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NZQA

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SUPERVISOR'S USE ONLY

Level 2 Physics, 2015

91170 Demonstrate understanding of waves

9.30 a.m. Tuesday 17 November 2015
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.

Merit

TOTAL 22

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QUESTION ONE: MIRRORS

Sela is experimenting with curved mirrors. She places a lighted candle in front of a **concave mirror** and obtains an image on a screen.

(a) State the nature (real or virtual) and the orientation (upright or inverted) of the image.

real image, inverted //

a

Both parts correct

(b) The image of the candle is formed 25.0 cm from the mirror. The focal length of the mirror is 16.0 cm. The height of the image is 0.50 cm.

Calculate the **distance** of the object from the mirror and the **height** of the object.

$d_i = 25\,cm$, $F = 16cm$, $h_i = 0.50cm$

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

$\frac{1}{d_o} = \frac{1}{f} - \frac{1}{d_i}$

$\frac{1}{d_o} = 0.0225$

$d_o = 44.44 = 44\,cm\,(2.sf) = 0.44m$ ✓

$\frac{d_i}{d_o} = \frac{h_i}{h_o}$

$\frac{25}{44.44} = \frac{0.5}{h_o}$

$h_o = \frac{0.5}{0.5630630631} \quad \frac{0.5}{0.5681818182}$

$h_o = 0.88\,cm\,(2.sf)$ ✓ //

$h_o = 0.0088\,m\,(3.sf)$

m

Both calculations correct

(c) Sela then placed the candle in front of a **convex mirror**.

Explain why she was unable to get an image of the candle on a screen.

This is because the image formed is a ✓ virtual image. The light rays do not cross each other. Virtual images cannot be cast on a screen. //

m

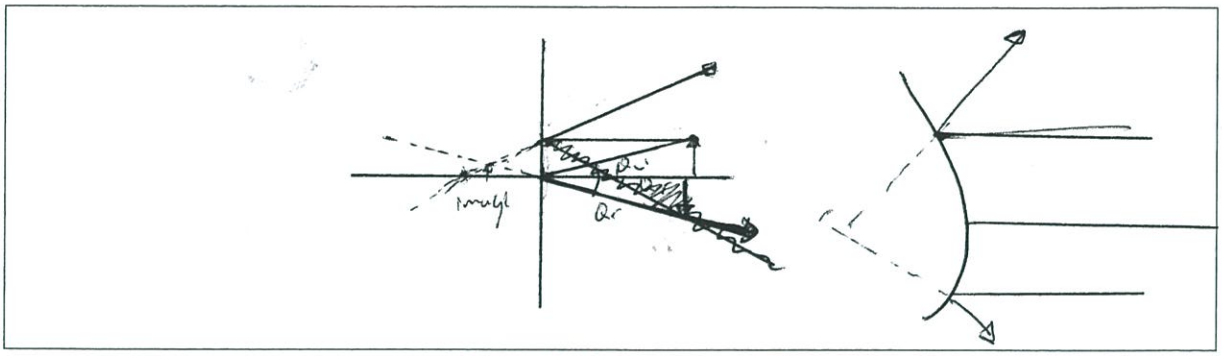
Type of image and explanation implied correctly

(d) Dentists use curved mirrors.

Write a comprehensive explanation for why dentists use curved mirrors instead of plane mirrors to examine a tooth.

In your answer include:

- the name of the type of mirror they use
- a ray diagram.



Dentists use convex ~~concave~~ mirrors
To see around corners in the mouth,
therefore reflecting images onto their eyes to
work.

Correct ray diagram for 'wider' field of view and why it could be used
But insufficient explanation of why this type of mirror may be used instead of a plane mirror.

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M

M6

QUESTION TWO: LENSES AND REFRACTION

(a) Tom uses a convex lens as a magnifying glass. He puts a petal of a flower 2.0 cm in front of the lens to study it. The lens has a focal length of 5.0 cm.

Calculate the distance of the image from the lens.

