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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

For Supervisor's use only

Level 1 Physics, 2009

90182 Demonstrate understanding of wave and light behaviour

Credits: Five
2.00 pm Thursday 26 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 all numerical answers, full working must be shown. The answer should be given with an SI unit.

For all 'describe' or 'explain' questions, the answer should be in complete sentences.

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 2–10 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 50 minutes answering the questions in this booklet.

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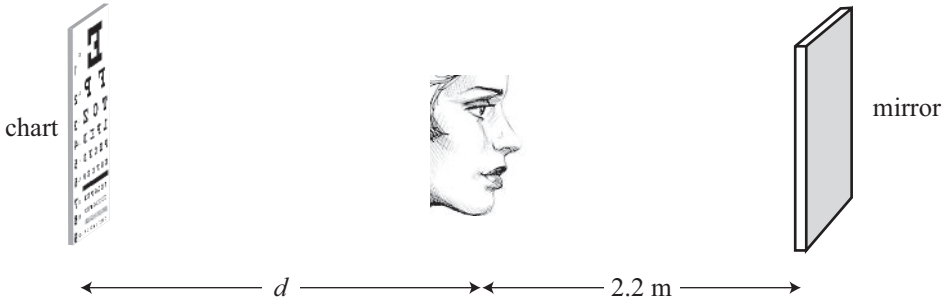
You may find the following formulae useful.

$$v = \frac{d}{t} \qquad v = f\lambda \qquad f = \frac{1}{T} \qquad \frac{n_1}{n_2} = \frac{v_2}{v_1}$$

QUESTION ONE: REFLECTION

The diagram shows Toni having her eyes tested in an eye clinic. A chart with letters on is placed behind her, and she sees the image of it in a plane mirror in front of her.



Toni is 2.2 m in front of the mirror. The image of the chart is 3.8 m behind the mirror.

(a) Calculate the distance (d) from the chart to Toni.

distance = _____

(b) Toni sees the image of the letters 'LPED' in the mirror.

In the box below, draw how these letters are written on the board behind her, and explain why they are written that way.

Letters on the board:

Explanation: _____

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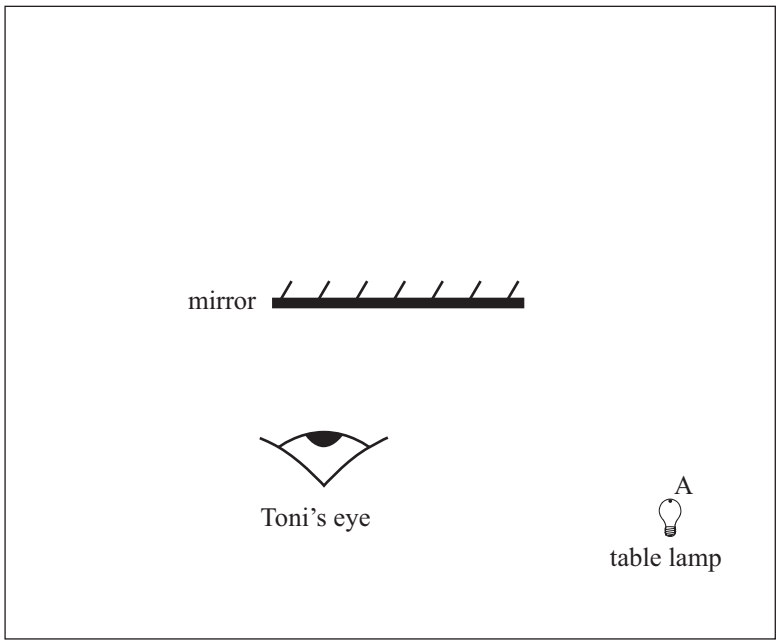
(c) Toni also sees the image of a table lamp in the mirror. The table lamp is behind her in the corner of the room, as shown in the diagram below.



On the diagram above, draw the position of the image. Also draw accurately two rays of light from the point A on the bulb to show how Toni's eye sees the image.

(d) As Toni leaves the eye clinic, the period of the sound produced by the door bell is 0.0032 s. The speed of sound in air is 340 m s^{-1}.

Calculate the wavelength of the sound waves in air produced by the door bell.

wavelength = _____

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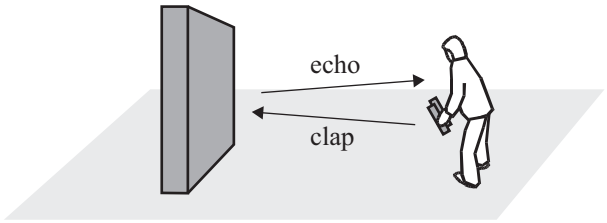
Bruce stands close to and facing a wall, holding a small piece of wood in each hand.



He now slowly moves away from the wall, while continuously clapping the pieces of wood **two times per second**. Bruce hears clap-echo-clap-echo while moving away from the wall. He stops moving when the sound of the clap and the echo from the wall are heard at the same time.

