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90182

NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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# Level 1 Physics, 2007

## 90182 Demonstrate understanding of wave and light behaviour

Credits: Five
9.30 am Friday 30 November 2007

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 2–12 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 50 minutes answering the questions in this booklet.

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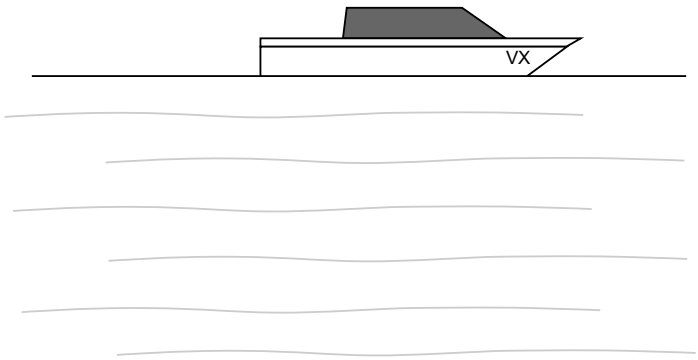
You may find the following formulae useful.

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

## QUESTION ONE: BOATING

Marie looks at her boat called "**VX**" moored in the harbour. The water is still and the boat is perfectly reflected in the water.




(a) On the diagram above, accurately draw the **image** of the **boat** as seen by Marie.

(b) Some words that can be used to describe images are: **real, enlarged, upright, virtual**.

State which ONE of the above descriptions applies to the image of the boat.
Explain the reason for your answer.

Description: _____

_____

Explanation: _____

_____

_____

_____

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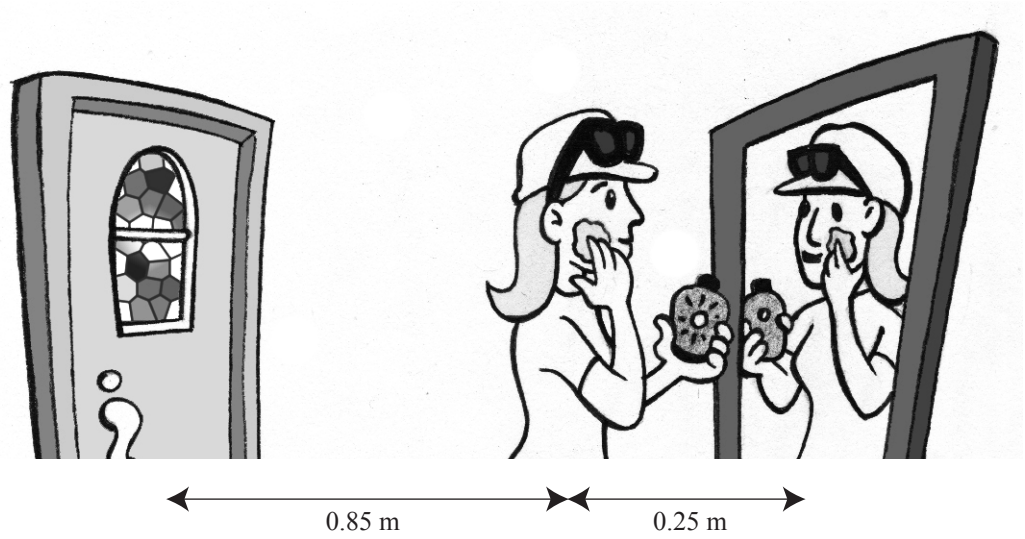
(c) Marie is now in the boat, in front of a mirror, putting some sunscreen on her face. She is 0.25 m from the mirror. There is a door behind her, which is 0.85 m from her as shown in the diagram.




Calculate how far the image of the **door** is from Marie.

image distance = _____

A long fishing rod is held upright on the boat. The engine of the boat causes the end of the fishing rod to vibrate. Marie estimates that the end vibrates back and forth **20** times a **minute**.

(d) Calculate the **period** of the vibration of the end of the fishing rod.

period = _____

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(e) The amplitude of the vibration of the end is **0.15 m**.

