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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

SUPERVISOR'S USE ONLY

Level 2 Physics, 2014

91170 Demonstrate understanding of waves

2.00 pm Tuesday 18 November 2014
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of waves.	Demonstrate in-depth understanding of waves.	Demonstrate comprehensive understanding of waves.

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 attempt ALL the questions in this booklet.

Make sure that you have Resource Sheet L2–PHYSR.

In your answers use clear numerical working, words and/or diagrams as required.

Numerical answers should be given with an appropriate SI unit.

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.

Merit

TOTAL 17

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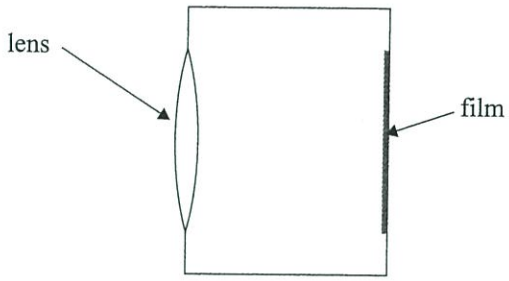
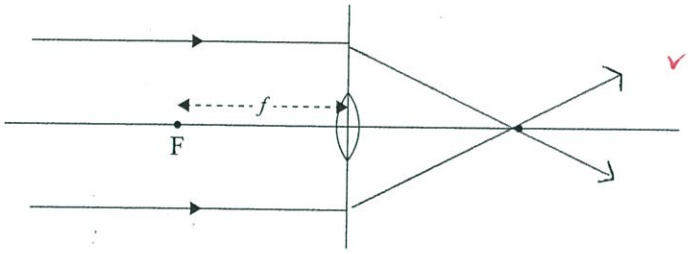
QUESTION ONE: THE CAMERA

Moana is on holiday at the beach and has a disposable underwater camera. The camera is like a box with a lens at the front and a film at the back, as shown in the diagram below.



(a) Complete the diagram below showing what happens to the two light rays.

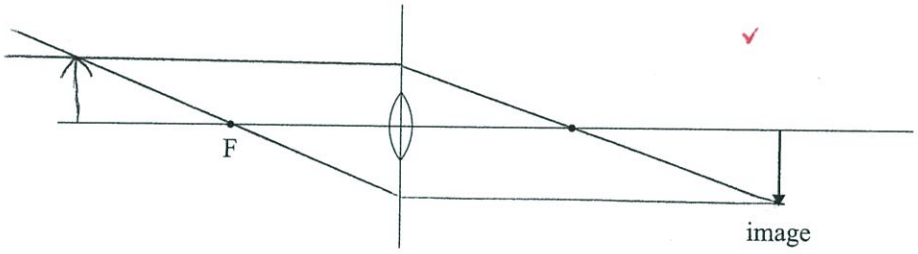


If you need to redraw this, use the diagram on page 8.

(b) The diagram below shows the **image** formed on the film when Moana takes a picture.

Draw two rays to locate the position of the **object**.

State the **nature** of the image (real OR virtual).



If you need to redraw this, use the diagram on page 8.

Nature of image: real, same size, upside down.

Correct rays AND nature

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(c) Moana takes another picture. The image is 1.5 cm high and 5.5 cm from the lens. The focal length of the lens is 5.0 cm.

Calculate the height of the object that she is taking a picture of.

$h_i = 1.5$ $d_i = 5.5$ $f = 5$

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ $\frac{1}{d_o} = \frac{1}{f} - \frac{1}{d_i}$

$\frac{1}{d_o} = \frac{1}{5} - \frac{1}{5.5}$ ✓ $\frac{1}{d_o} = 0.0181$

$d_o = 55\text{cm}$ ✓

$\frac{d_i}{d_o} = \frac{h_i}{h_o}$ $\frac{5.5}{55} = \frac{1.5}{h_o}$

$0.1 = \frac{1.5}{h_o}$

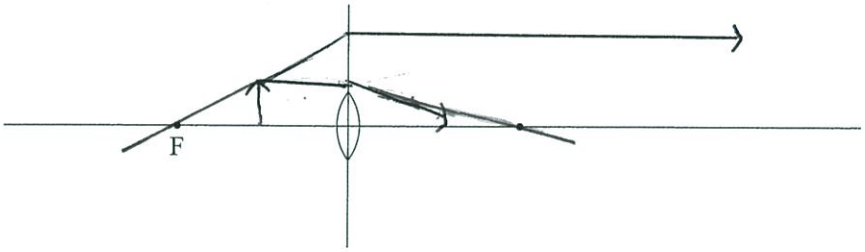
$h_o = 0.1 \times 1.5$ $h_o = 0.15\text{cm}$ //

