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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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SUPERVISOR'S USE ONLY

Level 1 Physics, 2014

90938 Demonstrate understanding of aspects of wave behaviour

2.00 pm Tuesday 25 November 2014
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 2–12 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: GEOLOGICAL SURVEY

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A speaker produces a sound wave.

(a) (i) Describe what a wave is.

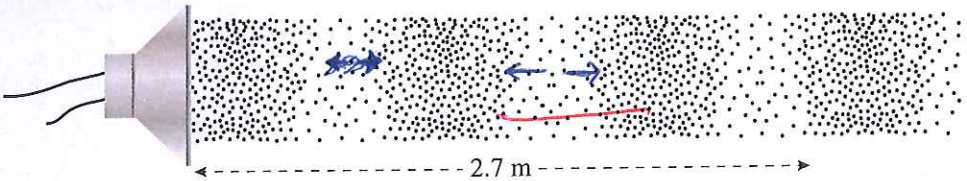
A wave is the movement of energy ~~by the~~ ~~wave~~ that is created by a force disturbing matter.

(ii) Using a physics idea, describe the function of a wave.

The function of a ~~sound~~ light wave in a fibre optic cable is to ~~transmit~~ transfer ~~energy~~ information that is ~~coded~~ stored in the wave.

a

(b) When a speaker produces a particular frequency of sound, the air particles in front of the speaker produce a pattern as shown in the diagram below.



(i) On the diagram above, draw arrow(s) to show the direction of movement of an air particle associated with the sound produced by the speaker.

(ii) From the information given in the diagram, calculate the wavelength of the sound wave in air produced by the speaker.

number of waves = 3

wavelength = $\frac{2.7}{3}$ = 0.9

Wavelength = ~~0.9m~~ 0.9m

m

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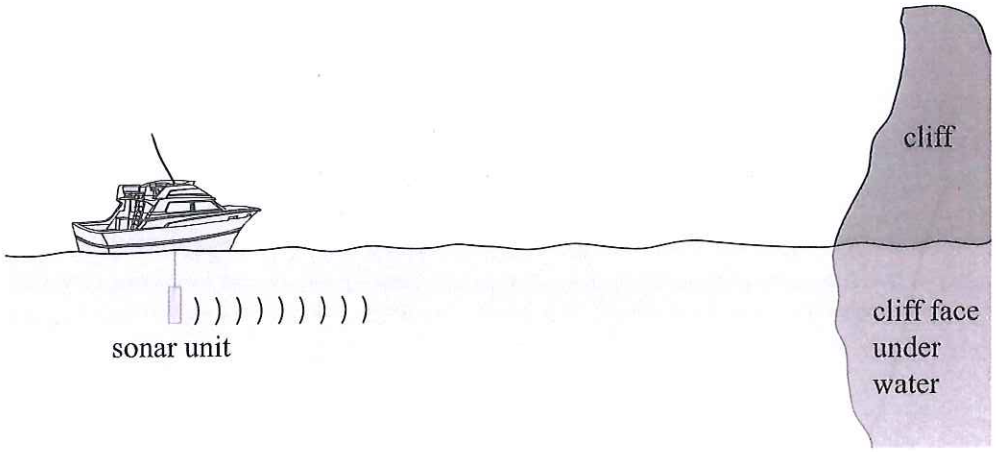
A scientist sets up a sonar unit to survey the water near a cliff. Part of the cliff face is submerged in water, as shown in the diagram. The transmitter in the sonar unit sends a pulse towards the submerged cliff face. The receiver in the sonar unit picks up the reflected pulse from the submerged cliff face 0.54 s later. The frequency of the sonar pulse is 10 kHz and its wavelength is 0.153 m.



(c) Calculate the distance between the sonar transmitter and the cliff face under water.

$f = 10\ kHz = 10,000\ Hz$ $\quad t = 0.54s$

$\lambda = 0.153m$ $\quad v = \frac{d}{t}$

$v = f\lambda = 10,000 \times 0.153$ $\quad d = vt$

$= 1530\ ms^{-1}$ $\quad d = 1530 \times 0.54$

$d = 826.2$

m

Distance = 826.2m

When an object is thrown into water, it creates waves on the surface of the water. The amplitude of the waves decreases as they travel outwards. The sketch below shows the amplitude against distance for the first wave.

