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NZQA

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SUPERVISOR'S USE ONLY

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.

Achievement

TOTAL 12

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QUESTION ONE: SOUND WAVES

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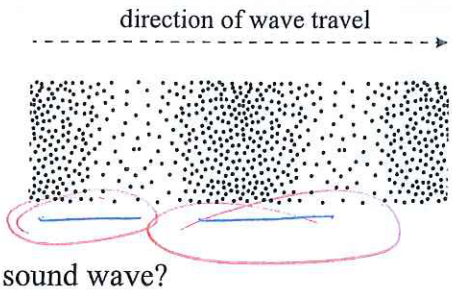
The diagram below represents sound waves travelling through a medium.



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

Longitudinal wave

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

Give a reason for your answer.

Two full wavelengths are shown in diagram above. This is because one wavelength consits of rarefraction and compression. There are 3 compressions but 2 rarefractions. Only two pairs of compressions and rarefractions.

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

In a longitudinal wave the particles travel parallel to the direction of the wave travel. So direction of motion of particles and wave travel are the same.

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.

http://ioniandolphinproject.org/species-guide/common-bottlenose-dolphin
http://fishingrigz.com/fish/snapper.html

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

Calculate the **period** of this wave.

150 kHz = 150,000 Hz

$f = \frac{1}{T}$ ∴ $T = \frac{1}{f}$

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

$= 6.7 \times 10^{-6}$

(2 sf)

Period: 6.7×10^{-6} sec

(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 = $343 \times 4.5 = 1543.5$ ms^{-1}

$v = \frac{2d}{t}$ ∴ $2d = vt$

$= 1543.5 \times 0.06$

$= 92.61$

$d = \frac{92.61}{2}$

$= 46.305$ Distance: 46.305 m

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

If an object is near the echo of the sound waves reflected will return quicker and louder than a distant object.

A4

QUESTION TWO: WAVE BEHAVIOUR

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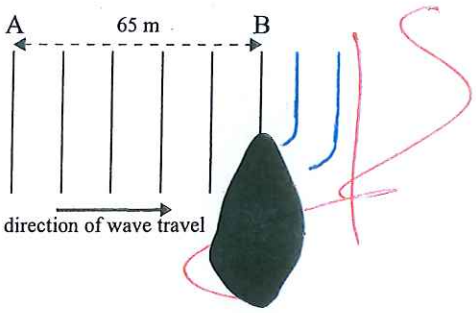
The diagram below shows water waves travelling towards a large rock near the shore line.



(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.

$\frac{65}{5} = 13\ m$

Wavelength: 13 m

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

Calculate the speed of the waves in water.

$v = f\lambda$

$= 0.25 \times 13$

$= 3.25\ ms^{-1}$

Speed: 3.25 ms-1

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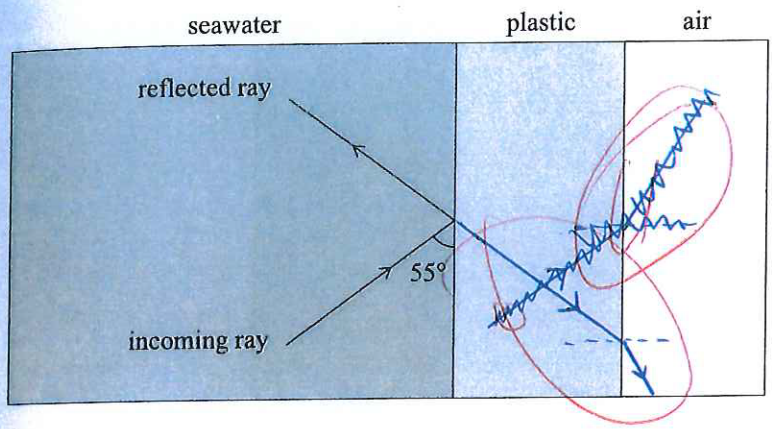
(d) When a person does underwater diving, light travels from the seawater through the plastic of a diver's mask to the eyes of the diver. The space between the mask and the diver's face contains air.

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°.

The angle of incidence is the angle between the normal (which is 90° to boundary surface) and the incident/incoming ray. Therefore angle of incidence is 90 - 55 = 35°. The ~~incident~~ angle of incidence equals angle of reflection so therefore it 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.

The speed of the ~~ray~~ reflected ray and incoming ray in seawater is the same. ~~This is because~~ The only thing different is that they travel in different directions. Speed is same as frequency and wavelength still same and ~~v~~ $v = f\lambda$.

