No part of the candidate evidence in this exemplar material may be presented in an external assessment for the purpose of gaining credits towards an NCEA qualification.

1

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90938

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NZQA

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QUALIFY FOR THE FUTURE WORLD
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Level 1 Physics, 2015

90938 Demonstrate understanding of aspects of wave behaviour

9.30 a.m. Thursday 19 November 2015
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of wave behaviour.	Demonstrate in-depth understanding of aspects of wave behaviour.	Demonstrate comprehensive understanding of aspects of wave behaviour.

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 L1–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.

Excellence

TOTAL 23

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QUESTION ONE: SOUND WAVES

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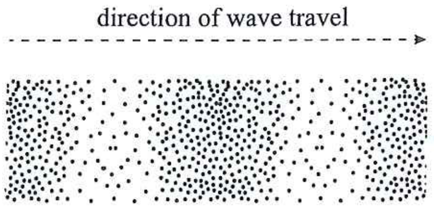
The diagram below represents sound waves travelling through a medium.



(a) (i) What **type** of wave is a sound wave?

A mechanical, longitudinal wave

(ii) How many **full** wavelengths are shown in the diagram above?

Give a reason for your answer.

2. In a logitudinal wave, a wavelength is the length between two identical points on waves that are next to each other. In this case, you can use the compression as the point to measure between. Looking from compression to compression, you can see two full wavelengths here.

(b) How does the direction of motion of particles in the medium compare to the direction of the wave travel?

In a logitudinal wave the particles move back and forth from a fixed position parallel to the wave. In a transverse wave the particles move back and forth from a fixed position perpendicular to the direction the wave is travelling.

Bottlenose dolphins use echolocation to locate their prey. They make clicking sounds and then listen to the echo of the sound waves reflected off objects in front of them.

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(c) A bottlenose dolphin produces a sound wave of frequency 150 kHz.

Calculate the **period** of this wave.

~~150,000~~ $T = \frac{1}{f}$

$T = \frac{1}{150{,}000}$ s

Period: $\frac{1}{150{,}000}$ s

(d) A dolphin sends out a clicking sound and receives an echo from a fish 0.060 s later. The speed of sound in water is 4.5 times faster than the speed of sound in air. The speed of sound in air is 343 m s^{-1}.

(i) Calculate the distance from the dolphin to the fish.

Speed of sound in water: $4.5 \times 343 = 1543.5$ m/s

$v = \frac{d}{t}$ $1543.5 = \frac{d}{0.06}$

$d = 92.61$ m

halve the distance → $92.61 / 2 = 46.305$ m

Distance: 46.3 m

(ii) Explain how a dolphin is able to distinguish a near object and a distant one by using echolocation.

The dolphin ~~...~~ can estimate how far away an object is by how long it takes for the echo to return to them. The further an object the longer it take for the echo to return. A near by object won't take very long to echo back.

E7

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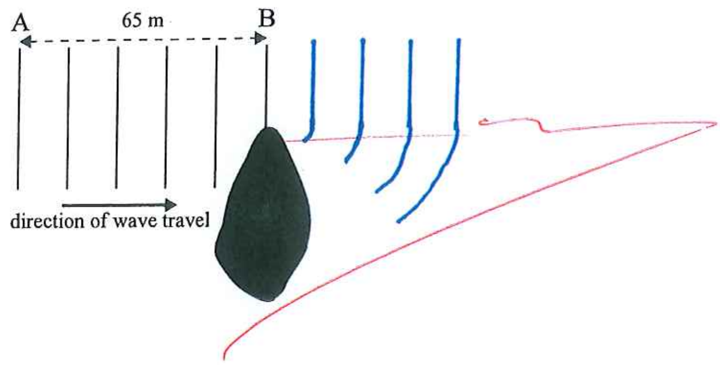
QUESTION TWO: WAVE BEHAVIOUR

The diagram below shows water waves travelling towards a large rock near the shore line.



(a) On the diagram above draw the wave pattern produced as the waves pass the tip of the rock.

(b) Name the physics concept that is related to this situation.

diffraction

(c) The lines on the diagram represent wave crests. The distance from wave crest A to wave crest B is 65 m.

(i) Calculate the wavelength of the water waves.

$65/5 = 13$ m

Wavelength: 13 m

(ii) The frequency of the water waves is 0.25 Hz.

