No part of the candidate's evidence in this exemplar material may be presented in an external assessment for the purpose of gaining an NZQA qualification or award.

SUPERVISOR'S USE ONLY

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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 2023

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

Do not write in any cross-hatched area (DO NOT WRITE). 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.

Achievement 11

QUESTION ONE: THE COSTUME SHOP

Marco and Harvey head to the mall to buy props for the school show. Their first stop is the costume shop.

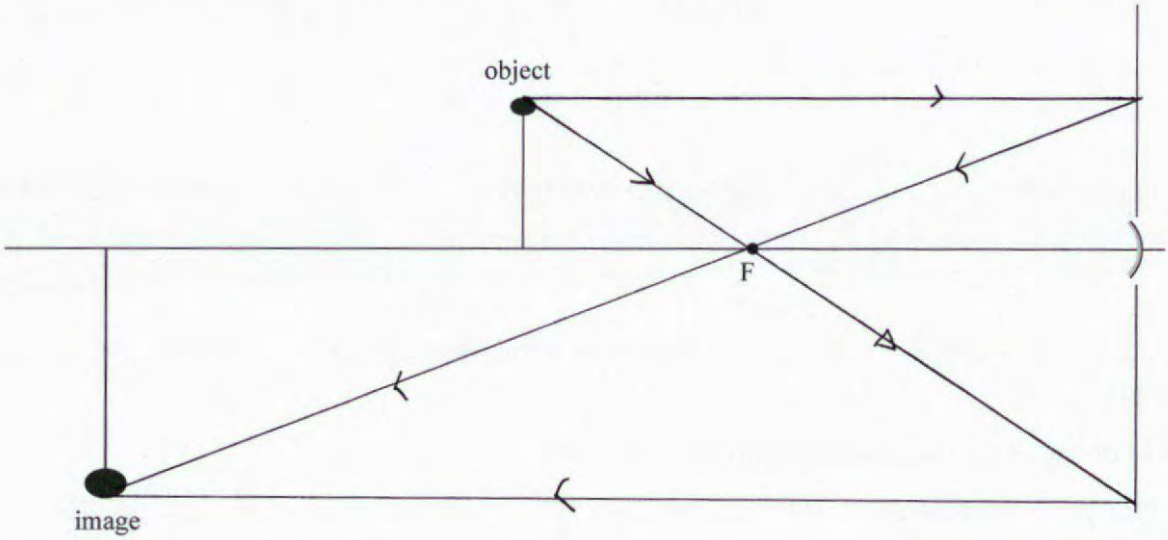
The students start looking at hats in a concave mirror of focal length 25 cm. The mirror image is initially real.

(a) Define the term real as it is used in this context.

The real rays converge onto a point

Marco stands 40 cm in front of the mirror and the image is formed in the location shown below.

(b) Complete the diagram below to show how this image forms.



(c) Calculate the magnification of the image formed.

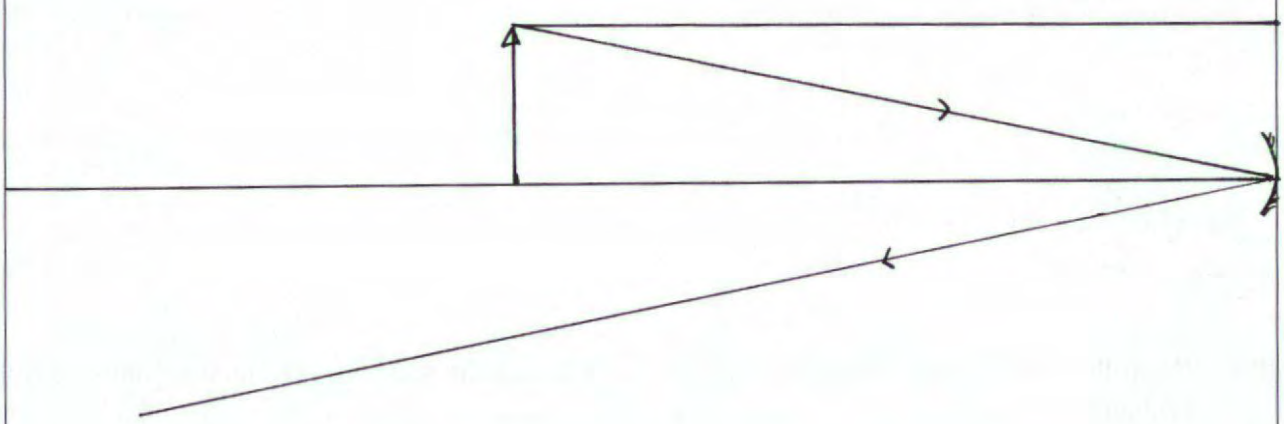
If you need to redraw your response, use the diagram on page 10.

