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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.

Achievement

TOTAL 15

ASSESSOR'S USE ONLY

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 and inverted //

Both correct.

a

(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.

$\frac{d_i}{d_o} = \frac{h_i}{h_o}$ $d_i = 25$ $f = 16cm$ $h_i = 0.50$

$d_o = ?\ 45$ $h_o = ?$

$\frac{1}{16cm} = \frac{1}{d_o} + \frac{1}{25}$ $\frac{1}{16} - \frac{1}{25} = \frac{1}{d_o} = \frac{1}{0.0225}$

$d_o = 44.44$ ✓ $= d_o = 45cm$

$\frac{d_i}{d_o} = \frac{h_i}{h_o}$ $\frac{25}{45} = \frac{0.5}{h_o}$ $= \frac{0.56}{cm} \times 0.5 = h_o$

→ $h_o = 0.28cm$

→ $d_o = 45cm$ //

Calculation for object height is incorrect.

a

(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.

Because it was a virtual ✓ image, the light rays didn't cross to a point making the image unable to get on the screen. //

Virtual image correct BUT no real reasoning as to why it cannot be projected on a screen.

a

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(d) Dentists use curved mirrors.

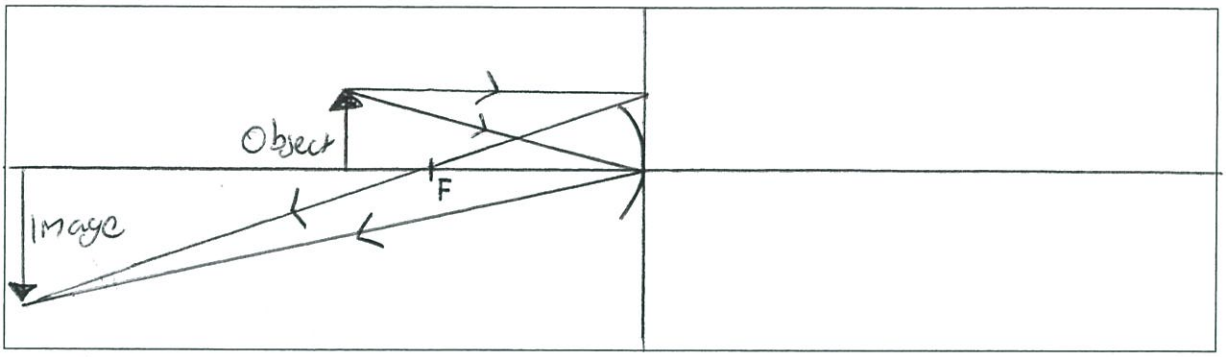
ASSESSOR'S USE ONLY

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.

Concave Mirror



The type of mirror they use is Concave Mirror's. This is because Concave mirrors create a real image ensuring the dentist can see inside the mouth of the occupent. By the use of plane mirrors the dentist would be unable to get inside the mouth and be able to see everything inside as the image would reflect straight back into the mouth. But from Concave mirrors the image comes out different making it able for the dentist to see. By the use of Concave you can get in behind the teeth to see behind them where all of this Stated above you can do with a plane mirror.//

a

Correct diagram and concave mirror But the rest of the answer does not enhance the idea of magnification or that a plane mirror does not magnify.

A4

QUESTION TWO: LENSES AND REFRACTION

ASSESSOR'S USE ONLY

(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.

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

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \quad \frac{1}{5} = \frac{1}{2} + \frac{1}{d_i}$

$\frac{1}{5} - \frac{1}{2} = \frac{1}{d_i}$

$-0.3 = \frac{1}{d_i}$

Correct calculation with negative sign.

$d_i = -3.333°$ $d_i = -3cm$ (2sf) // 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.

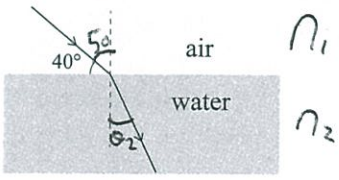
this is because the refractive index of the pool is alot larger than the laser through the air causing the colour to remain the same and deflect // —

Frequency not mentioned.

