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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.

Achieved

TOTAL 11

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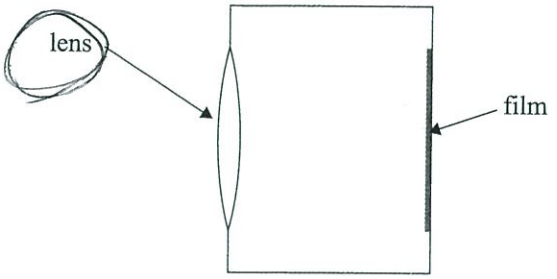
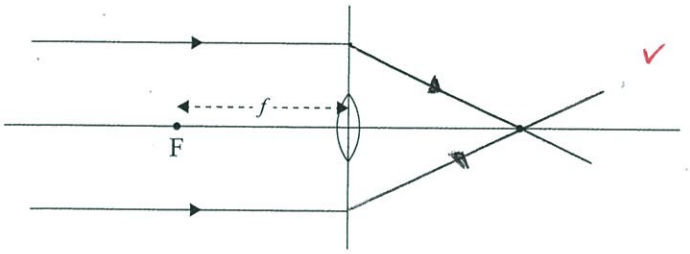
QUESTION ONE: THE CAMERA

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.

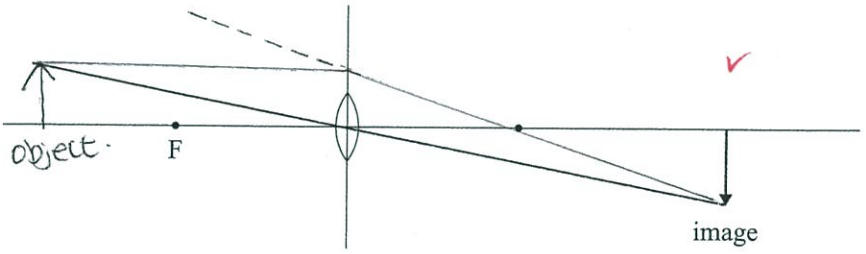


If you need to redraw this, use the diagram on page 8.

(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: virtual, inversed

Rays only, hence a.

Concave lens = −f

(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.

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$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$ $\quad \frac{1}{-5} = \frac{1}{5.5} + \frac{1}{d_o}$

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

$\frac{d_i}{d_o} = \frac{h_i}{h_o}$ $\quad$ i.e. $\frac{1}{d_o} = -0.38$ $\quad d_o = -2.6$ cm

$\frac{5.5}{2.6} = \frac{1.5}{h_o}$

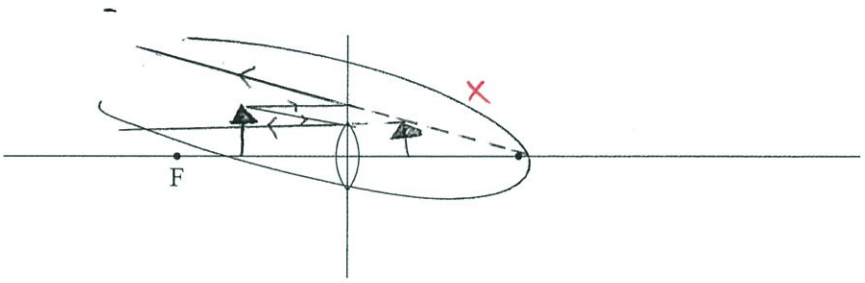
$h_o = 0.71$ cm.

a

Incorrect substitution BUT enough for a (consequential error).

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

Use the diagram below to explain your answer.



She cannot go closer than 5.0cm as the image will become virtual reduced inverted. This may affect the quality of the photo and may not be focused on the screen / film of the camera. //

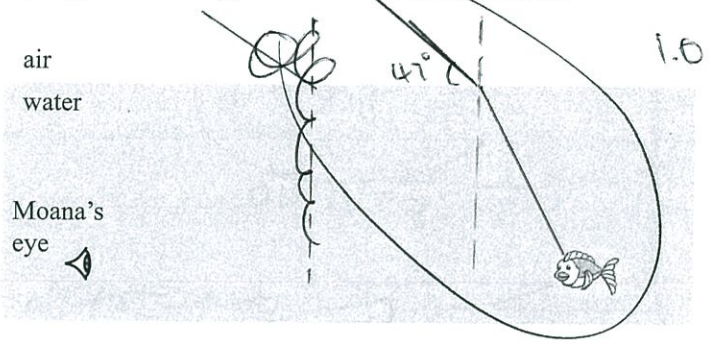
a

Wrong diagram. Explanation just enough for a.

