4.3 Wave Characteristics

Question Paper

Course	DP IB Physics
Section	4. Waves
Topic	4.3 Wave Characteristics
Difficulty	Medium

Time allowed: 80

Score: /59

Percentage: /100

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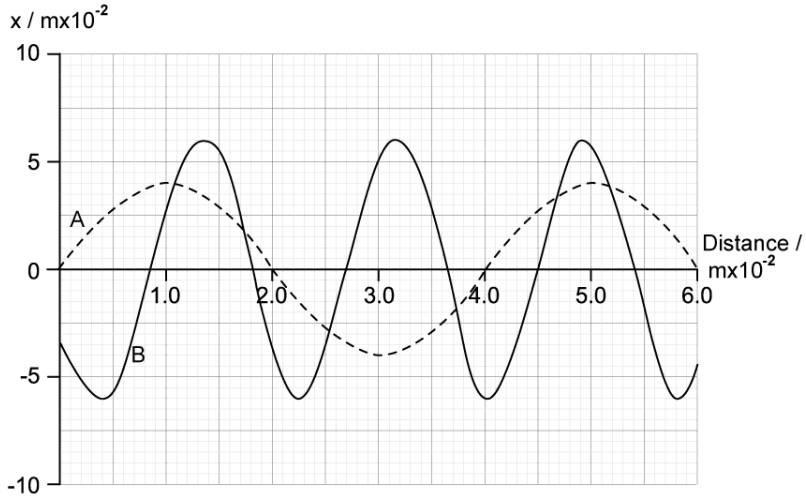
Question 1a

A large water tank is set up so that a wave can be generated at each end of the tank. The two waves, A and B, travel towards each other at the same speed.

The graph shows the variation of displacement of the water surface with distance travelled at a particular instant.



(a)
Deduce how many times greater the amplitude of B is to the amplitude of A.

[2 marks]

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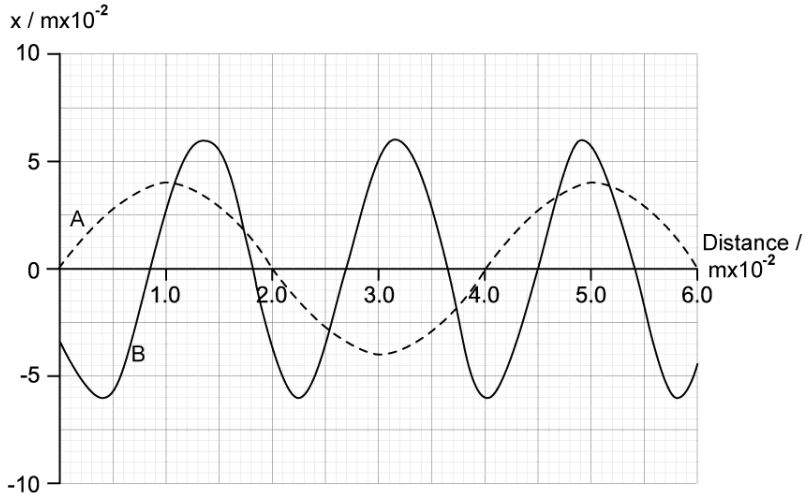
Question 1b

Wave A has a frequency of 9.0 Hz.



(b)

(i) Calculate the velocity of wave A

[2]

(ii) Determine the frequency of wave B

[2]

[4 marks]

Question 1c

(c) Explain how the stationary wave is generated in the tank.

[3 marks]

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Question 1d

(d)
Sketch a graph to represent the wave which would result from the superposition of wave A and wave B.

[4 marks]

Question 2a

Superposition occurs when two or more waves interfere with each other.

(a)
(I)
Explain the conditions required for a consistent stationary interference pattern to form during superposition.

[2]

(ii) Sketch a diagram to support your answer to part (i).

[2]

[4 marks]

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Question 2b

Superposition is often demonstrated using water waves which are transverse and clearly show increases and decreases in amplitude.

(b)
Describe how sound waves can also undergo superposition.