$\cancel{M = \frac{d_i}{d_o} = \frac{h_i}{h_o}}$ $S_i S_o = f^2$

$\cancel{M} = S_i S_o = 625$

(d) Harvey now stands 10 cm in front of the concave mirror.

By using a ray diagram and calculating the image distance and magnification, describe and explain the nature of the new image formed.



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

QUESTION TWO: THE WISHING POND

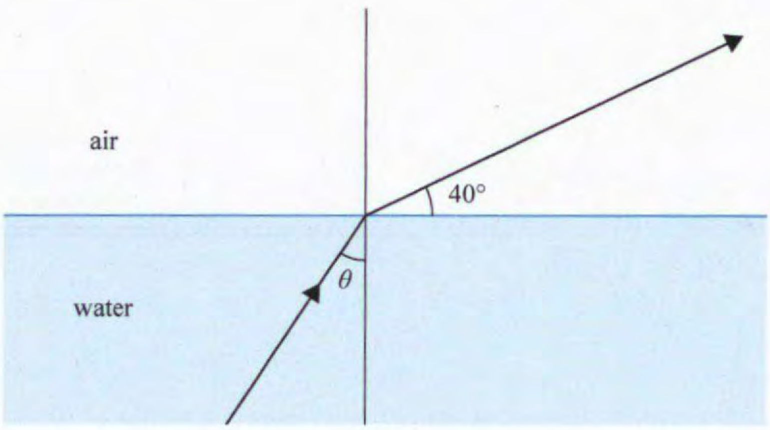
https://www.istockphoto.com/photo/many-coins-thrown-into-a-water-fountain-gm1278125918-377163413

The students walk past a wishing pond for a local charity. People throw coins into the water, and these are collected at the end of the day. As the students sit on the side of the pond, they notice the coins appear closer to the surface of the water than they actually are.

(a) Name the physics phenomenon that causes the coins to appear closer to the surface than they actually are.

Refraction.

(b) The following diagram shows the light ray as it leaves the water. The refractive index of water is 1.33 and air is 1.00.



1.00

1.33

Calculate the angle θ, shown at the surface of the water.

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1.33 \sin\theta_1 = 1.00 \sin 40°$

$\sin\theta_1 = \frac{1.00 \sin 40}{1.33}$

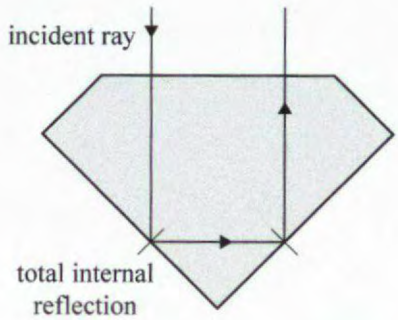
$\theta_1 = 29°$

(c) The students notice a diamond in a jeweller's shop. They know total internal reflection is the main cause of the sparkle of the diamond.

Refractive index of diamond = 2.42

Critical angle of diamond = 24.4°

Speed of light in air = 3.00×10^8 m s^{-1}



A ray of light passes through the boundary between air and the diamond.

(i) Calculate the speed of light in the diamond.

$\frac{n_1}{n_2} = \frac{v_2}{v_1}$

$\frac{1.00}{2.42} = \frac{v_2}{3.0 \times 10^8}$

$V_2 = \left(\frac{1.00}{2.42}\right) \times 3.0 \times 10^8$

$V_2 = 1.24 \times 10^8 \ ms^{-1}$

(ii) State what happens to the frequency of the light as it passes into the diamond.

