Waves 3

1.

A vertical screen is placed several metres beyond a vertical double slit arrangement illuminated by a laser. The diagram below shows a full-size tracing of the pattern of spots obtained on this screen. The black patches represent red light whilst the spaces between them are dark.

(a) Using the wave theory, explain how the pattern of bright and dark patches is formed.
You may be awarded marks for the quality of written communication provided in your answer.

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(3 marks)

(b) The slit separation was 0.90 mm and the distance between the slits and the screen was 4.2 m.

(i) Calculate the spacing of the bright fringes by taking measurements on the diagram of the tracing.

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(ii) Hence determine the wavelength of the laser light used.

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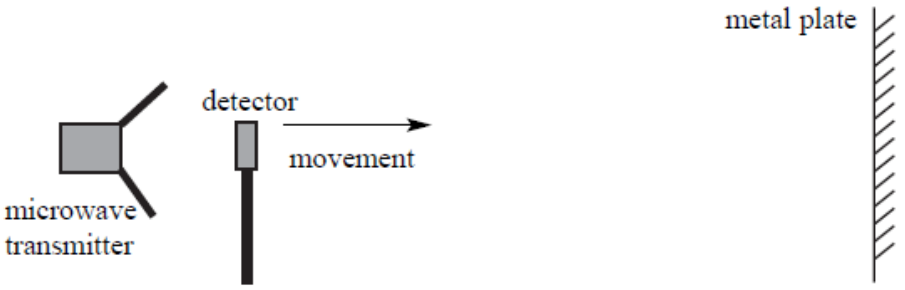
(4 marks)

2.



A microwave transmitter directs waves towards a metal plate. When a microwave detector is moved along a line normal to the transmitter and the plate, it passes through a sequence of equally spaced maxima and minima of intensity.

(a) Explain how these maxima and minima are formed.

You may be awarded marks for the quality of written communication in your answer.

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(4 marks)

(b) The detector is placed at a position where the intensity is a minimum. When it is moved a distance of 144 mm it passes through nine maxima and reaches the ninth minimum from the starting point.

Calculate

(i) the wavelength of the microwaves,

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(ii) the frequency of the microwave transmitter.

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(3 marks)

3.

(a) State what is meant by *coherent sources* of light.

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(2 marks)

(b)

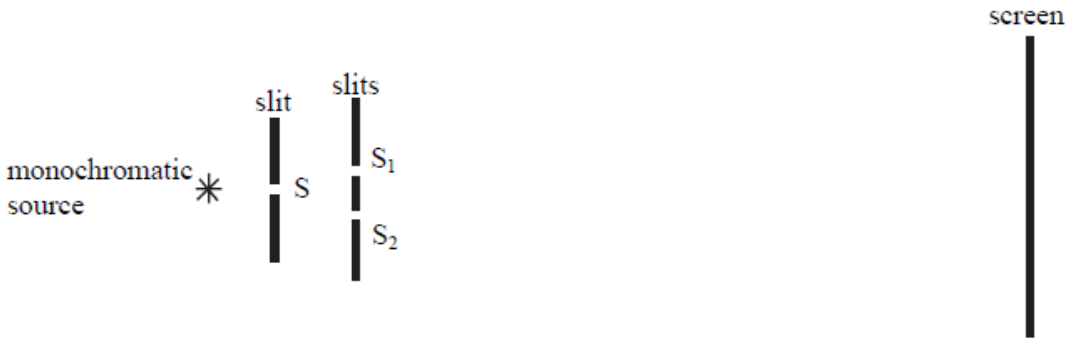

Figure 2

Young's fringes are produced on the screen from the monochromatic source by the arrangement shown in **Figure 2**.

You may be awarded marks for the quality of written communication in your answers.

(i) Explain why slit S should be narrow.

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(ii) Why do slits S_1 and S_2 act as coherent sources?

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(4 marks)

(c) The pattern on the screen may be represented as a graph of intensity against position on the screen. The central fringe is shown on the graph in **Figure 3**. Complete this graph to represent the rest of the pattern by drawing on **Figure 3**.

