

91170



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## Level 2 Physics 2021

### 91170 Demonstrate understanding of waves

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of waves.	Demonstrate in-depth understanding of waves.	Demonstrate comprehensive understanding of waves.

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 L2-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 room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (✂). This area may be cut off when the booklet is marked.

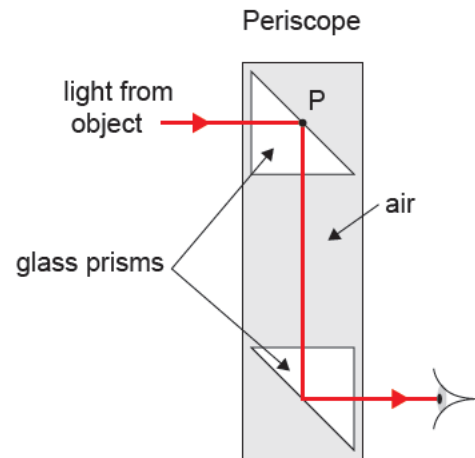
**YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.**

### QUESTION ONE: TRIP TO THE COAST

Fred and his younger sister Mary walk along the harbour wall path to look at the view from the end. The sea wall is too high for Mary to see over, so Fred gives Mary a periscope to look over the wall. The periscope uses two glass prisms.



Source: [www.gettyimages.co.nz/detail/photo/brighton-marina-harbour-wall-royalty-free-image/1145994471?adppopup=true](https://www.gettyimages.co.nz/detail/photo/brighton-marina-harbour-wall-royalty-free-image/1145994471?adppopup=true)



Refractive index of air: 1.00

Refractive index of glass: 1.52

- (a) Name the physics phenomenon that is occurring at the glass / air boundary at point P in the above diagram.

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- (b) Calculate the critical angle required for this phenomenon to take place in the periscope.

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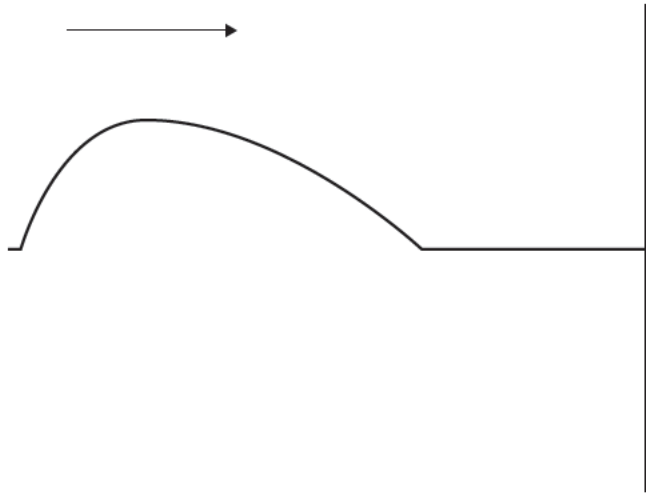
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- (c) At the end of the wall there is a post with a rope attached.

Mary and Fred grab the far end of the rope and send a pulse down the rope as shown below. They observe what happens.



Source: [www.pxfuel.com/en/free-photo-enbfm](http://www.pxfuel.com/en/free-photo-enbfm)

*If you need to redraw your response, use the diagram on page 10.*

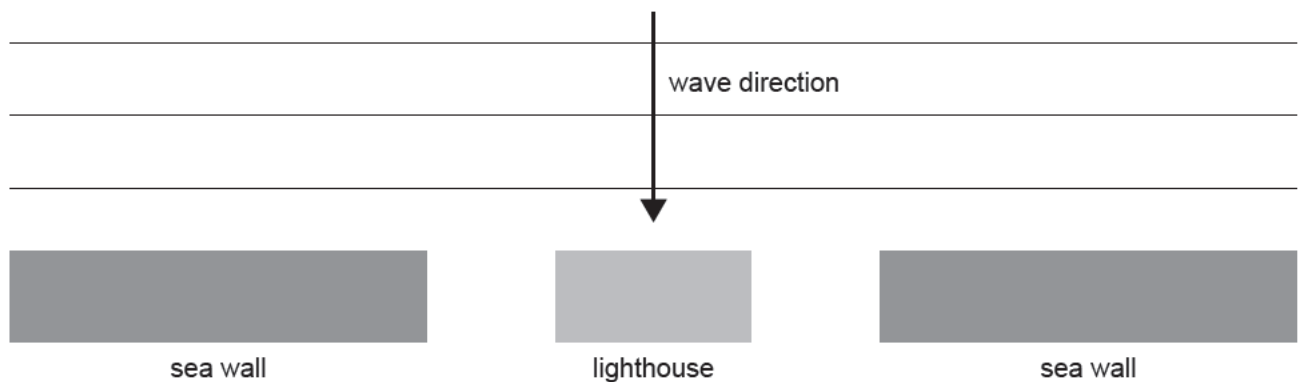
Complete the diagram above to show the reflected pulse.

