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NEW ZEALAND QUALIFICATIONS AUTHORITY
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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.

Excellence

TOTAL 22

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QUESTION ONE: GEOLOGICAL SURVEY

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A speaker produces a sound wave.

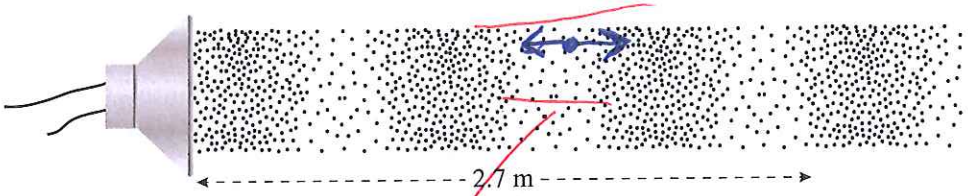
(a) (i) Describe what a wave is.

A wave is a transfer of energy through particle oscillations.

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

A wave helps to transfer energy from one place to another so that conservation of energy is kept.

(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.

2.7m = 3 waves

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

Wavelength = 0.9m

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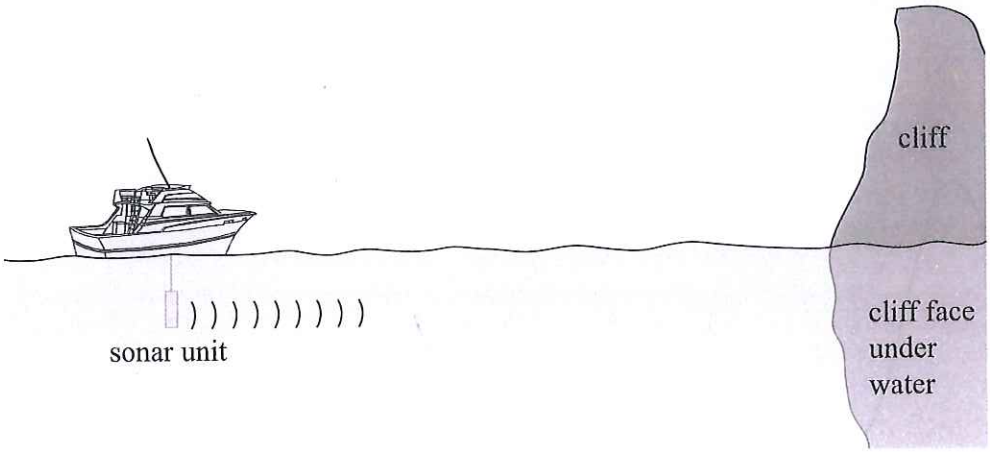
A scientist sets up a sonar unit to survey the water near a cliff. Part of the cliff face is submerged in water, as shown in the diagram. The transmitter in the sonar unit sends a pulse towards the submerged cliff face. The receiver in the sonar unit picks up the reflected pulse from the submerged cliff 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.

0.54s both ways so 0.27s one way

$v = f\lambda$

$= 10\,000 \times 0.153$

$= 1530\ ms^{-1}$

$v = \frac{d}{t}$ $d = vt$

$= 1530 \times 0.27$

Distance = 413.1 m

e

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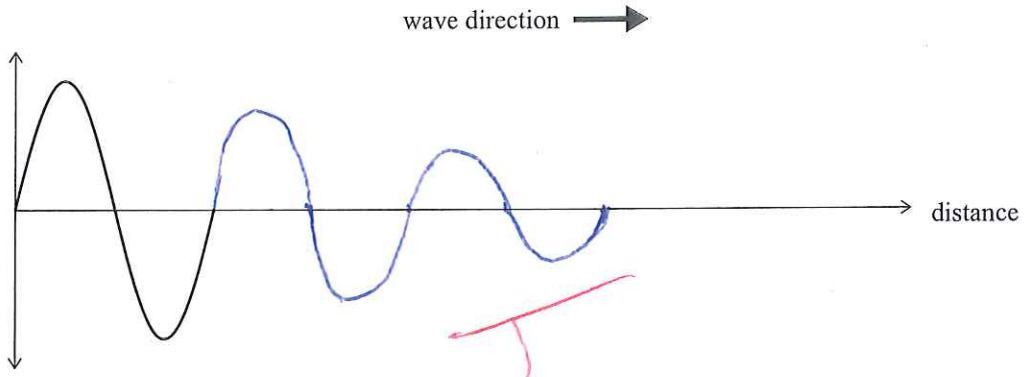
(d) (i) Complete the diagram by drawing the next two complete cycles of the wave as it travels outwards.



