Wave Basics

Question Paper 2

Level	A Level
Subject	Physics
Exam Board	OCR
Topic	Electrons , waves and photons
Sub-Topic	Wave Basics
Booklet	Question Paper 2

Time Allowed: **65 minutes**

Score: **/ 54**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** State **two** properties which distinguish electromagnetic waves from other transverse waves.

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..... **[2]**

(b) **(i)** Describe what is meant by *a plane polarised wave*.

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..... **[2]**

(ii) Light from a filament lamp is viewed through two polarising filters, shown in Fig. 6.1. The arrow beside each filter indicates the transmission axis of that polarising filter.

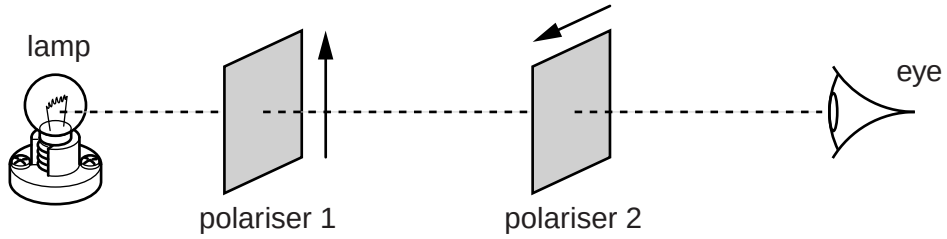

Fig. 6.1

Explain why the lamp cannot be seen by the eye.

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..... **[2]**

(iii) A third polarising filter is placed between the first two with its transmission axis at 45° to each of the others as shown in Fig. 6.2.

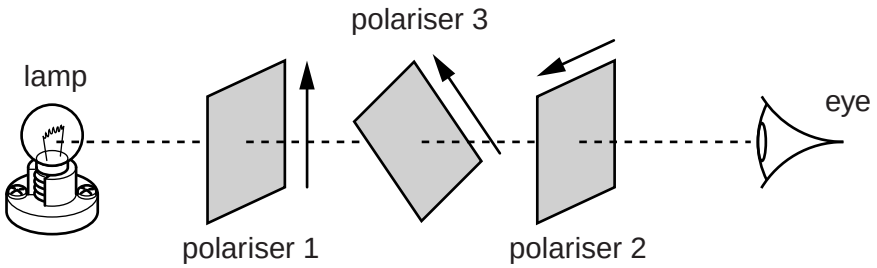

Fig. 6.2

Explain whether or not any light reaches the eye through the three filters.

In your answer you should state clearly the condition for light to be transmitted by a polarising filter.

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..... **[3]**

[Total: 9]

2 An estimation of the speed of electromagnetic waves can be made using the hot spots inside a microwave oven. Microwaves are emitted in all directions inside the metal walls of the oven at a frequency of 2.5×10^9 Hz causing stationary waves to be set up. Fig. 7.1 shows a typical pattern of the centres of the hot spots marked **X** in the central area of the floor of the oven.

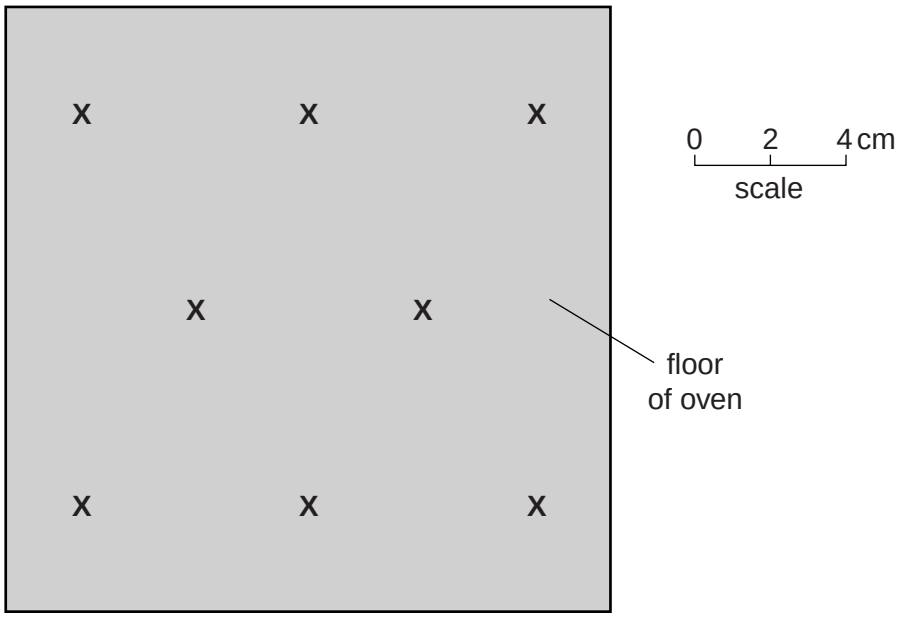

Fig. 7.1

These positions can be located to within a few millimetres by melting small areas in a bar of chocolate placed on the floor of the oven for a few seconds.