- (d) As they look over the wall, they notice that there are large waves in some areas, and no waves at all in other areas of the harbour.

The harbour has the design shown in the diagram below.

- (i) Complete the diagram to show the waves after they pass through the gaps between the sea walls and the lighthouse.

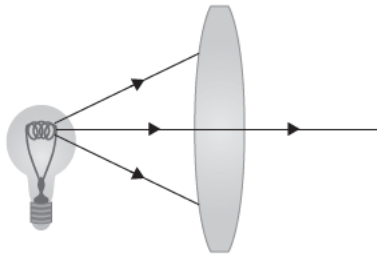
*If you need to redraw your response, use the diagram on page 10.*





## QUESTION TWO: THE LIGHTHOUSE

Fred sees a lighthouse by the harbour and tries to work out how it creates the beam of light. He discovers that rays from a point source of light pass through a lens and emerge as a parallel beam.



- (a) Identify the type of lens and state where the lamp must be positioned in order to get a parallel beam out.

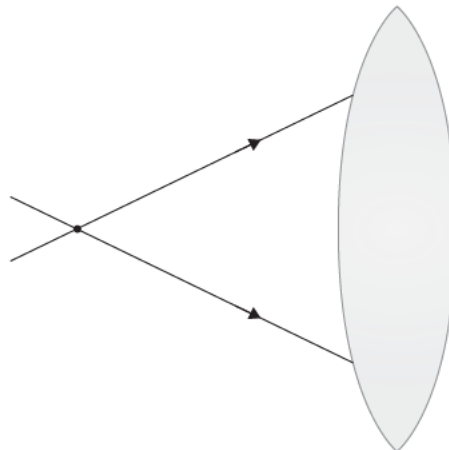
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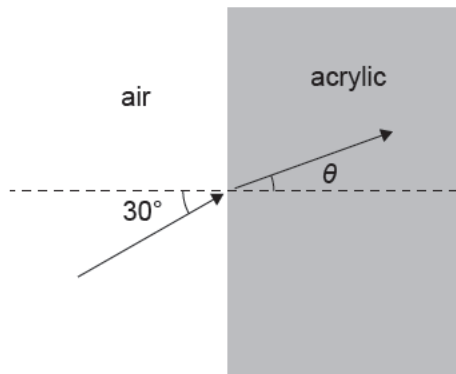
- (b) The ray diagram can be simplified to show just two rays of light as follows:

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



Complete the ray diagram above accurately to show how the light travels as it enters **and** exits the lens.

- (c) Back in the laboratory, Fred shines a ray of light at an angle of incidence of  $30^\circ$  into an acrylic block. The refractive index of air is 1.0. The speed of light in air is  $3.0 \times 10^8 \text{ m s}^{-1}$ , and the speed of light in acrylic is  $2.0 \times 10^8 \text{ m s}^{-1}$ .



- (i) Show that the refractive index of acrylic is 1.5.

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- (ii) Calculate  $\theta$ , the angle of the refracted ray in the acrylic.

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(d) Fred places an object 7.0 cm in front of a convex lens with focal length 5.0 cm.

(i) Calculate the distance of the image from the lens.

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(ii) Calculate the magnification.

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(iii) Use appropriate words selected from

**real, virtual, diminished, enlarged, upright, inverted**  
to describe the properties of the image formed.

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### QUESTION THREE: THE CAR

Fred notices the warning “Objects in mirror are closer than they appear” printed on a **convex** side mirror of his car.

- (a) Describe the type of image always formed by convex mirrors.

