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Draw a cross through the box (☒) if you have NOT written in this booklet

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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Physics 2026

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.

Show ALL working.

In your answers use clear numerical working, words, and / or diagrams as required.

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 2–16 in the correct order and that none of these pages is blank.

Do not write in the margins (////). This area will be cut off when the booklet is marked.

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

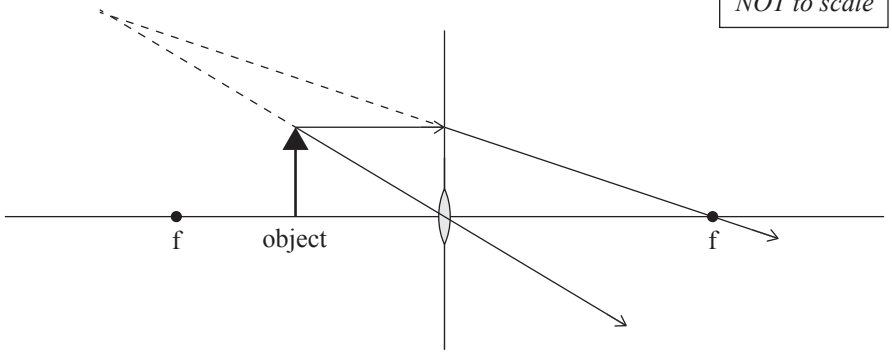
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QUESTION ONE: LENSES AND MIRRORS

Taisa is farsighted and uses a converging / convex lens as a corrective measure. She notices that when she holds a small object very close to her lens, the image appears larger and upright.

(a) Draw the image on the diagram below.

Diagram is NOT to scale



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

(b) The converging / convex lens has a focal length of 15 cm, and Taisa holds an object 10 cm from the lens.

(i) Use an appropriate formula to calculate the image distance.

(ii) State whether the image is real or virtual.

(c) A supermarket uses a large convex mirror at a corner to allow staff to view activity in an aisle. The mirror has a focal length of 2.0 m.



Source: www.amazon.com.au/Supermarket-Security-Mirror-Surveillance-Parking/dp/B0BZ541CC7

(i) An object is 6.0 m from the convex mirror.

Calculate the magnification.

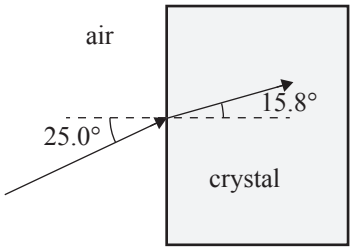
(ii) Describe three characteristics of the image formed by the convex mirror.

(d) By considering the properties of images in a concave mirror, explain whether a concave mirror would be a better choice for a security mirror than a convex one.

QUESTION TWO: REFRACTION

A geologist finds a large, clear crystal block. To determine its refractive index, they shine a ray of light into the crystal at 25.0°; the ray has an angle of refraction of 15.8°.

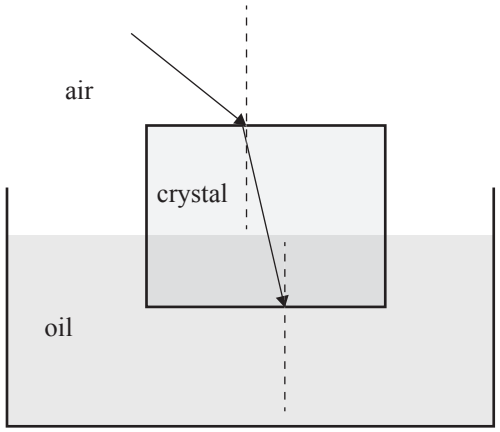
Speed of light in air = 3.00×10^8 m s^{-1} $\quad n_{air} = 1.00$



(a) Show that the refractive index of the crystal block is approximately 1.55.

(b) The geologist then places the crystal block into a container of transparent oil.

$n_{oil} = 1.37$



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

(i) On the above diagram, draw the refracted light ray in the oil.

(ii) Calculate the speed of the light ray in the oil.

(c) Light rays enter gemstones like rubies and diamonds, and reflect around the inside of the gemstones before exiting.



