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90254

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Level 2 Physics, 2004

90254 Demonstrate understanding of wave phenomena

Credits: Four
2.00 pm 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 2–8 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.

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

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad \frac{n_1}{n_2}=\frac{v_2}{v_1}=\frac{\lambda_2}{\lambda_1} \qquad v = f\lambda \qquad f=\frac{1}{T}$$

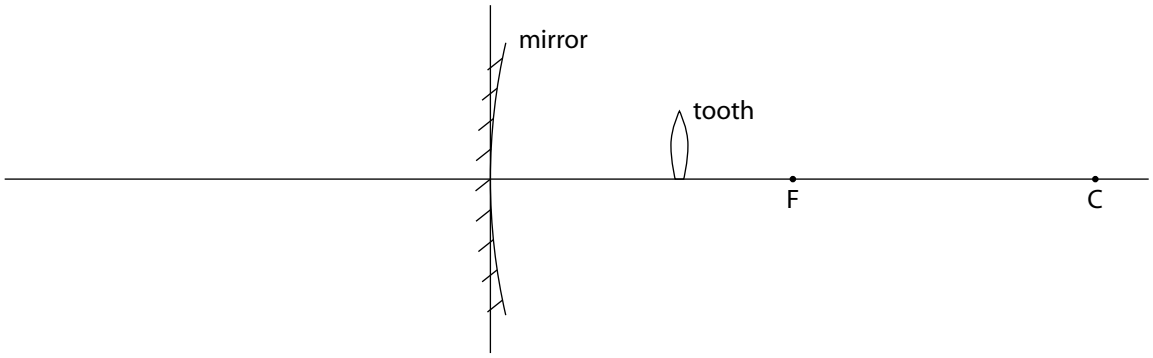
QUESTION ONE: MIRRORS AND LENSES

Mere is a dentistry student. She is using a magnifying mirror to look at the tooth of her patient, Lee.

(a) Name the type of mirror that can produce a magnified image.

_____

(b) Draw rays on the diagram below (not drawn to scale) to show how the image of Lee's tooth is formed in the mirror.



(c) Describe the nature of the image.

_____

(d) Lee's tooth is 2.5 cm away from the mirror. The mirror has a focal length of 4.0 cm. **Show by calculation** that the distance between the mirror and the image of the tooth is 6.7 cm.

_____

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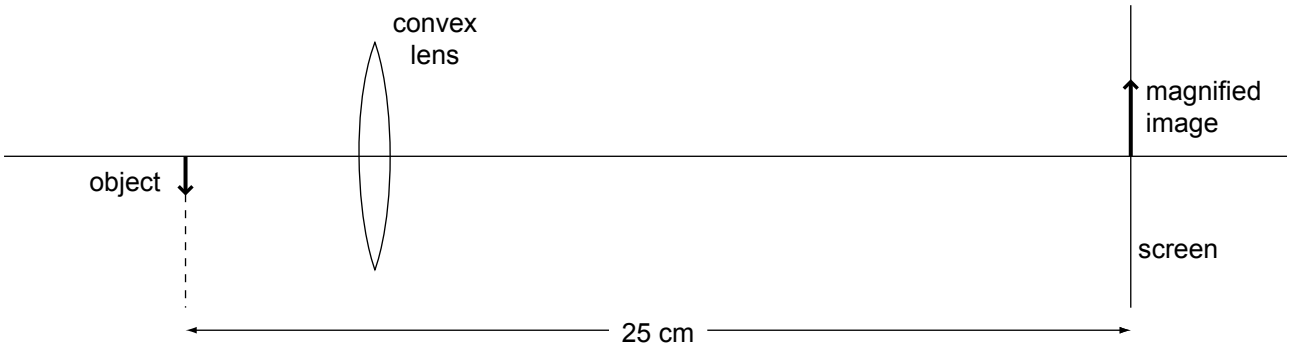
(e) Calculate the magnification of the tooth by the mirror.

Magnification = _____

(f) The **image** of the tooth is 2.0 cm high. Calculate the **actual height** of Lee's tooth.

Height of tooth = _____

Mere can use a convex lens to produce a magnified image of an object on a screen. A possible set-up is shown in the following diagram, which is **not** drawn to scale.



The convex lens has a focal length of 4.0 cm. A sharp magnified image is formed on the screen when the distance between the **object** and the **screen** is 25 cm.

(g) Calculate the distance between the **screen** and the **lens**.