A3

QUESTION THREE: REFLECTION

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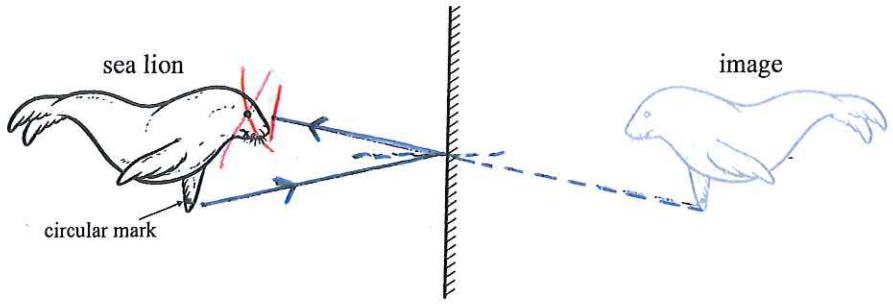
The photograph below shows a sea lion being reflected by the glass window of an underwater camera.

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 virtual image is something an image that we see that isn't actually really there and cannot be projected onto a screen. A real image ~~is~~ is able to be projected onto a screen.

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.

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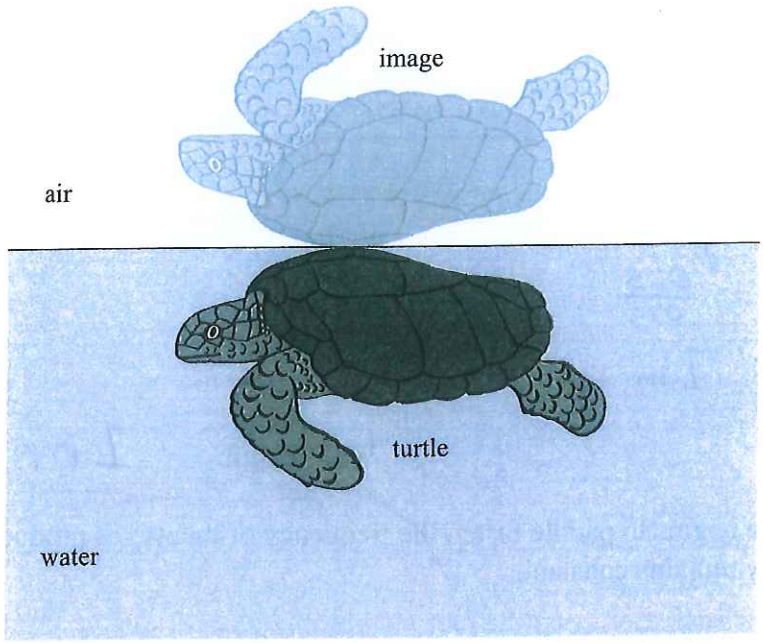

(c) Describe TWO conditions needed for total internal reflection to occur in the above diagram.

(1) The angle of incidence must be greater than the ~~dss~~ critical angle.

(2) The light needs to be travelling from a high refractive index to a low refractive index // (i.e. needs to be travelling from a more optically dense ~~to~~ substance to a less optically dense substance.)

Question Three continues on the following page.

(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.

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(i) Calculate the wavelength of the waves produced.

6 waves in 12 seconds = 0.5 waves in 1 second = 0.5Hz

15m in 30 s = 0.5 metres each second = $0.5 m s^{-1}$

$v = f\lambda$

$\therefore \lambda = \frac{v}{f}$

$= \frac{0.5}{0.5}$

$= 1 m$

Wavelength: 1m

(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.

