1

SUPERVISOR'S USE ONLY

90938

909380

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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.**

Merit

**TOTAL** 15

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## QUESTION ONE: WAVE PROPERTIES

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

Give an example of each.

Longitudinal: radio waves, sound waves light waves

Transverse: ~~sound waves~~ or water waves or earthquakes

(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.

longitudinal waves move parallel to the direction of energy / parallel to the direction the wave travels. the ~~particles~~ wave oscillates/vibrates back & forth. ~~and~~ Transverse waves move 90° / at right angles / perpindicular to the ~~be energy of~~ direction of energy / at right angles to the direction the wave travels. The particles in a transverse wave vibrate/oscillate 90° to the direction of energy/ direction the wave travels, transrerse waves move up & down from the equilibrium position / fixed ~~postion~~ position, these movements create the ~~amplitude~~ crest & ~~to~~ trough of the wave.

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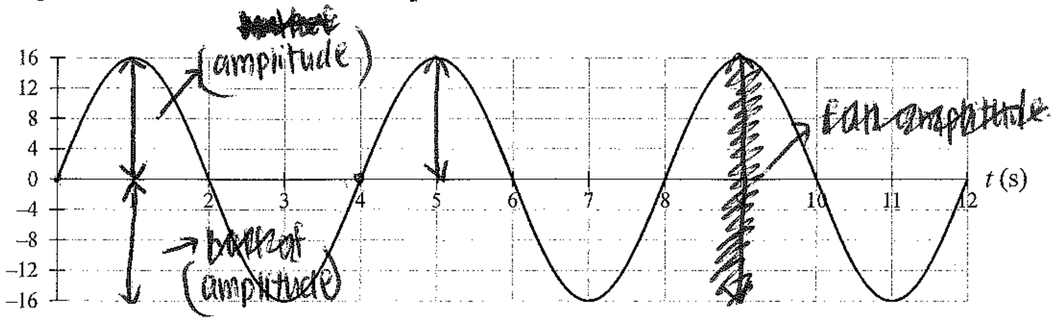
(i) On the diagram, **draw** and **label** the amplitude of the wave.

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.

$v = f\lambda$ $f\lambda = v$ $f = v/\lambda$

$f = 1/4$ $\boxed{f = 1/T}$

$f = 0.25$ Hz

1

Frequency: 0.25 Unit: Hz

the time for one oscillation.

maximum displacement from the equilibrium position

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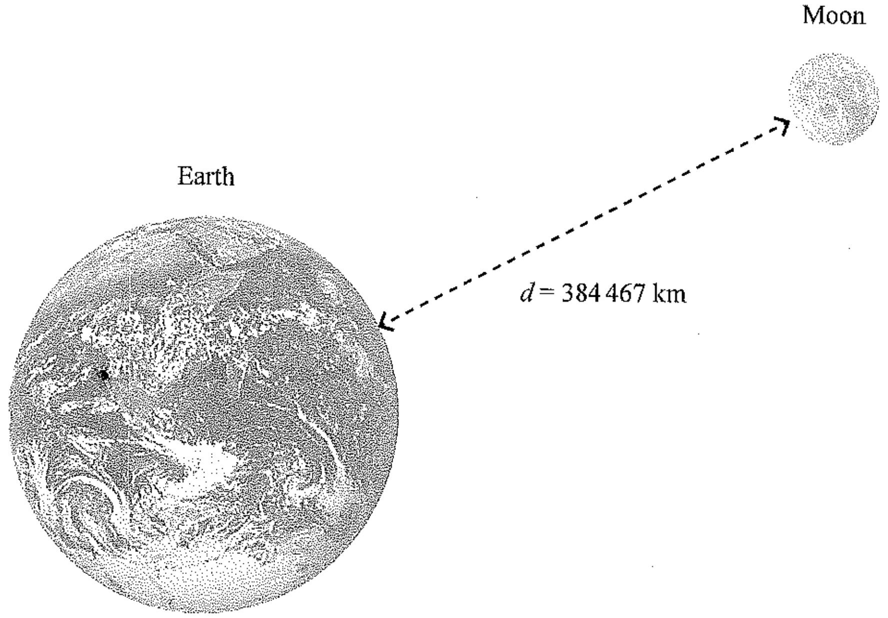
(d) Scientists have been able to calculate the distance between the Earth and the Moon by shining a red laser from Earth and reflecting the red laser on a mirror left on the Moon by the Apollo 11 mission back to a receiver on Earth.