$d_o = 2$ cm $\quad f = 5$cm

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o}$

$\frac{1}{d_i} = \frac{-3}{10}$

$d_i = -3.3$ cm (2.sf) ✓

$d_i = 0.033$ m (2.sf) ✓✓

Correct calculation with a negative sign.

m

(b) Tom goes to a pool. He shines a red laser into the pool. He notices that even though the light ray bends, its colour does not change.

Explain why the colour of the laser remains the same.

water is transparent so light is absorbed. ~~a medium for light to travel through is~~

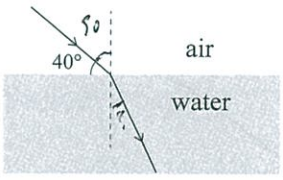
No 'real' reasoning.

—

(c) Tom shines the red laser at an angle of 40° to the surface of the water in the pool, as shown in the diagram below.

Refractive index of air = 1.00

Refractive index of water = 1.33



Calculate the angle of refraction.

$1 \sin 50° = 1.33 \sin \theta$

$\sin \theta =$

$\theta = 35.167891$

35.2° (3.sf). is the angle of refraction. ✓✓

î and calculation correct

m

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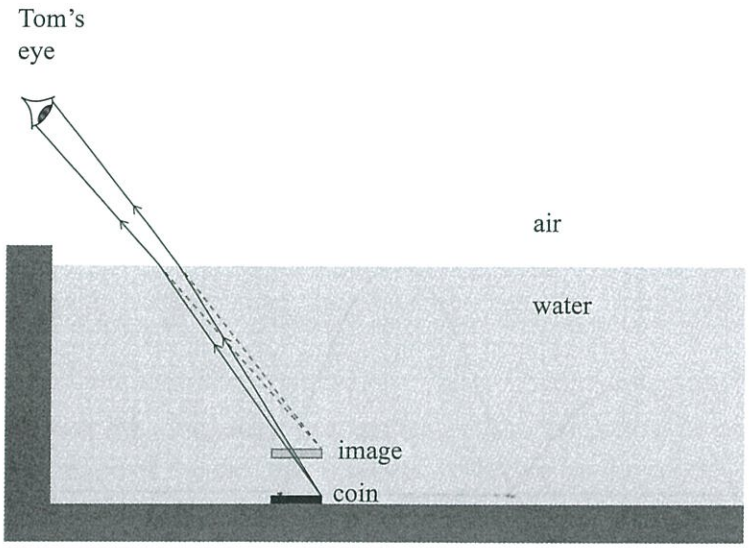
(d) There is a coin at the bottom of the pool. Tom looks at the coin from above and sees an image of the coin, as shown in the diagram below.



Write a comprehensive explanation for why the rays bend, and how the image of the coin at the bottom of the pool is formed when Tom looks at it from above.

Refraction is the bending of light as it travels from 1 medium to another. Refraction index is the ~~[illegible]~~ measure of how much light slows down in a substance (medium). greater refractive index greater speed loss. of light. As light passes through 1 medium to another, if it enters the new medium at an angle the light will bend. From low refractive index to high it will bend away from the normal ~~The normal is perpendicular to~~ Therefore the image of the coin is formed, seemingly higher due to the light travelling from the coin, in water to air, ~~Therefor the light~~ at an angle. Therefore the light bends away from the normal, and into Tom's eye. Due to this bend in ~~the~~ the light, the coin will appear to be where the image is, and not where the object is. Therefore it is due to the bend in light from water to air which forms the image of the coin at the bottom of the pool as Tom looks from above. //

a

Explanation has ray going into Tom's eye rather than the other way around
BUT then has incorrect bending of light from low refractive index to high refractive index, Some correction later, but no mention of 'tracing rays back' to image.

