

- 6 (a) The intensity of the light from a monochromatic laser is I_0 and is incident normally on a polarising filter. The polarising plane of the filter is currently vertical. The intensity of the light that emerges from the filter is equal to I_0 .

- (i) State what the observation suggests about the light from the laser.

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[1]

- (ii) Fig. 6.1 shows the polarising filter rotating slowly about a horizontal axis at right angles to its surface. As the angle θ through which the filter rotates increases from 0° to 360° , the intensity of the emerging light varies.

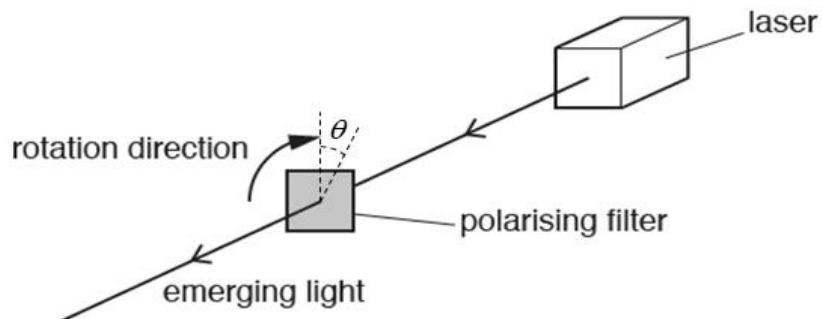


Fig. 6.1

On Fig. 6.2, sketch a graph to show how the intensity of the emergent light varies with the angle θ .

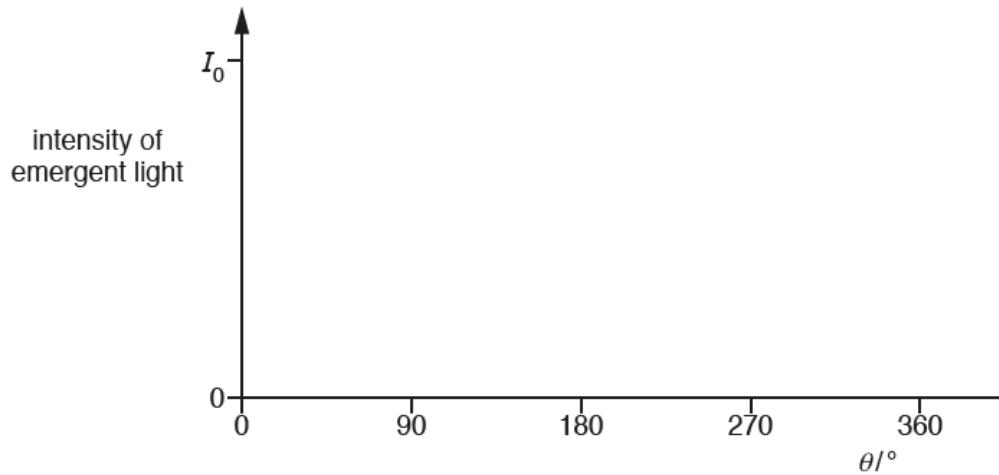


Fig. 6.2

[2]

- (iii) Fig. 6.3 shows light from the same laser reflecting off a surface before passing through the polarising filter. The intensity of the light incident on the polarising filter remains as I_0 .

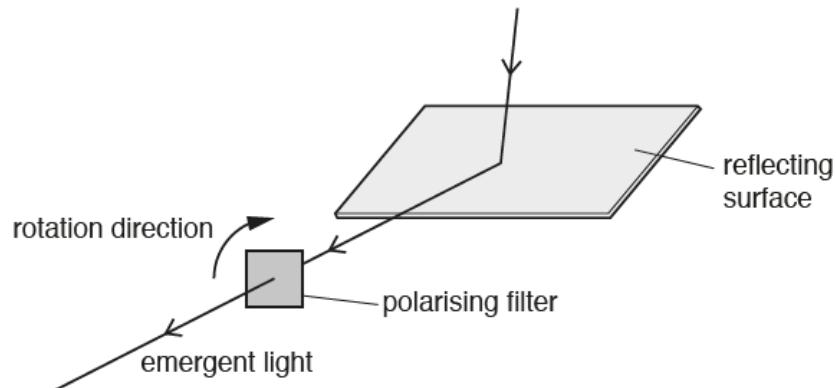


Fig. 6.3

When the polarising plane of the filter is vertical, the intensity of the emergent light is $0.179 I_0$. When the polarising plane of the filter is horizontal, the intensity of the emergent light is $0.821 I_0$.

Determine the intensity, in terms of I_0 , of the emergent light when the polarising direction of the filter is 30° from the vertical.

intensity = I_0 [2]

- (b) Light from the laser in (a) is now incident on a double slit. The light emerging from the slits is detected by a light sensor attached to a toy train moving at a constant speed as shown in Fig. 6.4.

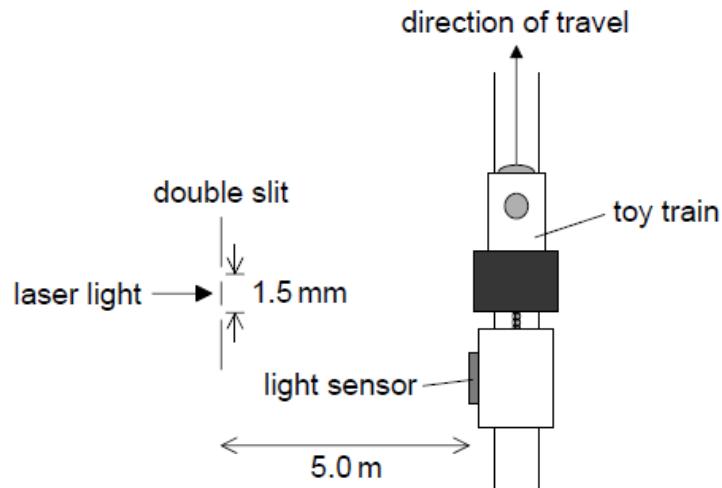


Fig. 6.4

Fig. 6.5 shows the variation with time of the output voltage from the light sensor as the train moves parallel to the slits at a constant speed. The output voltage is proportional to the intensity of light incident on the sensor.