(a) Explain how a stationary microwave pattern is set up in the oven.

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..... **[3]**

(b) Explain whether the points marked **X** on Fig. 7.1 are at nodes or antinodes in the wave pattern.

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..... **[2]**

(c) Fig. 7.1 is drawn to **half scale**. By using measurements taken from the diagram make an estimate of the speed *c* of the microwaves. Make your reasoning clear.

c = ... $m\,s^{-1}$ **[4]**

[Total: 9]

3 **(a)** Define the following terms as applied to wave motion

(i) *displacement* and *amplitude*

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..... **[2]**

(ii) *frequency* and *phase difference*.

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..... **[2]**

(b) Fig. 6.1 shows a transverse pulse on a *slinky*, an open wound spring, at time $t = 0$. The pulse is travelling at a speed of $0.50\,m\,s^{-1}$ from left to right. The front of the pulse is at point **X**, 0.25 m from the point **P**.

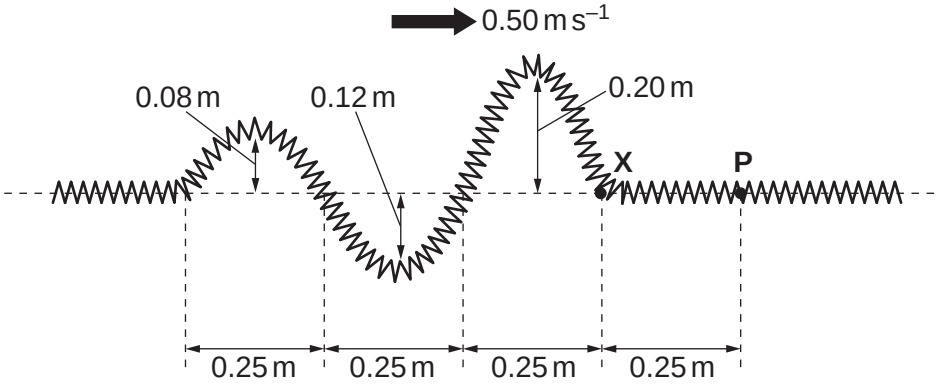

Fig. 6.1

On Fig. 6.2 draw a displacement *y* against time *t* graph of the motion of point **P** on the slinky from *t* = 0 to *t* = 2.5 s.

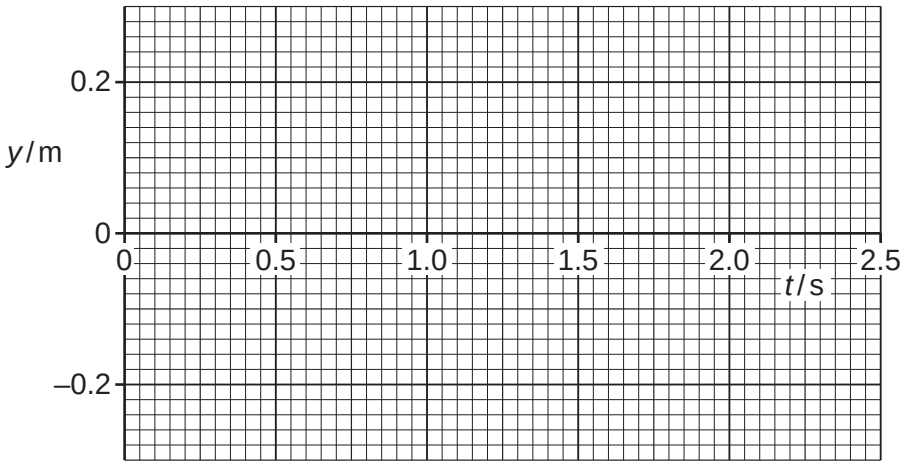

Fig. 6.2

[4]

[Total: 8]

4 **(a)** State **two** properties shared by all electromagnetic waves which distinguish them from all other waves.