The frequency will remain unchanged.

(d) (i) Using appropriate calculations, show that the critical angle for diamond is 24.4°.

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

(ii) Explain total internal reflection in terms of the conditions required, and include a definition of the critical angle.

For total internal reflection to occur the angle of incidence must be greater than the critical angle, the ray must also transfer into a denser medium. The critical angle is the ~~angle~~ ~~at~~ minimum angle at which total internal reflection can occur.

QUESTION THREE: THE OPTICIAN

The students decide to try out some prescription glasses. They try out two types of glasses, both of the same shape and material but with different thicknesses.

Thick lens
www.aliexpress.com/i/4001151117795.html

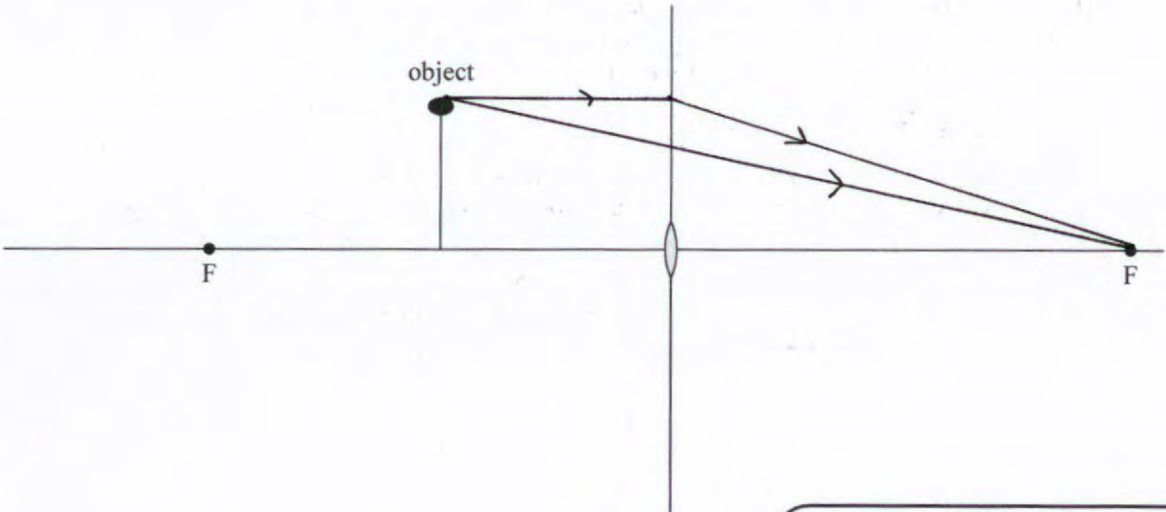
Thin lens
www.amazon.in/Artificial-Glass-Crystal-Watchmakers-Accessories/dp/B09ZTT7C19

(a) How does the focal length of the thin lens compare to the focal length of the thick lens?
No calculation required.

The thick lense will have a much longer focal length.

