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NZQA

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2

SUPERVISOR'S USE ONLY

Level 2 Physics, 2018

91170 Demonstrate understanding of waves

9.30 a.m. Friday 9 November 2018
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 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.

TOTAL

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QUESTION ONE: THE ENLARGED EYE

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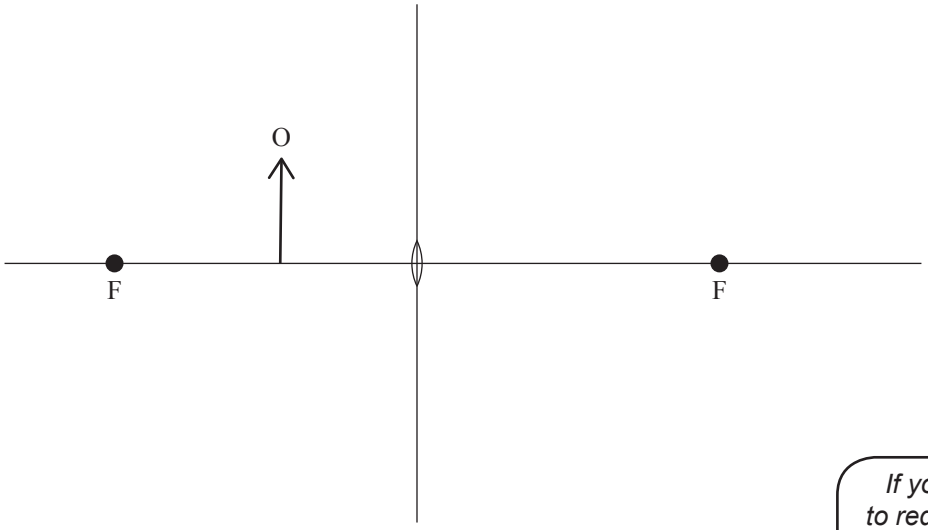
Sophie and her friend John were investigating magnifying glasses (convex lenses). Sophie laughed at the size that John's eye appeared when he placed the lens over his eye.

www.123rf.com/photo_11597957_funny-boy-looking-through-magnifying-glass-with-surprise.htm

(a) Complete the following ray diagram to show how John's eye (the object) appears enlarged, as in the photo.

Clearly indicate its size and position.



If you need to redraw your ray diagram, use the diagram on page 9.

The lens has a focal length of 12 cm. John holds the lens 5 cm from his eye.

(b) Calculate the distance the image is from the lens, and state the nature of the image produced.

(c) If the eye (object) has a height of 2.0 cm, calculate the magnification AND the height of the image of the eye.

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(d) John cannot see the image of his own eye by looking through the lens. He decides to put the lens down and select one of three types of mirror – plane, convex or concave.

convex mirror

concave mirror

plane mirror

(i) Which type of mirror would give the best upright and magnified image of his eye?

Justify your choice.

(ii) Where would John's eye need to be positioned to get an enlarged upright image for your choice of mirror?

(iii) Clearly explain where John's eye would need to be positioned to obtain the largest upright image possible for your choice of mirror.

QUESTION TWO: LASER IN THE JUICE

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Later, Sophie shines a green laser beam from air into a glass of juice. When she does, she notices that the light refracts.

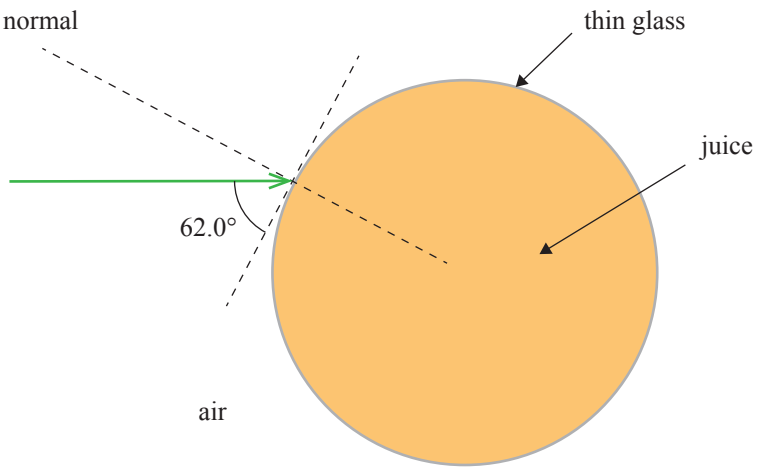
v_{light} in air $= 3.00 \times 10^8$ m s^{-1}

$n_{air} = 1.00$

$n_{juice} = 1.34$

(a) Define 'refraction'.