Calculate the average **speed** of the vibration of the end of the fishing rod.

speed = _____

(f) Marie uses her cellphone to check the marine forecast. The frequency of the waves produced by the cellphone is **$8.5 \times 10^9$ Hz** and their speed in air is **$3.0 \times 10^8$ m s$^{-1}$**.

Calculate the **wavelength** in air of the waves produced by the cellphone.

wavelength = _____

(g) A glass bottle containing juice is on the dashboard of the boat. A beam of red light from an indicator lamp on the dashboard travels through the glass into the juice.

Use the information below to calculate the refractive index of the juice.

| | |
|---|---|
| Refractive index of glass for red light | = 1.50 |
| Wavelength of red light in glass | = $4.35 \times 10^{-7}$ m |
| Frequency of red light in glass | = $4.60 \times 10^{14}$ Hz |
| Speed of red light in juice | = $2.20 \times 10^8$ m s$^{-1}$ |

refractive index = _____

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## QUESTION TWO: RADIO COMMUNICATION

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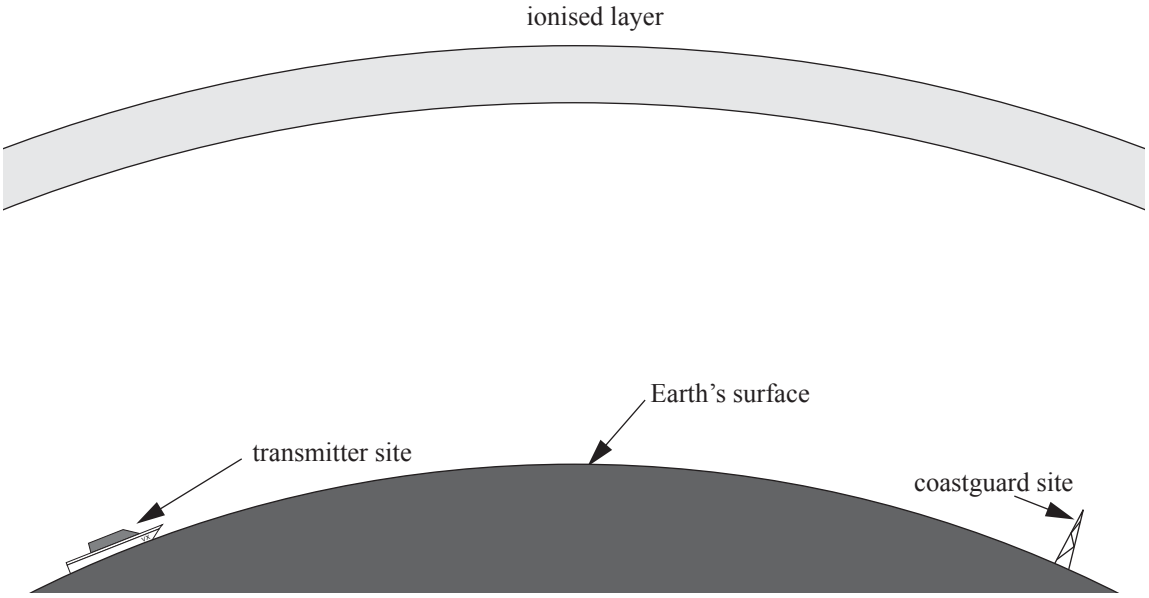
The boat is out at sea. Marie uses a marine radio to contact the coastguard.

(a) Marine radio converts sound waves into radio waves.

State ONE **difference** between the sound waves and the radio waves.

Radio waves travel in straight lines. Long-distance radio communication is possible because radio waves reflect off the ionised layer of the Earth's atmosphere.




(b) On the above diagram **draw** the path of the waves showing how they travel from the boat to the coast guard by reflecting off the ionised layer.

(c) The total distance traveled by the radio waves from the boat to the coastguard is **340 km**. The speed of the radio waves is $\mathbf{3.0 \times 10^8\ m\ s^{-1}}$.

