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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.

Merit

TOTAL 18

ASSESSOR'S USE ONLY

QUESTION ONE: SOUND WAVES

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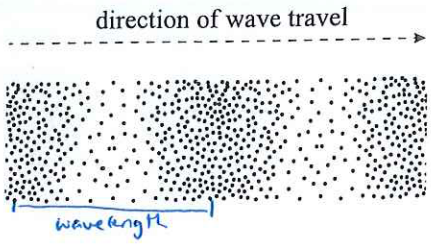
The diagram below represents sound waves travelling through a medium.



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

A longitudinal wave and also a mechanical wave. ✓

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

Give a reason for your answer.

There are two full wavelengths shown in the diagram becase ~~[illegible]~~ wavelength is measured from two identical points on adjacent waves. There are 3 compressions shown so therefore there are two ~~two~~ full wavelengths shown. ~~[illegible]~~ ✓

M

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

~~[illegible]~~ Overall there is no net movement (they just provide transport for the energy) by of particals in the medium, ~~as~~ ~~because the wave is~~ moving parallel to the wave direction the wave is travelling in through compression and rarefaction. In comparison to the wave itself which is ~~moving parallel to the~~ the energy travelling to the right. ✓

a

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.

$T = 1/f$

$= 1/150{,}000$

$= 6.67 \times 10^{-6}$ s

Period: 6.67×10^{-6} s

M.

(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. $V = d/t$

The time of the echo includes getting to the fish and getting back to the dolphin

① $\therefore t = 0.060 \div 2$

$t = 0.030$

② $V_{\text{in water}} = 343 \times V_{\text{air}}$

$= 343 \times 4.5$

$= 1543.5 \text{ m s}^{-1}$

③ $v = d/t$

$d = vt$

$= 1543.5 \times 0.030$

$= 46.31$ m

Distance: 46.31 m

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

A dolphin is able to distinguish between a near object and a far one because, ~~the near object will take~~ it will take less time for ~~the dolphin to get~~ the echo of a near object to reach the dolphin where as the echo from a far object will take more time to reach the dolphin.

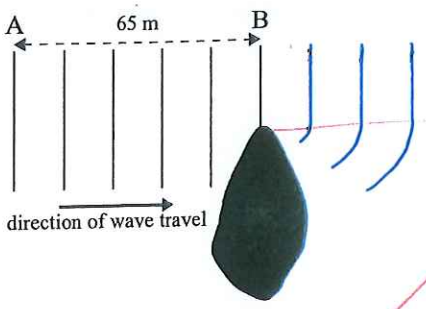
E

E8

ASSESSOR'S USE ONLY

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.

wavelength = distance from identical points on adjacent waves

5 waves present

$\therefore \lambda = 65 \div 5$

$= 13\text{ m}$

Wavelength: 13 m

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

Calculate the speed of the waves in water.

$v = f\lambda$

$v = 0.25 \times 13$

$= 3.25\text{ m s}^{-1}$

Speed: 3.25 m s^{-1}

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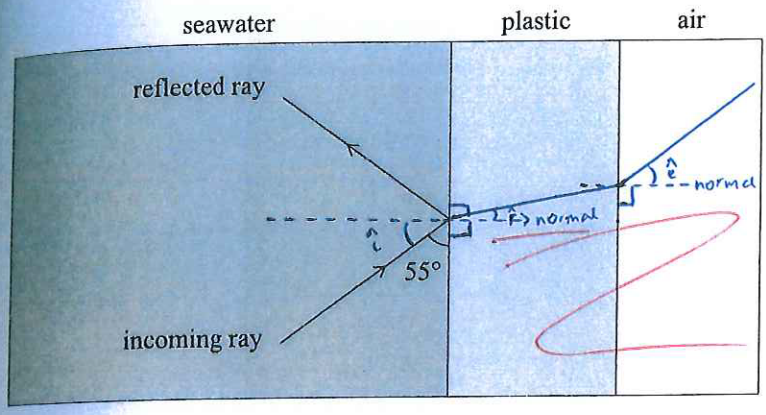
(d) When a person does underwater diving, light travels from the seawater through the plastic of a diver's mask to the eyes of the diver. The space between the mask and the diver's face contains air.

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°.

Because the $\hat{i} = \hat{r}$. The $\hat{i}$ and $\hat{r}$ are always measured from the normal so $\hat{i} = 35°$ and therefore ~~because the $\hat{r}$ is always~~ $\hat{r} = 35°$.