(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.

n_1 Refractive index of air = 1.00

n_2 Refractive index of water = 1.33



Calculate the angle of refraction.

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

$1 \times \sin 50 = 1.33 \times \sin\theta_2$

$\sin 50 = 1.33 \times \sin\theta_2$

$\left(\frac{\sin 50}{1.33}\right) = \sin\theta_2$

$0.576 = \sin\theta_2$

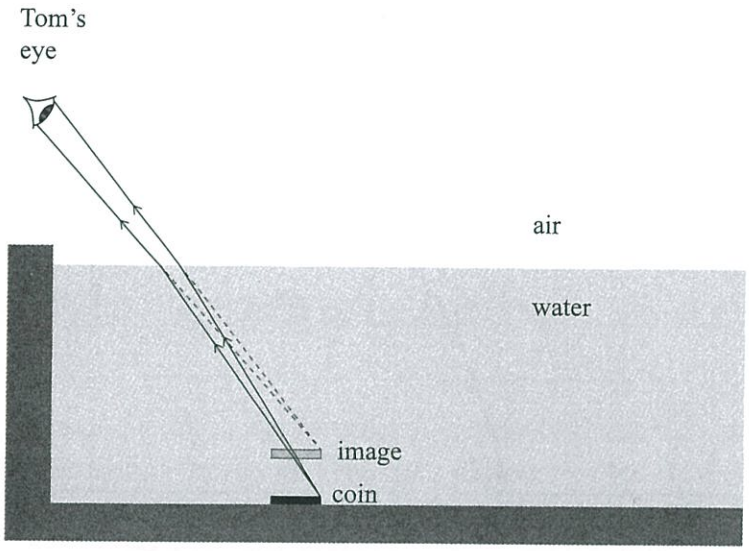
$\sin^{-1} 0.576 = \theta_2$

Correct ✓ and calculation.

$\theta_2 = 35.2° = \boxed{\theta_2 = 35° \text{ (2sf)}}$ or 40 ✓ m

(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.

ASSESSOR'S USE ONLY



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.

without the water tom would have been unable to see the coin, but due to the water the coin refracts in ~~on~~ the more dense medium which is water causing the coin to create an image in the eye of sight of tom. 11

None of the points required have been adequately mentioned.

A4

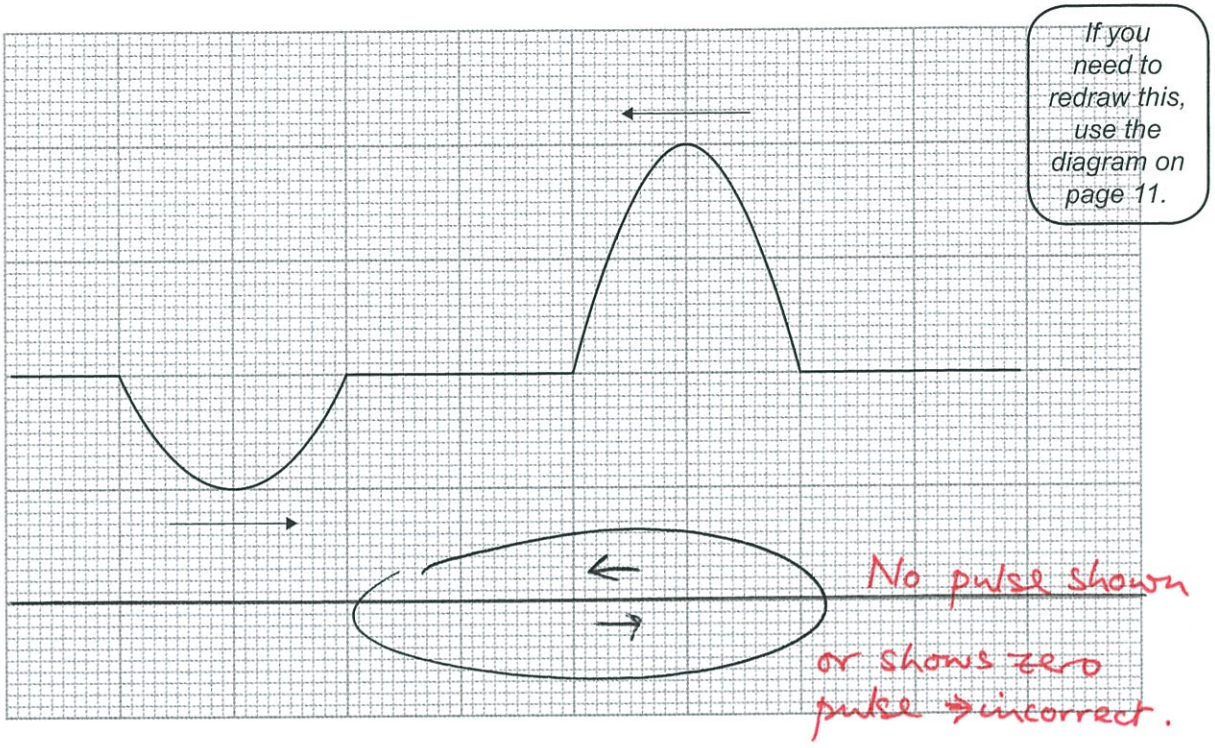
(1SP)