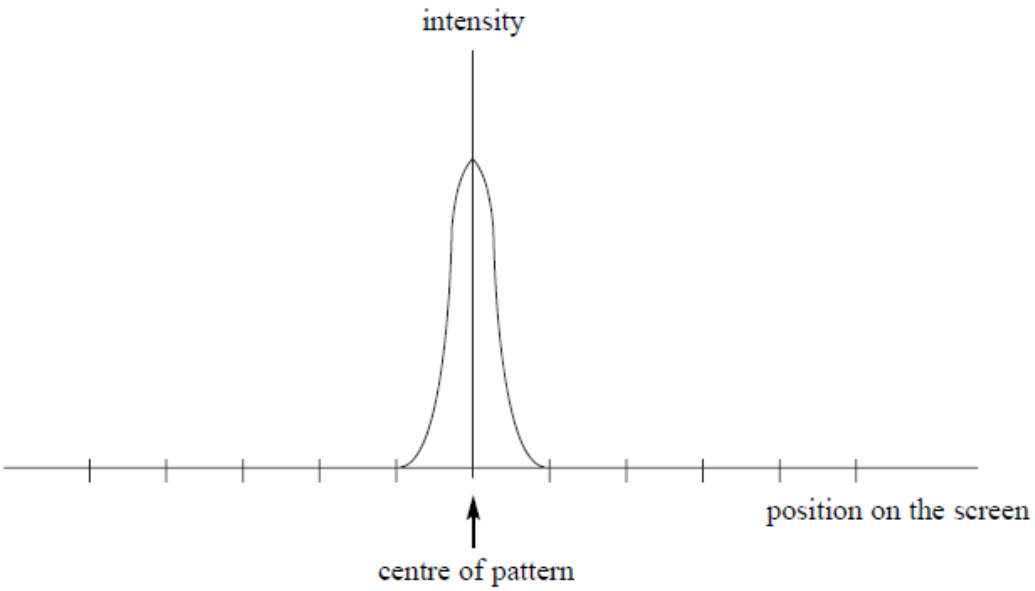


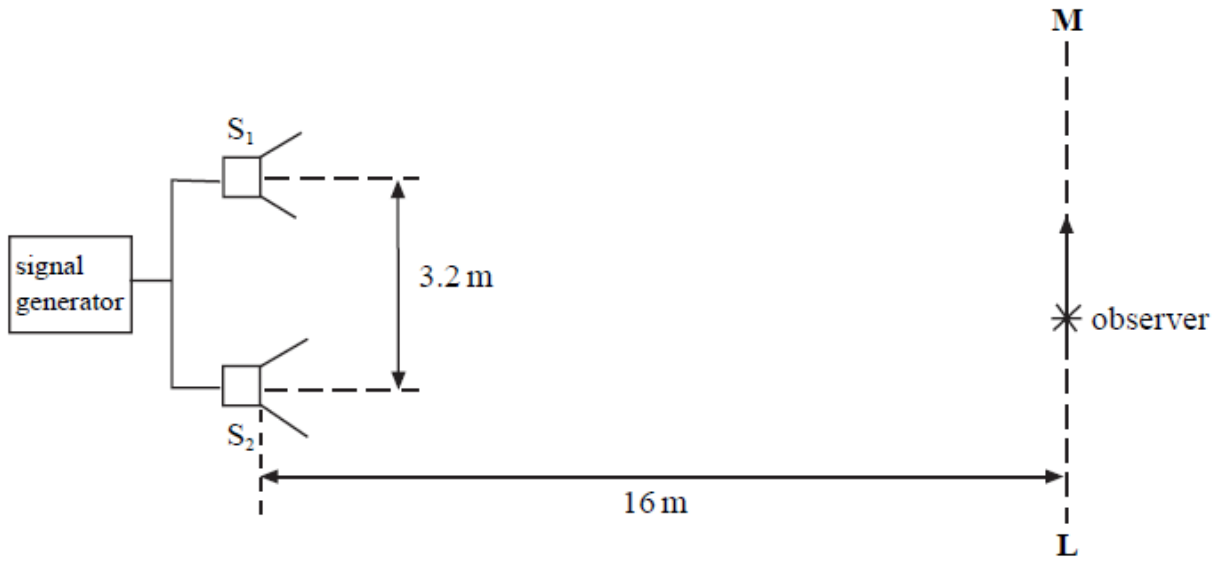
Figure 3

(2 marks)

4.

(a) Two identical loudspeakers, S_1 and S_2, are connected to the same signal generator so that each produces a sound wave of frequency 850 Hz. They are arranged in the open air, as shown in **Figure 1**, with their centres 3.2 m apart. An observer who walks along the line **LM**, 16 m away from the loudspeakers, notices that there are minima of sound every 2.0 m.

Figure 1



Calculate

(i) the wavelength of the sound waves,

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(ii) the speed of sound in the air.

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(2 marks)

(b) You may be awarded additional marks to those shown in brackets for the quality of written communication in your answers.

(i) The sound waves from the loudspeakers in part (a) produce interference effects. Light waves from two separate small monochromatic light sources of the same frequency do not produce observable interference effects. Explain why the loudspeakers are able to produce interference effects but the light sources do not.

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(ii) Describe and explain how interference effects may be produced from a single monochromatic light source using appropriate additional equipment.

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(5 marks)