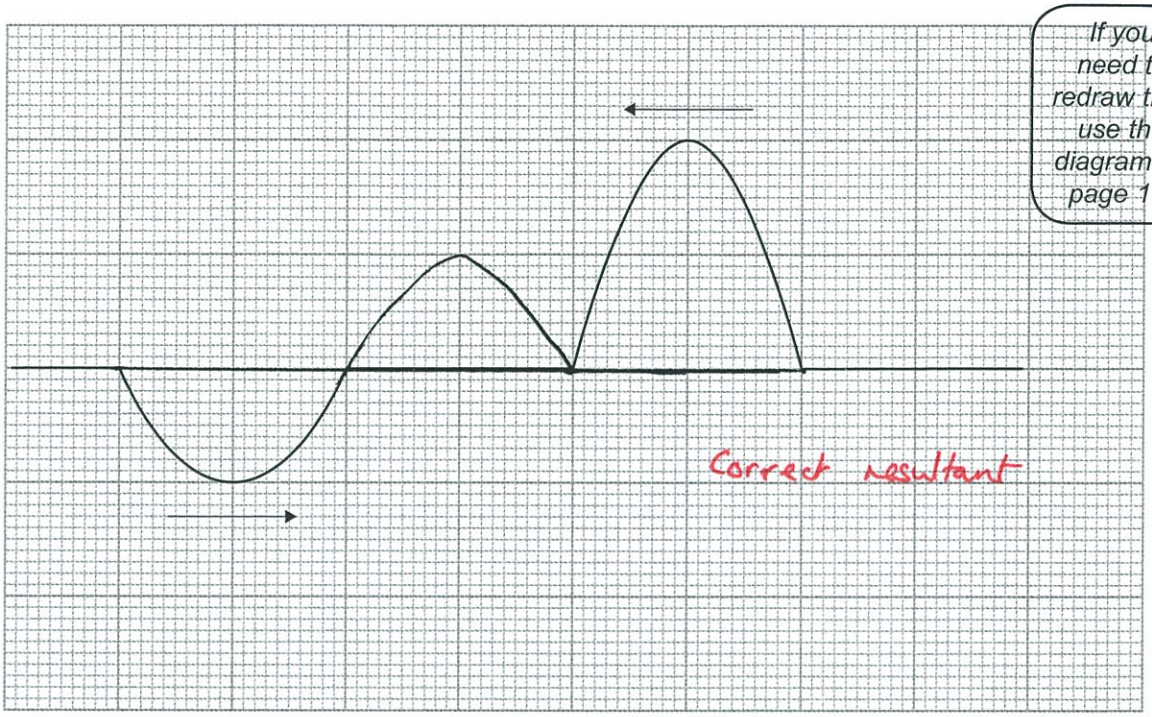
M5

QUESTION THREE: ROPES AND A MIRAGE

ASSESSOR'S USE ONLY

(a) Tom and his friend Ellen hold each end of a rope. Each of them sends a pulse along the rope in opposite directions. The grid below shows the motion of the pulses.

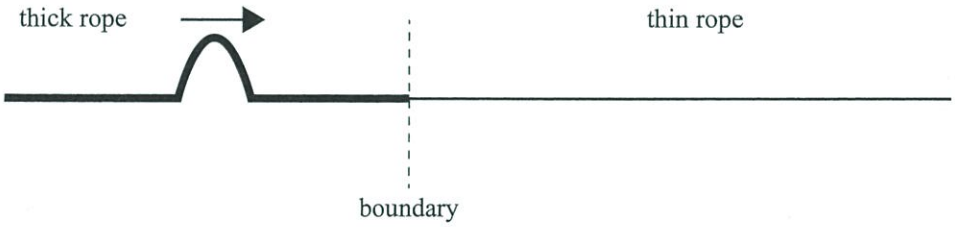
On the grid, draw the resultant pulse when the two pulses are fully superposed.