Calculate the speed of the waves in water.

$v = f\lambda = 0.25 \times 13 = 3.25$ m/s

Speed: 3.25 ms^{-1}

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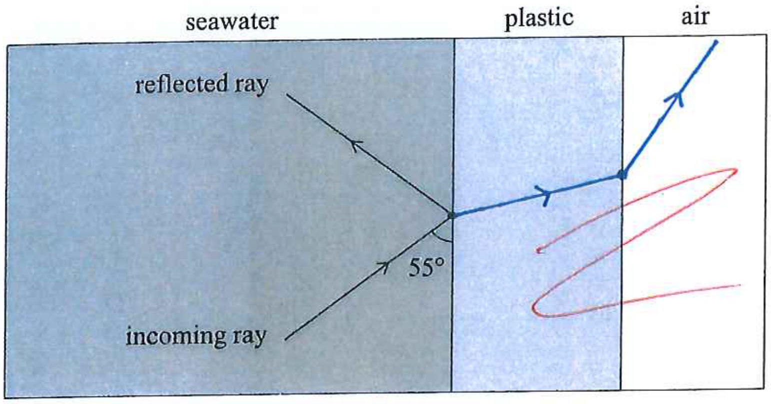
(d) When a person does underwater diving, light travels from the seawater through the plastic of a diver's mask to the eyes of the diver. The space between the mask and the diver's face contains air.

The diagram below shows a ray of light travelling from the seawater to the plastic of a diver's mask. Part of the incoming ray is reflected.

http://underwaterdive.com/about/instructors/john-german/



(i) The incoming ray strikes the seawater-plastic boundary at 55°, as shown in the diagram.

State why the angle of reflection in the above situation is 35°.

'Normal' is point at 90° to the boundary, in the place the wave hits the boundary. the angle between the incoming ray and normal must equal 35°. The angle of incidence is always equal to the angle of relection so the angle between the normal and the reflected ray must also be 35°.

(ii) Plastic is optically denser than seawater, and air is optically less dense than plastic.

On the diagram above, draw the path of the reflected ray through the plastic into the air.

(iii) Compare the speed of the **reflected ray** in seawater with the speed of the **incoming ray** in seawater.

Explain your answer.

Their speeds would be the same. Since the ray is traveling through water in both intances, the optical density ~~of the~~ of the matter is the same for both. Since optical density is what affects the speed of the ray, the speed must stay the same.

E8

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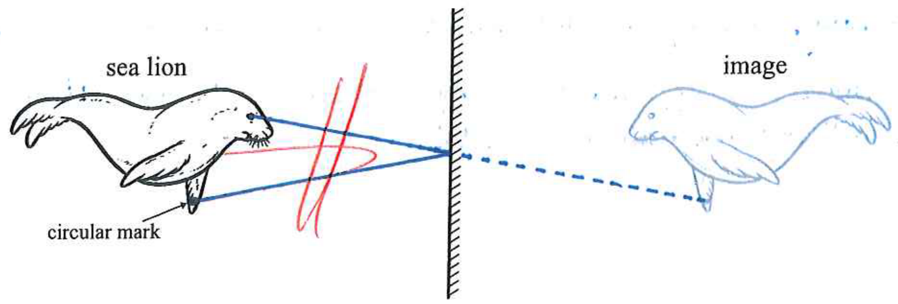
QUESTION THREE: REFLECTION

The photograph below shows a sea lion being reflected by the glass window of an underwater camera.

www.wodumedia.com/wp-content/uploads/2012/10/An-Australian-Sea-Lion-becomes-enchanted-when-it-sees-its-reflection-for-the-first-time-in-the-lens-of-the-giant-IMAXR-3D-camera-for-the-filming-of-the-IMAX-3D-film-Under-the-Sea-3D.-Photo-2008-Michele-Hall-used-with-permissi-1.jpg

(a) On the diagram below, draw rays to show how the sea lion can see the circular mark on the tip of its flipper in the glass window.



(b) The image formed by the glass window is a virtual image.

State how a virtual image is different from a real image.

A real image can be projected onto a screen, a virtual image can not.