Mistake in mathematical rearrangement (so not e).

m

(d) Explain why Moana cannot take a picture of any object closer than 5.0 cm.

Use the diagram below to explain your answer.



when the object is between the mirror and the focal point there is no image formed on convex lense //

a

Diagram just sufficient to award an a.

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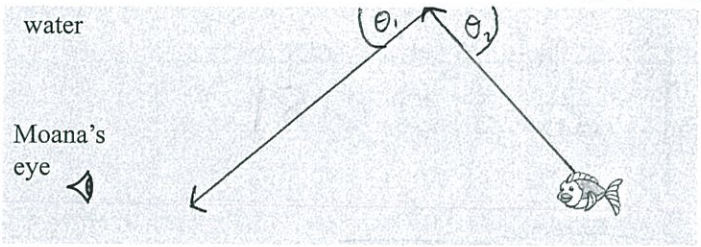
QUESTION TWO: AT THE BEACH

Moana is swimming under the water. She can see a fish, and she can also see an image of the fish caused by light reflecting at the water/air interface.



$\theta_1 = \theta_2$

If you need to redraw this, use the diagram on page 8.

(a) State the full name of the process by which Moana can see the image of the fish reflecting at the water/air interface.

Draw one ray on the above diagram to show this process.

total internal ~~reflect~~ reflection. //

(b) The critical angle at the water/air interface is 47°. The refractive index of air is 1.0.

Calculate the refractive index of the water.

$\theta_1 = 47°$ $\theta_2 = 90°$ $n_2 = 1.00$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$ $n_1 = \frac{n_2 \sin\theta_2}{\sin\theta_2}$

$n_1 = \frac{1.00 \sin 90}{\sin 47}$ ✓

$n_1 = 1.37$ //

Correct throughout

(c) A beam of red light passes from the air into the water.

Calculate the **wavelength** and the **frequency** of the light beam as it travels through the water.

The speed of light in air is 3.0×10^8 m s^{-1}.

The wavelength of red light in air is 6.5×10^{-7} m.

$V = f\lambda$

$f = \frac{V}{\lambda}$ ~~air~~ — $f = (3 \times 10^8) \div (6.5 \times 10^{-7})$

$f = 4.62 \times 10^{14}$ ✓

frequency stays the same

so frequency in water of light beam is

4.62×10^{14} Hz

$\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1}$ $\frac{1.00}{1.37} = \frac{\lambda_2}{6.5 \times 10^{-7}}$ $\lambda_2 = 4.75 \times 10^{-7}$ ✓ //

no units given But still

(d) Moana is in her garden, which is just outside her room. There is a radio playing in her room and the door of her room is open.

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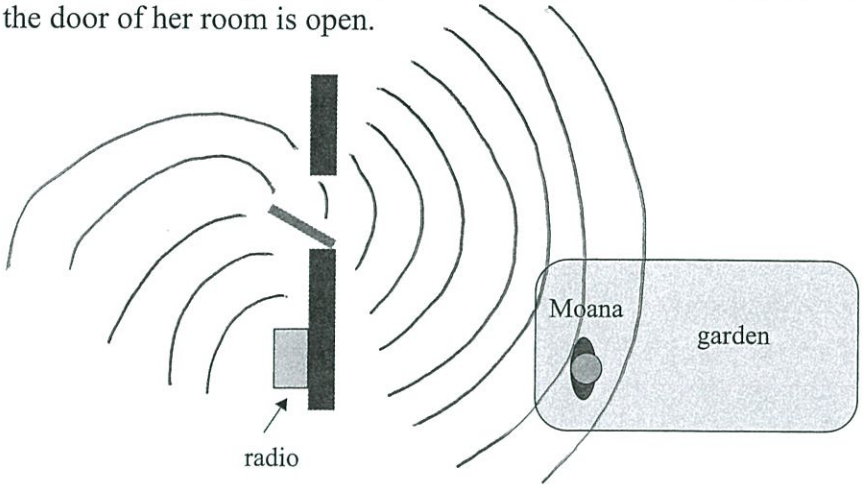


By comparing the wavelengths of light and sound waves, discuss why Moana can hear, but not see, the radio.