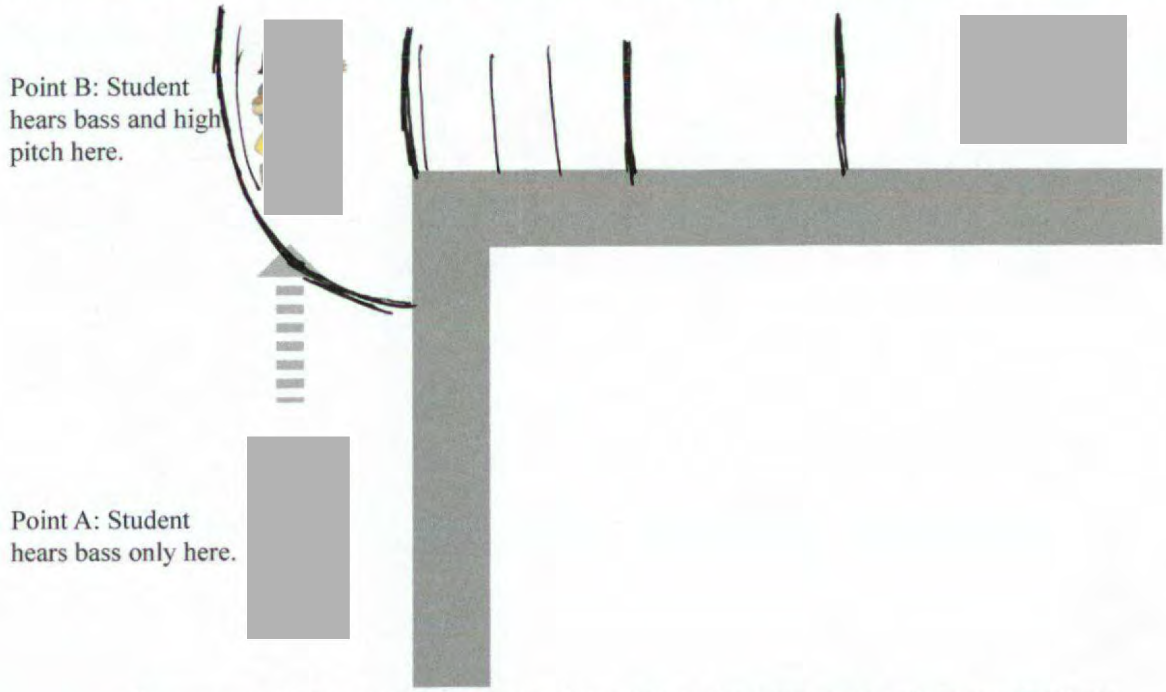
(b) A different set of glasses has convex lenses with focal length 30 cm.

Complete the ray diagram below to show the position and appearance of the image produced.



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

(c) The students walk further along the mall and hear music playing from a radio around the corner. At point A they only hear the low pitch of a bass guitar, and cannot work out the tune. At point B they hear the bass guitar and the high pitch of an electric guitar playing the same track of music.



Sources: www.kindpng.com/imgv/iiRhiJh_ykle-caillou-cartoon-asian-cartoon-characters-disney-hd/
https://whyy.org/articles/seaside-heights-bans-loud-music-on-beaches/

Why do they hear the bass guitar and not the electric guitar at point A, even though they are both at the same volume?

Your answer should identify the physics phenomenon, and explain the effect of the corner on this process.

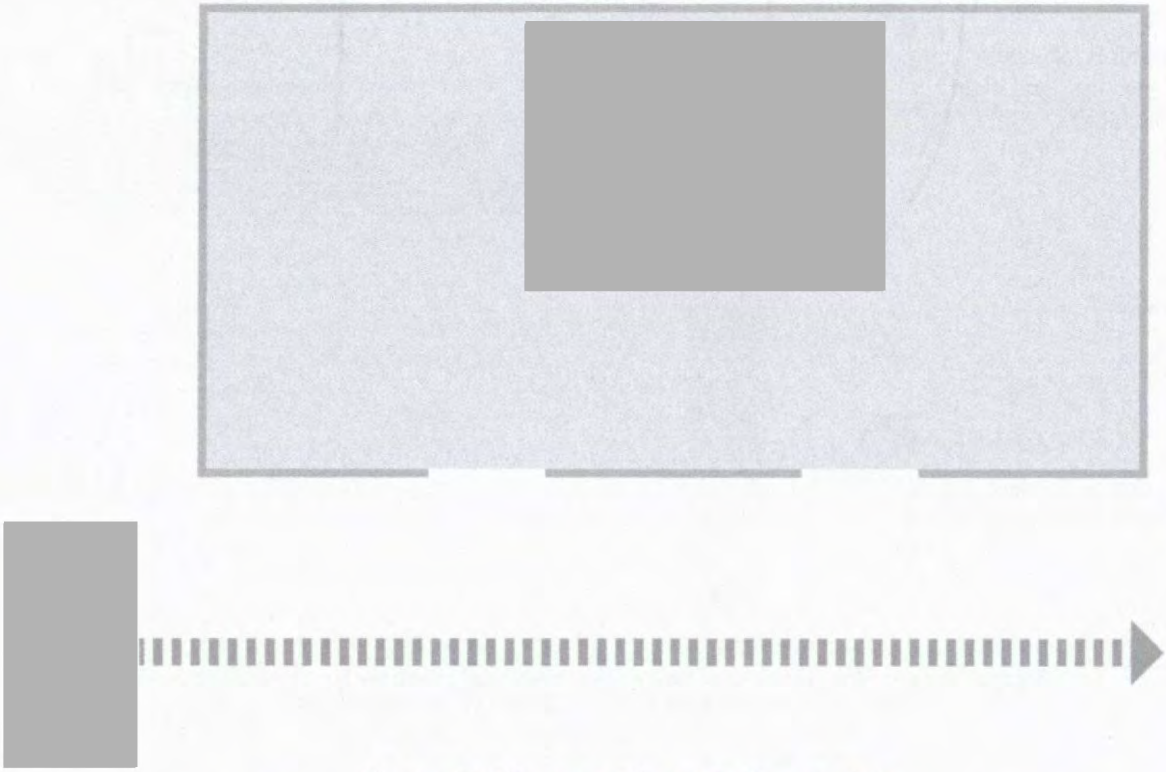
You may use the diagram above to support your answer.