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..... **[2]**

(b) The two columns below list four regions of the electromagnetic spectrum and four orders of magnitude of wavelength in m.

region	wavelength / m
microwaves	10^{-12}
ultra violet light	10^{-8}
gamma rays	10^{-6}
infra red light	10^{-4}

Draw a straight line from each **region** box to the corresponding **wavelength** box. **[2]**

(c) Fig. 8.1 shows a microwave receiver **R** placed between a microwave transmitter **T** and a flat metal sheet.

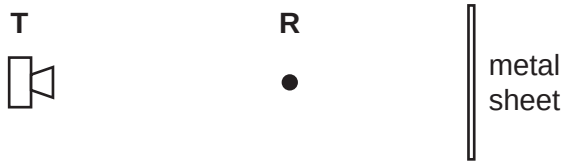

Fig. 8.1

(i) Explain why **R** receives two signals of different amplitude but of the same frequency.

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..... **[2]**

(ii) Explain why the strength of the detected signal varies between maximum and minimum values as **R** is moved towards or away from the metal sheet.

In your answer you should make clear how the maxima and minima occur.

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..... **[3]**

(iii) Determine the wavelength of the microwaves given that the distance between adjacent positions of maximum and minimum signal strength is 7.5 mm.

wavelength = ... mm **[1]**

(iv) The amplitude of the signal from the transmitter is *a*. The amplitude of the two signals detected at **R** are 0.8*a* and 0.6*a*. The changes in amplitude of the detected signals are negligible as **R** moves 7.5 mm. Show that the ratio

$$\frac{\text{maximum intensity of detected signal}}{\text{minimum intensity of detected signal}}$$

is about 50.

[3]

[Total: 13]

5 In Fig. 5.1 the solid line on the graph represents the displacement y against position x of a **progressive** transverse wave on a stretched wire at time $t = 0$. The dotted line shows the displacement at a later time $t = 0.75$ ms, where the wave has moved to the right.

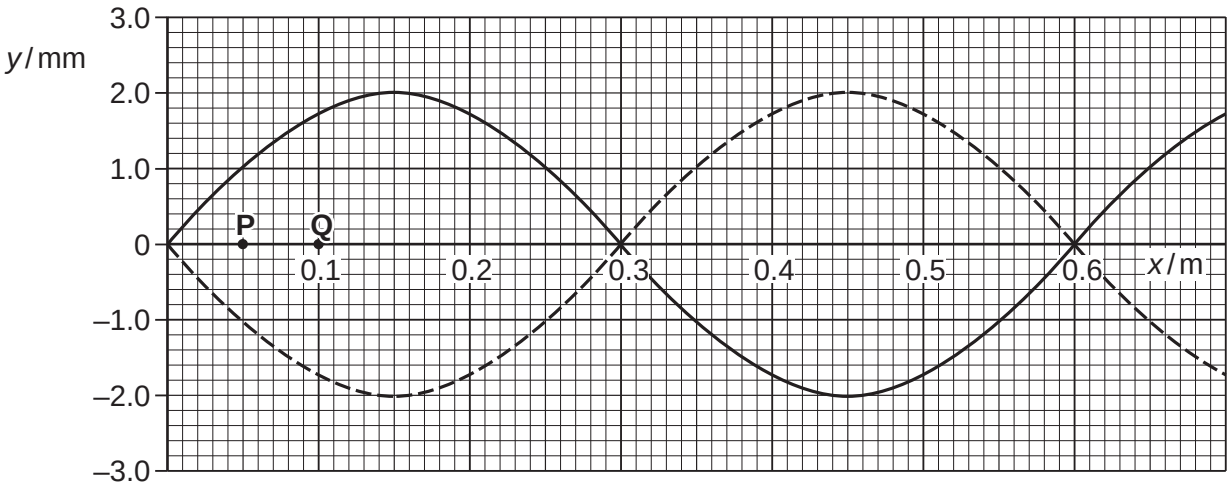

Fig. 5.1

(a) (i) Determine the wavelength of the wave.

wavelength = ... m **[1]**

(ii) 1 Explain how Fig. 5.1 shows that the period of the wave is 1.5 ms.