(b) The diagram below shows the cross-section of the glass, looking down from above, with the juice inside. For the purpose of this question, you can assume the glass itself is very thin and has negligible effect on the path of the light rays.



If you need to redraw your ray diagram, use the diagram on page 9.

(i) Complete the diagram, clearly showing the refraction of the light ray as it enters the juice.

(ii) Calculate the angle of refraction.

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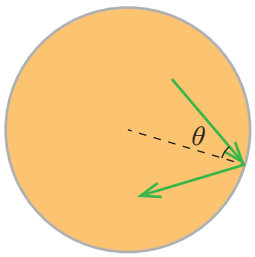
(c) When the light hits the side of the glass, as shown on the right, the rays "bounce" back inside.



(i) Under what condition will the ray "bounce back", as shown in the diagram?

(ii) Calculate the minimum angle at which the light has to hit the side of the glass for this effect to occur.

(d) The green laser used in this experiment has a frequency 5.60×10^{14} Hz in air.

(i) By first calculating the wavelength of the laser in air, calculate the wavelength of the light rays **in the juice**.

(ii) Explain why the wavelength of the green laser in juice is different from its wavelength in air.

QUESTION THREE: RADIO AND LIGHT WAVES

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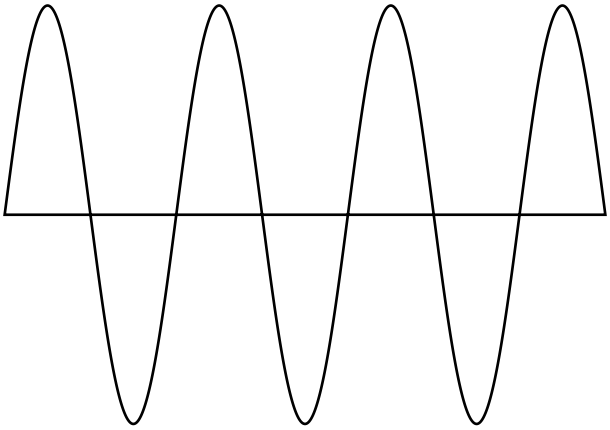
Sophie decided to investigate the difference between AM and FM waves. She knew that both are radio waves that travel at 3.00×10^8 m s^{-1} and can travel large distances.

An important difference, she discovered, was the size of their wavelengths. Sophie's favourite AM radio station transmitted waves with a wavelength of 550 m, whereas her favourite FM station transmitted waves with a 3.3 m wavelength.

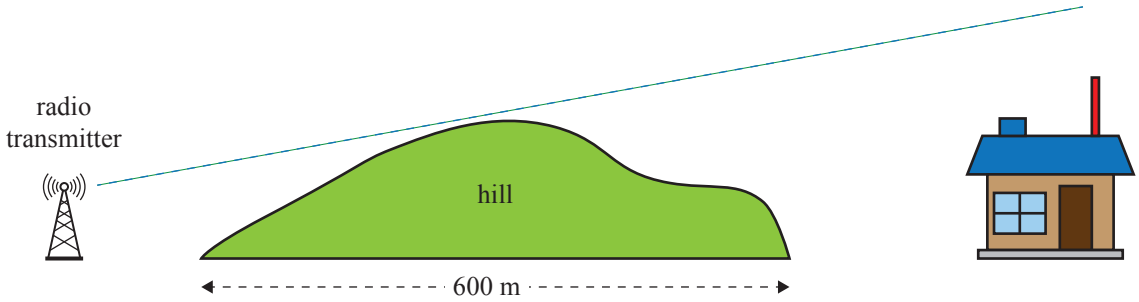
Wavelength (λ) and amplitude (A) are properties of these waves.