A4

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.



REDRAWN ON PG 8.

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.

refraction //

(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.

$n_1 \sin\theta_1 = n_2 \sin\theta_2$ $\quad 90-47=43.$

$1.0 \sin 90 = n_2 \sin 43.$ Wrong angle used.

$\frac{1}{1} = n_2 \sin 43.$

$\frac{1}{\sin 43} = n_2$ $\quad n_2 = 1.047.$ water's refractive index = 1.47 //

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

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.

wavelength: $v = f\lambda$

frequency = $f = \frac{1}{T}$

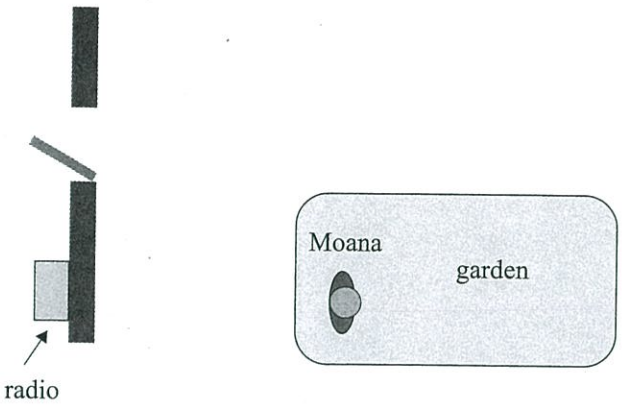
$\frac{n_1}{n_2} = \frac{\lambda^2}{\lambda_1}$ $\quad \frac{1.0}{1.47} = \frac{\lambda_2}{6.5\times10^{-7}}$ $\quad \lambda_2 = \frac{1.0}{1.47} \times 6.5\times10^{-7} = 4.42\times10^{-7}$ m

$v = f\lambda$ $\quad \frac{v_2}{v_1} = \frac{n_1}{n_2}$ $\quad \frac{v_2}{3.0\times10^{-8}} = \frac{1.0}{1.47} = 2.04\times10^{-8}\ ms^{-1} = v_2$

$v = \frac{1}{T}\lambda$ $\quad 2.04\times10^{-8} = \frac{1}{T} \times 4.42\times10^{-7}$ $\quad 0.05 = \frac{1}{T}$ $\quad f = 0.05$ Hz //

$f = v\lambda$

(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.



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

Moana can hear but not see the radio as sound waves are longitudinal waves. This means that it can travel through mediums. The wavelengths of sound waves are much longer than light waves. ~~Light waves can cannot~~

Moana cannot see the radio as light waves have shorter wavelengths thus, not diffracting enough. ✓

M

Ideas of λ and diffraction, but insufficient evidence to award an e.

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A3

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.

$f = \frac{1}{T}$

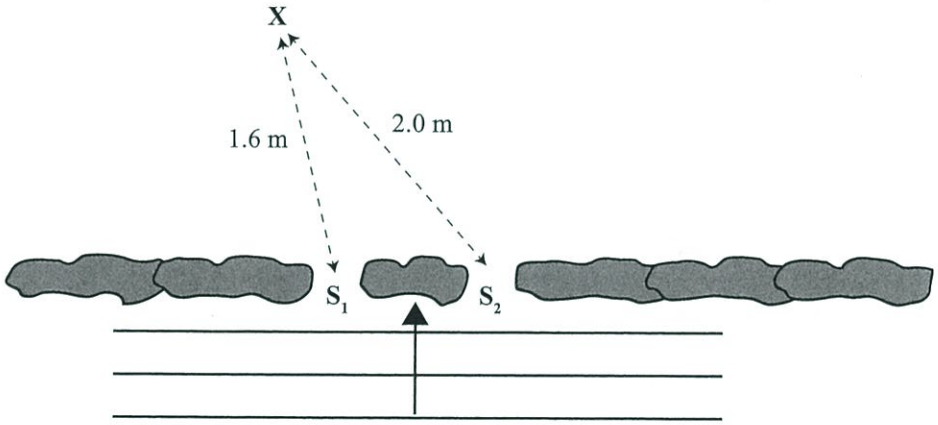
$f = v\lambda \quad = 0.5 \times 1.2$

$= 0.6\ Hz$ (2.S.f)//

(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.

