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NZQA

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MANA TOHU MĀTAURANGA O AOTEAROA

For Supervisor's use only

Level 2 Physics, 2009

90254 Demonstrate understanding of waves

Credits: Four
2.00 pm Tuesday 17 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 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.

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \qquad \text{or} \qquad s_i s_o = f^2$$

$$m = \frac{d_i}{d_o} = \frac{h_i}{h_o} \qquad \text{or} \qquad m = \frac{f}{s_o} = \frac{s_i}{f}$$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad \frac{n_1}{n_2} = \frac{v_2}{v_1} = \frac{\lambda_2}{\lambda_1}$$

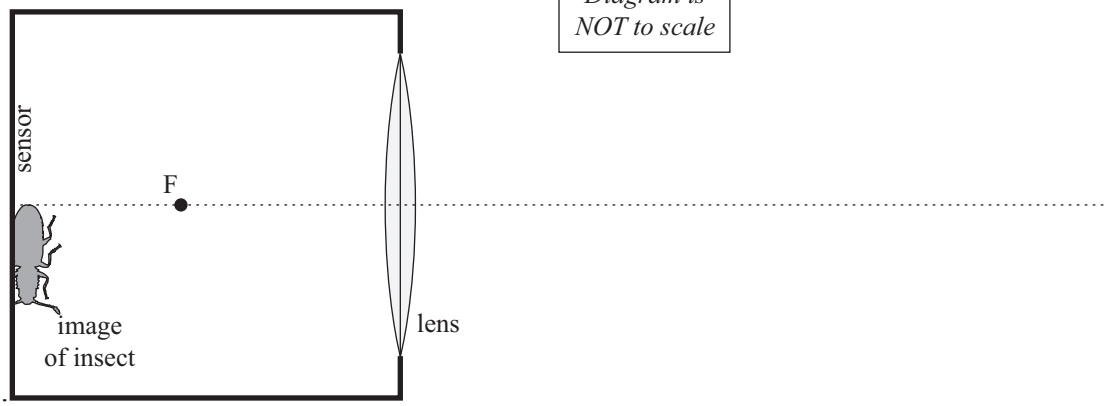
$$v = f\lambda \qquad f = \frac{1}{T} \qquad v = \frac{d}{t}$$

Speed of light in a vacuum = 3.00×10^8 m s $^{-1}$

QUESTION ONE: LENSES

Bianca is trying out her new digital camera. She knows that the camera is basically a box with a lens at the front and a sensor at the back. The camera lens has a focal length of 100 mm.
She takes a picture of an insect which is 12 mm from head to tail.
The image of the insect is formed at the back of the camera, and is shown in the diagram below.

Diagram is NOT to scale



(a) On the diagram above, draw two rays to locate the position of the insect. Show the insect on your diagram.

(b) The magnification is 0.33.

Calculate the size of the insect's image.

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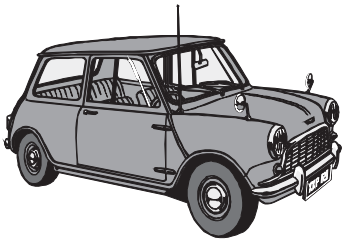
(c) Explain what change must be made to the **distance** from the **sensor** to the **lens** if the lens was made with glass with a **higher** refractive index.

Bianca is driving to the boat harbour in her car. She looks in the rear-view mirror and notices that the image of a man standing behind her looks smaller than it does in a plane mirror.
The focal length of her rear-view mirror is 40 cm.



(d) Name the type of mirror she is looking at.

(e) The man is 1.8 m tall, and he is 11 m away from the mirror.

Calculate the height of his image. (The focal length of the mirror is 40 cm.)

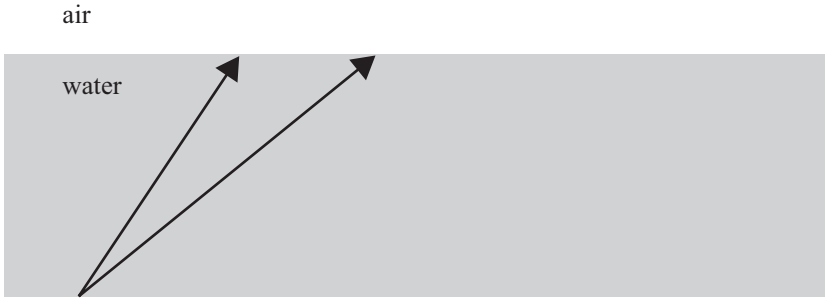
QUESTION TWO: REFRACTION

Assessor's use only

When Bianca is sailing her boat out of the harbour, she notices that the apparent depth of the water is different from the real depth.