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

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

$v = f\lambda$ $\quad f = 1/2.17\times10^{-15}$ $\quad \lambda = 6.5\times10^{-7}$ m

$f = 4.61\times10^{14}$ Hz

$v = 4.61\times10^{14} \times 6.5\times10^{-7}$

$v = 300000000$ m s$^{-1}$ (2dp)

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

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

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

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

$v = d/t$ $d/t = v$ $\boxed{t = d/v}$

$t = 384{,}467\text{km} \div 3.0 \times 10^8 \text{ms}^{-1}$

$t = 384{,}467\text{ km} \div 3{,}00000\text{kms}^{-1}$ $(3.0 \times 10^5)$

$t =$ 1154 ~~[illegible]~~) $1.28 \times 10^{10}$ s

Time: ~~148 ×10⁷ s~~ $1.28 \times 10^{10}$ s

M5

## QUESTION TWO: WATER AND LIGHT

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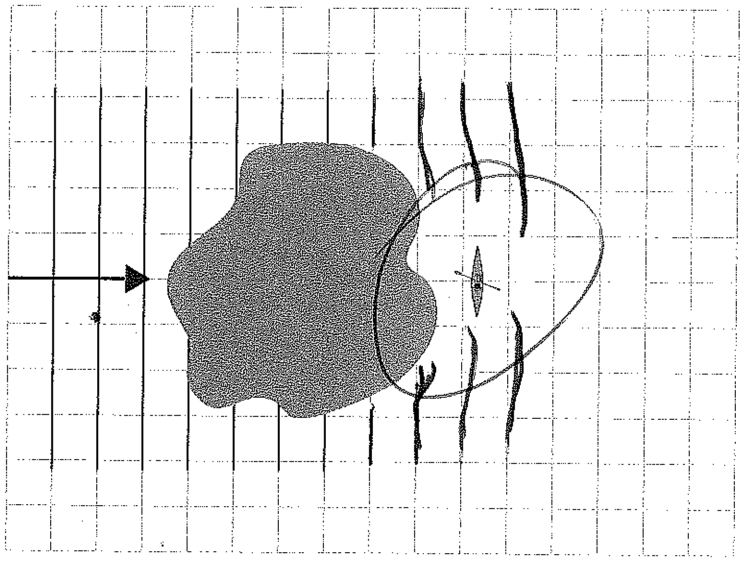
(a) While sea kayaking, people can go behind small islands for safety from large ocean waves.

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

direction of wave



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

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

This is where the waves are calmer. Due to diffraction, the waves must bend/diffract when facing an obstacule, and is shown by the curve of the waves in the diagram. The wavelength of these waves ~~are~~ aren't short enough for the wave to bend/curve enough to reach the kayaker. Therefore this is a safer place as the waves are calm. Because shorter wavelength means more to bend/curve/diffract

(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= 4÷6 = 0.67 (2.dp)

0.67s

blue - short λ = more bend

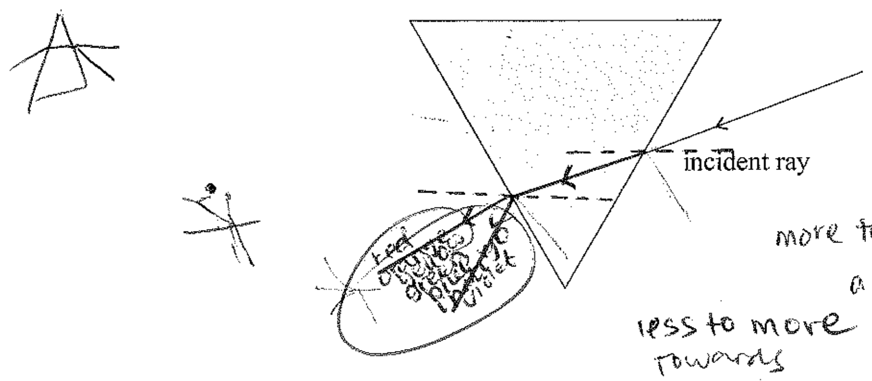
Period: 0.67s

The time for one oscillation.

(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.*

more to less

away from normal.

less to more
towards

(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.