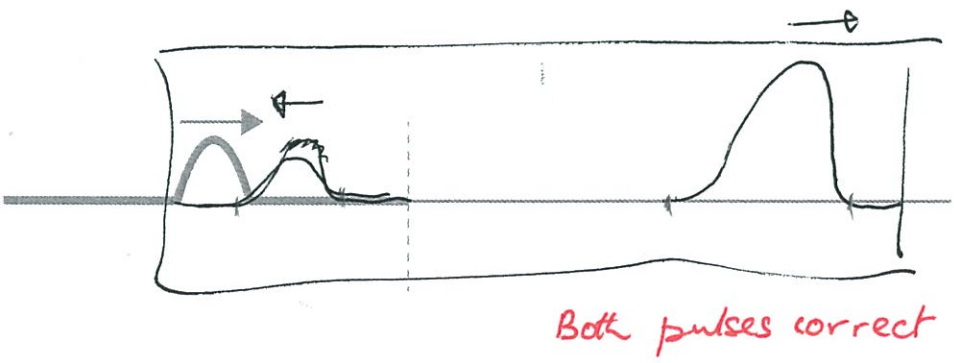
If you need to redraw this, use the diagram on page 11.

a

(b) Tom ties a thick rope to a thin rope, as shown in the diagram below. He then sends a pulse from the thick rope towards the thin rope. The pulse travels faster through the thin rope.



In the box below draw a diagram to show what happens to the pulse as it undergoes reflection and transmission (refraction) once it reaches the boundary between the two ropes.



m

(c) Explain what happens to the **amplitude** of the pulse in the thick rope when it reflects.

The amplitude of the pulse in the thick rope will decrease ✓ due to energy ✓ lost ~~as~~ causing the thin Rope to move to the right at a greater speed. //

Both what and why correct.

(d) Tom drives down the motorway on a hot sunny day. He notices a mirage ahead of him. A mirage is the image of the sky that has been reflected by the road. The air just above the surface of the road is hotter than the layers of air above it. Hot air is less optically dense than cold air.

Write a comprehensive explanation for why Tom sees a mirage.

This is due to refraction. The light from the cold air will bend (refract) towards the normal, × and into Tom's eys. This is because it is ~~de~~tracting from a high optical density to a low optical density. Refraction is the bending of light from one medium to another if it enters the new medium at an angle. Therefore the light will bend into ~~Toms eyes~~ the Road and into Toms eyes. This is why he sees a mirage. //

Incorrect bending of light from cold air to hot air. No mention of Total Internal Reflection.

ASSESSOR'S USE ONLY

M

M5

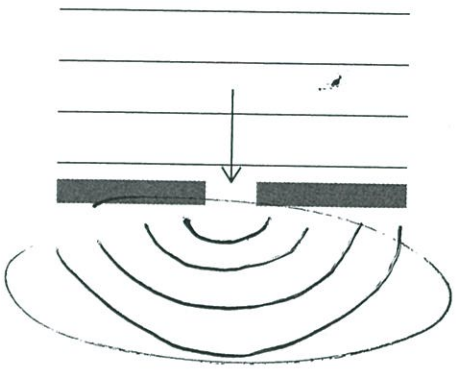
QUESTION FOUR: WAVES

ASSESSOR USE ONLY

(a) Tom and Ellen watch waves in the ocean. The diagram below shows the wave crests approaching a gap in a sea wall.

On the diagram, draw the wave crests after they have gone through the gap.

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



Wavelength incorrect after passing through the gap.

(b) Tom and Ellen stand on a beach, watching the waves. They notice that the wave fronts are closer together when they reach shallow water, as compared to the distance between wave fronts in deep water.

On one occasion, the distance between wave crests in deep water is 1.75 m. The speed of waves in deep water is 12.0 m s^{-1}. The speed of waves in shallow water is 4.5 m s^{-1}.

Calculate:

- the frequency of the waves
- the distance between wave crests in shallow water.

frequency $= \frac{v}{\lambda}$ frequency is same in deep and shallow.