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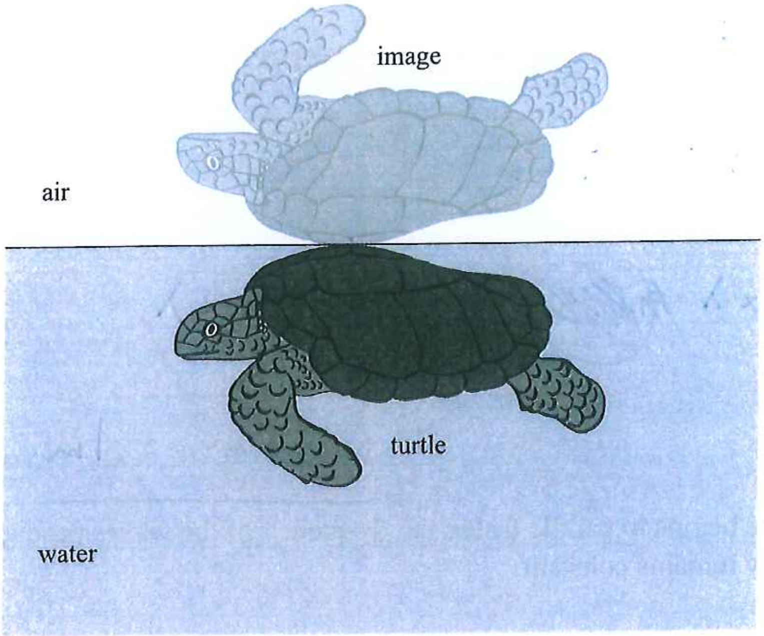
A turtle floats just under the surface of water. An underwater diver sees an inverted image of the turtle directly above it. This image is caused by total internal reflection. The diagram below shows the turtle and its image.



(c) Describe TWO conditions needed for total internal reflection to occur in the above diagram.

(1) The boundary that the light is reflected on must be going from more to less optically dense. i.e. water to air, like in this diagram

(2) The angle that the light hits the surface of the water before being reflected into the diver's eyes must be greater than the critical angle.

Question Three continues on the following page.

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(d) When the turtle paddles on the surface of water, it produces waves. The turtle produces 6.0 surface waves in 12 seconds. Each wave travels 15 m in 30 s.

(i) Calculate the wavelength of the waves produced.

Frequency: $\frac{6}{12} = 0.5$ Hz

Velocity: $\frac{15}{30} = 0.5 \text{ m s}^{-1}$

$v = f \times \lambda$ ~~m~~ $0.5 = 0.5 \times \lambda$

$\lambda = 1$ m

Wavelength: 1 m

(ii) When the turtle begins to paddle faster, the frequency of the waves produced **doubles**, but the velocity remains constant.

Explain how the wavelength of the waves changes when the frequency of the wave doubles.

The wavelength must be halved. Since $v = f\lambda$, for the velocity to stay the same, if the frequency increases the wavelength must proportionately decrease. Since the frequency doubled, the wavelength must halve.

E8

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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Annotated Exemplars

Excellence exemplar for 90938 2015		Total score	23
Q	**Grade score**	**Annotation**	
1	E7	(a) (i) and (ii) **Merit.** Correctly describes the wave as longitudinal and clear explanation of why there are two full wavelengths (b) **Merit.** Correctly describes the direction of the *vibration* of the particles as parallel to the direction of the wave motion (c) **Achieved.** Correct calculation of the time period using the information given with correct unit but answer given as a fraction (d) (i) and (ii) **Excellence.** Correct calculation of distance and explanation of how the dolphin distinguishes the two object	
2	E8	(a) **Merit.** The diagram shows that the wave is diffracting in the correct manner and that there is no change in wavelength. (b) **Achieved.** Correctly named physics concept (c) (i) and (ii) **Merit.** Speed correctly calculated with appropriate units. (d) (i), (ii) and (iii) **Excellence.** Full explanation including correct ray diagram, correct explanation of the relationship between the angle of incidence, normal and angle of reflection , and correct description that light does not change speed on reflection because the medium has not changed	
3	E8	(a) **Not Achieved.** For Achieved, a diagram of one ray needs to be drawn including arrows to indicate the correct direction of the rays going from the object to the sea lion's eyes. (b) **Achieved.** Correct statement regarding virtual images. (c) (i) and (ii) **Merit.** Both of the conditions for Total Internal reflection are stated correctly. (d) (i) and (ii) **Excellence.** Correct calculation of the wave speed and correct wavelength calculated and full explanation regarding the wavelength change.	