(e) Calculate how far Bruce is from the wall when the sound of clapping coincides with the echo. The speed of sound in air is 340 m s^{-1}.

distance = _____

QUESTION TWO: LIGHT INTERACTIONS

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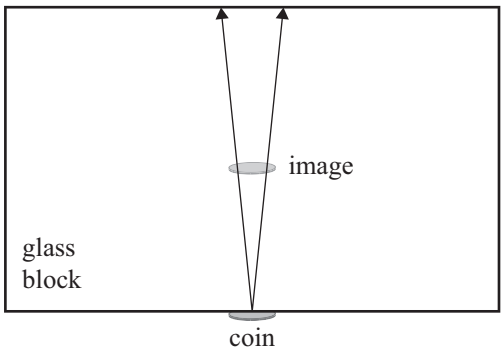
A rectangular glass block is placed on top of a coin. When viewed from above, the image of the coin is above the actual coin, as shown in the diagram below.



(a) Name the phenomenon that causes the image of the coin to appear above the coin.

_____

(b) The diagram above shows two light rays from the coin arriving at the top surface of the glass block.

Complete the rays to show how the eye sees the image of the coin.

The coin is 6.7 cm from the top of the glass block. The image formed is 4.2 cm from the top of the glass block. The speed of light in air is 3.0×10^8 m s^{-1} and refractive index of air is 1.0. The refractive index of the glass is given by the following equation.

$$\text{refractive index of glass} = \frac{\text{depth of the coin}}{\text{depth of the image}}$$

(c) Calculate the speed of light in the glass block.

_____

_____

_____

_____

_____

_____

speed of light = _____

A small torch is shone into the bottom of a glass block. The diagram shows the path of three rays from the torch.

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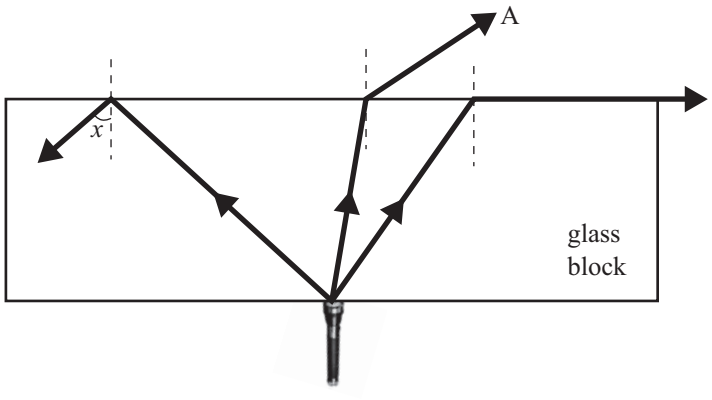

(d) On the above diagram, use the letter '**c**' to label the critical angle for the glass-air boundary.

(e) The critical angle for the glass–air boundary is 38.4°.

State what this tells you about the size of **angle *x*** in the diagram above.

(f) Explain, giving reasons, why the **ray A** bends the way it does at the glass–air boundary.

QUESTION THREE: WAVE BEHAVIOUR

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The dots below represent particles in a medium, through which waves are travelling in the direction shown by the arrow.

(a) Describe the motion of the particles when the wave travelling is (i), a transverse wave, and (ii), a longitudinal wave:

(i) transverse wave: _____

_____

_____

_____

(ii) longitudinal wave: _____

_____

_____

_____

(b) The grid below represents 1.0 cm squares.

On this grid, draw a diagram of a transverse wave of wavelength 16.0 cm and amplitude 3.0 cm.

(c) Calculate the speed of the wave you have drawn, if its period is 0.80 s.

_____

_____

_____

speed = _____

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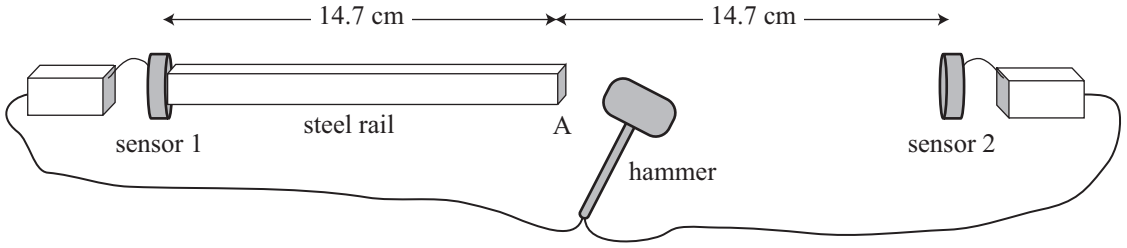
The following diagram shows two sound sensors. One is placed at the end of a long steel rail, and the other is placed in air. Both sensors are 14.7 cm from the end A of the steel rail. Each sensor is connected to an electronic timing device. Both timing devices start when the hammer hits the rail, and stop when the sensors receive the first wave.



(d) When the hammer strikes the rail, each sensor receives the first wave at different times.

Explain, giving reasons, why this happens.

(e) The speed of the waves in the rail is 3500 m s^{-1}. The time taken for a wave to travel along the rail is 0.0042 s.

Show that the length of the rail is 14.7 cm.
(You must show the appropriate formula and the correct working.)

(f) When the hammer strikes the rail, a wave reaches sensor 1 in 0.0042 s, and sensor 2 receives a wave **0.040 s later**. The wavelength of the sound waves in air is 0.35 m.

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Calculate the frequency of the sound produced in air when the hammer hits the rail.

frequency = _____

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

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Question number	

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