QUESTION THREE: ROPES AND A MIRAGE

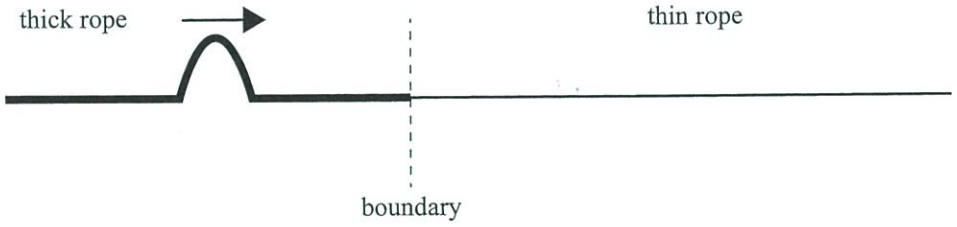
ASSESSOR'S USE ONLY

(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.

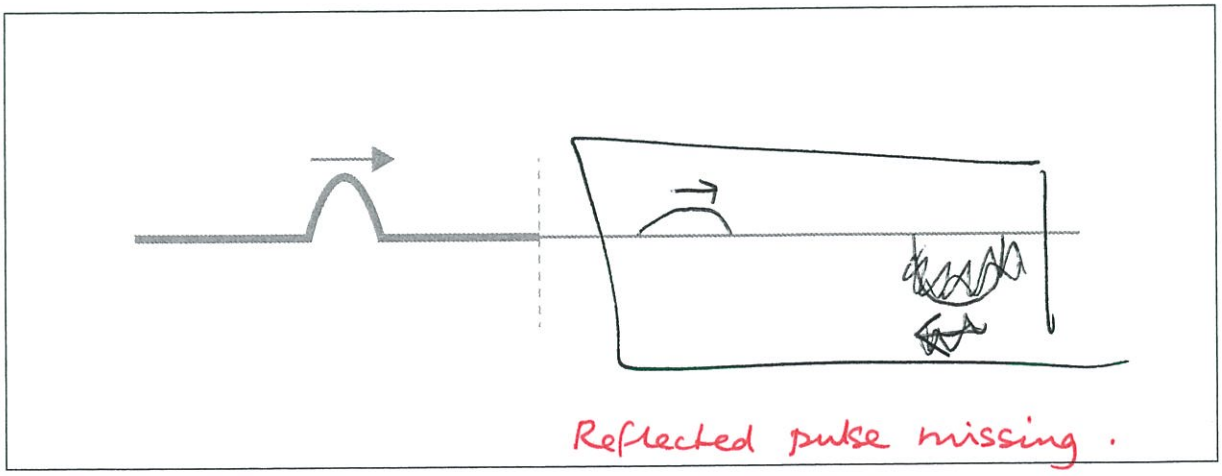
On the grid, draw the resultant pulse when the two pulses are fully superposed.