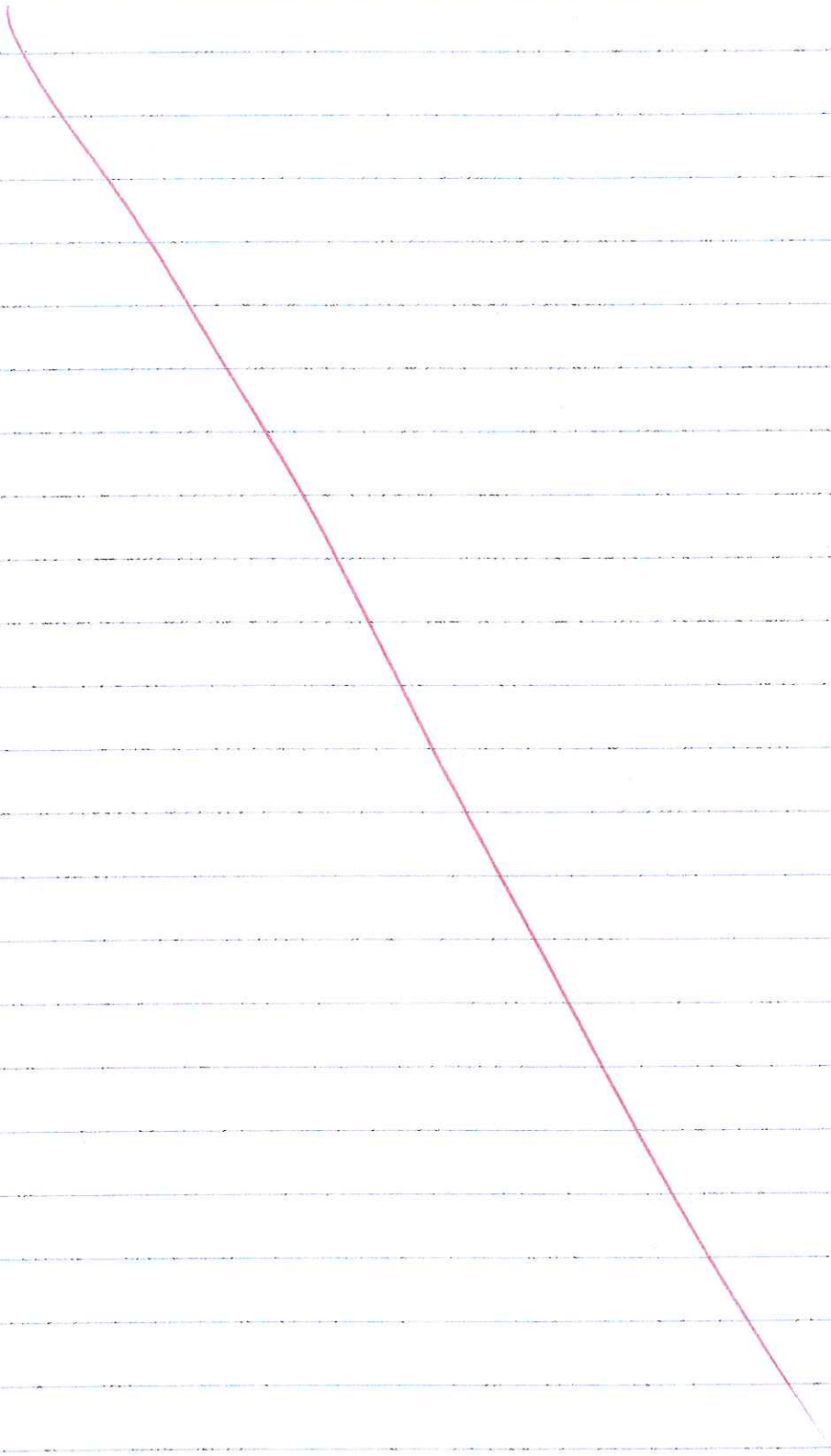
When the frequency of the wave doubles the ~~wavelength of~~ the wavelength halves. The higher the frequency the shorter the wavelength (and vice versa). This is because since frequency has increased it means more waves are produced each second, which therefore means the wavelengths will be shorter. (Frequency and wavelength are inversely proportional to each other)

M5

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

QUESTION NUMBER

ASSESSOR'S USE ONLY



Annotated Exemplars

Achieved exemplar for 90938 2015		Total score	12
Q	**Grade score**	**Annotation**	
1	A4	(a) (i) and (ii) **Achieved.** Correctly describes the wave as longitudinal but unclear explanation of why there are two full wavelengths (b) **Achieved.** For Merit the direction of the vibration of the particles needs to be parallel to the direction of the wave motion not the direction of travel (c) **Achieved.** Correct calculation of the time period using the information given but incorrect unit. (d) (i) and (ii) **Achieved.** Candidate has calculated a distance without halving the distance	
2	A3	(a) **Not Achieved.** For Achieved the diagram should show sufficient wave fronts to be able to determine whether the wave is diffracting in the correct manner and whether 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) **Achieved.** Correct explanation of the relationship between the angle of incidence, normal and angle of reflection but for Merit there also needs to be a correct ray diagram or a description that light does not change speed on reflection because the medium has not changed.	
3	M5	(a) **Not Achieved.** For Achieved, a diagram of one ray needs to be drawn including 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) **Not Achieved.** For Achieved one of the conditions for Total Internal reflection needs to be stated correctly. (d) (i) and (ii) **Excellence.** Correct calculation of the wavelength with appropriate units and a correct explanation regarding the wavelength change.	