$f = \frac{12}{1.75}$

$f = 6.857142857$

$f = 6.9\ Hz$ (2.sf) ✓

$\frac{v_2}{v_1} = \frac{\lambda_2}{\lambda_1}$ / $\frac{4.5}{12} = \frac{\lambda_2}{1.75}$

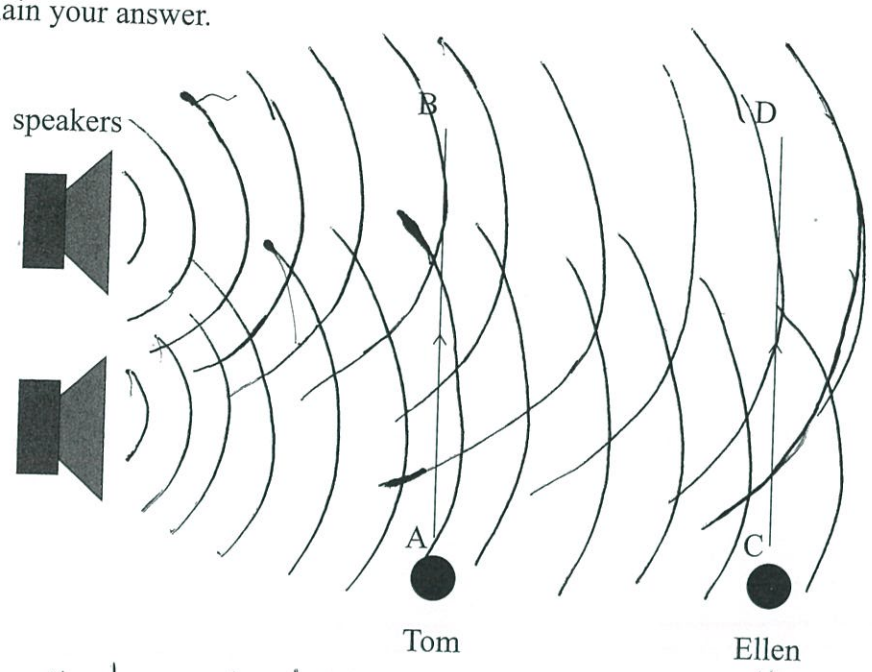
$\lambda_2 = 0.65625\ m$

$\lambda = 0.66\ m$ (3.sf) ✓ M1

Both calculations correct (with units).

(c) Two speakers producing the same sound are placed close together.
Tom walks along line AB and Ellen walks along line CD.

- Describe the sound that Tom hears.
- Compare the sound that Tom hears with the sound that Ellen hears.
  Explain your answer.



Tom will hear loud, then soft sounds, loud, then soft as he walks along line AB. This is due to the constructive interference, which is a point of high intensity, therefore loud sound. Ellen will hear the same thing however Ellen will have longer periods of softer sounds due to the being less constructive interence along her line CD. As it is further away, ~~Ther~~ There are less points of constructive interference where Ellen's line is //

Both correct description of what Tom hears and what Ellen hears and correct explanation with an attempt at a diagram.

m

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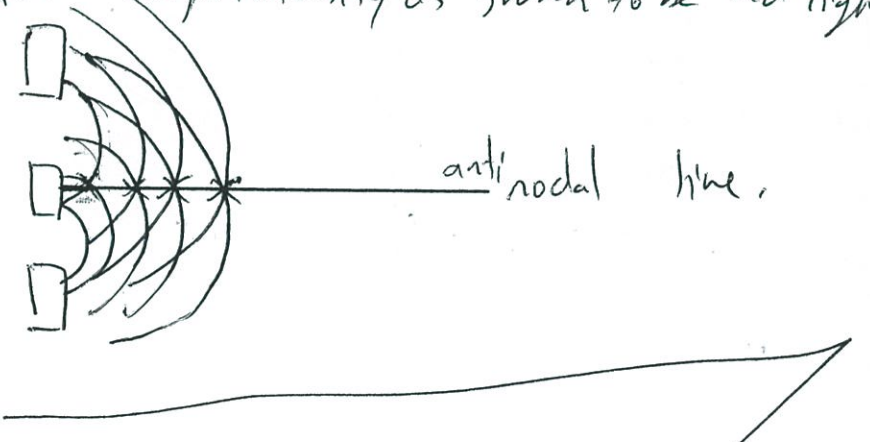
Question Four continues on the following page.

(d) Tom shines a red laser through the two slits and gets the following pattern on a screen.

Write a comprehensive explanation for why there are alternate bright and dark bands on the screen.