[3 marks]

Question 2c

Two microwave transmitters are placed 15 cm apart and connected to the same source. A receiver is placed 70 cm away and moved along a line parallel to the transmitters. The receiver detects and alternating pattern of maxima and minima.

(c)
Explain how the maxima and minima are formed.

[3 marks]

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Question 2d

One transmitter is removed and a metal grille is placed between the transmitter and the receiver. The grille is rotated through 180° and back round again. The signal at the receiver is heard to rise and fall as the grill rotates.

(d)

(i) Explain what causes the rising and falling signal.

[2]

(ii) Sketch a graph to show the pattern of rising and falling signal.

[2]

[4 marks]

Question 3a

(a)

Distinguish between light which is polarised and unpolarised.

[2 marks]

Question 3b

(b)

Outline the function of an analyser when investigating polarised light.

[2 marks]

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Question 3c

The analyser is used to investigate polarised light. Light with intensity 11.94 W m^{-2} is incident on a polarising filter. The transmission axis of the analyser is fixed at an angle of 35° to the electric field of the polarised light.

(c)

(i) Write down the intensity of the light transmitted by the polarising filte

[1]

(ii) Calculate the intensity of the light transmitted by the analyser

[2]

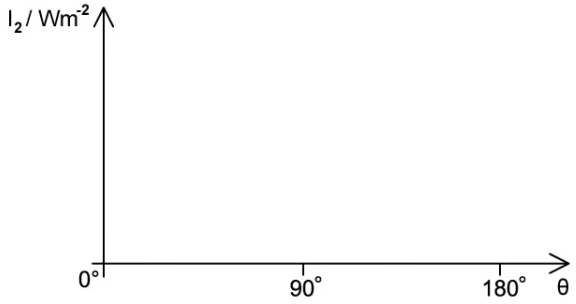
[3 marks]

Question 3d

The analyser is rotated through 180°.

(d)

Sketch a graph to show the variation of intensity I_2 with angle θ of the light leaving the analyser.



[2 marks]

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Question 4a

A microwave transmitter is set up 75 cm away from a receiver which is connected to an oscilloscope so that the intensity of the wave incident on the receiver can be determined.

Initially the intensity is found to be 32 mW m^{-2}. The receiver is moved to a new position 125 cm from the transmitter. The new intensity is found to be 11.6 mW m^{-2}.

(a)
Show that these results support the theory that intensity is related to distance according to an inverse square law.

[3 marks]

Question 4b

The transmitter remains at 125 cm and the energy of the signal is increased. The new intensity is found to be 46.4 mW m^{-2}.

(b)
Determine the factor by which the energy was increased.

[2 marks]

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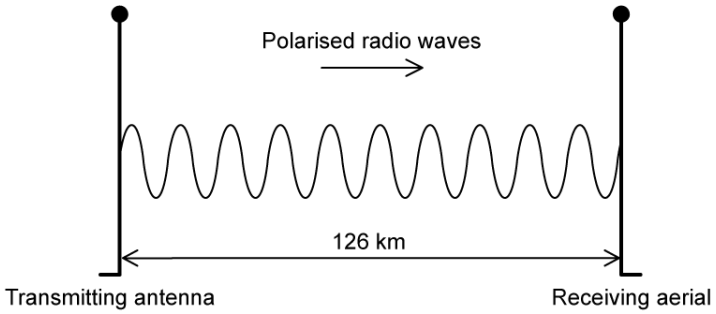
Question 4c

Radio waves are emitted from a straight conducting rod antenna such that the plane of polarisation of the waves is parallel to the rod. An identical metal conducting rod, known as an aerial, is used for reception.



(c)

Suggest why the receiving aerial must be set up parallel to the transmitting antenna.

[2 marks]

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Question 4d

The receiving aerial is moved so that it leans 22° from its original position. The power of the received signal in the new position is 15 μW.

