1

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90938

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NEW ZEALAND QUALIFICATIONS AUTHORITY
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Level 1 Physics, 2016

90938 Demonstrate understanding of aspects of wave behaviour

2.00 p.m. Tuesday 15 November 2016
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 2–14 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: WAVE PROPERTIES

(a) There are two types of waves, longitudinal and transverse.

Give an example of each.

Longitudinal: Sound waves.

Transverse: Light waves.

(b) Explain the differences between a longitudinal and a transverse wave.

Your answer should include:

- how the particles in the wave move
- how the wave travels.

The particles in ~~B~~ longitudinal waves vibrate parallel to the direction the wave is travelling in. This means that the Particles in the longitudinal wave can be travelling in the same direction or the opposite direction the wave is travelling in. ~~or to the~~

Transverse waves however, oscillate ~~perpendicular 90°~~ ~~at~~ 90° ~~at~~ (perpendicular) to the direction the wave is travelling in. ~~B longitudinal~~

~~All~~ All Longitudinal waves require a medium to travel ~~to~~ through, whereas ~~transverse waves do not~~, not all transverse waves require a medium to travel through.

(c) A circuit that has an alternating current is connected to an oscilloscope. The oscilloscope screen displays a waveform of the alternating current, as shown below.

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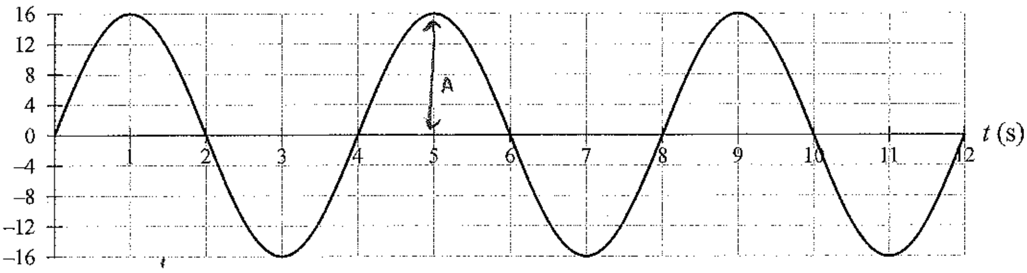
(i) On the diagram, **draw** and **label** the amplitude of the wave. Amplitude – A

If you need to redraw your response, use the diagram on page 11.



(ii) Use the information in the diagram above to determine the **frequency** of the wave.

Give a unit with your answer.

$f = \frac{2}{8} =$ 0.25

Frequency: 0.25 Unit: Hz

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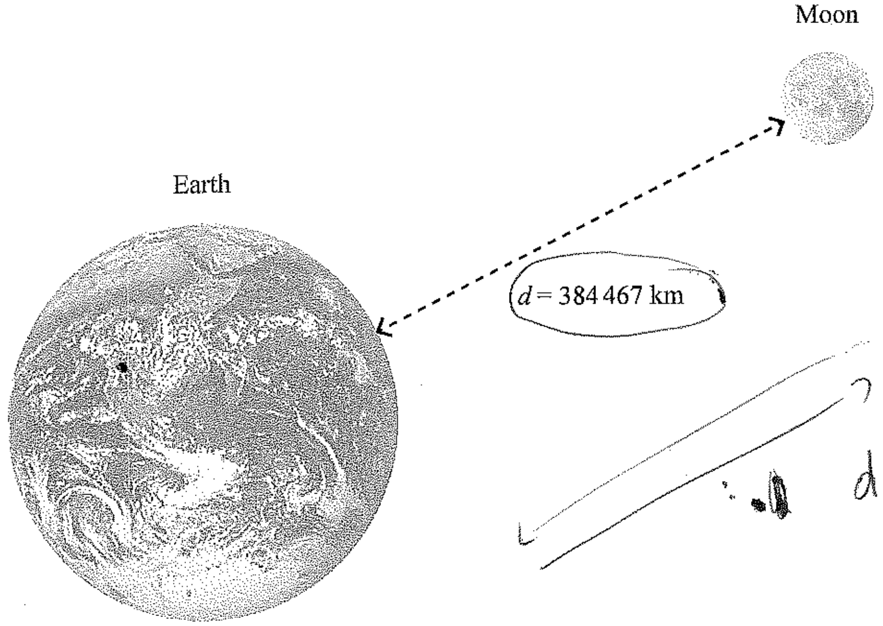
(d) Scientists have been able to calculate the distance between the Earth and the Moon by shining a red laser from Earth and reflecting the red laser on a mirror left on the Moon by the Apollo 11 mission back to a receiver on Earth.