Calculate the **time** taken by the waves to travel from the boat to the coastguard.

time = _____

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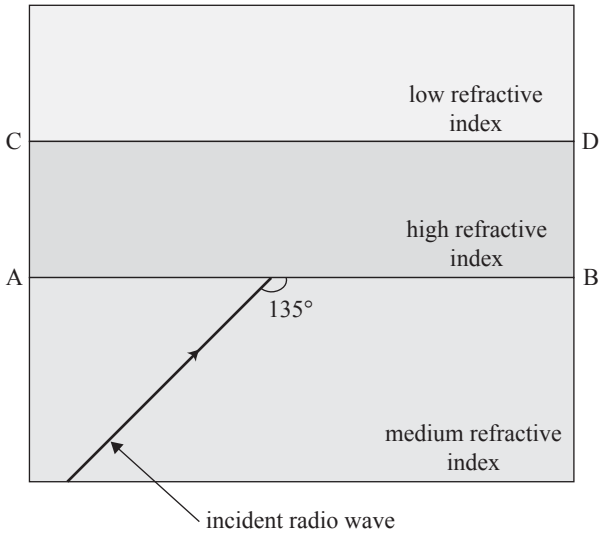
The ionised layers of the atmosphere have different refractive indices. Higher frequency radio waves can travel through these layers to a satellite. Radio waves travel in straight lines but as they cross the boundary between these layers they refract.




(d) A radio wave is incident on the boundary AB at an angle of 135° to the boundary as shown in the above diagram. Calculate the angle of incidence.

angle = _____

The comparative refractive indices of different layers are shown in the diagram above.

(e) Complete the diagram to show how the radio wave refracts at the boundaries AB and CD.

(f) Explain why the radio wave **refracts** at the boundaries AB and CD as shown by your answer to (e). Give reasons.

## QUESTION THREE: BACK TO THE HARBOUR

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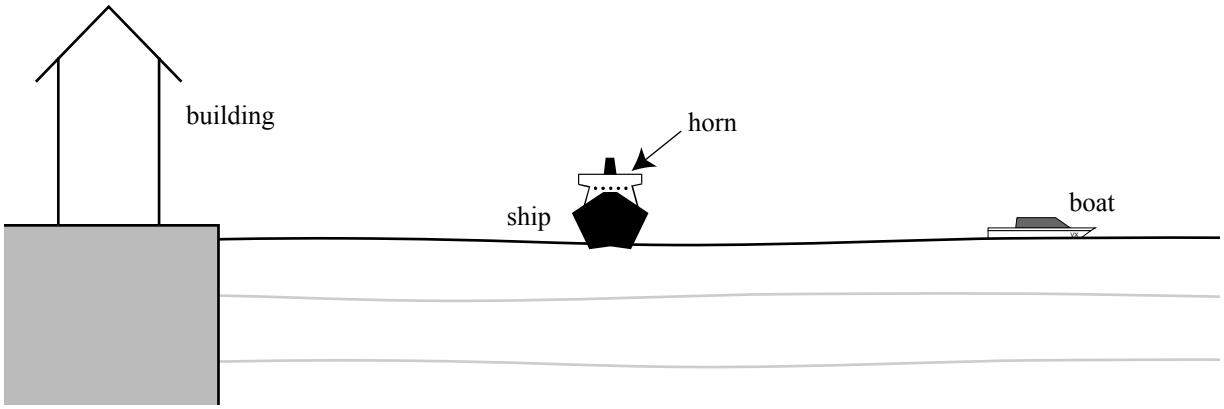
(a) On the return journey, the boat is anchored at the entrance to the harbour. The motion of the waves in the harbour makes the boat bob up and down **15** times a minute. Marie estimates that it takes **54 s** for a wave to travel between two buoys which are **100 m** apart.

Calculate the **wavelength** of the waves.

wavelength = _____

(b) When Marie is waiting at the harbour entrance, a ship sounds its horn. Marie hears the loud sound of the horn **0.84 s** after it is sounded. Then **5.8 s** after the first loud sound, she hears a faint echo of the horn from a tall building on the wharf. The speed of sound in air is **335 m s$^{-1}$**.