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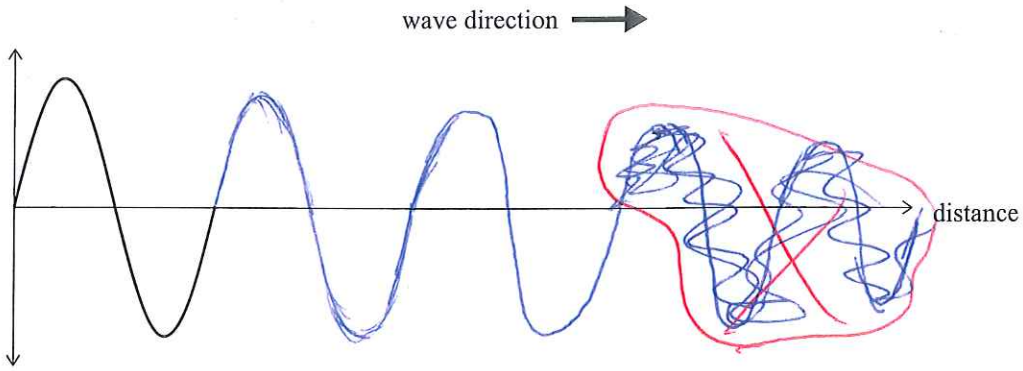
(d) (i) Complete the diagram by drawing the next two complete cycles of the wave as it travels outwards.



(ii) Using physics ideas, explain why the amplitude of the wave decreases as it travels outwards.

a

The amplitude of a wave represents the amount of energy. ~~that~~ As the wave travels some of the energy is lost. Because energy is being lost the amplitude decreases.

M5

QUESTION TWO: BEHAVIOUR OF SOUND WAVE

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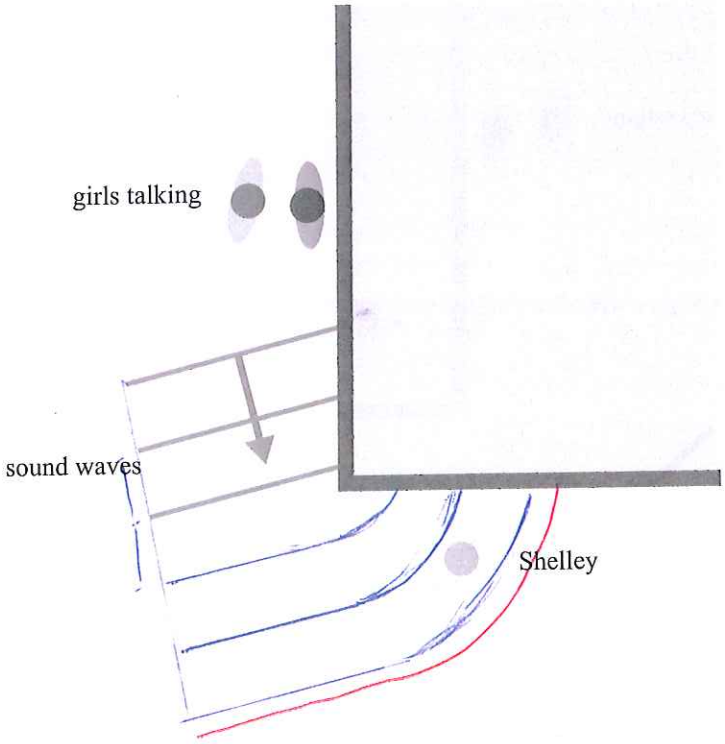
The diagram below shows two friends talking to each other next to a gymnasium wall. Shelley is standing near the corner of the gymnasium building. She can hear her friends around the corner, even though she cannot see them.



(a) Complete the diagrams to show how the sound waves diffract around the corner to reach Shelley's ear.

M

(b) Shelley notices that she is able to hear low frequency sounds from the girls' chat more loudly than high frequency sounds.

Explain why the low frequency sounds from the girls' chat are heard more loudly than the high frequency sounds.

Low frequency waves have longer wavelengths than higher frequency waves ($v = f\lambda$, $f \propto \frac{1}{\lambda}$). The longer wavelengths bend around the corner much more than the shorter wavelengths.
Because of this, Shelley hears lower frequency sounds louder than higher frequency sounds.

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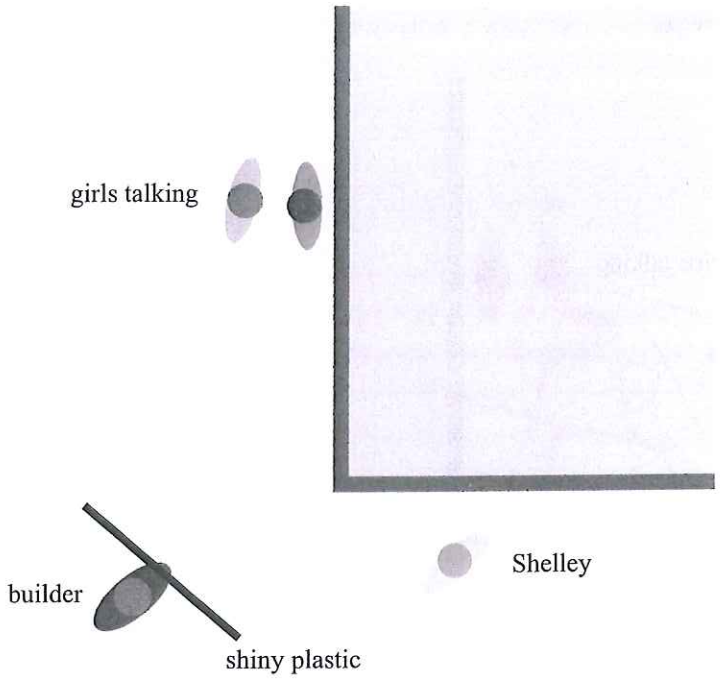
(c) When a builder carrying a large **shiny plastic board** passes by the corner of the gymnasium building, as shown in the diagram, the sound waves are reflected off the board towards Shelley.