As ~~th~~ ~~W~~ white light is made up of the visible spectrum (~~ROGY~~ ROYGBIV). These colours all have different wavelengths and frequencies from eachother, therefore ~~there~~ that is why there is space/gap from each individual colour & why they don't collide when leaving the prism. The speed/velocity of light changes from one medium to another, slowsdown when enters the prism & speeds up when leaving the prism, this changes the path of the colours & how much they refract. red ~~diffracts~~ refracts the least as it has the longest wavelength. However violet ~~(the last colour of the seven colours)~~ refracts/bends the most as it has a shorter wavelength. Blue refracts/bend more than red but less than violet as it's wavelength is greater than red but smaller than violet.

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## QUESTION THREE: CAR MIRRORS

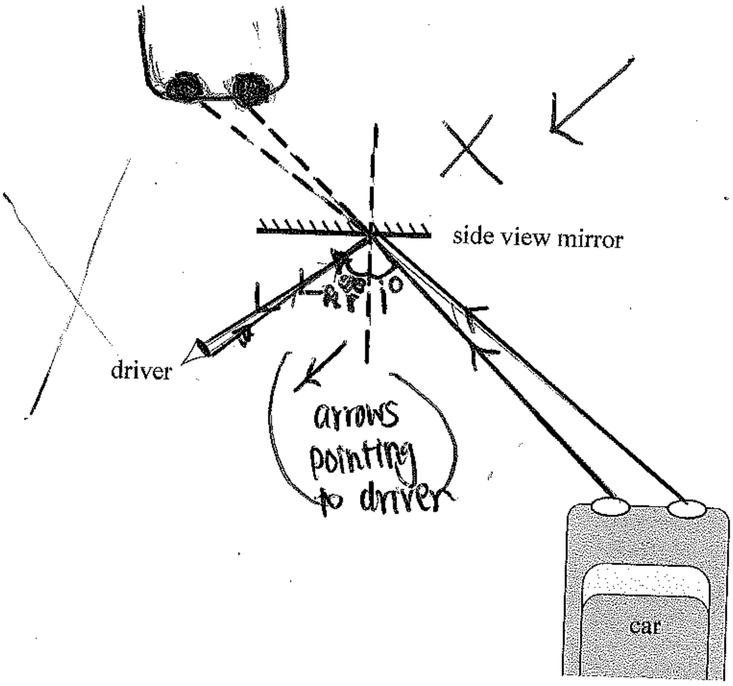
Side mirrors on the outside of cars are designed to reflect light so the driver can see what is beside them.

(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.

diagram on page 12

not thisone !!




i° = angle of incidence

r° = angle of reflection.

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

2 rays.

(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?

~~In~~ Obeying the law, the angle of incidence equals to the angle of reflection. i° = r°

(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.

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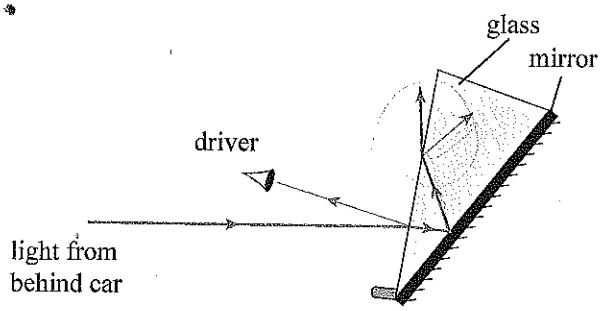


more → less

more → less

away

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.

light from the behind car ~~hits~~ enters the glass surface, as it's a flat surface, the light rays reflected will be regular. As some light is reflect from the front of the glass surface, this doesn't affect the direction of ~~the~~ rest of the light.

The ~~ra~~ ~~remaing~~ remaining light is reflected from the mirror, plane mirror = flat/smooth surface, means all light rays will be even + regular.

The reflected ~~reflected~~ light reflects (from the mirror) in a certain direction at a certain angle so that some light is refracted and some light is Totally Internally Reflected (TIR). The light that is refracted will bend ~~towards~~ away from the normal as it is entering ~~a less~~ an ~~a~~ optically less dense medium to an optically more dense medium, and because the light speeds up. The light that is ~~tot~~ Totally Internally reflected is reflected since the angle of incidence is greater than the critical angle and the light was trying to leave an optically more dense medium & enter an optically less dense medium. However, light rays travels in straight lines.