Sound waves can diffract around objects and sometimes go through objects depending on the density. as on the diagram above the sound waves from the radio can go through the door and out to Moana. But light waves can not diffract around objects. this is why Moana can not see the radio behind the wall in her room. // a

Idea of diffraction correct
But no mention of wavelength and its influence.
Hence, a only.

M6

QUESTION THREE: WATCHING THE WAVES

(a) Moana is watching water waves coming into the beach. She estimates the wave speed to be 0.50 m s^{-1} and the wavelength to be 1.2 m.

Calculate the frequency of the waves.

Give your answer with the correct unit and correct number of significant figures.

$v = f\lambda$

$f = \frac{v}{\lambda}$ $f = 0.5 \div 1.2$

$f = 0.42\,Hz$ //

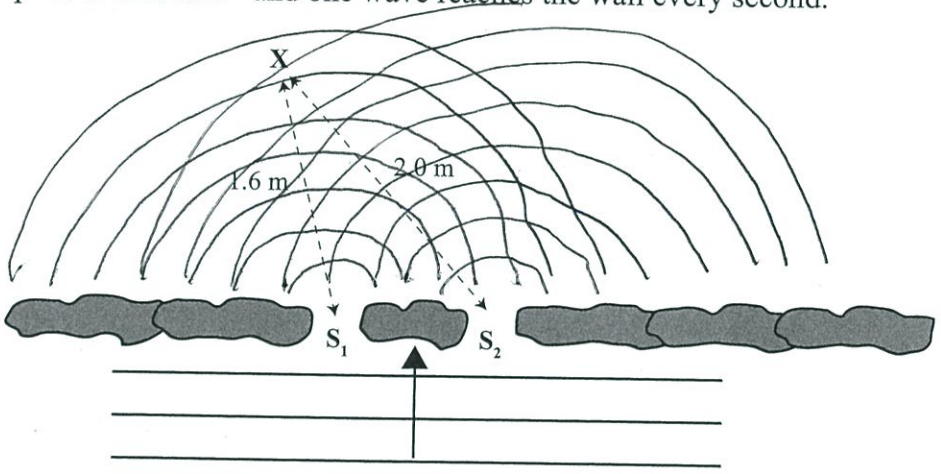
a

a

(b) At another place there are two gaps (labelled S_1 and S_2) in the line of rocks. There is a set of waves passing through the gaps, creating an interference pattern.

The difference between the distances from S_1 to **X** and S_2 to **X** is 0.40 m.

The wave speed is 0.80 m s^{-1} and one wave reaches the wall every second.



Is the point **X** at a node or an antinode?

Explain your answer.

Correct answer BUT not backed by mathematical evidence or material provided.

Point X is at a node. this is because a trough is meeting a crest. This means it is 180° out of phase causing destructive interference. At point X because it is a node and the trough and crest of the waves are cancelling eachother out ~~the~~ it will ~~be~~ feel calm and less bumpy to if it was at an antinode point. this is where it is in phase and constructive interference where crest meets crest and trough meets trough.