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..... **[1]**

2 Calculate the speed of the wave along the wire.

speed = ... $m\,s^{-1}$ **[2]**

(b) Consider the oscillations of the wire at positions **P** ($x = 0.05$ m) and **Q** ($x = 0.10$ m). See Fig. 5.1. For the **progressive** wave on the wire state the difference, if any, in **amplitude** of the oscillations of the wave at **P** and **Q**.

difference = ... mm **[1]**

(c) (i) Describe the diference between the *displacement* and the *amplitude* of a wave.

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..... **[2]**

(ii) Describe how a *stationary* wave is different from a *progressive* wave.

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..... **[2]**

(d) Fig. 5.2 shows the wire of Fig. 5.1 under tension fixed at points $x = 0$ and 0.60 m. The frequency of the mechanical oscillator close to one end is varied so that a **stationary** wave is set up on the wire.

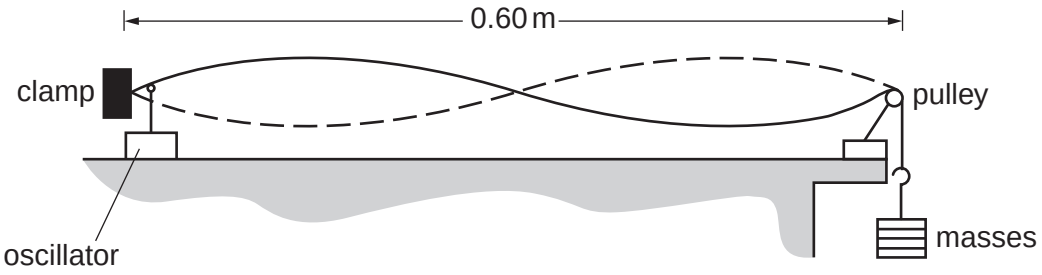

Fig. 5.2

(i) By considering the motion of progressive waves on the wire, explain how the stationary wave is produced.

In your answer you should make clear how the stationary wave arises.

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..... **[3]**

(ii) In Fig. 5.3 the solid line on the graph represents the displacement y against position x of the **stationary** wave on the stretched wire at time $t = 0$. The dotted line shows the displacement at a later time $t = 0.75$ ms.

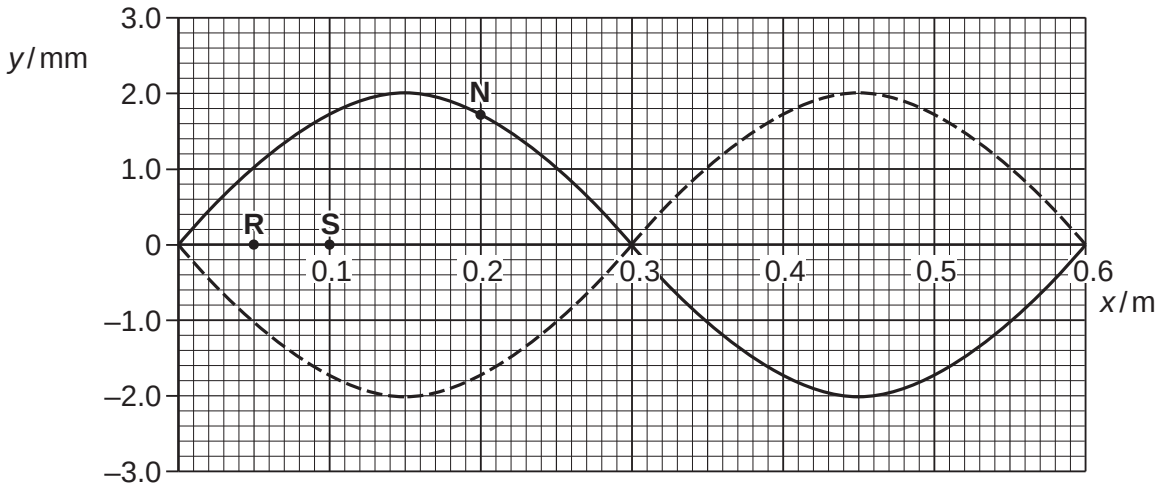

Fig. 5.3

For the **stationary** wave on the wire

1 state the difference, if any, in **amplitude** of the oscillations at **R** and **S**

difference = ... mm **[1]**

2 mark with an **X** the position of one antinode **[1]**

3 mark with a **Y** on the dotted line on Fig. 5.3 where the point **N** on the wave is at $t = 0.75$ ms. **[1]**

[Total: 15]