(i) The scientists are using a red laser with a wavelength of 6.5×10^{-7} m and a period of 2.17×10^{-15} s.

Show that the speed of the red laser light is 3.0×10^{8} m s^{-1}.

$f = \frac{1}{T} = 1 \div (2.17 \times 10^{-15})$

$= 4.6083 \times 10^{14}$ Hz

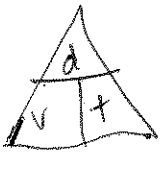
$v = f\lambda = (4.6083 \times 10^{14}) \times (6.5 \times 10^{-7})$

$= 3.0 \times 10^{8}$ m s^{-1}

(ii) The distance between the Earth and the Moon is 384 467 km. → 384 467 000 m

Calculate the time it takes for the laser light to leave Earth and return to hit the receiver.

$v = \frac{d}{t}$ $t = d/v$ $(384\,467\,000 \times 2) \div (3.0 \times 10^8)$



Time: 2.56 s

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E7

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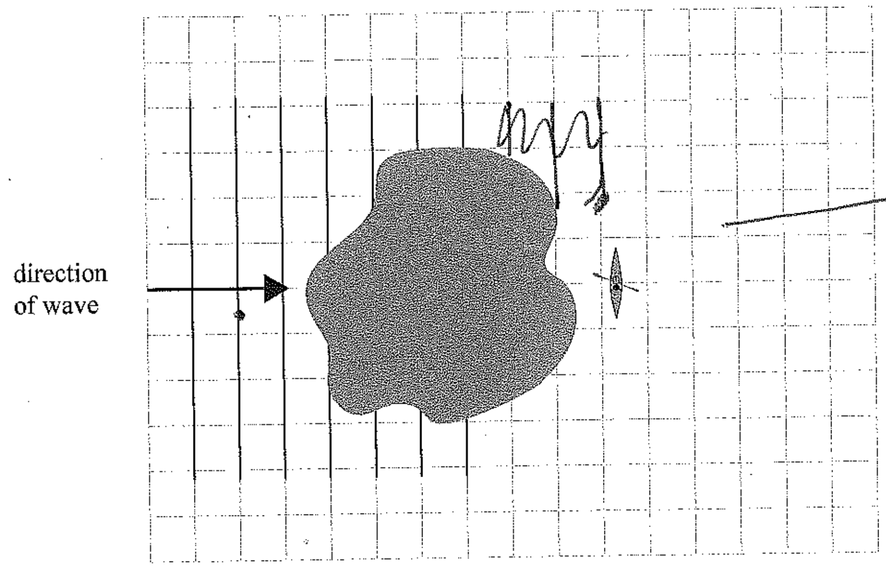
QUESTION TWO: WATER AND LIGHT

(a) While sea kayaking, people can go behind small islands for safety from large ocean waves.

Complete the diagram below to show how the waves travel around the small island.



If you need to redraw your response, use the diagram on page 11.

2

(b) (i) With help from the diagram in (a), explain why a kayaker would go behind the island for safety.

when waves diffract around a barrier (ie the island) the waves lose energy (the amplitude of the wave decreases), hence once the water waves diffract ~~around the~~ around the island, the intensity of the waves will be smaller than before the waves diffracted around the island. This means that the waves behind the the islands will not be so large.

(ii) As the kayaker is watching the waves pass from behind the island, he counts 6 waves in 4 seconds.

