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90182

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 1 Physics, 2004

90182 Demonstrate understanding of wave and light behaviour

Credits: Five
9.30 am Thursday 18 November 2004

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 pages 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.

Achievement Criteria *For Assessor's use only*		
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 concise 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 40 minutes answering the questions in this booklet.

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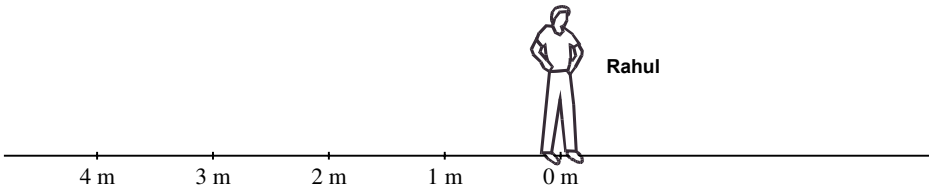
You may find the following formulae useful.

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

QUESTION ONE: REHEARSING THE SCHOOL PLAY

Rahul was rehearsing his part in the school play on the stage. The stage light in front of him casts his shadow on the floor behind him.

stage light



(a) On the diagram above, draw in the light rays to find the **length** of his shadow on the floor.

Length = _____

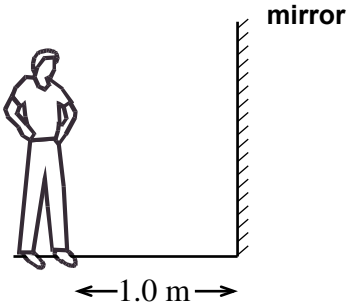
(b) The formation of shadows can be explained using a certain property of light. State this property of light.

_____

_____

_____

Rahul now stands in front of a mirror to check out his costume.
His distance from the mirror is **1.0** metre as shown in the diagram.



(c) What is the distance between Rahul and his image?

Distance = _____

(d) Rahul's image in the mirror is **laterally inverted.**
Describe what 'laterally inverted' means.

_____

_____

_____

A beam of light from the spotlight falls at the point P on the mirror, at an angle of **35°** to the mirror as shown in the diagram below.

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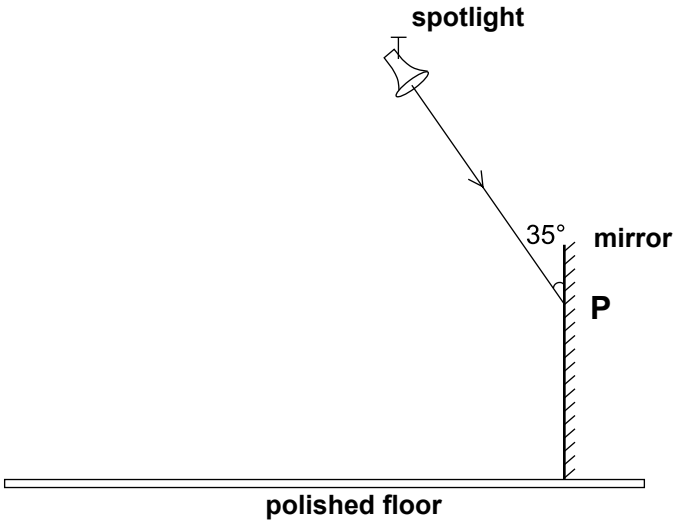

(e) Calculate the **angle of incidence** at the point P.

Angle of incidence = _____

(f) After reflection at the point P, the beam of light travels towards the polished floor and reflects off it as if the floor is a mirror.

(i) Complete the diagram to show the **path** of the beam of light.

(ii) Use your diagram to calculate the **angle of reflection** at the point where the beam of light reflects off the floor.