The point x is a node ✓ as it is a ~~con~~ deconstructive interference, thus meaning that there is a difference in wavelengths $((n+\frac{1}{2})\lambda)$ ~~else,~~ ~~it~~ is either trough + crest or ~~vice versa~~ crest + trough. Antinodes do not have difference in wavelengths $(n\lambda)$ and so either crest meets crest or trough meets trough.//

Correct for node BuT no evidence either mathematical or otherwise to give more than a .

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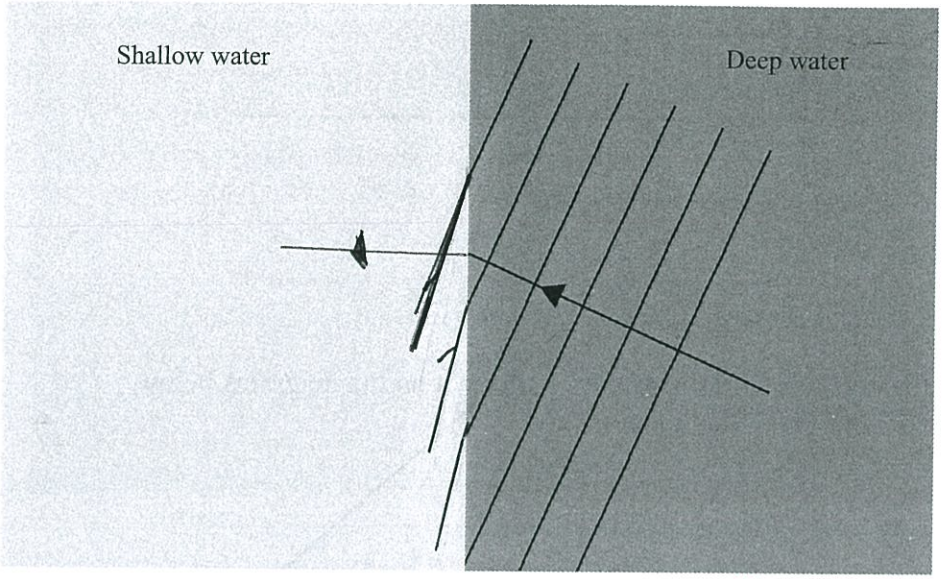
(c) Moana watches the waves travel from deep to shallow water. In shallow water, the waves travel more slowly, compared to in deep water.

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



redrawn on pg 9

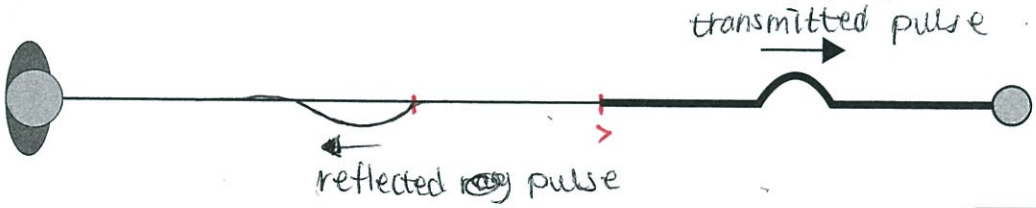
If you need to redraw this, use the diagram on page 9.

Diagram on Page 9 just worth m (90° angle)

(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.

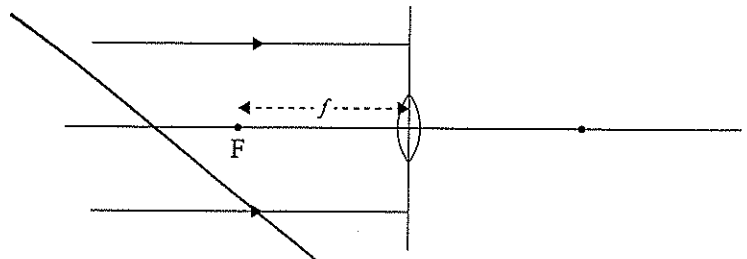
Give reasons for your answer.

