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NZQA

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MANA TOHU MĀTAURANGA O AOTEAROA

For Supervisor's use only

Level 1 Physics, 2008

90182 Demonstrate understanding of wave and light behaviour

Credits: Five
9.30 am Tuesday 25 November 2008

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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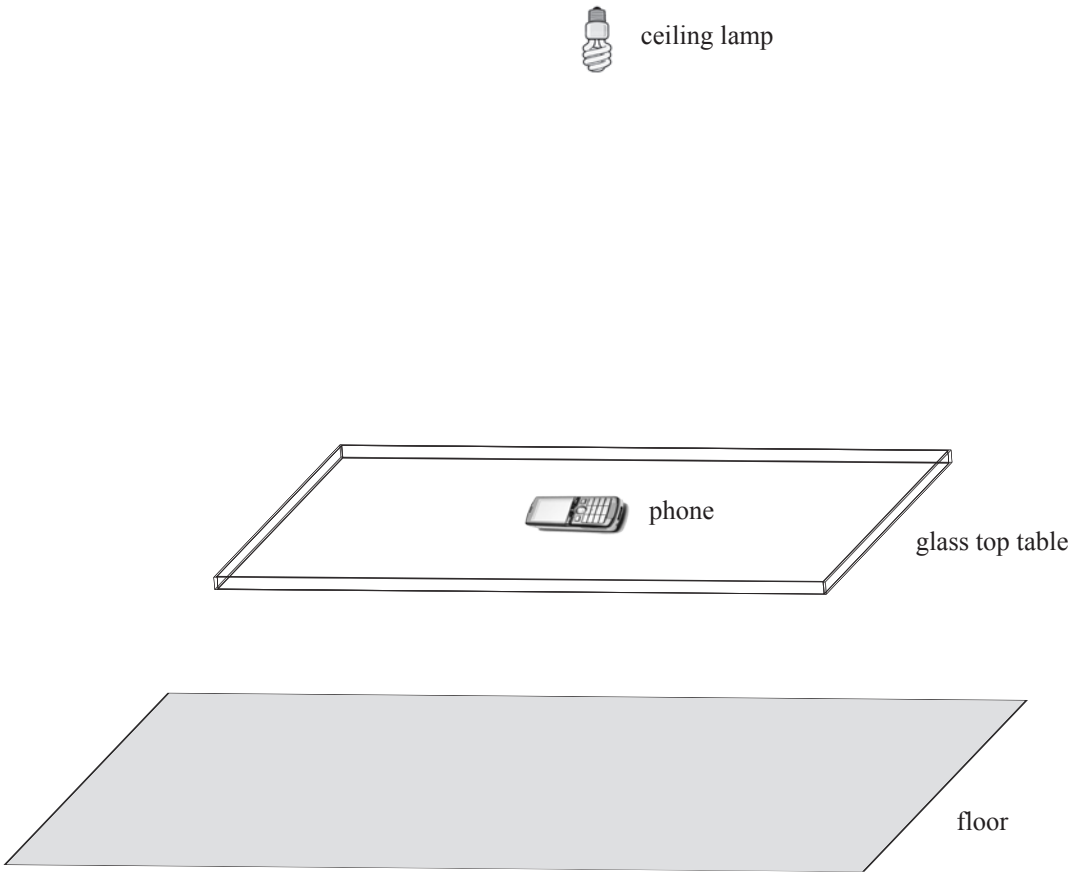
You may find the following formulae useful.

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

QUESTION ONE: COMMUNICATION TECHNOLOGY

Jordan leaves his cellphone on a table which has a clear glass top. The light from the ceiling lamp above the table casts a shadow of the cellphone on the floor.



(a) On the above diagram, draw **rays** to show how the light from the ceiling lamp casts a shadow of the cellphone on the floor, and draw in the **shadow** of the cellphone.

(b) Explain why the lamp produces a shadow of the cellphone on the floor.

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(c) Jordan's cellphone rings and the frequency of the ring tone is **1.75 kHz**.

Calculate the period of the ring tone.

period _____

(d) The speed of sound in air is **330 m s^{-1}**.

Calculate the wavelength in air of the sound waves produced by Jordan's cellphone.

wavelength _____

(e) Explain how the speaker in the cellphone produces sound waves in the air and how these waves travel to Jordan's ear.

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Jordan's cellphone uses a network employing light transmission through fibre optic cables.