(d)

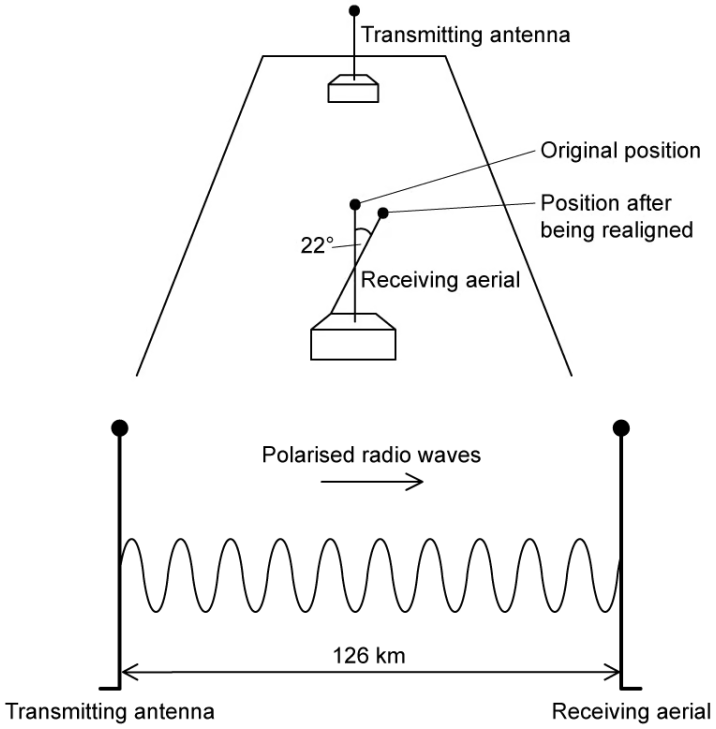
(i) Calculate the power that was received in the first position.

[2]

(II)

Calculate the minimum time between the wave leaving the transmitting antenna and being received at the receiving aerial.

[1]



[3 marks]

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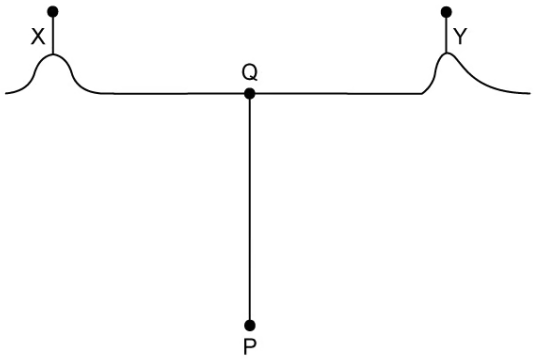
Question 5a

A group of hikers are exactly equidistant between two radio transmitters, X and Y. The transmitters are set to an operating wavelength of 200 m and have the same power outputs.



(a)
The hikers at point P receive a signal with zero amplitude. Outline what information about the signal you can assume from this.

[3 marks]

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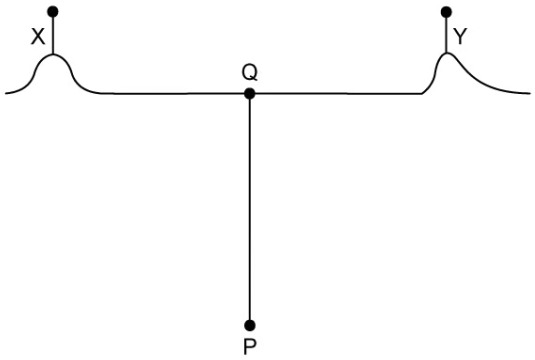
Question 5b

(b)
The hikers walk towards point Q on the line shown and continue to receive a signal of zero amplitude.

Once at Q they turn and walk towards Y, continuing until they receive a signal with amplitude double that emitted from either transmitter.



(i) Explain why there is no increase in amplitude detected on the walk from P to Q

[2]

(ii) Calculate the distance they walked along the line from Q to Y

[2]

[4 marks]

Question 5c

The hikers continue moving from Q towards the transmitter at Y where the distance QY is 20 km. The signal continues to rise and fall as they walk.

(c)
Calculate how many times they will hear the signal fall in intensity as they walk.

[2 marks]

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Question 5d

The hikers are wearing polarising glasses to protect their eyes from glare.

(d)

(i) Describe how glare is caused.

[2]

(II)

Explain how polarising glasses reduce glare from the surface of a road without reducing the amount of light entering the eye from above.

[2]

[4 marks]

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