(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.



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

When it reflects ~~and~~ back the pulse will come back on the other side of the rope, being slightly slower as less energy is in it. ~~Slightly~~ There for the amplitude decreases every times the rope reflects until it stops. //

ASSESSOR'S USE ONLY

M4

(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.

~~Because of hot air trying to rise~~ Hot air rises, and because of the cold air being more optically dense than the hot air the cold air acts as a barrier stopping the hot air from rising causing the ~~hot~~ hot air to stay low to the ground, thats why Tom is able to see it. //

None of the actual points required to explain the mirage have been mentioned.

N2

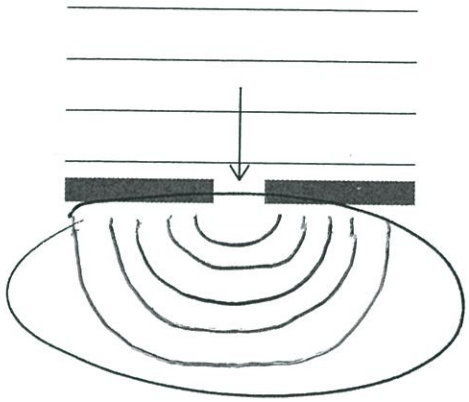
QUESTION FOUR: WAVES

ASSESSOR'S 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 is incorrect.

(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.

Deep water = $f = \frac{v}{\lambda}$ $f = \frac{12}{1.75}$ $f = 6.86$ ✓

~~Shallow water $f = \frac{v}{\lambda}$ $f = \frac{4.5}{1.75}$ $f = 2.57$~~

in Shallow water: $f = \frac{v}{\lambda}$ $f = \frac{4.5}{1.75}$

$f = 2.57$

distance between waves in Shallow water = $\lambda = \frac{v}{f}$

$\lambda = \frac{4.5}{2.57}$ $\lambda = 1.75$ m ✗

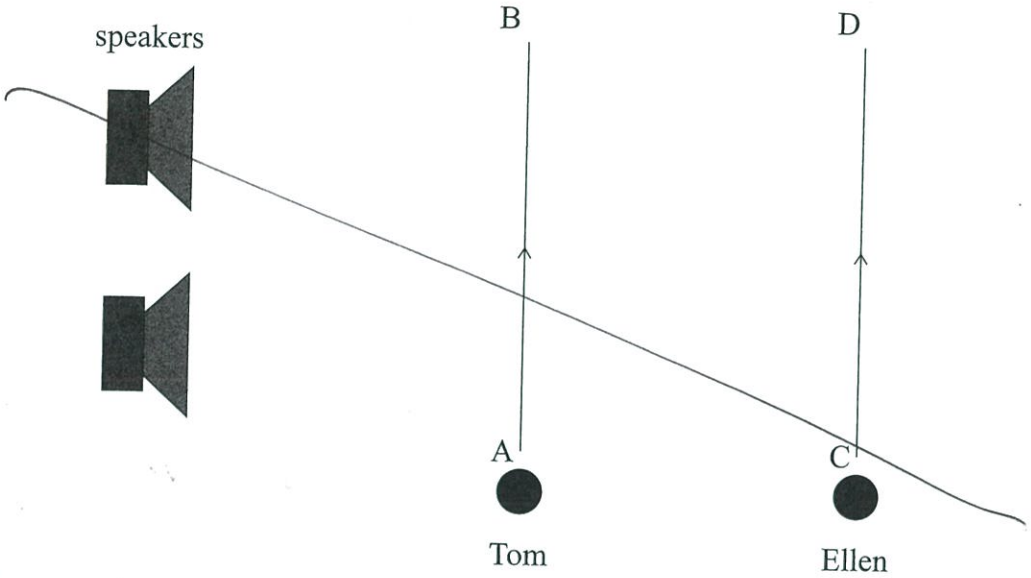
The second part of the calculation is incorrect.

a

(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.