A silica glass optic fibre is used to transmit Jordan's phone call between two points. The refractive index of the silica glass optic fibre is **1.55**. The speed of light in a vacuum is $\mathbf{3.00 \times 10^8\ m\ s^{-1}}$. The distance travelled by the light through the optic fibre is **100 km**.

$$\text{Refractive index of light in a medium} = \frac{\text{Speed of light in a vacuum}}{\text{Speed of light in the medium}}$$

(f) Calculate the time taken by the light to travel the distance of **100 km** through the optic fibre.

time _____

QUESTION TWO: WAVE MOTION

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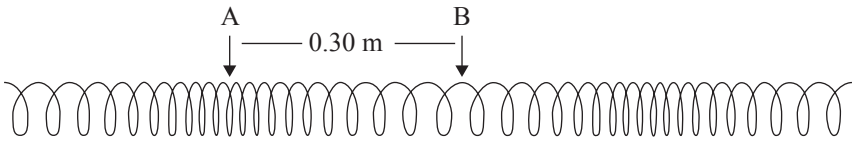
One end of a stretched slinky is moved back and forth to create a wave. The diagram below shows a wave travelling through a stretched slinky. The point A is in the middle of a compression and the point B is in the middle of a rarefaction. The distance AB is **0.30 m**. The frequency of the wave through the slinky is **2.5 Hz**.

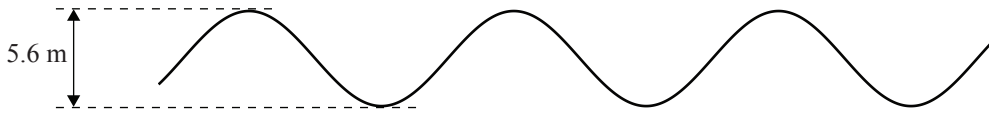


(a) Calculate the speed of the wave through the slinky.

speed _____

(b) State how the wave in the above slinky is **similar** to a sound wave.

The diagram below is a sketch of a wave in the sea during a storm.



(c) Calculate the amplitude of the wave.

amplitude _____

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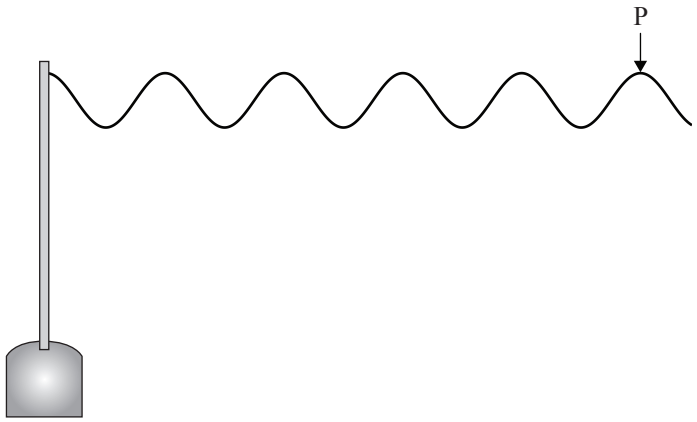
(d) Waves in the sea are transverse waves.

State what is meant by a "transverse wave".

(e) The diagram below is a sketch of a radio wave travelling through the air from the transmitter aerial of a radio station. A crest leaves the aerial and travels a distance of **4.50 km**, arriving **1.5×10^{-5} s** later at the point P.



Use the above data and the information given in the diagram to calculate the frequency of the wave in **kilohertz**.

frequency _____

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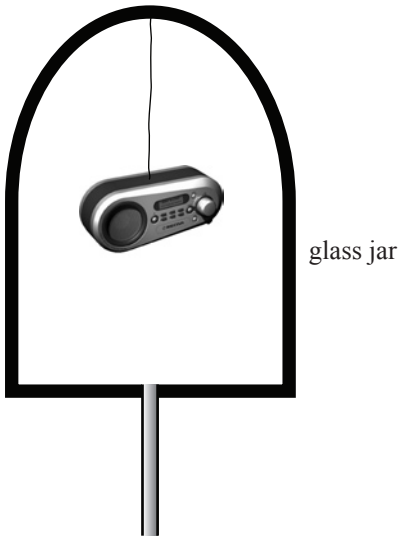
(f) A radio is turned on and then hung inside an airtight glass jar as shown in the diagram below. The jar is then connected to a vacuum pump. The pump is started and the air is **slowly** removed from the glass jar.



Describe what happens and explain why.