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

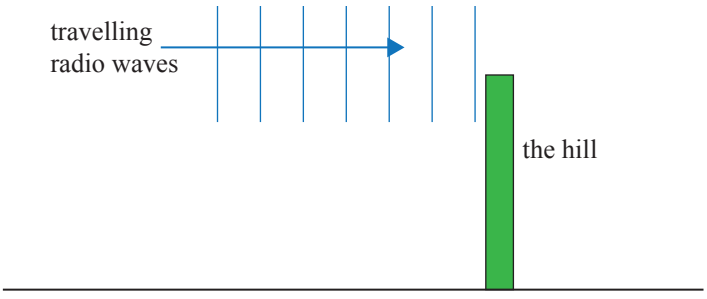


If you need to redraw this, use the diagram on page 10.

At home, Sophie's radio could detect one of the radio stations, even though a hill was between her house and the transmitter.



This can be modelled using the diagram below.



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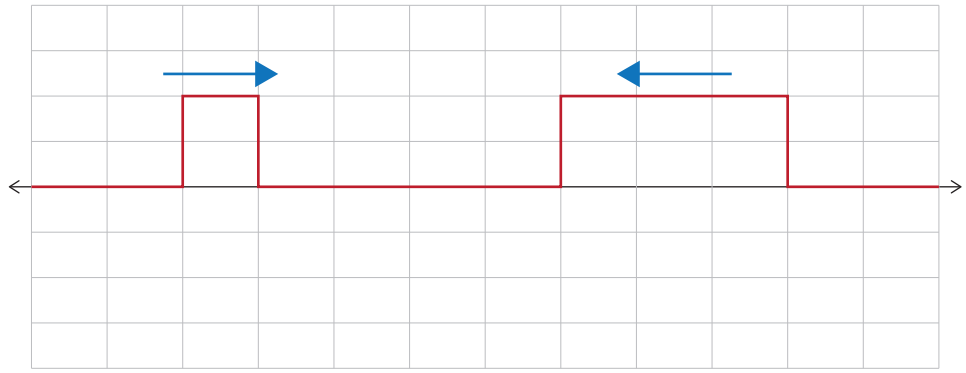
(b) Name the phenomenon that allows this to happen, and state whether the AM or FM station is most likely to be detected at the house.

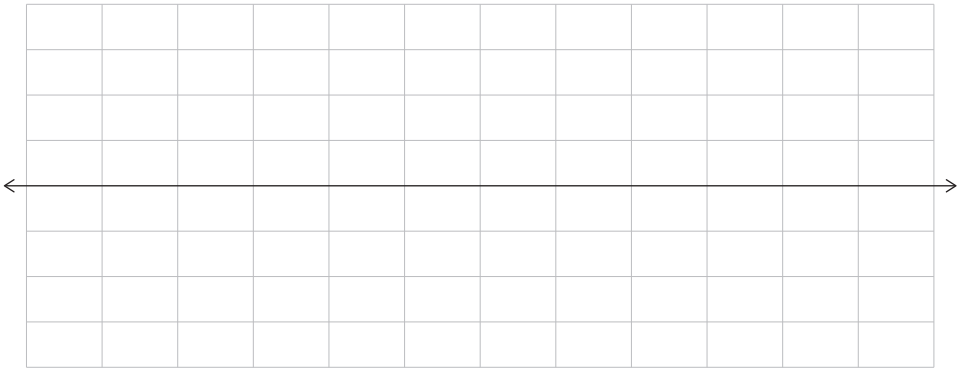
Give a reason for your answer.

(c) To listen to her other favourite radio station, Sophie used her fibre optic cable internet connection. The music is encoded as light pulses which are either ON or OFF.

To show what happens when two pulses are sent through a fibre optic cable in opposite directions, a simplified diagram is presented below. Each pulse travels 3 squares horizontally every time period.



Draw the resulting superposition after one time period, on the diagram below.