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

Amplitude is a measure of how much energy a wave has. As the wave travels outwards, the initial energy of the wave is not maintained as energy is lost to other forms so the energy in the wave decreases, so the amplitude decreases as the wave travels outwards.

M

E7

QUESTION TWO: BEHAVIOUR OF SOUND WAVE

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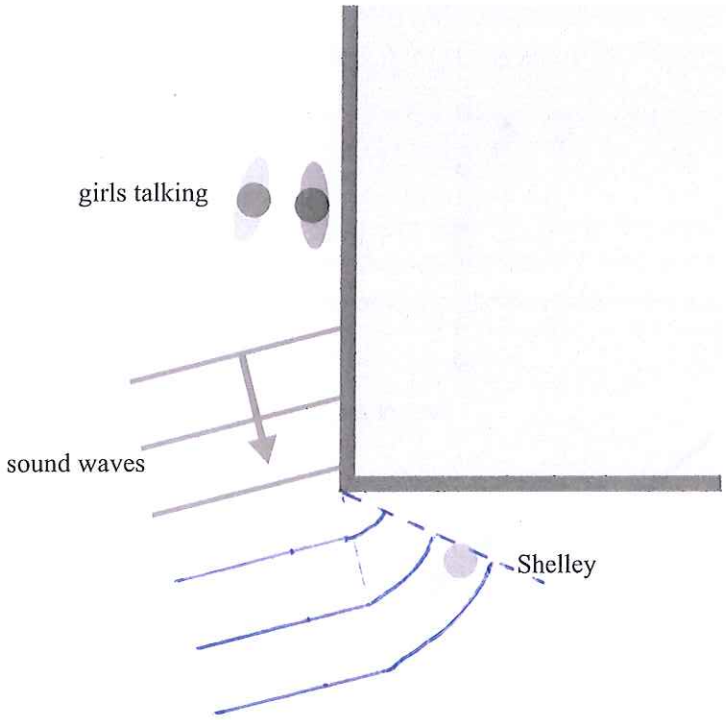
The diagram below shows two friends talking to each other next to a gymnasium wall. Shelley is standing near the corner of the gymnasium building. She can hear her friends around the corner, even though she cannot see them.



M

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

(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 sounds have a higher wavelength since the wave velocity is the same ($v = \lambda f$, λ and f are inversely proportional) Larger wavelengths will diffract around the corner more than shorter wavelengths (of the high frequency sounds) so the sound waves with the larger wavelengths will be heard more easily. This is why the low frequency sounds (which have long wavelengths) will be heard more loudly than high frequency

