given with an SI unit to an appropriate number of significant figures.

For each 'describe' or 'explain' question, the answer should be written or drawn clearly with all logic fully explained.

Formulae you may find useful are given on page 2.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

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.

For Assessor's use only	**Achievement Criteria**	
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Identify or describe aspects of phenomena, concepts or principles.	Give descriptions or explanations in terms of phenomena, concepts, principles and / or relationships.	Give explanations that show clear understanding in terms of phenomena, concepts, principles and/or relationships.
Solve straightforward problems.	Solve problems.	Solve complex problems.
Overall Level of Performance (all criteria within a column are met)		

You are advised to spend 35 minutes answering the questions in this booklet.

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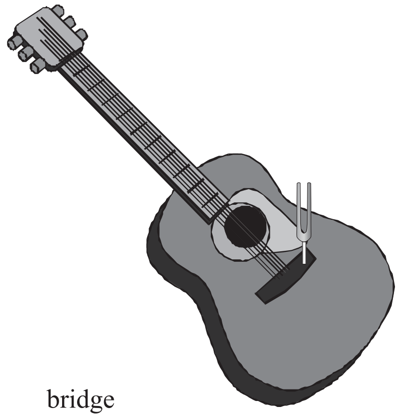
You may find the following formulae useful.

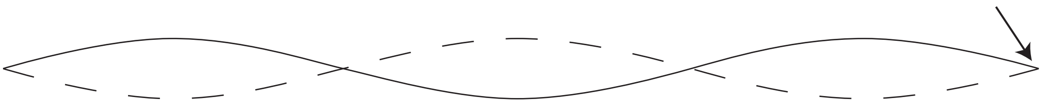
$$d\sin\theta = n\lambda \qquad n\lambda = \frac{dx}{L} \qquad f' = f\frac{v_W}{v_W \pm v_S} \qquad v = f\lambda \qquad f = \frac{1}{T}$$

QUESTION ONE: STRINGS AND STANDING WAVES



Sarah has a six-stringed guitar. Each string is tuned to a different pitch. She finds that when she places a tuning fork of frequency 512 Hz on the bridge of her guitar, ONE of the strings starts to make a sound at the **same** frequency as the tuning fork. She looks at the string very carefully and sees that it is oscillating with THREE antinodes, as shown in the diagram.

Diagram is NOT to scale



(a) Show that the natural fundamental frequency of the string is 171 Hz.

(b) Explain why energy from the tuning fork appears to be transferred only to this string.

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(c) The string has a length (between the two fixed ends) of 0.635 m.

Calculate the velocity of the travelling wave in the string.

velocity = ____________

(d) The thickness and tension in two other strings (numbers 2 and 3) are such that a travelling wave in string 3 moves 1.005 times faster than the wave in string 2 (so that $\frac{v_3}{v_2} = 1.005$).

Both strings are the same length. When they are plucked, they both vibrate in their fundamental mode. The two sounds cause beats at a frequency of 1.2 Hz.

Calculate the fundamental frequency of string 2.

frequency = ____________

QUESTION TWO: DOPPLER DUCK

A teacher wants to make a video that demonstrates the Doppler effect. He uses a rubber duck to make circular ripples on a pond of still water. The teacher moves the duck up and down. Circular ripples spread out on the pond, as shown in the images below from two video clips.

(a) Explain why the ripples are circular.

(b) In the right-hand image above, the teacher was moving the duck with a horizontal velocity in addition to its vertical oscillation.

(i) Draw an arrow on the image below to show the direction of the duck's horizontal velocity.

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(ii) Explain how you can deduce the horizontal motion of the duck from the pattern of ripples.

(c) Careful analysis of the second video clip shows that the ripples are travelling at 0.400 m s^{-1}, the teacher's hand moves up and down 19 times over 5.00 s, and the wavelength of the ripples behind the duck is 0.135 m.

Use the information given to calculate:

(i) The frequency at which the ripples move a small twig floating directly behind the duck.

frequency = ______________

(ii) The horizontal speed of the duck.

speed = ______________

QUESTION THREE: INTERFERENCE OF SOUND WAVES

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

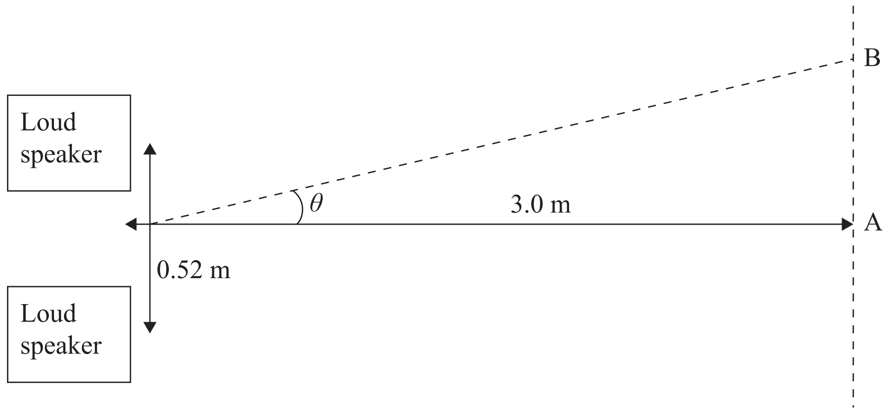
A teacher demonstrates interference of waves by connecting two speakers to a signal generator. The signal generator produces a single frequency. The instructions recommend that this demonstration is set up outdoors.

For copyright reasons, this resource cannot be reproduced here.

http://www.practicalphysics.org/imageLibrary/jpeg400/123.jpg

(a) Explain why the students hear regular quiet spots as they walk slowly in front of the loudspeakers (as shown in the diagram) and why the demonstration is not so effective in a typical classroom.

Two microphones are used to detect the loudness of the sound and to identify nodes and antinodes. Microphone A is placed on the central **antinode** and microphone B is placed on an adjacent **node**. The loudspeakers are 0.52 m apart. The microphones are placed 3.0 m from the loudspeakers and the frequency is set to 1.30 kHz.



(b) Calculate:

(i) The wavelength of the sound waves.

wavelength = ____________________

(ii) The angular separation, θ, between microphones A and B.

angular separation = ____________________

Extra paper for continuation of answers if required.
Clearly number the question.

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