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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

For Supervisor's use only

Level 3 Physics, 2007

90520 Demonstrate understanding of wave systems

Credits: Four
9.30 am Friday 30 November 2007

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 all numerical answers, full working must be shown, and the answer must be rounded to the correct number of significant figures and given with an SI unit.

For all 'describe' or 'explain' questions, the answers 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 2–9 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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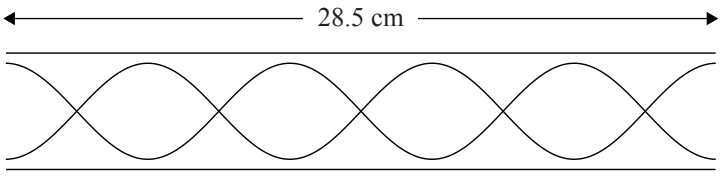
You may find the following formulae useful.

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

QUESTION ONE: STANDING WAVES

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

Carlie plays the recorder. The recorder can be modelled as an open pipe. On one occasion, the note Carlie plays has the following standing wave pattern for one of its overtones (harmonics). The length of the pipe when she plays this note is 28.5 cm.



(a) Calculate the wavelength of the standing wave shown in the diagram.

wavelength = _____

(b) Which harmonic (or overtone) is shown in the diagram above?

_____ harmonic OR _____ overtone

(c) By first calculating the wavelength that the fundamental standing wave would have in this length of pipe (or otherwise), calculate the frequency of the fundamental standing wave.

frequency = _____

(d) Explain how the fundamental standing wave is produced in this pipe.

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Opening or closing holes along the length of the pipe can produce different frequency notes. Carlie first plays a note with all holes closed. She then opens the last hole.

(e) Explain how the frequency of the note produced will change.

QUESTION TWO: THE DOPPLER EFFECT

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

Carlie plays her recorder on a float in a local parade. Carlie's friend Edward is in the crowd listening to Carlie play. At one point in the performance, Carlie plays the **same** note for several seconds.

(a) Explain why, as the float travels towards Edward at a constant speed, the pitch of the note **heard** by Carlie is different to the pitch of the note **heard** by Edward.

When the float is traveling at 1.2 m s^{-1}, the **apparent** frequency of the note that Edward hears is 673 Hz.

(b) Re-arrange an appropriate formula to find an expression for the true frequency of the source, and use this re-arranged formula to calculate the frequency of the note Carlie plays.

frequency = _____

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(c) Even though there is only a small difference in these two frequencies, explain why neither Carlie nor Edward hear **beats** in this situation.

Fale is further down the street and hears a different part of the performance. As the float passes Fale, the apparent wavelength of a note he hears when the float is moving towards him changes to a different apparent wavelength when the float is moving away from him. The **difference** in the apparent wavelengths ($\lambda'_{\text{moving towards}}$ and $\lambda'_{\text{moving away}}$) of the note he hears is 0.0032 m.

The apparent wavelength, λ', in the Doppler effect can be calculated from:

$$\lambda' = \lambda\left(\frac{v_w \pm v_s}{v_w}\right)$$

(d) If the speed of the float is still 1.2 m s^{-1} as it passes Fale, calculate the frequency of the note emitted by the recorder.

frequency = _____

QUESTION THREE: DIFFRACTION GRATING

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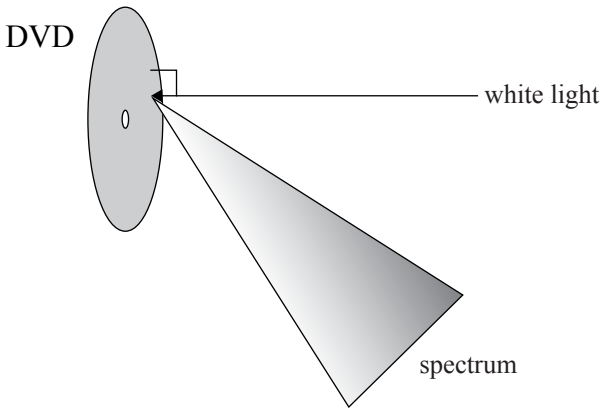
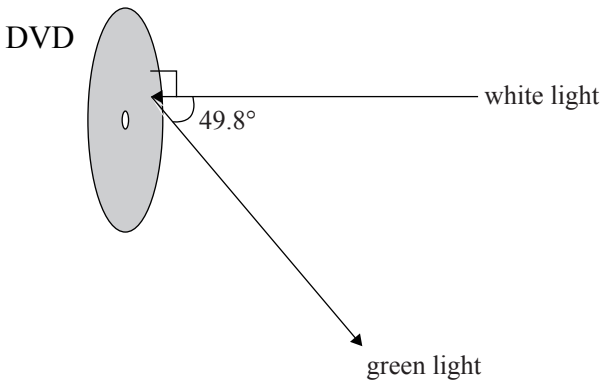
The band Carlie plays in has produced a DVD of its performances. When looking at the DVD, Carlie sees a spectrum "reflected" from the surface of the DVD. The diagram below shows a first order spectrum being produced when white light is shone on to the DVD perpendicular to its surface.
The DVD can be modelled as a diffraction grating. On a DVD, lines are drawn on the surface. The distance between the lines is called the track spacing. The track spacing on the DVD is equivalent to the slit spacing of a diffraction grating.



(a) Which colour light is seen "reflected" at the **smallest** angle in the spectrum?

The **smallest** angle at which green light is seen is 49.8°. Green light has a wavelength of 5.65×10^{-7} m.



(b) (i) Show that the spacing of the tracks on the DVD has an unrounded value of 7.3973×10^{-7} m.

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(ii) Round this answer to the correct number of significant figures.

track spacing = _____

A CD produces spectra in the same way that a DVD produces spectra. The track spacing on a DVD is **less** than that on a CD.

(c) The angle at which violet light (wavelength 438×10^{-9} m) forms its first bright fringe when "reflected" from a CD is 20.4° **less** than the angle of the first bright fringe of violet light "reflected" from a DVD.

Calculate the track spacing on a CD.

track spacing = _____

Note that Question Three continues on the next page.

(d) More spectra are produced using a CD than a DVD.

Explain why. (Calculations are not required.)

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

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