Calculate the period of the wave.

$T = \frac{4}{6}$

Period: 0.67 s

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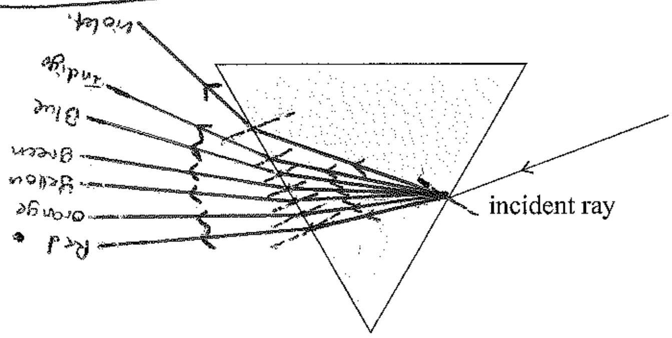
(c) The kayaker notices a mist from the water that is creating a rainbow. He remembers from science class that white light can be separated into the colours of the rainbow if it goes through a prism.

Complete the diagram below to show how white light is being separated into its different colours.

Draw and label all seven colours.



If you need to redraw your response, use the diagram on page 11.

(d) The prism has an optical density that increases as the frequency of the light increases.

Explain why the prism alters the path of **red** and **blue** light differently, as you have drawn in the diagram above.

Red has a longer ~~a~~ wavelength than blue light, ie has a lower frequency than blue, hence will have a ~~R~~ lower optical density (Refractive index) in the prism than blue ~~R~~ light, hence red light will slow down ~~more in the prism~~ less than blue light when entering the prism, ie ~~red~~ ~~red light will~~ blue light will bend more towards the normal than red light. ~~Because red light~~ ~~when~~ ~~Therefore~~ Therefore ~~once through~~ the red and blue light ~~go~~ ~~travel~~ are travelling in different directions ~~when~~ in the prism as ~~the each has bend~~ blue light bent towards the normal more than red light. ~~once the red light travels the prism it will bend away from~~ when the red and blue light leave the prism ~~and~~ and enter air, because all electromagnetic waves travel ~~at the~~ at $3 \times 10^8 ms^{-1}$ in air, red and blue will travel at the same speed in ~~the~~ air (both wavelengths have the same refractive index in air), ie blue light will bend more away from the normal than red light (both wavelengths will bend away from the normal when entering air as air is less optically dense than glass) ~~reason for~~ ~~the~~ because blue light will increase speed by a larger amount than red light in order to reach a speed of $3 \times 10^8 ms^{-1}$ (as blue light slowed down more than red light when entering the prism).

E8

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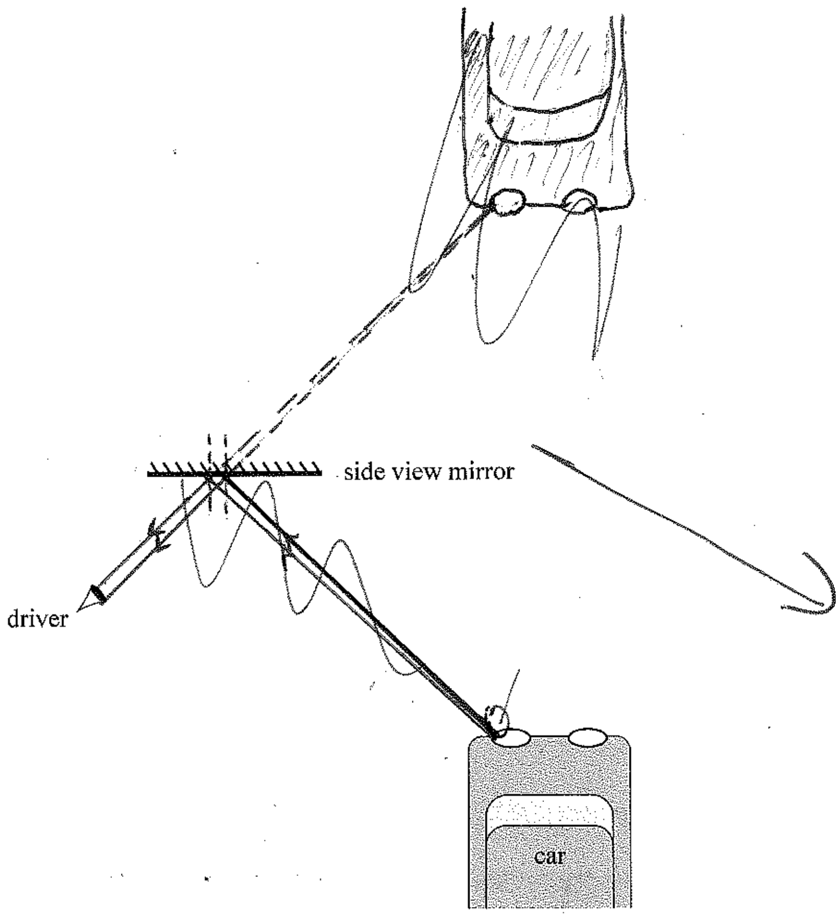
QUESTION THREE: CAR MIRRORS