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

The Student only hears Bass at point A as Bass has a much lower frequency than electric guitar. The bass difracts around the corner, from $f = \frac{v}{\lambda}$ the lower the frequency the longer the wavelength, Since bass has such a low frequency it has a very large wavelength and is able to diffract around the corner

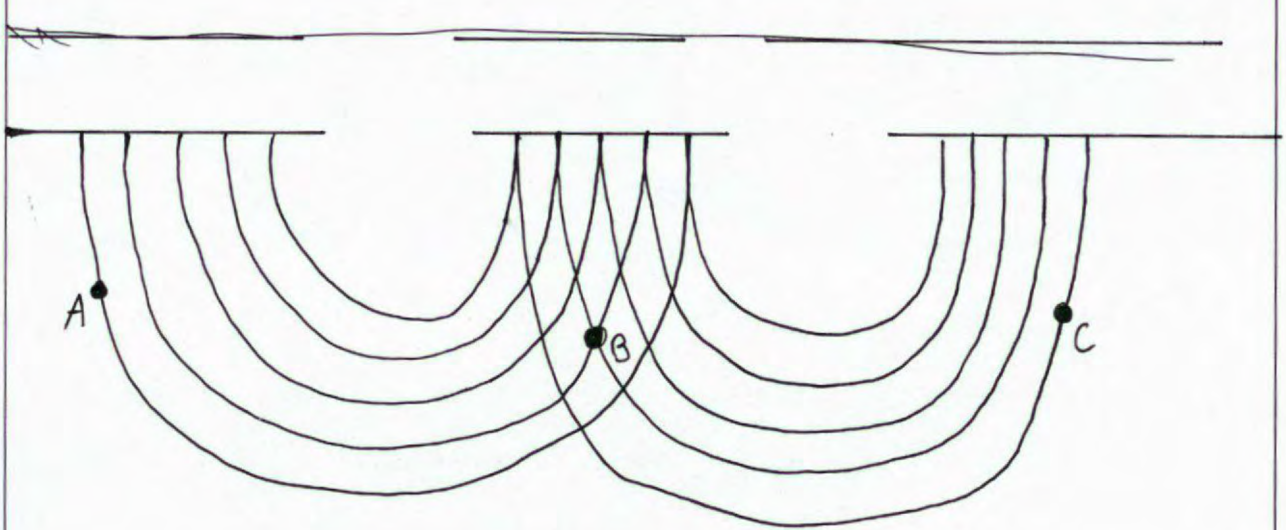
Question Three continues on the next page.

(d) Later they pass by the hall where a band is tuning their instruments and playing a single frequency. The hall has two open doors. The students notice the sound appears to vary in volume as they walk past the doors. Assume the tuning frequency is played at a constant volume.