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

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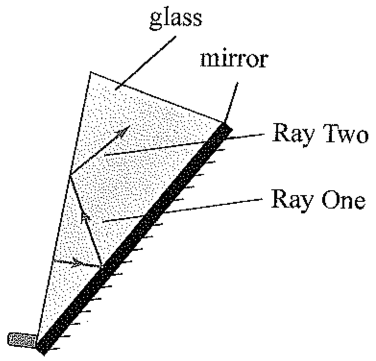


State what is occurring to Ray One at the boundary between the glass wedge and the air, that forms Ray Two.

Give reasons why.

~~Ra~~ TIR (total internal reflection) is what is occuring to Ray one. Ray Two is light reflected from Ray one. The conditions for TIR are; the angle of incidence must be greater than the critical angle, the light must be entering an optically ~~more~~ less dense medium from an optically ~~less~~ more dense medium. The light e the glass wedge ~~ha~~ave (favour) both conditions for TIR. Therefore TIR is the phenoneuma that is happening to Ray One.

~~To~~ TIR is when the light ray is TI reflected back into the same medium.

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M5

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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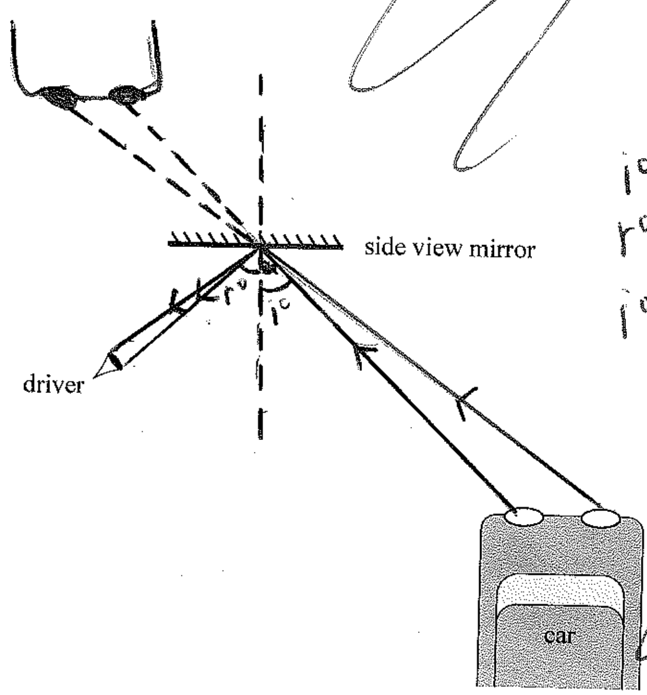


i° = angle of incidence
r° = angle of reflection
i° = r°

Seen

**Merit exemplar 2016**

| **Subject:** | **Physics** | **Standard:** | **90938** | **Total score:** | **15** |
|---|---|---|---|---|---|

| **Q** | **Grade score** | **Annotation** |
|---|---|---|
| 1 | M5 | (a) **Not Achieved** Radio waves incorrectly identified as longitudinal waves<br>(b) **Achieved** Uses concepts of parallel and perpendicular movement correctly but does not mention compressions/rarefactions<br>(c) **Merit**<br>(i) Amplitude correctly shown<br>(ii) Frequency correctly calculated with unit<br>(d) **Merit**<br>(i) Correct formula and substitution shown in order to show speed of light<br>(ii) Correct formula and substitution in order to find time but fails to account for doubling the distance |
| 2 | M5 | (a) **Achieved** The diagram shows some diffraction but curvature uneven<br>(b) **Merit**<br>(i) Amount of diffraction linked to wavelength<br>(ii) Correct period<br>(c) **Not Achieved** The refraction of the rays is incorrect - doesn't split in prism and refracts in wrong direction<br>(d) **Merit** Correct link between frequency/wavelength of Red and Blue light and how much the refract, but no link to their change in speed |
| 3 | M5 | (a) (i) **Not Achieved** Image is in incorrect position<br>(ii) & (iii) **Achieved** angle of incidence and angle of reflection correctly identified, and also states that these are equal.<br>(b) **Merit** Explains that light reflects of the glass at the back of the mirror and that when it hits the glass/air boundary again some of the light is reflected back into the rear view mirror. However, does not explain refraction at either boundary, especially the second time refracting the light away from the driver<br>(c) **Merit** States Total Internal Reflection and mentions both conditions for it to occur |