$n_{diamond} = 2.42$

Source: www.etsy.com/nz/listing/1746153725/

$n_{ruby} = 1.76$

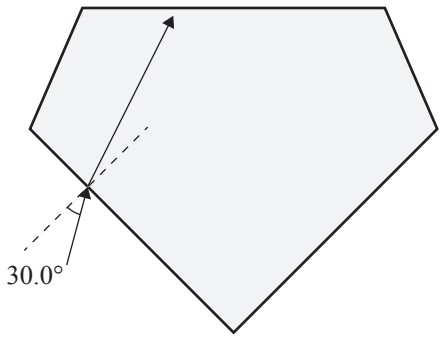
Source: www.gemrockauctions.com/learn/a-z-of-gemstones/ruby-gemstone-information?srsltid=AfmBOopzF_H86q6gB-

(i) Define total internal reflection, and state the two conditions required for it to occur.

(ii) Calculate the critical angle for a ruby-air boundary.

$n_{\text{ruby}} = 1.76$

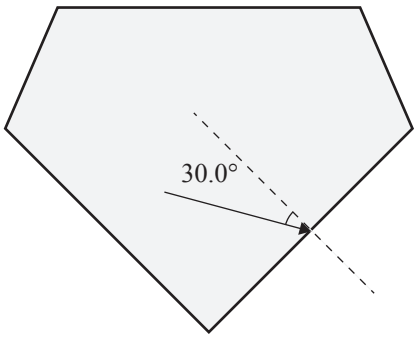
(d) (i) A light ray enters the diamond from air at an angle of 30.0° to the normal.



Calculate the angle of refraction inside the diamond.

$n_{\text{diamond}} = 2.42$

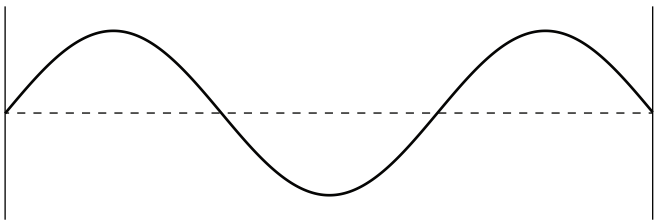
(ii) A diamond is cut with flat faces so that light entering it is internally reflected multiple times before exiting. After one of the internal reflections, the ray hits the diamond-air boundary at 30.0° to the normal inside the diamond.



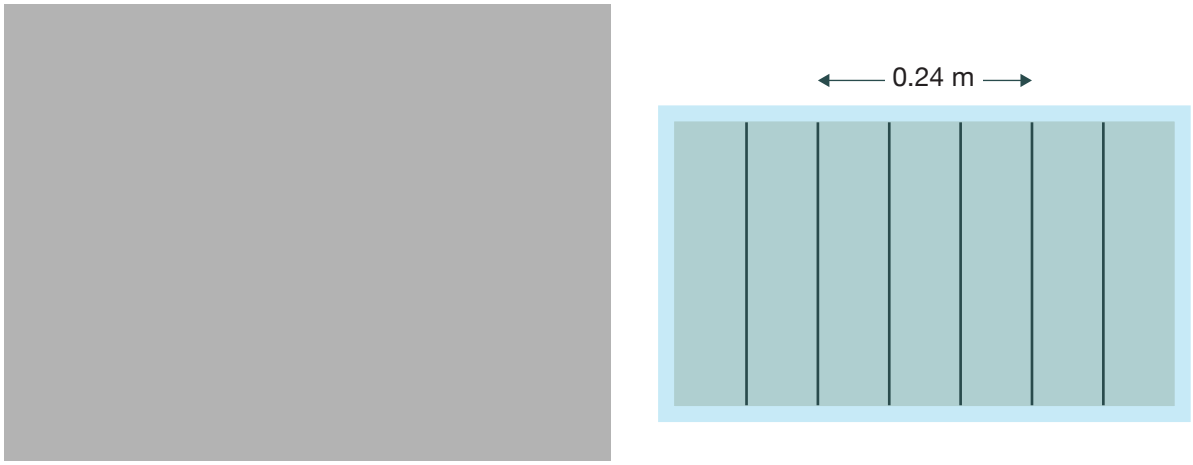
Carry out a calculation and explain whether this ray will exit the diamond.