If you need to redraw this, use the diagram on page 10.

Question Three continues on the following page.

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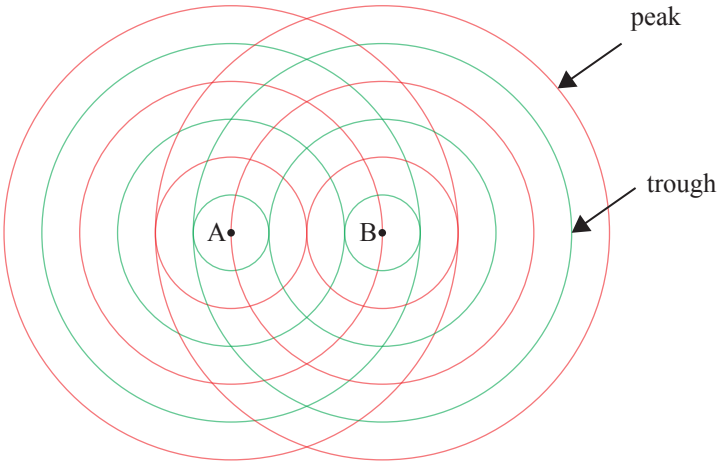
(d) In another place, Sophie decides to try to make the radio signal stronger by using two FM transmitting aerials, A and B, placed 6.6 m apart.

Sophie needs to know where the resultant signal will be strongest or weakest.

On the diagram below (not to scale), mark one point where the resultant signal will be a **maximum** (mark it as X), and one where the strength of the signal will be a **minimum** (mark as Y).

Comprehensively explain why these points result in different signal strengths.



If you need to replot your points, use the diagram on page 10.

Point X: _____

Point Y: _____

SPARE DIAGRAMS

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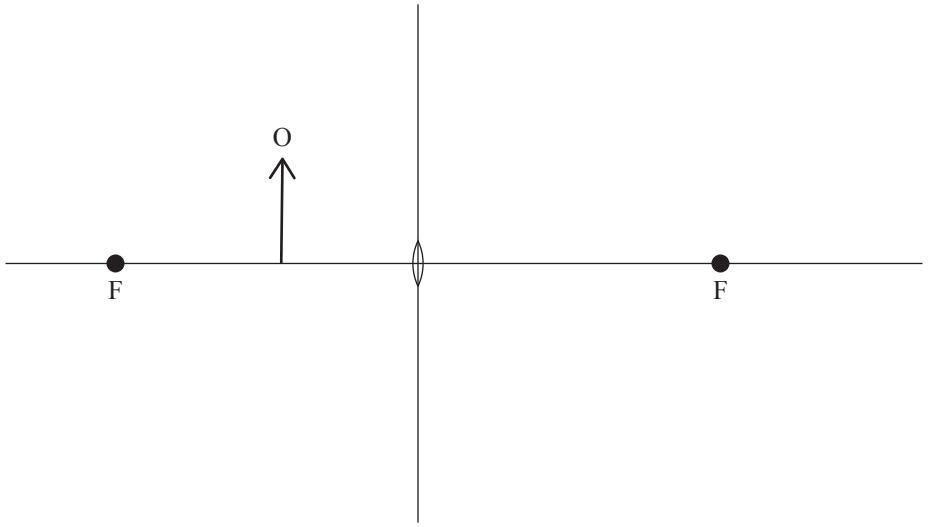
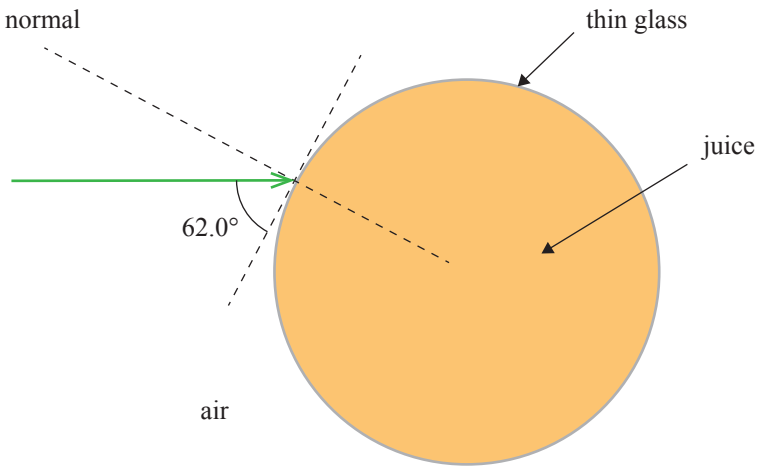
If you need to redraw your ray diagram for Question One (a), use the diagram below. Make sure it is clear which diagram you want marked.