Angle of reflection = _____

QUESTION TWO: GOING HOME

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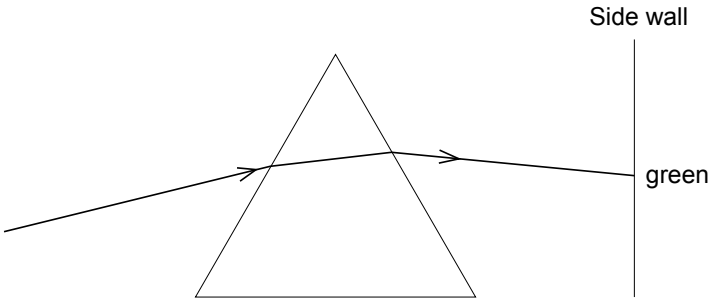
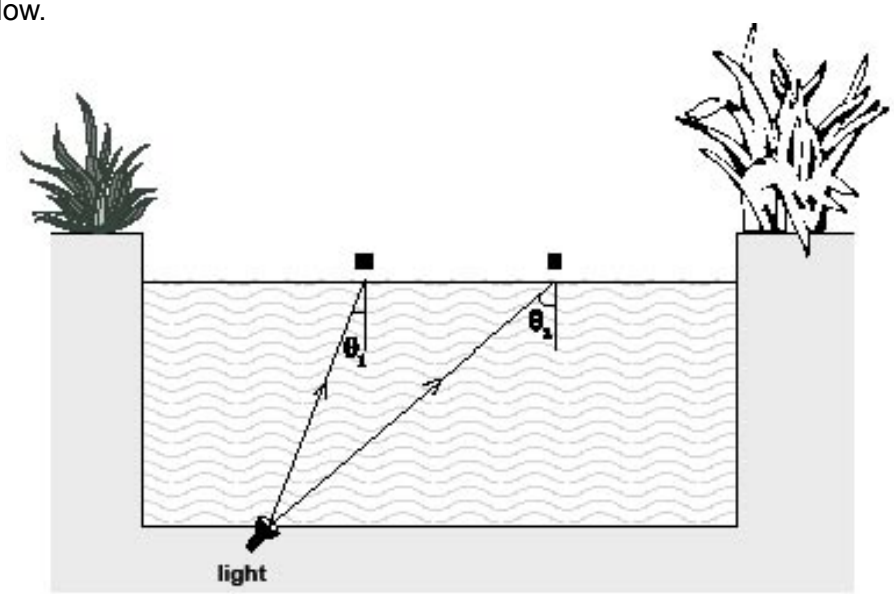
After the rehearsal, Rahul gets a ride with Samantha. In Samantha's car there is a large triangular glass prism on the dashboard. The sunlight is incident on the glass prism in such a way that it produces a spectrum of colours on the side wall. The diagram shows the path of the green ray through the prism to the side wall.



(a) Draw and label the paths of the **yellow** and **violet** rays through the prism to the side wall of the car.

(b) Explain why different colours refract by differing amounts in the prism.

When Rahul gets home it is dark. He turns on the light at the bottom of the small pool in the garden. Light rays from the bulb reach different places on the surface of the water, as shown in the diagram below.



Angle θ_1 is **less** than the critical angle of light in water and angle θ_2 is **greater** than the critical angle of light in water.

(c) (i) On the above diagram, **complete** the path of the light ray that arrives at A.

(ii) On the above diagram, **accurately complete** the path of the light ray that arrives at B.

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(d) Explain why the light ray bends the way it does at A.

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_____

_____

For safety reasons, the light bulb at the bottom of the pool is placed under a thick piece of glass. The light from the bulb travels through the glass to the water.

The refractive index of water is **1.3**.
The speed of light in water is $\mathbf{2.3 \times 10^8\ ms^{-1}}$.
The refractive index of glass is **1.6**.

(e) Use the above data to calculate the **speed** of light in the glass.

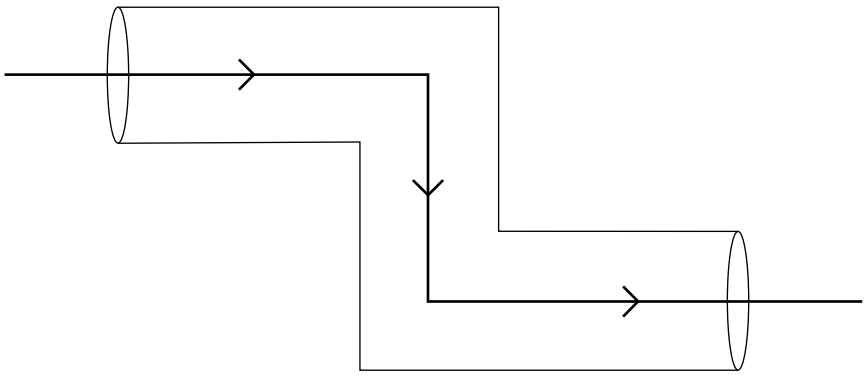
_____

_____

_____

Speed of light in glass = _____

(f) Rahul uses a pair of binoculars to view the moon. Prisms are commonly used in binoculars to change the direction of light. **Complete** the diagram below by correctly drawing two triangular **prisms** to show how the light ray can follow the path as shown.