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Source: [www.dreamstime.com/stock-photo-wing-mirror-view-passenger-side-car-view-wing-mirror-car-driving-road-image98162488](https://www.dreamstime.com/stock-photo-wing-mirror-view-passenger-side-car-view-wing-mirror-car-driving-road-image98162488)

- (b) Explain why **concave** mirrors would be no good as car mirrors to see distant objects.

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- (c) Complete the ray diagram below to locate the image formed by a **convex** mirror.



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



- (d) A car 1.5 m high is 5.0 m behind Fred. When Fred looks in his **convex** mirror of focal length 20 cm, he sees an image of the car.

Calculate the distance AND height of the image that Fred sees in the mirror.

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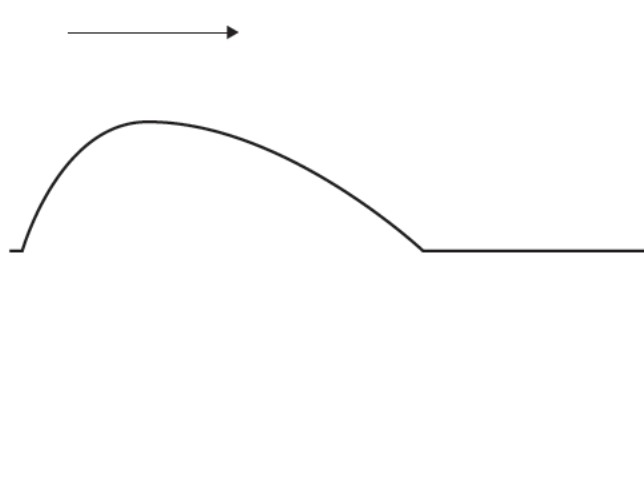
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Image distance = \_\_\_\_\_

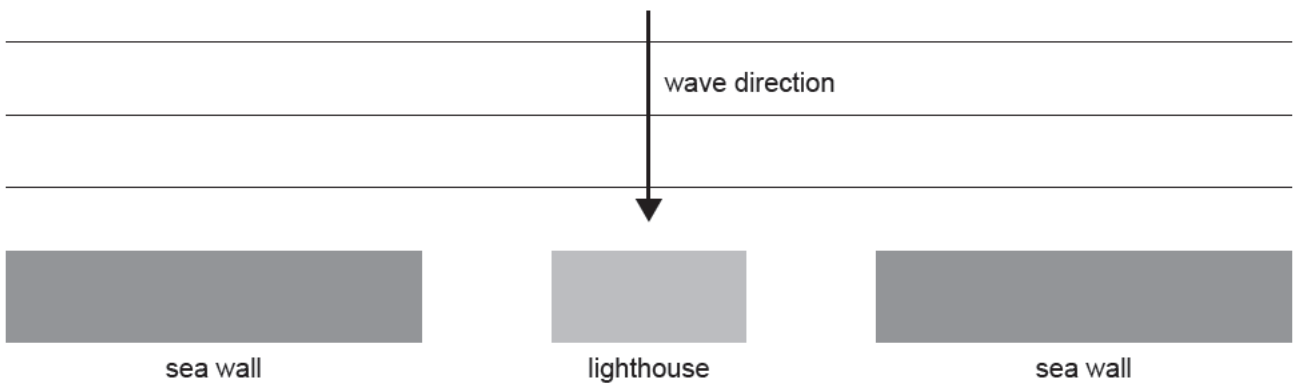
Image height = \_\_\_\_\_

## SPARE DIAGRAMS

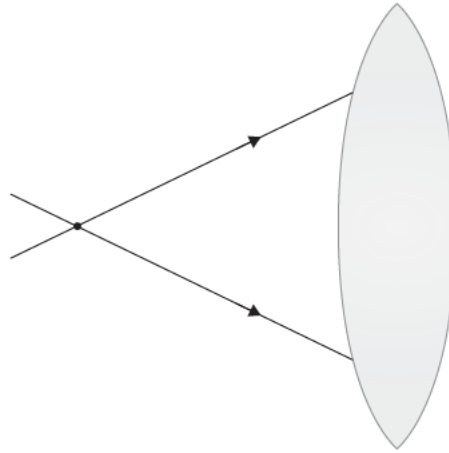
If you need to redraw your response to Question One (c), use the diagram below. Make sure it is clear which answer you want marked.



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



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



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



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

QUESTION  
NUMBER

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