Explain how the sound heard by Shelley in the above situation is different from the sound heard due to diffraction in the previous situation.

The sound heard by Shelley is ~~natural~~ louder ~~than~~ in the above situation.

(d) Explain how the phenomena diffraction and reflection, affect the amplitude and direction of the sound waves.

(i) the amplitude of the waves

The shiny plastic helps reflect ~~some of~~ the waves towards Shelley. The shiny surface helps reduce the energy lost and so helps maintain the amplitude. Only some of the sound waves are diffracted towards Shelley.

(ii) the direction of the waves

The corner of the gym causes the sound waves to bend around the corner, changing its direction. The shiny plastic reflects ~~some of~~ the waves, changing the direction.

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2

M5

QUESTION THREE: ELECTROMAGNETIC WAVES

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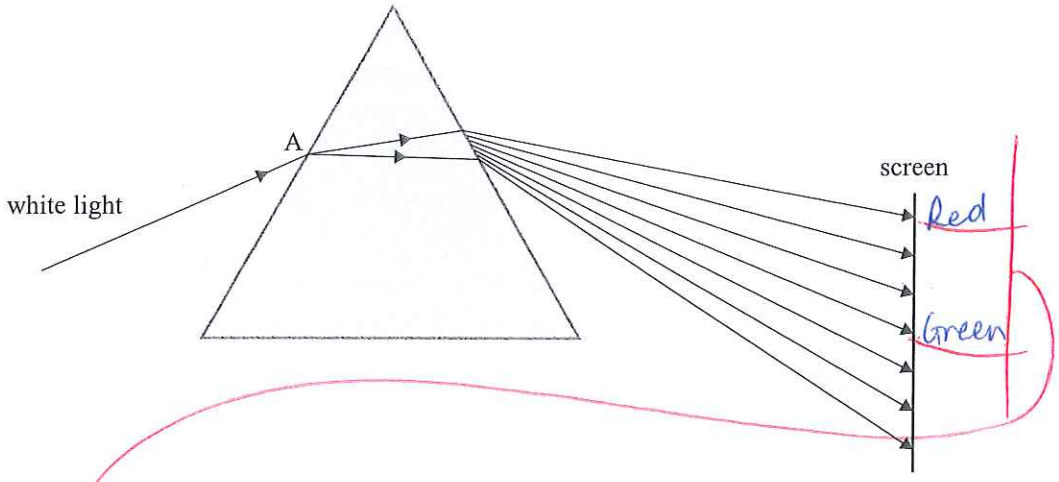
The diagram below shows a ray of white light entering a prism at point A.



(a) State the TWO phenomena that take place as the incident ray **enters** the prism at point A.

~~Reflection~~ 3 Refraction
Transmission

a

(b) (i) On the diagram above, label the position of the red and green rays on the screen.

(ii) Explain why the light splits up in this way.

~~Each~~ White light consists of different coloured ~~light~~ light waves. Each wave has a different wavelength, red being the shortest of the colours ~~and~~ in the visible spectrum. Because of the different wavelengths each refracts at a different angle. Because the prism sides are not parallel this causes the light rays to seperate (split up).