The two arrows indicate two rays of light travelling from the bottom of the harbour towards the surface of the water.

If you need to redraw your solution to Question Two (a), use the diagram on page 9.



(a) Complete the diagram above to show where the bottom of the harbour **appears** to be. Use your diagram to explain why Bianca observes that the harbour depth appears to be different from what it really is.

(b) State what happens to the **frequency and speed** of the light as it leaves the water.

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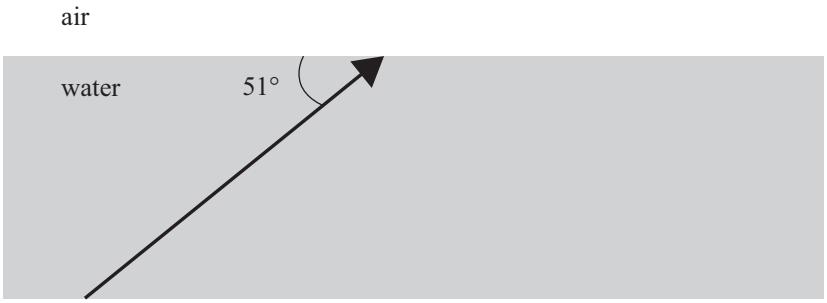
(c) One light ray is incident on the water / air interface as shown.

The refractive index of water is 1.33.
The refractive index of air is 1.00.

Calculate the angle of refraction.

Give your answer to the correct number of significant figures.



(d) Use the relationship $n_1 \sin\theta_1 = n_2 \sin\theta_2$ to derive the formula for the **critical angle** at an interface.

Use the formula to show whether a ray that is incident on the water / air interface at an angle of incidence of 50° would be refracted into the air.

QUESTION THREE: WAVES

Assessor's use only

Bianca notices that there is a shallow triangular reef near her boat. There is deep water all around the reef.

The water waves travel at a speed of 1.6 m s^{-1} in deep water, and 1.2 m s^{-1} in shallow water.

The waves have a wavelength of 45 cm in deep water.

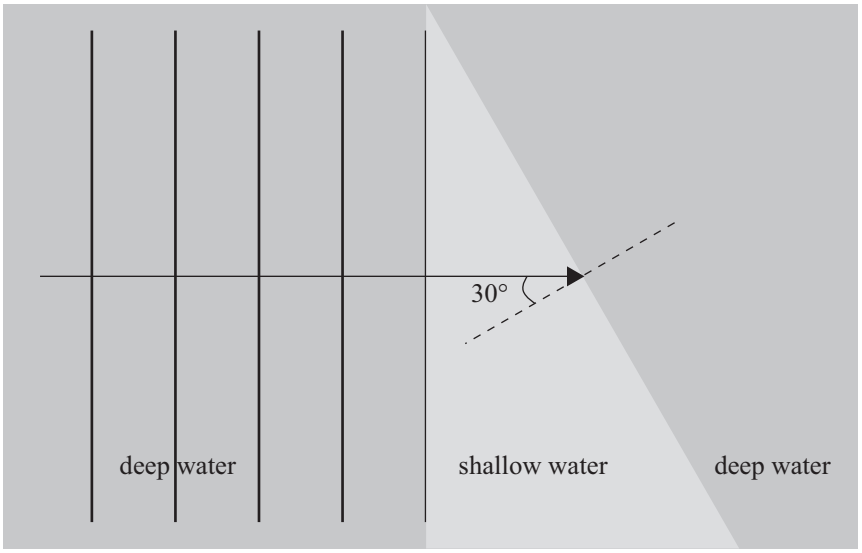


Diagram is NOT to scale

(a) Show that the **wavelength** of the waves in **shallow water** is 34 cm.

(b) Calculate the time it takes for one complete wave to move onto the reef.

(c) On the diagram above, show what happens to the waves as they travel through the shallow water and then into deep water.

Make sure you make it clear (use labels if necessary) what has changed and what has stayed the same.

If you need to redraw your solution to Question Three (c), use the diagram on page 9.