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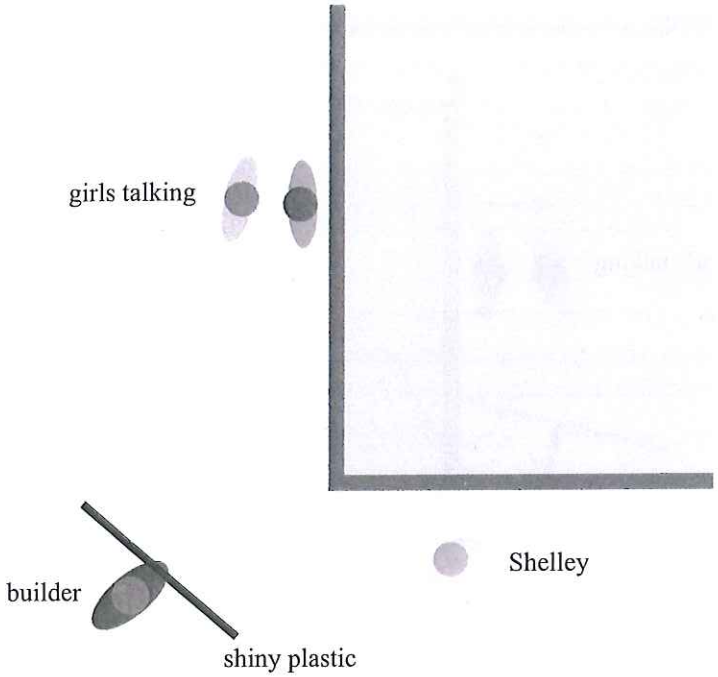
(c) When a builder carrying a large **shiny plastic board** passes by the corner of the gymnasium building, as shown in the diagram, the sound waves are reflected off the board towards Shelley.



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

She will be able to hear all frequency sounds equally this time (as opposed to mainly low frequency last time) because all wavelengths will travel to the plastic and reflect off it towards Shelley equally. because angle of incidence is equal to angle of reflection, no matter what the wavelength or frequency

M

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

(i) the amplitude of the waves

In both phenomena, the amplitude (energy) of the wave will decrease as energy is lost. In diffraction there is energy in the wave spread over a larger area/front. In reflection, energy is lost when the wave is reflected off the plastic, not all energy in the wave is maintained.

(ii) the direction of the waves

In reflection the whole wavefront reflects off and changes direction so that angle of incidence = angle of reflection (measured to the normal). In diffraction the wave direction continues in a line however some of the the wavefront will bend around the corner so this part of the wave will be travelling in a slightly different direction.

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e

E7

QUESTION THREE: ELECTROMAGNETIC WAVES

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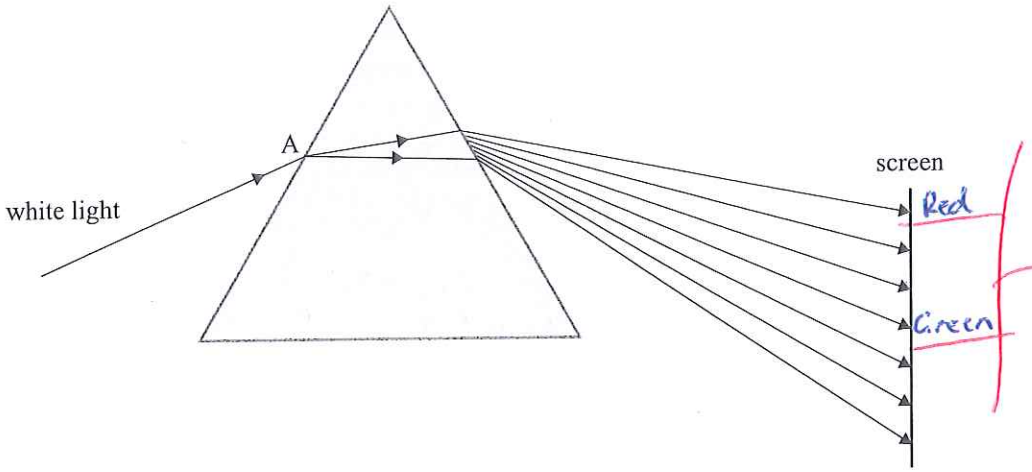
The diagram below shows a ray of white light entering a prism at point A.