QUESTION THREE: WAVES

(a) On the diagram below, clearly label the amplitude and the wavelength.



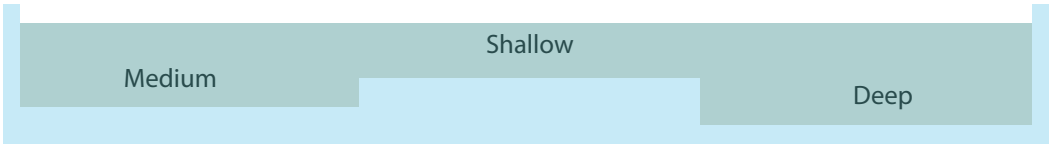
(b) A bar in a ripple tank vibrates up and down 20 times in 5.0 seconds, and produces waves in the water. The lines in the diagram below show 4 wave crests in 0.24 m.



Source: www.cyberphysics.co.uk/Q&A/KS4/waves/A6.htm

Calculate the speed of the waves in the water.

(c) The ripple tank is set up so that it has three different depths of water. Waves are generated in the medium-depth region and travel to the right, through the shallow region and into the deep region.

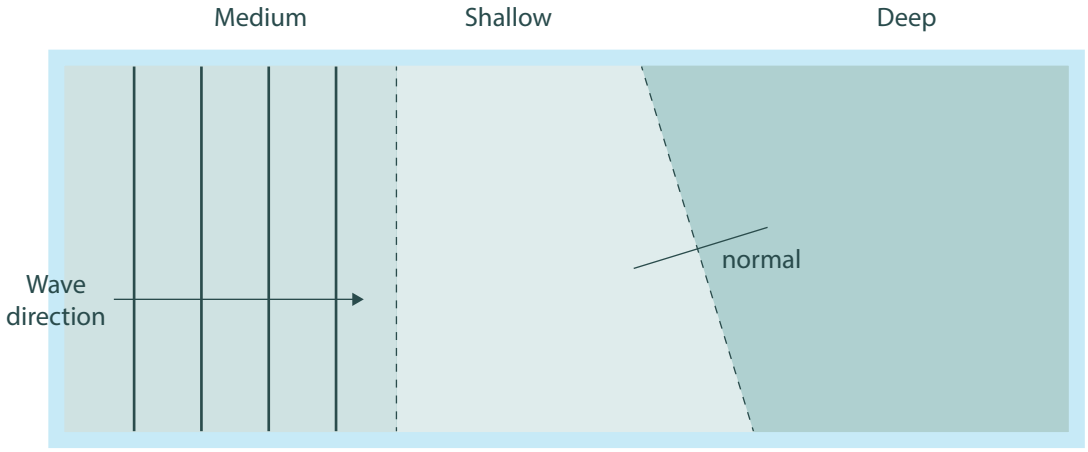


Side view

(i) State what happens to the speed of the wave as it goes from the medium-depth region to the shallow region.

(ii) Draw wave crests on the top-view diagram below to show the waves travelling from the medium-depth water through the shallow water and into the deep water.

For each section, draw an arrow to show the direction the waves are travelling.

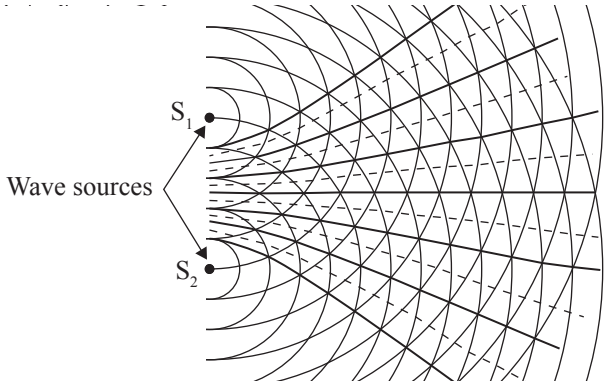


Top view

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

Question Three continues on the following page.

(d) The ripple tank is set up with two point-sources (S_1 and S_2) that produce identical water waves in phase with each other.



(i) In the boxes below draw two waves in phase.