In your answer include concepts about path difference and interference.

This is because as wave pass thrugh an opening, of similar size in its wavelength it will diffract. Due to there being 2 slits, the crest of the wavelengths will cross over at certain times, these are points of constructive interference therefore high intensity. Showed by the red line. The black shown in screen are points of deconstructive interference, where a crest and a trough meet. Therefore less light. Due to the path difference there will be a ~~nodal~~ antinodal line formed which is a line of constructive interferance between two waves, which is therefore high intensity as shown to be red light.



This cannot be awarded an 'e' because there is insufficient detail concerning the path difference for constructive and destructive interference.

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M

M6

SPARE DIAGRAMS

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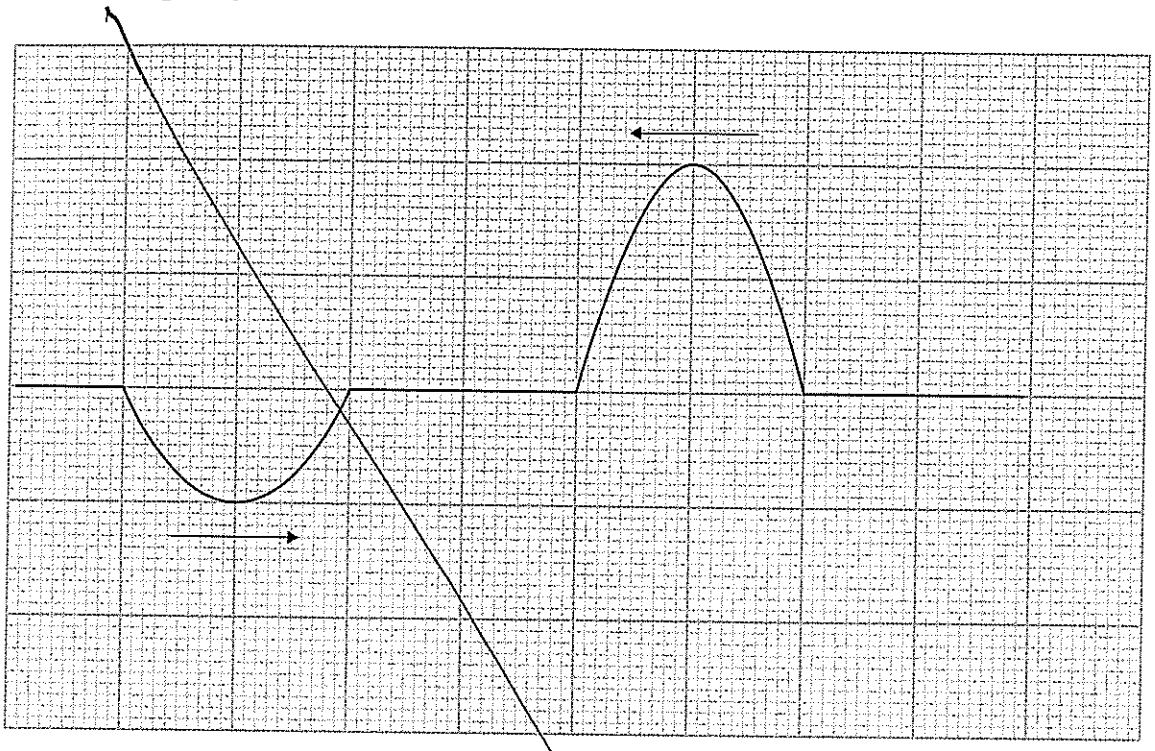
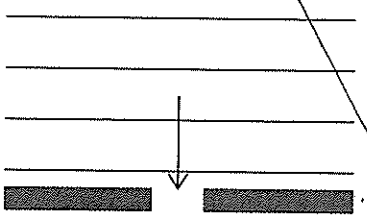
If you need to redraw the pulse from Question Three (a), draw it on the diagram below. Make sure it is clear which diagram you want marked.



If you need to redraw your completion of the diagram from Question Four (a), draw it on the diagram below. Make sure it is clear which diagram you want marked.