(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.

M

(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 reflected ray is the same as the incoming ray because the frequency and wavelength have not changed as a result of reflection, but rather the amplitude (which is a measure of energy) of the wave has changed so the reflected ray will be less bright than the incoming ray but the speed of the light ray will not have changed

M6

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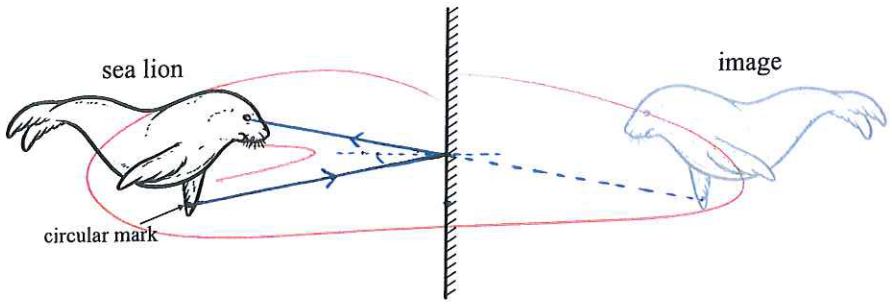
QUESTION THREE: REFLECTION

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.

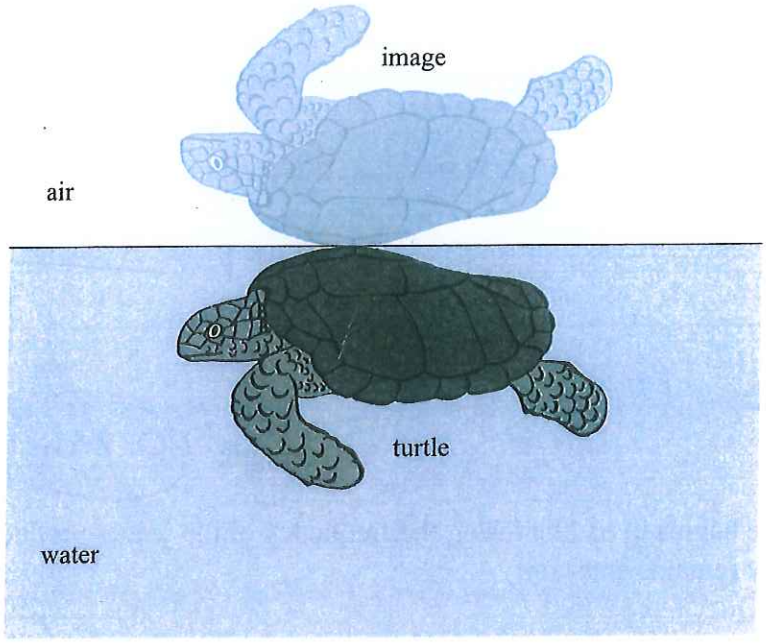
State how a virtual image is different from a real image.

- The virtual image is not real
- The virtual image cannot be projected onto another surface but the real image can.

a

ASSESSOR'S USE ONLY

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 light ray must hit a boundary / interface from a higher optical density to a lower optical density.

The light ray must be traveling through the high optical density and refract at the boundary to the lower optical density. So must be from boundary from water to air.

(2) The angle of incidence (of the light rays reflected off the turtle) must be greater than the critical angle.

PT

M

Question Three continues on the following page.

ASSESSOR USE ONLY

(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.

$v = f\lambda$

① $v = d/t$

$v = 15/30$

$v = 0.5\,ms^{-1}$

② $f = 6$ waves per 12 seconds

$= 12/6$

$= 2\,Hz$

③ $v = f\lambda$

$\lambda = v/f$

$= 0.5/2$

$\lambda = 0.25\,m$

Wavelength: 0.25m

(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 changes when the frequency of the wave doubles because an increase in frequency means that more waves are passing a point per second. This means that ~~assuming that the speed of wave remained constant)~~ that in order for more waves (assuming the speed of the wave remained constant) in order for there to be more waves passing a point per second, the wavelength ~~was~~ of the waves must have decreased.