ASSESSOR'S USE ONLY



As tom walks past he will hear parts of destructive interferance where there is little/no sound and parts of Constructive interference where he will hear a large amount of volume, Ellen will have the same, She will have areas of destructive interference and constructive interferance but overall will hear less volume as shes further away from the speakers. //

M

Both points correct.

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.

On the bright spots there is constructive interferance (in phase and anti-nodle) where there is light and in the dark areas it is destructive interferance (out of phase and nodle) where it produces no light. //

No mention of path difference for antinode ($n\lambda$) or node $(n-\frac{1}{2})\lambda$. Hence, only 'm'.

ASSESSOR'S USE ONLY

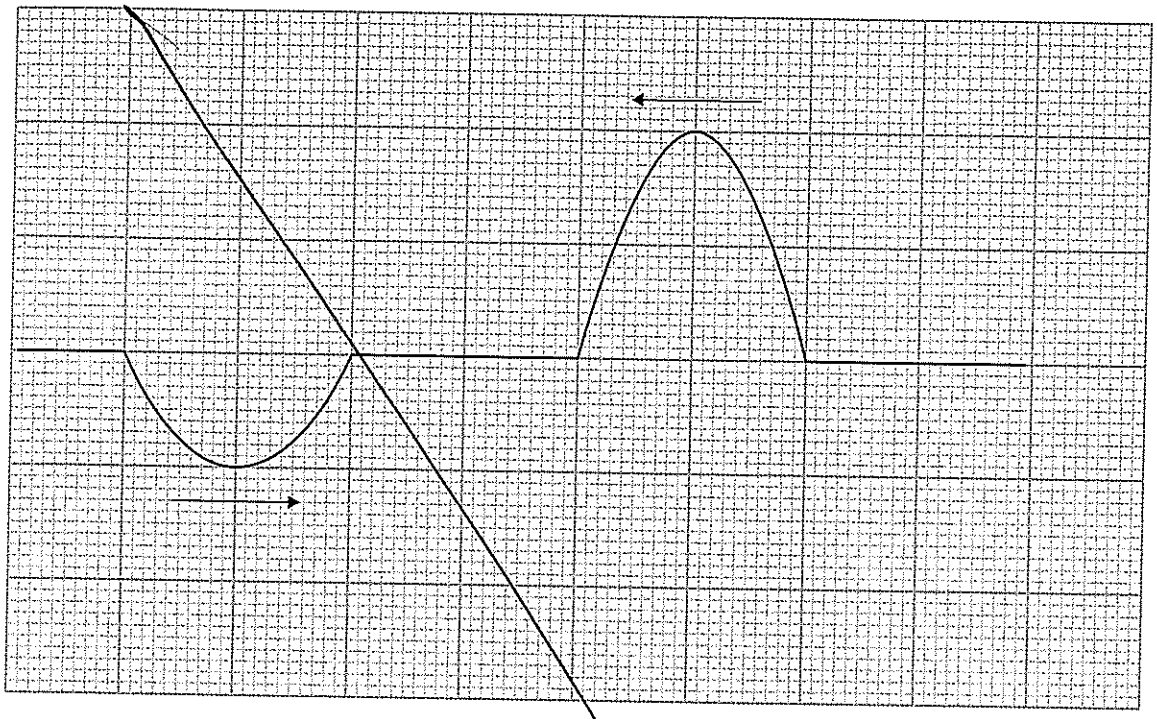
M

M5

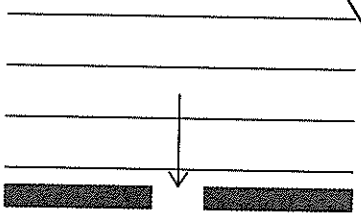
SPARE DIAGRAMS

ASSESSOR'S USE ONLY

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.