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

QUESTION NUMBER

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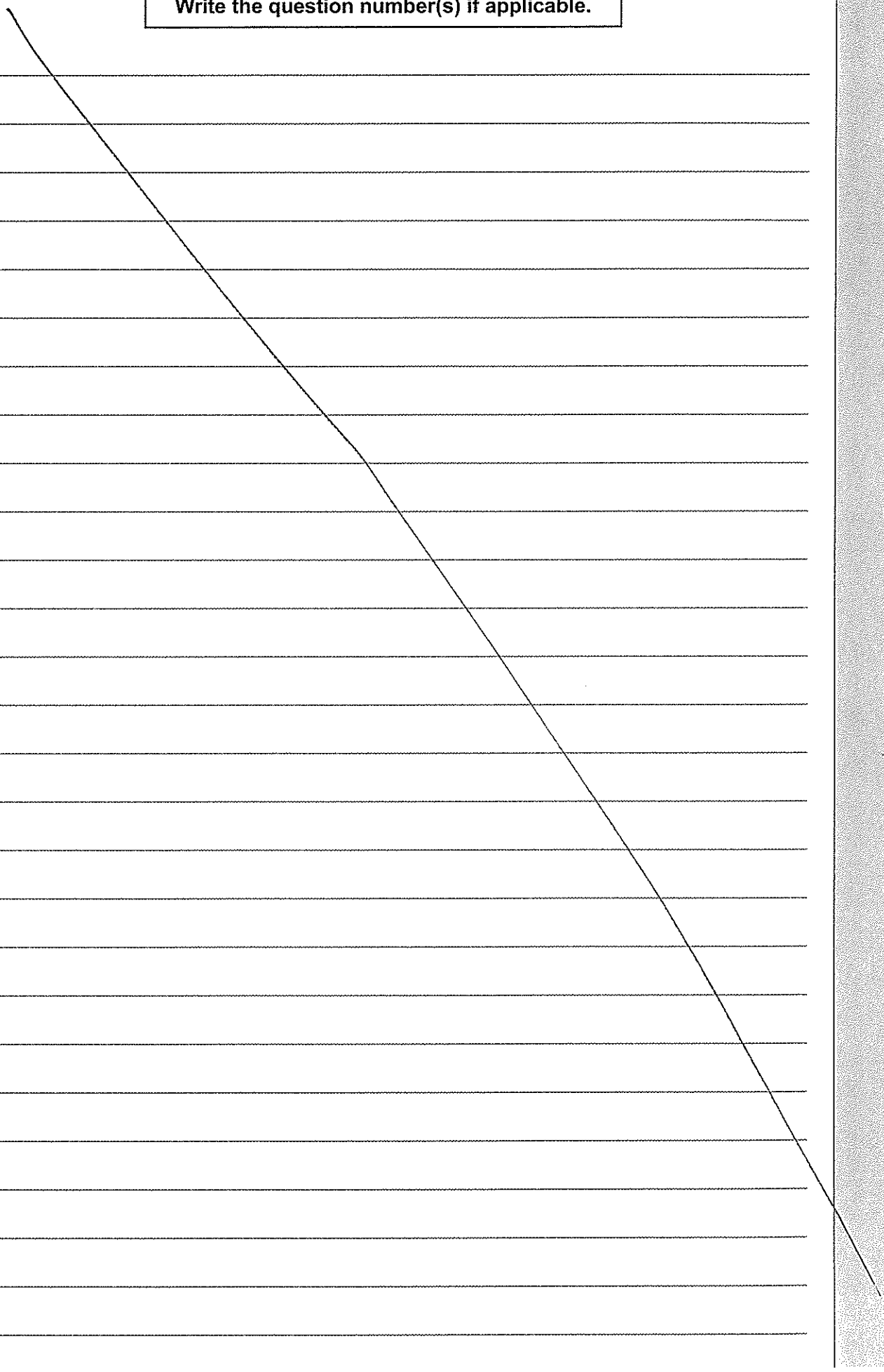

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