Assessor's use only

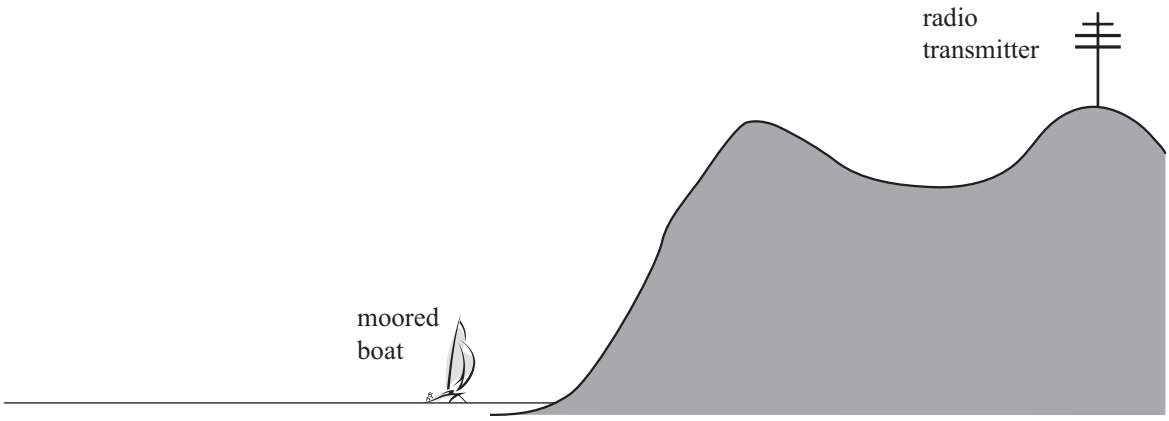
(d) The wavelength changes as the waves go from shallow water to deep water.
The waves have a wavelength of 0.45 m in deep water.
The waves have a wavelength of 0.34 m in shallow water.

Refer to the diagram and calculate the **angle of refraction** when the waves go from **shallow** water to **deep** water.

Question Three continues on the following page.

Assessor's use only

Bianca is sitting in her boat listening to the radio. The radio signal is coming from a distant transmitter.



(e) Explain why the radio waves can reach her boat, even though she cannot **see** the transmitter.

(f) Bianca is sitting on the beach listening to music. She is the same distance away from each of the two speakers. Unfortunately when she connected the speakers to the radio, she connected the wires to one speaker the wrong way round. This means the two speakers are vibrating exactly out of phase.

Explain clearly what effect this will have on the sound Bianca hears.

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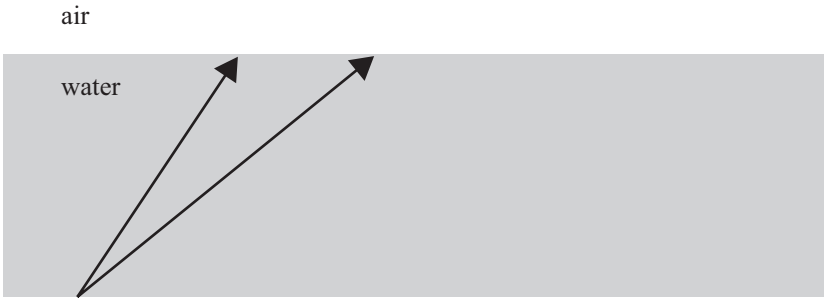
SPARE DIAGRAMS

Assessor's use only

If you need to redraw your solution to Question Two (a), draw it on the diagram below. Make sure it is clear which diagram from the question you want marked.



If you need to redraw your solution to Question Three (c), draw it on the diagram below. Make sure it is clear which diagram from the question you want marked.

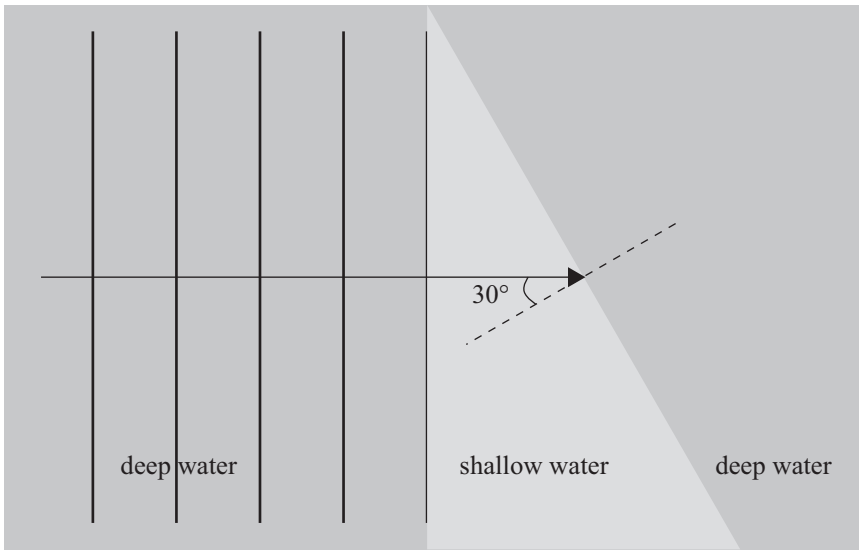


Diagram is NOT to scale

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

Assessor's use only

Question number