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

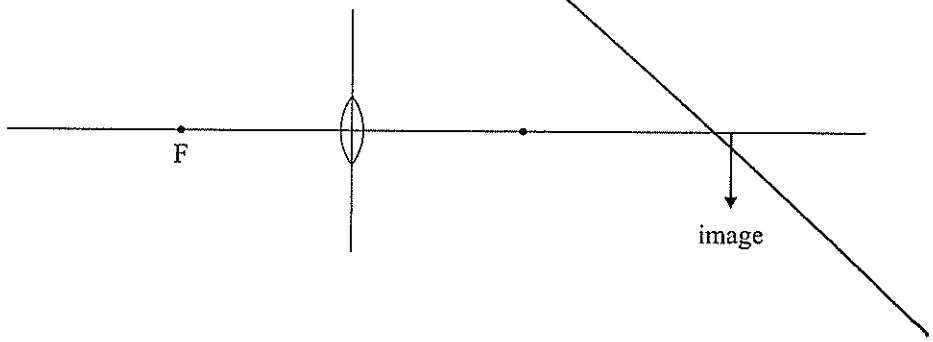
The reflected pulse is out of phase with the transmitted pulse as its crest + ~~meet~~ trough, and is reflected back inversed. The distance travelled would be much smaller than the transmitted pulse as the pulse is much smaller //

SPARE DIAGRAMS

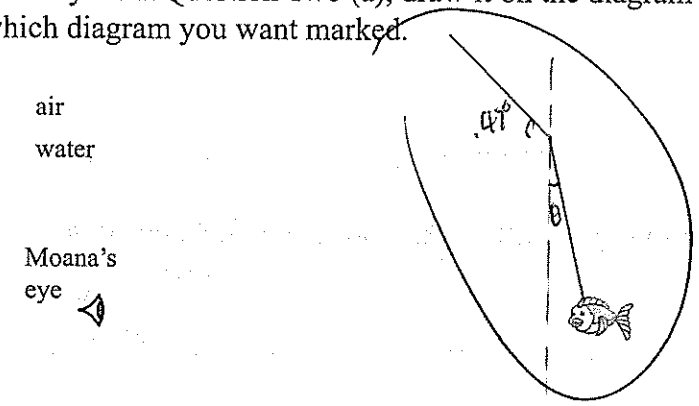
If you need to redraw your completion of the diagram from Question One (a), draw it on the diagram below. Make sure it is clear which diagram you want marked.



If you need to redraw the ray from Question One (b), draw it on the diagrams below. Make sure it is clear which diagram you want marked



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



seen

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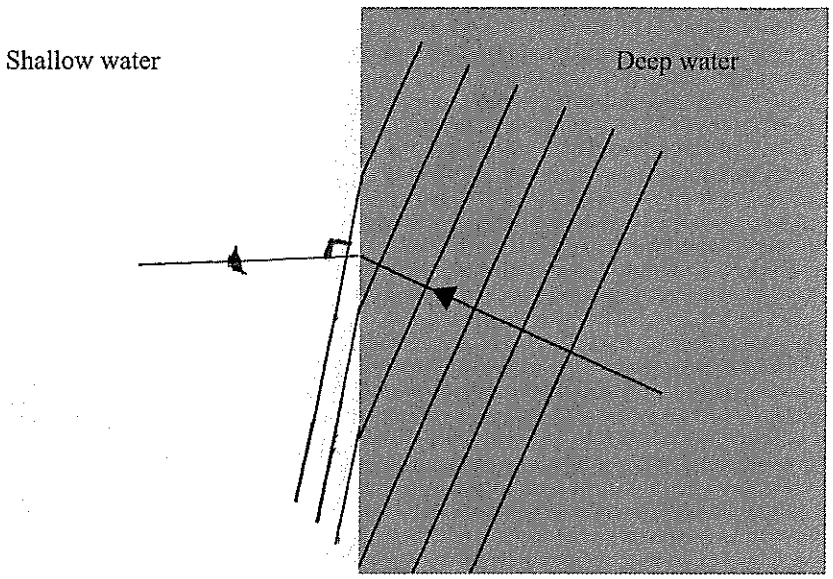
If you need to redraw your completion of the diagram from Question Three (c), draw it on the diagram below. Make sure it is clear which diagram you want marked.



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.