Side mirrors on the outside of cars are designed to reflect light so the driver can see what is beside them.

(a) (i) Complete a ray diagram to show how the side view mirror allows the light to travel from the car to the driver.

Show where the image of the car is formed.



If you need to redraw your response, use the diagram on page 12.

2

(ii) On your diagram above, label ONE of the rays with the angle of incidence and the angle of reflection.

(iii) How does the angle of incidence compare with the angle of reflection?

The angle of incidence is equal to the angle of reflection.

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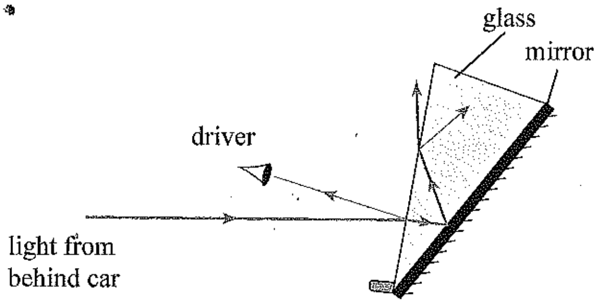
(b) Inside the car is a rear view mirror.

At night, the reflected glare from the headlights of a following car can impede the vision of the driver. With the pull of a lever, the mirror can be moved to a night-time position, which reduces the glare, as shown in the diagram below.

In this night-time position, a **small percentage of the light reflects** from the front of the glass surface and enters the driver's eye.



Using the diagram above, explain how reflection and refraction alter the path of the **remaining light** so that the glare of the headlights of the following car seen by the driver is reduced.

when the light from behind car enters ~~the~~ ~~through~~ the glass, as glass is ~~a~~ has a higher refractive index than air, the light slows down, and so bends towards the normal changing direction, ~~and~~ this is called refraction. ~~The refracted ray then is reflected off~~ The ray ~~then~~ ~~into the~~ is then reflected off the mirror, where the angle of ~~that~~ incidence is equal to the angle of reflection where the light ray changes direction again due to this reflection. The light ray then reaches the glass-air boundary ~~where there is~~ there is some partial reflection, and the rest of the light enters ~~the~~ air, speeding up (as air is less optically dense than glass), hence bending away from the normal changing direction ~~which~~ away from the driver's eyes.

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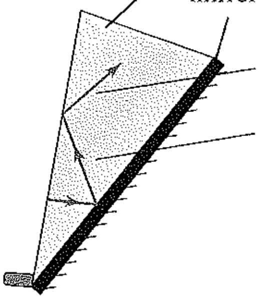
(c) The diagram below shows the path that a ray of light takes as it travels in the glass wedge.



State what is occurring to Ray One at the boundary between the glass wedge and the air, that forms Ray Two.

Give reasons why.