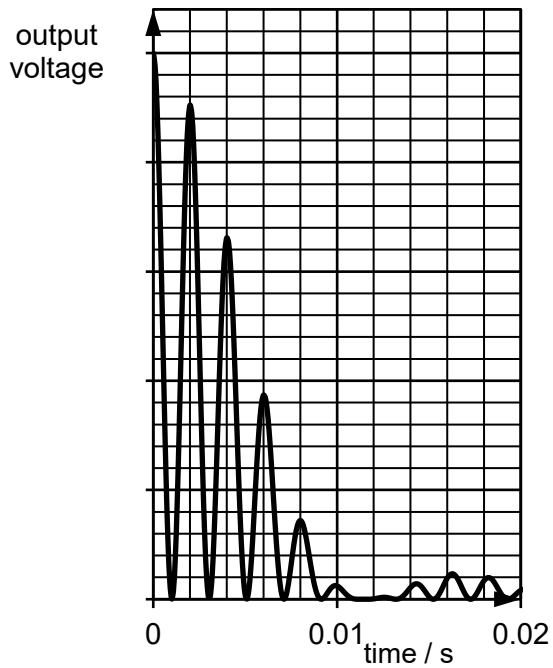


Fig. 6.5

- (i) With reference to the light passing through the slits, explain the variation of the output voltage shown in Fig. 6.5.
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- (ii) The separation between the slits is 1.5 mm and the laser light has a wavelength of 630 nm. The distance between the track and the slits is 5.0 m.

1. Calculate the separation between two adjacent maxima detected by the train.

separation = m [2]

2. Hence, determine the speed of the train.

speed = m s^{-1} [2]

- (c) One of two the slits in Fig. 6.4 is now covered. When the train moves across the remaining slit, the first minima is detected when the light sensor is at 0.13 m from the centre of the fringe pattern.

- (i) Determine the width of the slit.

$$\text{width} = \dots \text{m} [2]$$

- (ii) The slit width is now widened.

State the changes that will be observed at the central bright fringe.

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..... [2]

- (d) The light sensor on the train is replaced with a sound sensor. The train now travels away from a loudspeaker that is emitting unidirectional sound waves of constant amplitude and frequency towards a reflecting barrier as shown in Fig. 6.6.

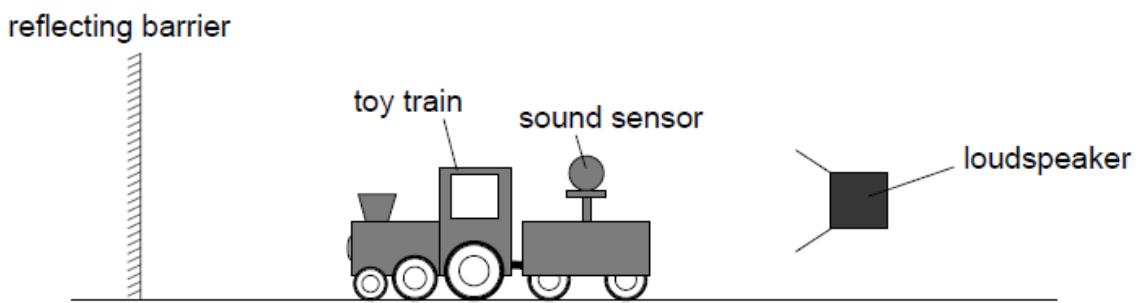


Fig. 6.6

On Fig. 6.7, sketch the variation with time of the output voltage from the sound sensor. Explain your answer.

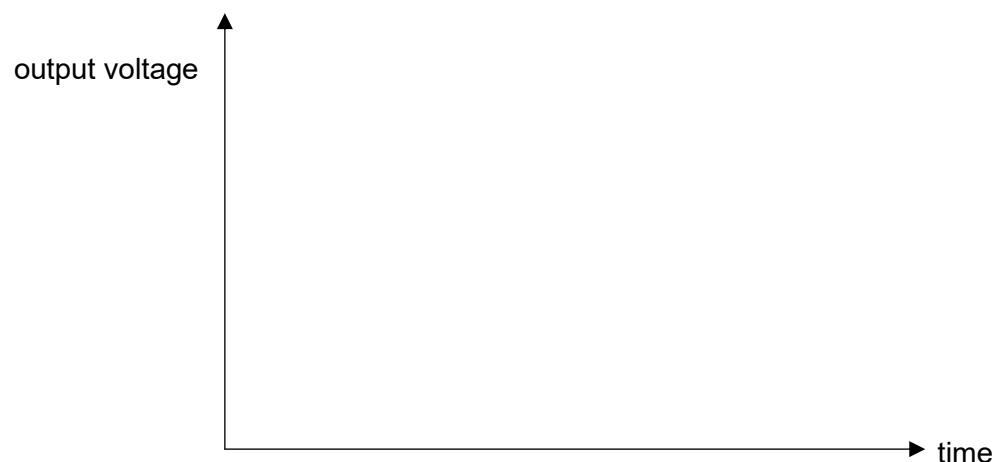


Fig. 6.7

[3]

[Total: 20]