Calculate the **distance** between the building and the ship. Assume that the building, ship, and boat are in a straight line.

distance = _____

(c) The boat's structure is made from iron. As the anchor is pulled up, the sound waves made by it travel through the air and through the iron structure of the boat.

Explain why the speed of sound waves in the iron structure is **greater** than the speed of sound in the air.

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## QUESTION FOUR: FIBRE OPTICS

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Modern telecommunications use fibre optic cables to transmit data. The fibre optic cables carry information in light waves. Fibre optic cables contain thin fibres of very pure glass. Light is totally internally reflected in the glass fibre as it travels through it.

(a) Describe TWO **conditions** necessary for total internal reflection to take place.

Condition 1. _____

_____

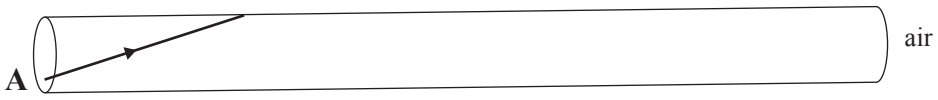
_____

Condition 2. _____

_____

_____

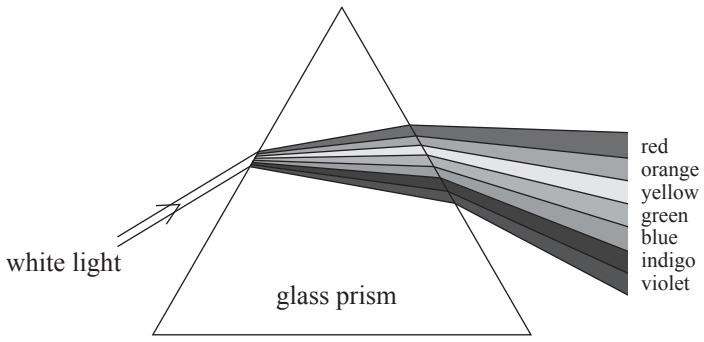
(b) A ray of light is sent from the end A of the glass fibre as shown in the diagram below.




glass fibre

Complete the **path** of the ray to show how it **travels** through the glass fibre and how it **refracts** from the glass fibre to air.

(c) The diagram below shows a beam of white light being split into seven colours by a glass prism.




Name the colour that has the **slowest** speed in the prism.

Name _____

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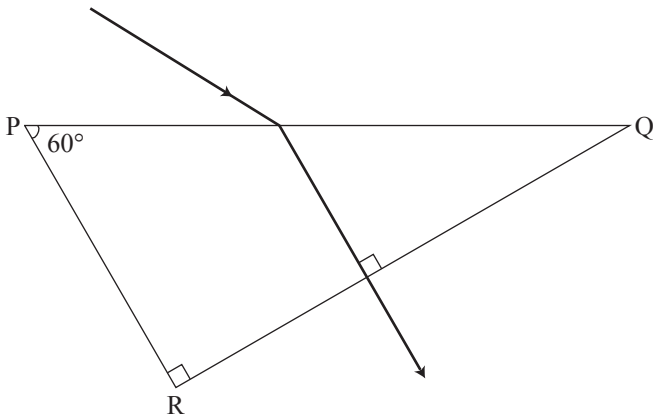
(d) In fibre-optic communication, electric pulses are converted into pulses of light of a single colour, and transmitted through the optic fibre. On the receiving end of the optic fibre, the light is converted back into electric pulses.

If pulses of white light are used, then the electrical pulses at the receiving end become less clear.

Explain why.

(e) A ray of light is incident on the side PQ of a prism. After refraction, the ray leaves the side QR of the prism at **90°** to it, as shown in the diagram below.




Use the information given in the diagram to calculate the angle of **refraction**.
(You may show your workings by recording the appropriate angles on the diagram.)

angle = _____

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

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Question number