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

Wave 1:

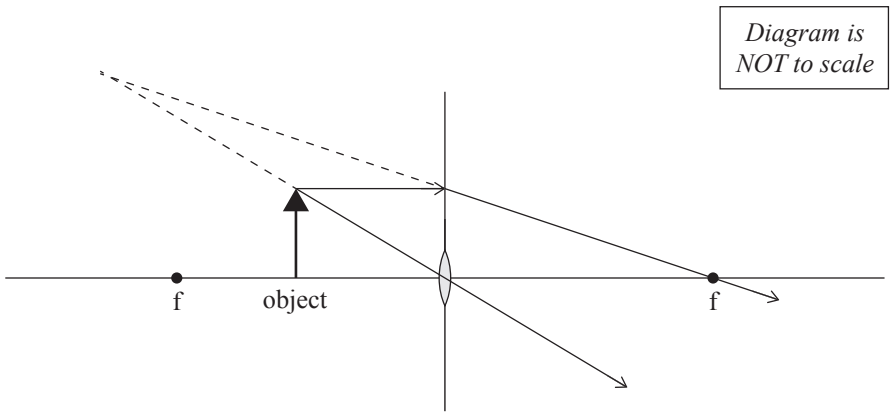
Wave 2:

(ii) Describe what is seen in the ripple tank and how the pattern was formed.

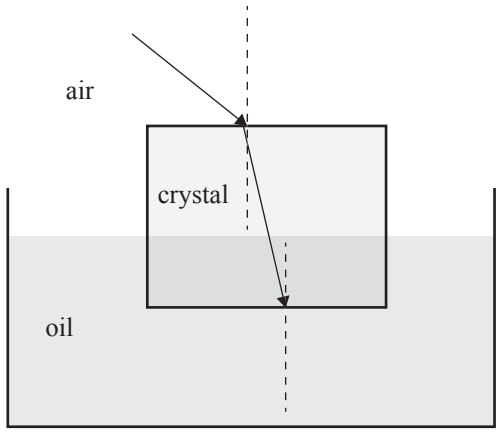
Your answer should explain the effect of path difference on the pattern.

SPARE DIAGRAMS

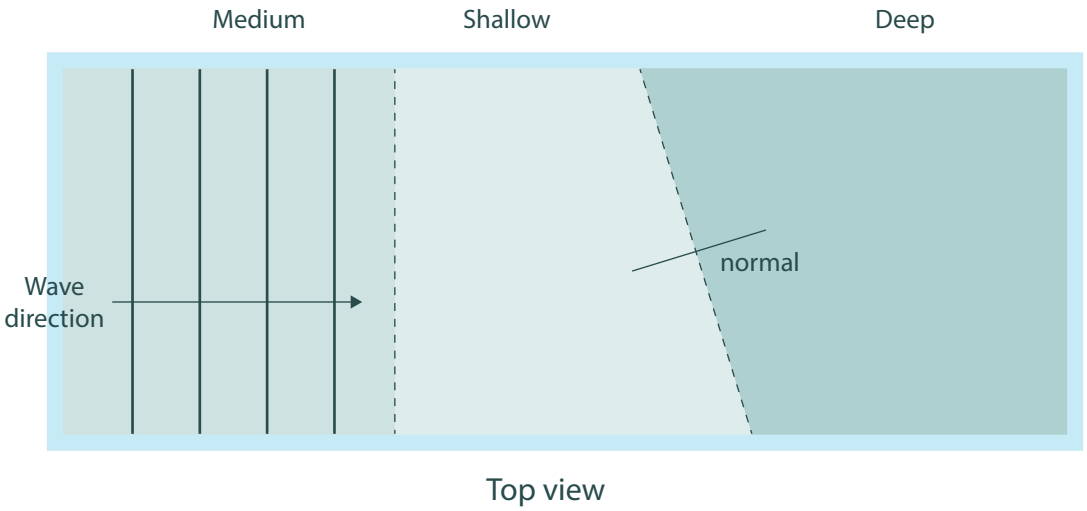
If you need to redraw your response to Question One (a), use the diagram below. Make sure it is clear which answer you want marked.



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



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

Wave 1:

Wave 2:

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

QUESTION NUMBER

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

QUESTION NUMBER

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

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