a

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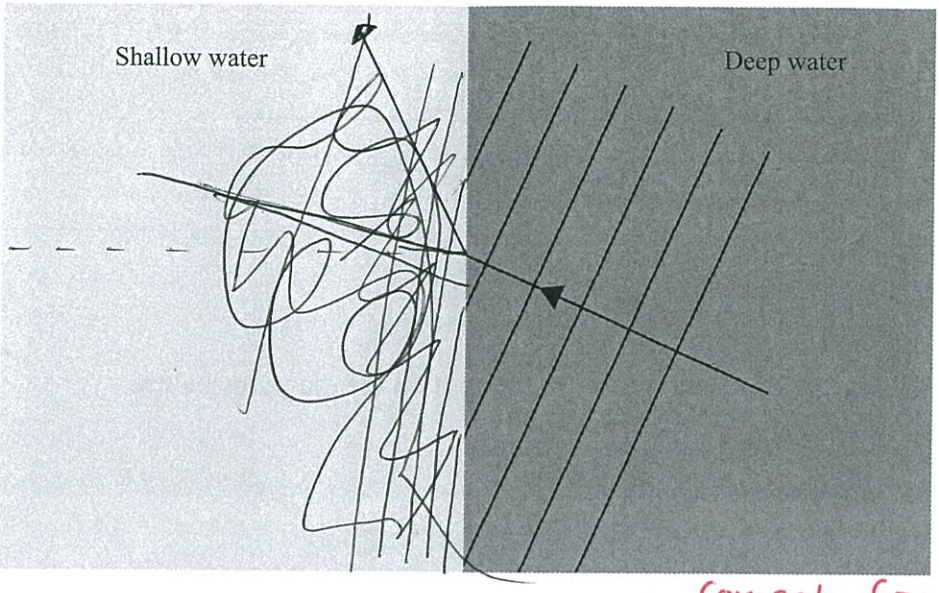
(c) Moana watches the waves travel from deep to shallow water. In shallow water, the waves travel more slowly, compared to in deep water.

Complete the diagram showing the **wavefronts** and the **wave direction** in the shallow water.



If you need to redraw this, use the diagram on page 9.

Correct for both λ and direction on redraw.

(d) At school, Moana investigates waves in springs. She connects a light spring to a heavy spring, and ties the heavy spring to the leg of a bench. Moana sends a single pulse along the light spring, as shown in the diagram below.

(Waves travel faster in a light spring than in a heavy spring.)

The diagram below shows the pulse after it has moved into the heavy spring.

On the same diagram, draw the pulse reflected in the light spring showing:

- the **phase** of the pulse
- the **distance travelled** by the pulse.

If you need to redraw this, use the diagram on page 9.

Give reasons for your answer.

the refected pulse will be smaller as it will lose ~~more~~ energy ~~than~~ from hitting the edge of the chair and reflecting back. //

Incorrect diagram and insufficient explanation.

M5

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

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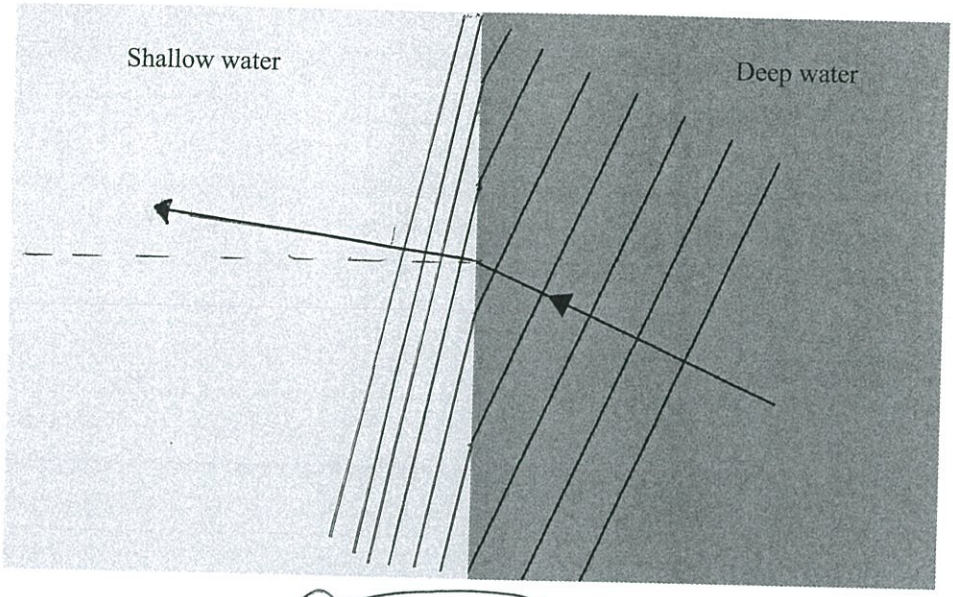

Seen

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