QUESTION THREE: BACK TO SCHOOL

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At school, Rahul's physics teacher sets up an experiment to demonstrate sound waves in air. A loudspeaker and a microphone are set up facing each other a few metres apart. The loudspeaker is connected to a sound generator whose frequencies can be changed. The diagram below shows the experimental set up.

(a) The loudspeaker cone vibrates at a frequency of **0.050 kHz**. Calculate the period of the vibrations. Give the correct unit with your answer.

Period = _____ _____ (unit)

(b) Sound waves are longitudinal waves. On the diagram above, draw a wave **pattern** to represent the **longitudinal waves** produced in air between the loudspeaker and the microphone.

(c) Explain how the vibrations of the cone of the loud speaker **produce** sound waves in the air and how these waves are **transmitted** through the air.

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The distance between the loudspeaker cone and the microphone is adjusted to **2.55 m**. When the loudspeaker cone vibrates at a frequency of **2000 Hz** there are exactly **15** complete waves in the air between the loudspeaker cone and the microphone.

(d) Show that, as sound travels in the air between the loudspeaker and the microphone, its speed is 340 ms^{-1}.

The teacher now changes the frequency of the generator. The distance between the loudspeaker and the microphone is also changed so that **10** complete waves are set up between the loudspeaker and the microphone. It takes **0.010** second for a wave to travel from the loudspeaker cone to the microphone.

(e) Calculate the **wavelength of the sound wave** between the loudspeaker and the microphone.

Wavelength = _____

(f) Measurements of the speed of sound have shown that sound travels faster in water than in air. Explain why the speed of sound is faster in water than in air.

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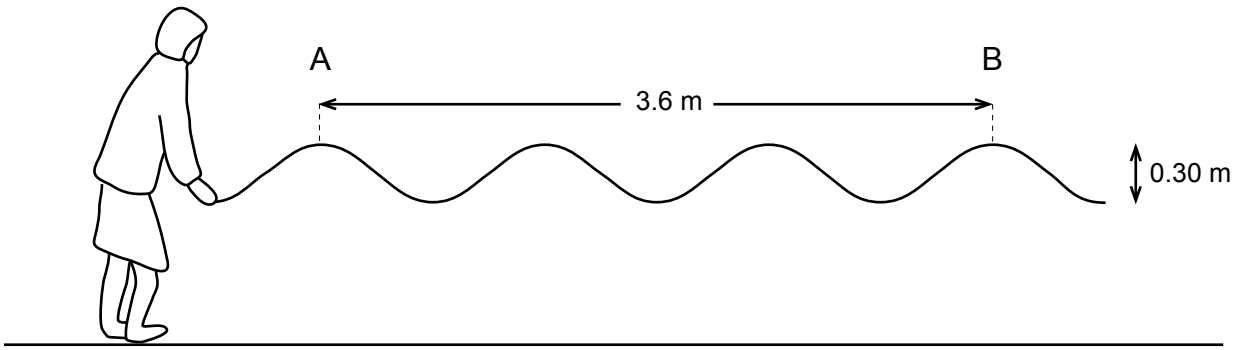
The physics teacher now sets up a transverse wave on a long elastic cord by moving her hand up and down, as shown in the diagram below.



(g) Give an **example** of a transverse wave in nature.

_____

The teacher's hand makes one complete up and down movement in **0.40 seconds**. Her hand moves through a vertical height of **0.30 m**. The distance AB is **3.6 m**.

(h) Calculate the **amplitude** of the wave.

_____

Amplitude = _____

(i) Determine the **wavelength** of a wave.

_____

_____

Wavelength = _____

(j) Calculate the **speed** of the wave in the elastic chord.

_____

_____

_____

_____

_____

Speed = _____

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

Assessor's use only

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