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



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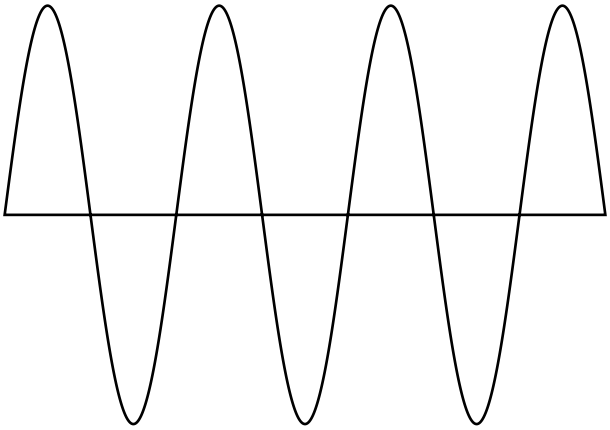
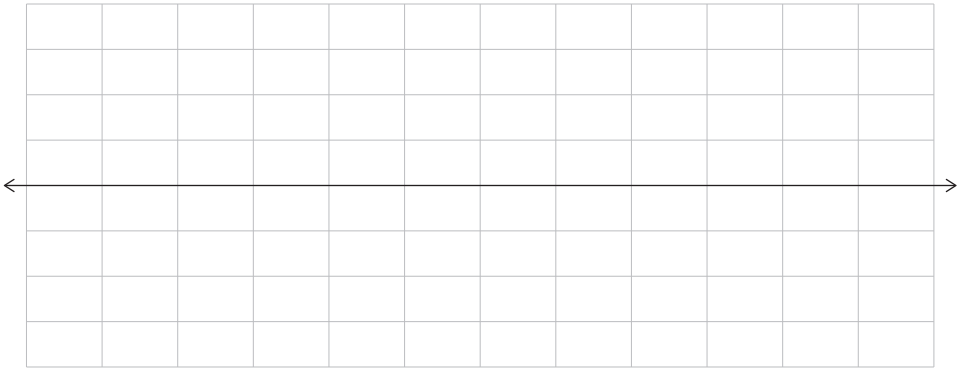
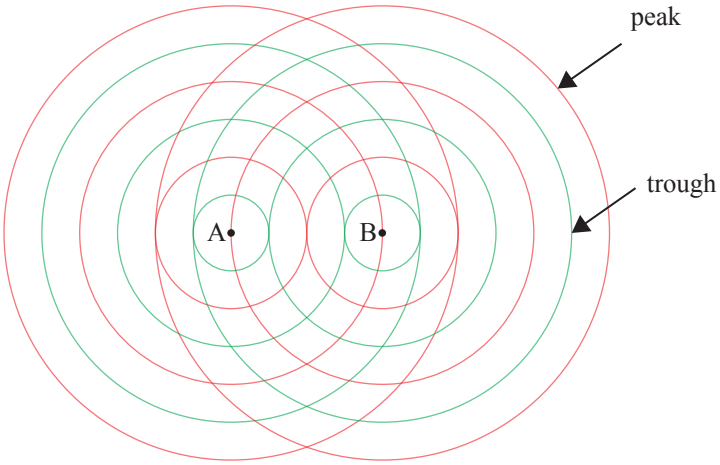
If you need to redraw your diagram for Question Three (a), use the diagram below. Make sure it is clear which diagram you want marked.



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



If you need to replot your points for Question Three (d), use the diagram below. Make sure it is clear which diagram you want marked.



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

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