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

Refraction of light in a new medium and
Dispersion of white light into different wavelengths (colours) a

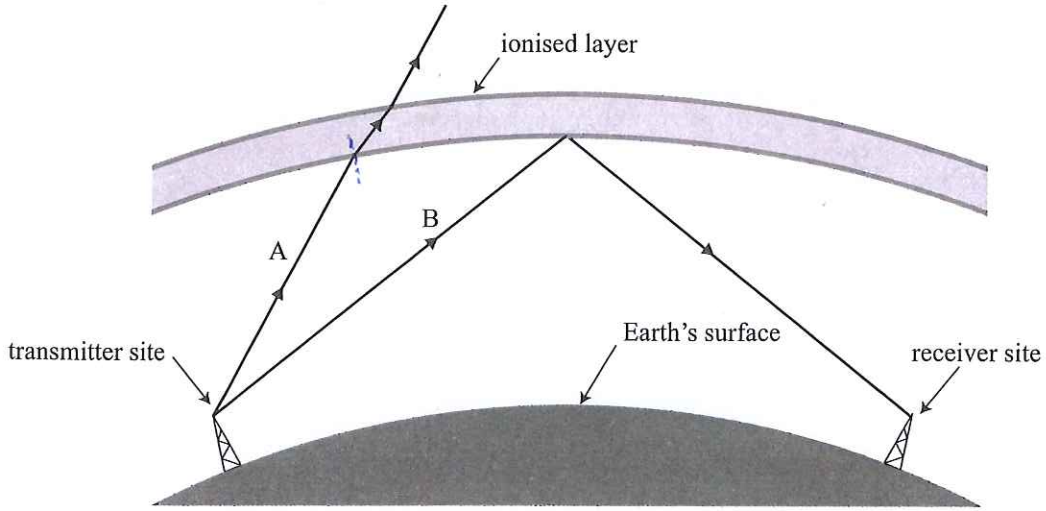
(b) (i) On the diagram above, label the position of the red and green rays on the screen.

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

White light is made up of different colours of light in the spectrum which have all different wavelengths.
When the white light enters the prism, the various wavelengths of light change velocity different amounts and so refract at different amounts
Red light (long wavelength) refracts/bends the least whi
Violet light (very short wavelength) refracts/bends the most. m

ASSESSOR'S USE ONLY

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.

The ionised layer ~~is~~ is less optically dense than the earths atmosphere. The incidence angle of A is less than the 'critical' angle so refracts in and out of the ionised layer into space. Then Ray B has a larger incidence angle than Ray A larger than the critical angle, so tries to refract away from normal but the angle of refraction would be greater than 90° so instead the ray is reflected off the less optically dense medium as if it has hit a plane mirror so angle of incidence = angle of reflection.

e

(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.

For copyright reasons, this image cannot be reproduced here.

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.

ASSESSOR'S USE ONLY

(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.

At sunrise, there is a high incidence angle so relatively high refracted angle. This will make the apparent position of the sun alot further up in the sky than it actual position. As the morning goes on the amount of refraction that occurs will decrease as the angle of incidence decreases. At Midday, the sun is direct overhead so angle of incidence = 0° so angle no no refraction occurs so the apparent position of the sun is exactly where the sun is

e.

E8

Excellence exemplar for 90938 2014		Total score	22
Q	**Grade score**	**Annotation**	
1	E7	(a) **Achievement.** For Achievement, the description of the wave needed to include the term disturbance or the idea that waves carry energy. For Merit, there needed 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) **Excellence.** The distance between the cliff and the transmitter is correctly calculated as 413 m. (d) **Merit.** There is a clear decreasing of amplitude of the wave and an attempt to draw the wavelength of the wave remaining constant has been made and backed up in the written description.	
2	E7	(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) **Merit.** There is a comparison between diffraction versus reflection including the idea that the reflected sound has all of the different frequencies (and the diffracted does not). (d) **Excellence.** There is a discussion of the effects both of reflection and diffraction on the amplitude AND the effects both of reflection and diffraction on the direction of the wave. Also, the effect of reflection on the direction of the wave is explained using Physics.	
3	E8	(a) **Achievement.** Correctly states both of the phenomena. (b) **Merit.** Correctly identifies position of red and green rays and explains dispersion correctly. (c) **Excellence.** Identifies phenomena as Total Internal Reflection and correctly describes the main aspects of Total Internal Reflection. (d) **Excellence.** Completes the diagram and correctly draws the apparent position and correctly explains the change in apparent position between sunrise and midday.	