Description _____

_____

_____

_____

Explanation _____

_____

_____

_____

_____

_____

_____

QUESTION THREE: REFRACTOMETER

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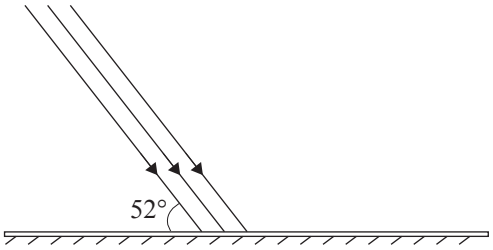
A refractometer is an optical instrument used in fruit industries to determine the refractive index of fruit juices. The refractive index of the fruit juice is related to the amount of sugar in it.
A drop of fruit juice is placed on the glass window of the refractometer. Light travels from the air through the fruit juice. It then travels through the glass window of the refractometer and falls on a mirror below it. The mirror reflects the beam to change its direction of travel.

The diagram below shows the beam of light, which is incident on the mirror in the refractometer.



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http://www.arssales.com/equine/assets/images/refractometer0202.jpg

(a) Complete the diagram above to show how the beam leaves the mirror.

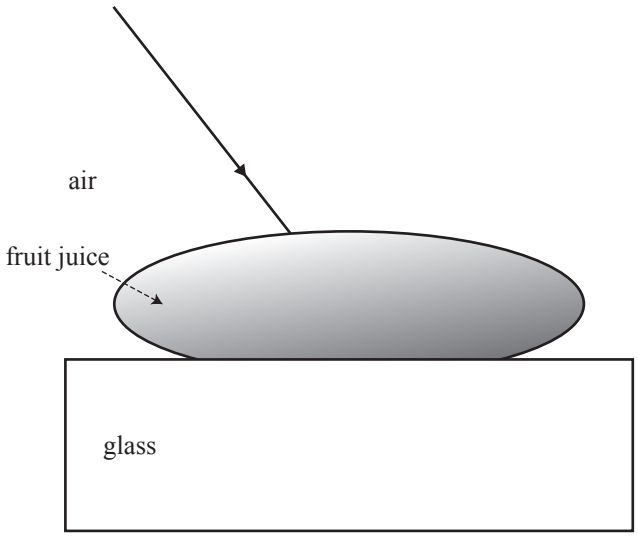
(b) The angle between the incident ray and the mirror is 52°.

Calculate the **angle of reflection** of the ray.

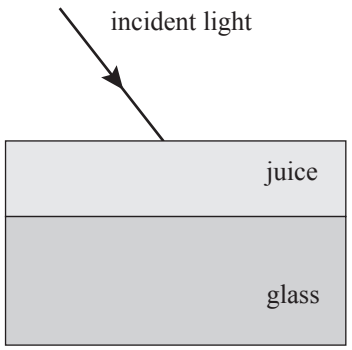
angle _____

(c) Complete the following diagram to show the path of a ray as it travels from the air through the fruit juice into the glass window of the refractometer.

Refractive index of fruit juice = 1.43
Refractive index of glass = 1.54
Refractive index of air = 1.00



(d) Light travels from the air through the fruit juice and through the glass window of the refractometer.



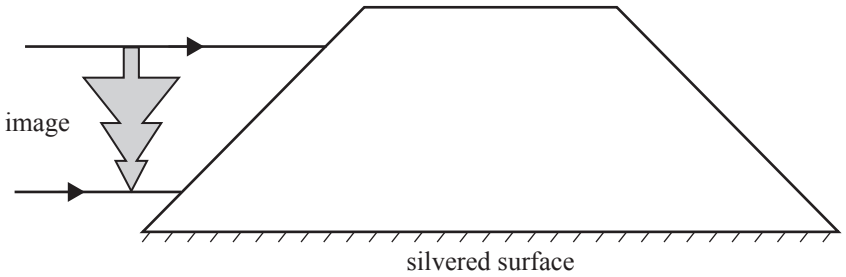
Use the following data to calculate the speed of light in the glass window.

Refractive index of air = 1.00
Speed of light in air = 3.00×10^8 m s^{-1}
Refractive index of fruit juice = 1.43
Refractive index of glass = 1.54

speed of light _____

(e) Prisms are used in optical instruments to invert images. The diagram below shows two rays from an upside down image of a tree striking one side of the prism. The base of the prism is silvered like the back of a mirror to cause reflection.

Complete the path of the rays **accurately** to show how the image of the tree is inverted by the prism.



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

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Question number