a

A4

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

QUESTION NUMBER

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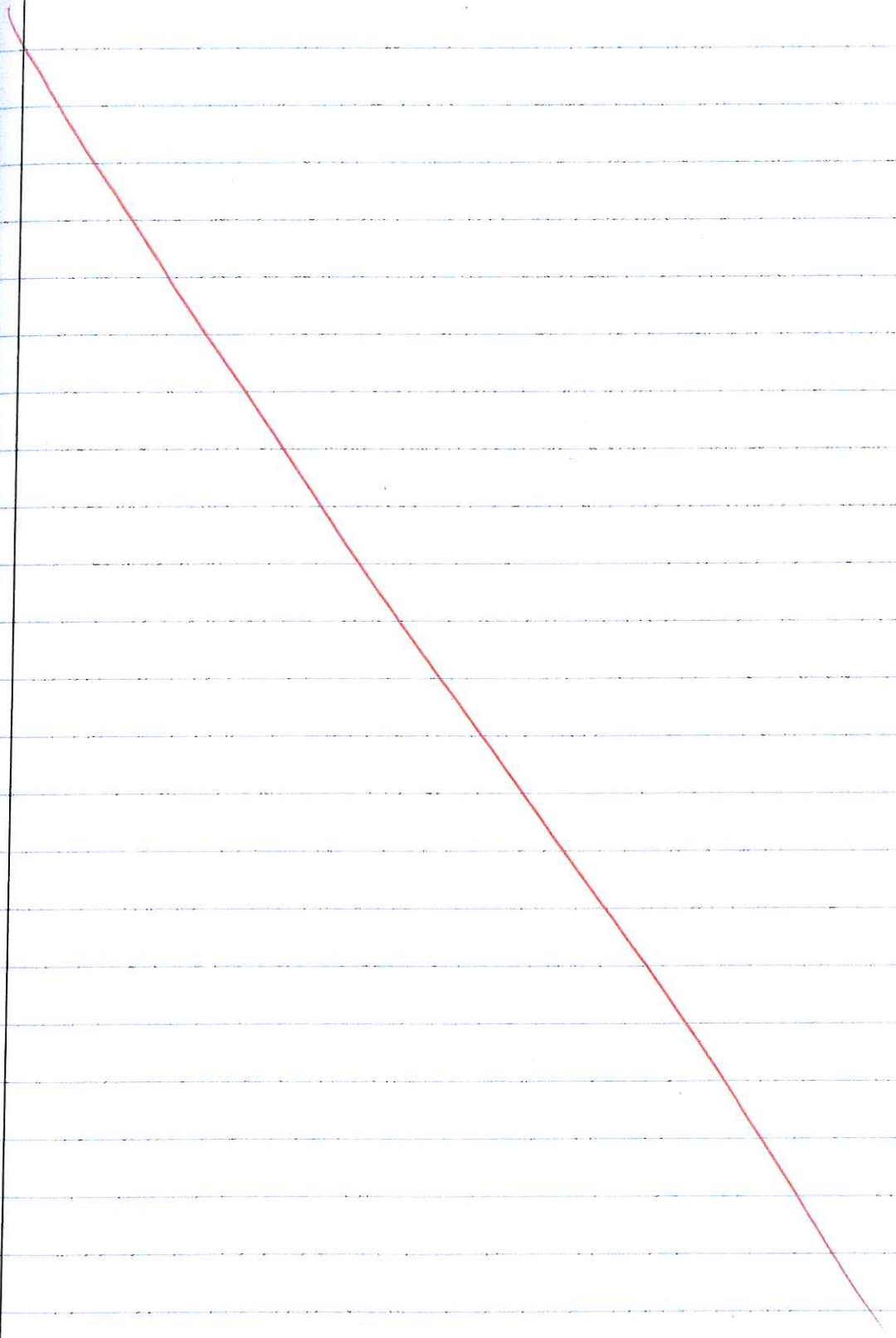

Annotated Exemplars

Merit exemplar for 90938 2015		Total score	18
Q	**Grade score**	**Annotation**	
1	E8	(a) (i) and (ii) **Merit.** Correctly describes the wave as longitudinal and clear 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 *movement* of the particles (c) **Merit.** Correct calculation of the time period using the information given with correct unit. (d) (i) and (ii) **Excellence.** Correct calculation of distance and a full (includes a bit of flipper story) explanation of how the dolphin distinguishes the two object	
2	M6	(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) **Merit.** Correct ray diagram and a description that light does not change speed on reflection because the medium has not changed but for Excellence there also needs to be correct explanation of the relationship between the angle of incidence, normal and angle of reflection	
3	A4	(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) **Merit.** Both of the conditions for Total Internal reflection are stated correctly. (d) (i) and (ii) **Achieved.** Correct calculation of the wave speed but incorrect wavelength calculated and only partial explanation regarding the wavelength change.	