a

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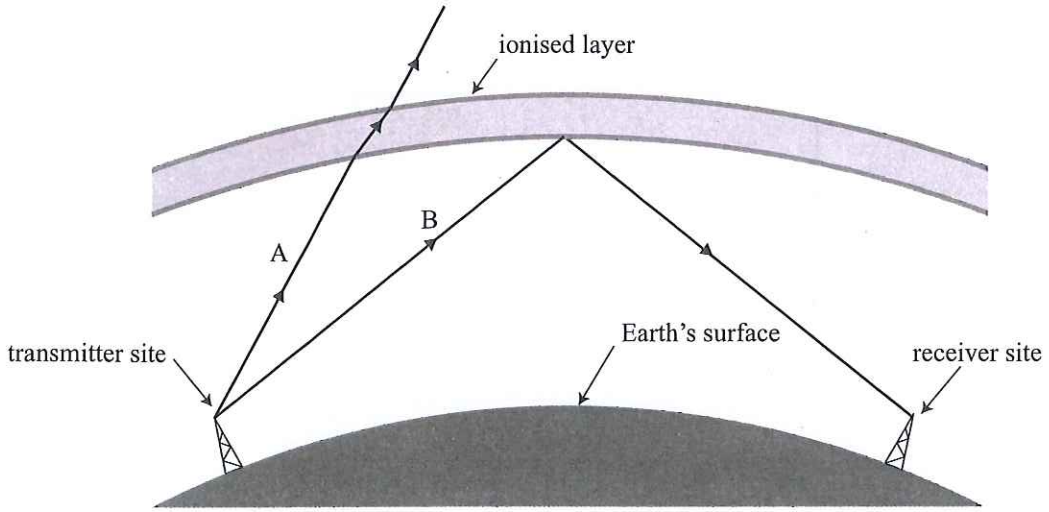
Radio waves travel in straight lines. Long-distance radio communication between distant locations on the Earth's surface is possible due to the existence of the ionised layer of the Earth's atmosphere. Two radio waves, A and B, are broadcast from the surface of the Earth. When the radio waves reach the ionised layer of the Earth's atmosphere, ray A travels into space and ray B bounces back towards the Earth's surface, as shown in the diagram.



(c) (i) Name the phenomenon that causes ray B to bounce back towards the Earth's surface.

Total internal reflection.

(ii) In terms of the optical properties of the ionised layer, discuss why ray B bounces back towards the Earth's surface, while ray A is transmitted.

e

The ionised layer is less optically dense than the atmosphere. The angle of incidence of radio wave A is ~~too small for total inter~~ smaller than the critical angle ~~of~~ of the air and so refracts and ~~escapes~~ transmits. The angle of incidence of Ray B is greater than the critical angle and so it is reflected completely.

(d) The diagram below shows the true positions of the Sun from sunrise to midday. Light reaching the Earth from the Sun has to pass through the Earth's atmosphere. The atmosphere is **optically denser** than the space outside the atmosphere.

Adapted from: http://jeweell.com/data_images/out/75/1134759-earth.jpg

(i) Complete the diagram showing the path of the ray from the mid-morning sun after it enters the atmosphere.

(ii) On the diagram, draw the **apparent position** of the mid-morning sun, as seen by the viewer on Earth.

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(iii) The angle of incidence of the light hitting the atmosphere decreases from sunrise to midday.

Explain how the **apparent position** of the Sun as seen from the Earth changes between sunrise and midday compared to its true position.

You may make sketches on the diagram to aid your answers.

As the angle of incidence decreases, the ~~apparent~~ distance between the apparent position and true position decreases. At sunrise the large angle of incidence results in the ~~per~~ apparent position being close to the actual position (see diagram). As the angle of incidence ~~incre~~ decreases the angle of refraction decreases, causing the apparent position to be closer to the true position.

M

E7

Merit exemplar for 90938 2014		Total score	17
Q	**Grade score**	**Annotation**	
1	M5	(a) **Achievement.** For Achievement, the description of the wave needs to include the term disturbance or the idea that waves carry energy. For Merit, there needs to be a clear idea that there is no transmission of matter (only energy) – which in this case there was not. (b) **Merit.** The direction of movement of air particles has been shown to be both to the right and the left and the wavelength has been correctly calculated by the length of the waves shown (2.7) divided by the number of waves (3) = 0.90m. (c) **Merit.** The distance between the cliff and the transmitter is incorrectly calculated as 826 m (as opposed to the Excellence answer which includes halving the time). (d) **Achievement.** There are two ideas correct here – either worth an Achievement. There is a clear decreasing of amplitude of the wave but the wavelength of the drawn wave is inconsistent AND there is a description that the wave loses energy but no mechanism causing the energy loss is described.	
2	M5	(a) **Merit.** The diagram shows the wave diffracting AND the wavelength of the wave before and after striking the obstacle is consistent. (b) **Merit.** There is the correct idea that low frequency waves have a longer wavelength and there is discussion of that lower wavelength diffract more than shorter wavelength but no discussion on the effect of this on what Shelley hears. (c) **Achievement.** There is a comparison between diffraction versus reflection, but there is no attempt to explain why the reflected sound is louder based on different frequencies. (d) **Not Achieved.** For Achievement, there needs to be discussion of the effects both of reflection and diffraction on the amplitude OR the effects both of reflection and diffraction on the direction of the wave.	
3	E7	(a) **Achievement.** Correctly states one of the phenomena (refraction). (b) **Achievement.** Correctly identifies position of red and green rays but does not explain dispersion well. (c) **Excellence.** Identifies phenomena as Total Internal Reflection and correctly describes the main aspects of Total Internal Reflection. (d) **Merit.** Completes the diagram and correctly draws the apparent position but doesn't quite explain the change in apparent position between sunrise and midday.	