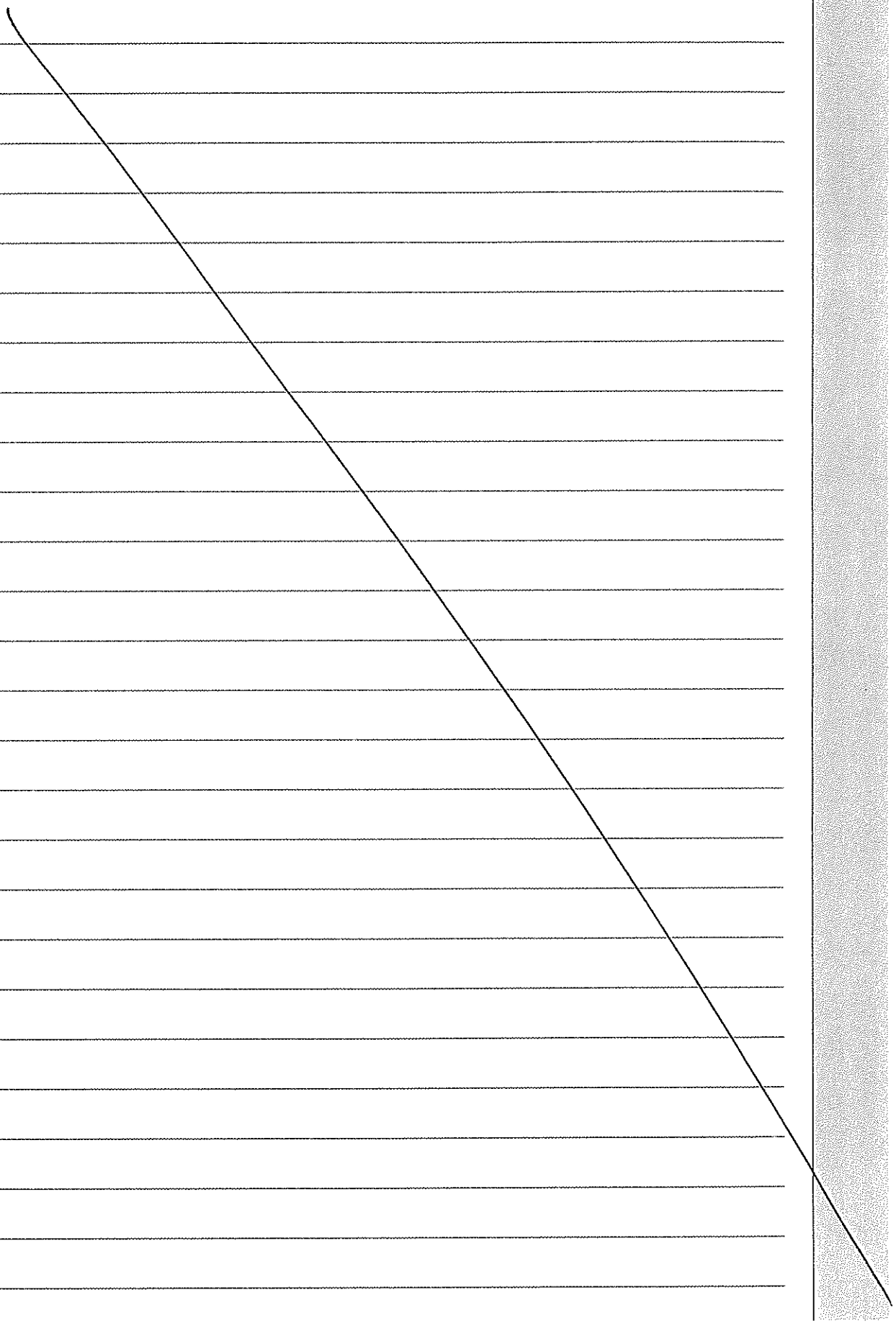
If you need to redraw your completion of the diagram from Question Four (a), draw it on the diagram below. Make sure it is clear which diagram you want marked.



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

QUESTION NUMBER

ASSESSOR'S USE ONLY



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