Distance = _____

QUESTION TWO: WAVES

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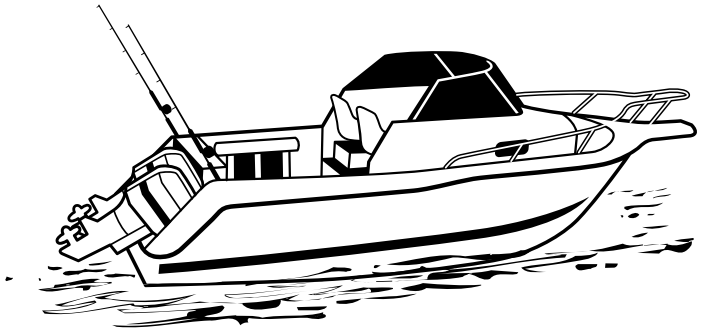
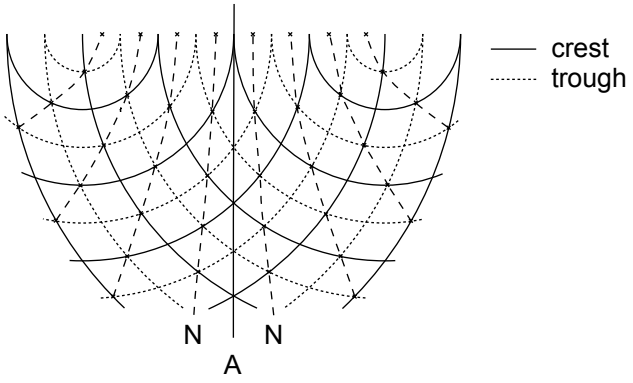
Mere is now on holiday, and she is sitting in a boat that is stationary on a calm lake. There are two outboard motors at the back of the boat. These motors have been pulled up out of the water. Drops of water are dripping from both motors at the same time and at the same constant rate onto the surface of the lake.



Mere looks down and sees that the resulting pattern of waves produced by the dripping water is as shown below. The interference pattern has nodal lines (N) and antinodal lines (A).



(a) The surface of the water remains approximately flat along a nodal line. Explain clearly why this is so.

(b) After a while, the frequency of the dripping water from both sources is **halved**. Describe what effect this change will have on the **wavelength** and on the **pattern of the nodal lines.**

A wind begins to blow producing straight waves on the surface of the lake. Mere watches what happens to the waves as they go past a stone wall in the water.

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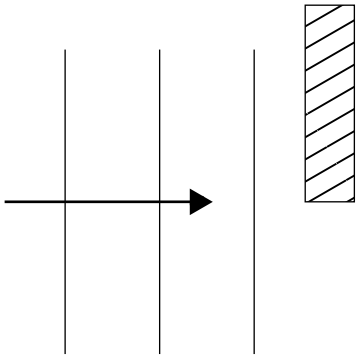

(c) Complete the above diagram by drawing **carefully** the appearance of the wave crests as they continue **to the right** of the three crests already shown. Indicate the direction(s) of the waves that you draw.

(d) Name this phenomenon.

_____

(e) If the crests of the waves are 1.3 m apart and they are travelling at a speed of 2.0 m s^{-1}, calculate the frequency of the waves. Give a **unit** with your answer.

_____

_____

_____

Frequency = _____ _____ unit

(f) Mere was studying straight waves in a **different** part of the lake. Using a stopwatch, she counted 12 complete waves passing her in 56.7 seconds. She estimated that the distance occupied by the 12 **complete waves** was 48 m. Calculate the speed with which the waves were travelling. Give your answer to the correct number of **significant figures.**

_____

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Speed = _____

QUESTION THREE: REFRACTION

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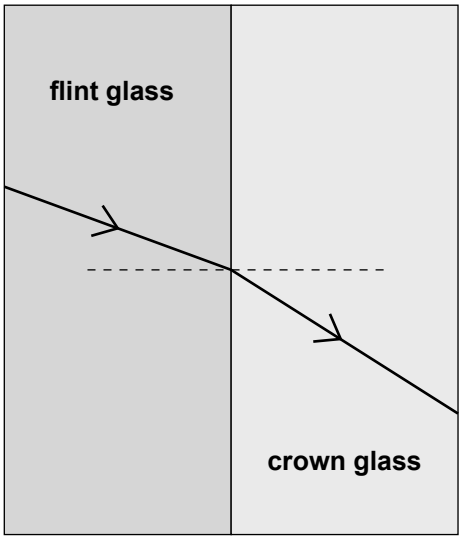
Lee is a keen astronomer. He discovers that good telescope lenses are often made of two types of glass of different refractive index cemented together.

The diagram shows the path of a ray of light as it travels through two such pieces of glass.



(a) Clearly mark the angle of incidence for the ray from flint glass to crown glass in the diagram. Label it θ_1.

Use the information below to answer the questions (b), (c) and (d).

Refractive index of crown glass = 1.52
Refractive index of flint glass = 1.66
Speed of light in crown glass = 1.974×10^8 m s^{-1}
Angle of incidence in flint glass = 19.8°

(b) **Show** that the angle of refraction in the crown glass is 21.7°.

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

Speed of light = _____

(d) Calculate the size of the critical angle for the flint glass/crown glass boundary.

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Critical angle = _____

(e) Give a detailed explanation of what is meant by the phrase **'the critical angle for the flint glass/crown glass boundary**'.

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

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Question number