Ray one ~~hits~~ ~~which is the~~ hits the glass-air boundary at an angle which is larger than critical angle for the glass-air boundary. Ray one ~~s~~ is also travelling from a more optically dense medium to a less optically dense medium. These are the two conditions required for total internal reflection ~~which~~. When Ray two ~~is reft~~ (~~which~~ hence total internal reflection occurs) is reflected off the glass-air boundary (which acts like a mirror), (hence ~~no~~ refraction occurs only reflection) hence Ray one is the incident ray and Ray two is the reflected ray where the angle of incidence is equal to the angle of reflection.

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E8

If you need to redraw your response to Question Three (a), use the diagram below. Make sure it is clear which answer you want marked.

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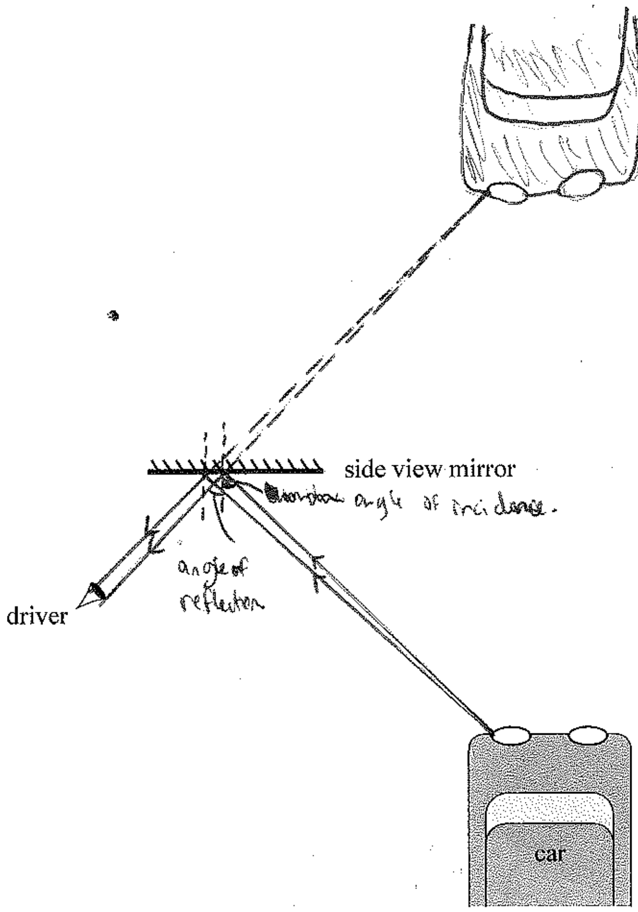

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Annotated Exemplar Templates for Standard 90938 for 2016

Excellence exemplar 2016

Subject:	Physics		**Standard:**	90938	**Total score:**	23
Q	**Grade score**	**Annotation**				
1	E7	(a) **Achieved** Examples are correct (b) **Achieved** Uses concepts of parallel and perpendicular movement correctly but does not mention compressions/rarefactions or crests/troughs (c) **Merit** (i) Amplitude correctly shown (ii) Frequency correctly calculated with unit (d) **Excellence** (i) Correct formula and substitution shown in order to show speed of light (ii) Correct time calculated				
2	E8	(a) **Merit** The diagram shows the waves diffracting in the correct manner, with constant wavelength and even curvature. (b) **Achieved** (i) Amount of diffraction not linked to wavelength (ii) Correct period (c) **Merit** The diagram shows correct refraction and dispersion (d) **Excellence** Links wavelength/frequency to changing speed in the prism and explains as blue travels slower it is deviated more than red.				
3	E8	(a) (i) **Merit** Two rays drawn correctly, locating image in correct position (ii) & (iii) **Achieved** angle of incidence and angle of reflection correctly identified, and also states that these are equal. (b) **Excellence** Explains that light refracts when entering rear view mirror, reflects of the glass at the back of the mirror and refracts again, away from the driver, when the light leaves the rear view mirror (c) **Merit** States Total Internal Reflection and mentions both conditions for it to occur				