Sources: https://www.pngwing.com/en/free-png-njmzc
www.kindpng.com/imgv/iiRhiJh_ykle-caillou-cartoon-asian-cartoon-characters-disney-hd/

Through the use of appropriate diagrams and the use of physics concepts, identify, describe, and explain the physics phenomena that are taking place to cause the sound to vary in volume.

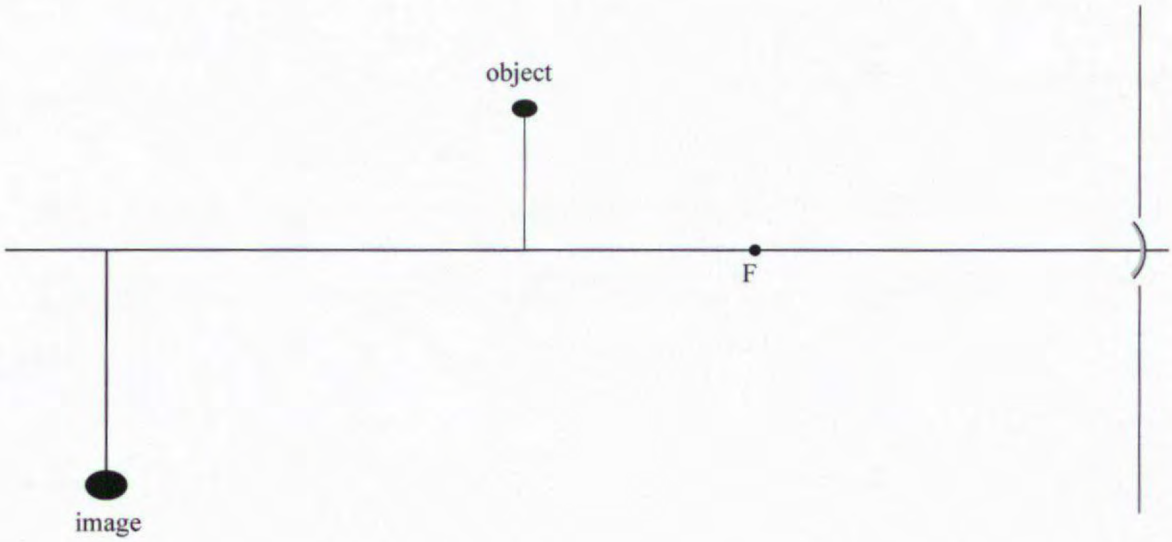


If you need to redraw your diagrams, use the space on page 12.

On the ~~dia~~ diagram below the Student would hear the band at equal volume at points A and C, however, at Point B it would be louder. This is due to ~~s~~ Super-position. At points A and C there is only one wave hitting the Student, but at point B there is an overlap of Sound-Waves. This overlap is where the music would be louder. At every point where this happens the music will sound louder.

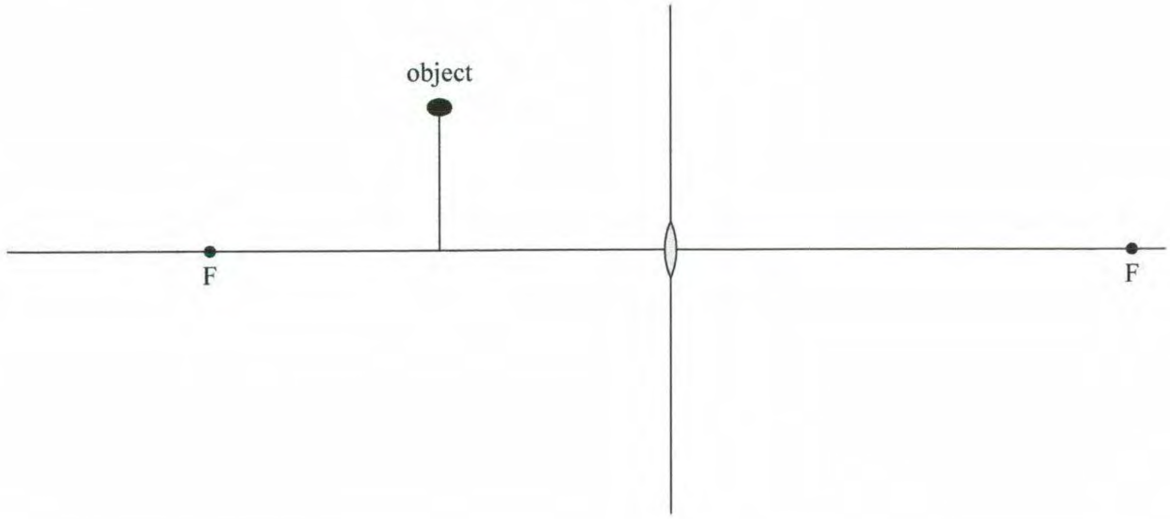
SPARE DIAGRAMS

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

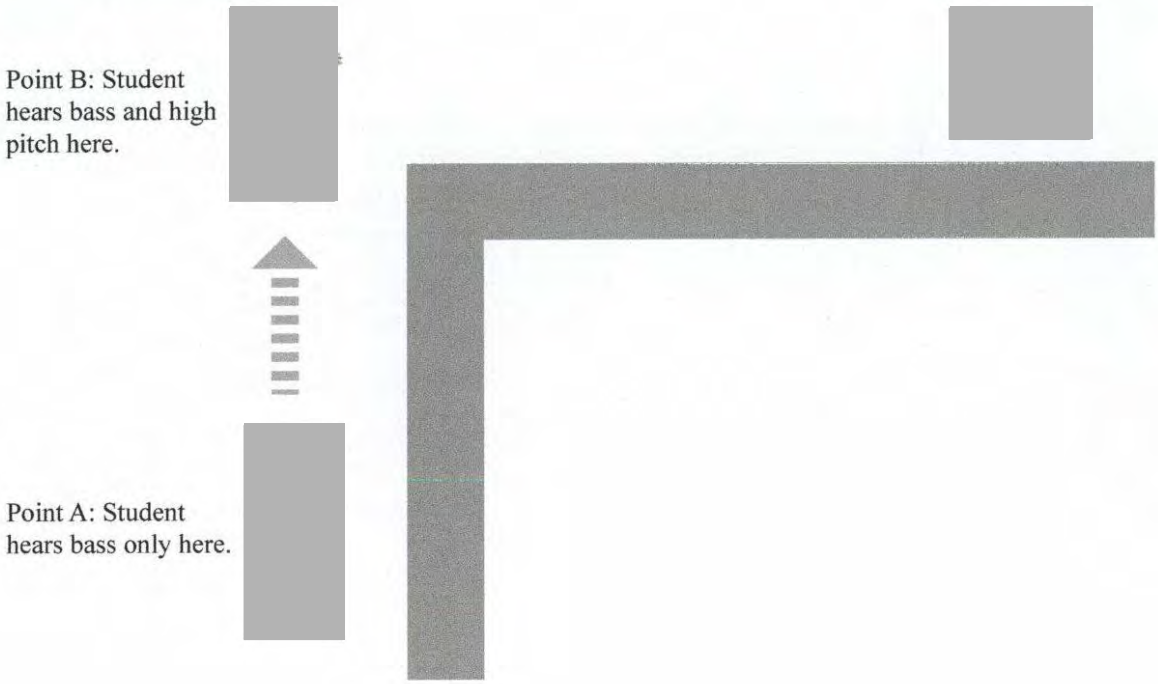


If you need to redraw your response to Question One (d), use the space below. Make sure it is clear which answer you want marked.

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



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



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

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

QUESTION NUMBER

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

QUESTION NUMBER

91170

Achievement

Subject: Physics

Standard: 91170

Total score: 11

Q	Grade score	Marker commentary
One	A4	(a) Correct definition of real image, (b) correct ray diagram (with arrows), but all calculations incomplete or non-existent.
Two	A4	(a) Refraction identified, (b) wrong angle of refraction used but correct calculation, (c) simple calculation and ‘frequency unchanged’ correct, but mistakes regarding total internal reflection.
Three	A3	The lens parts (a) and (c) were incorrect but good understanding of diffraction and a passable 2-point source interference pattern redeemed this answer.