9 **(a)** **(i)** Deduce the phase difference between the two waves shown in Fig. 9.1. State the unit for phase difference.

Fig. 9.1

phase difference …… unit ……..…… [2]

(ii) Explain how you can tell that the two waves in Fig 9.1 are coherent.

……..……..……..……...

……..……..……..…… [2]

(b) A beam of unpolarised light with intensity I_0 directed towards two ideal polarising filters.

Fig. 9.2 shows that the beam meets the first filter with its plane of polarisation vertical. The plane of polarisation of the second filter is at an angle of ϕ with respect to the vertical.

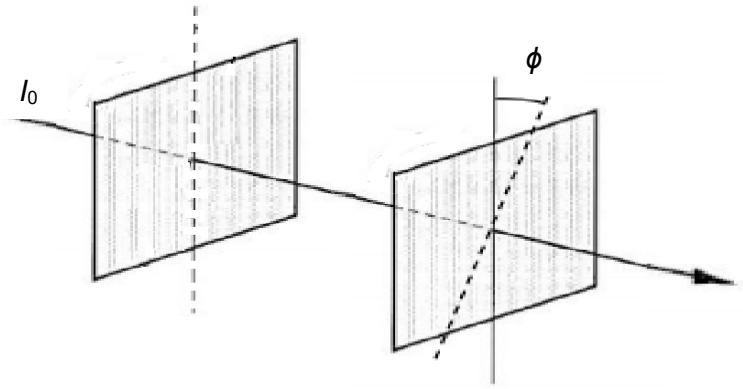


Fig. 9.2

In terms of I_0 and/or ϕ,

(i) state the intensity of the beam after it passes through the **first** polarising filter,

intensity = …….. [1]

(ii) determine the intensity of the beam after it passes through the **second** polarising filter.

intensity = …….. [1]

(iii) The planes of polarisation of the two filters are now aligned vertically.

The two filters are then rotated through 360° in opposite directions in their own plane at equal speeds as shown in Fig. 9.3.

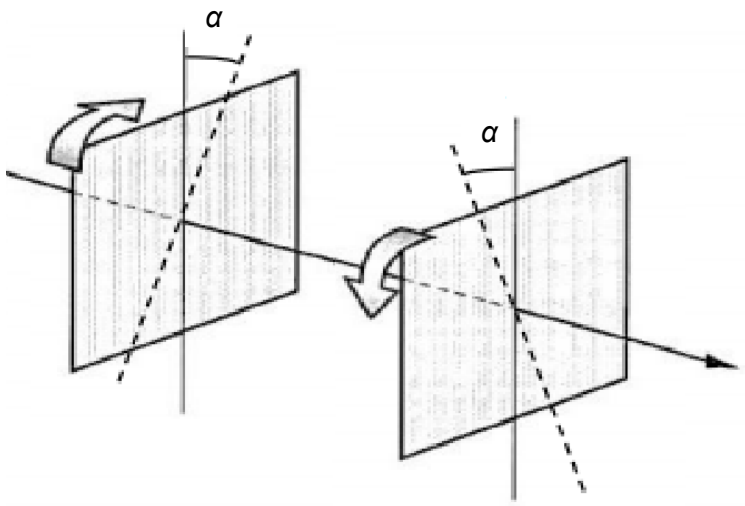
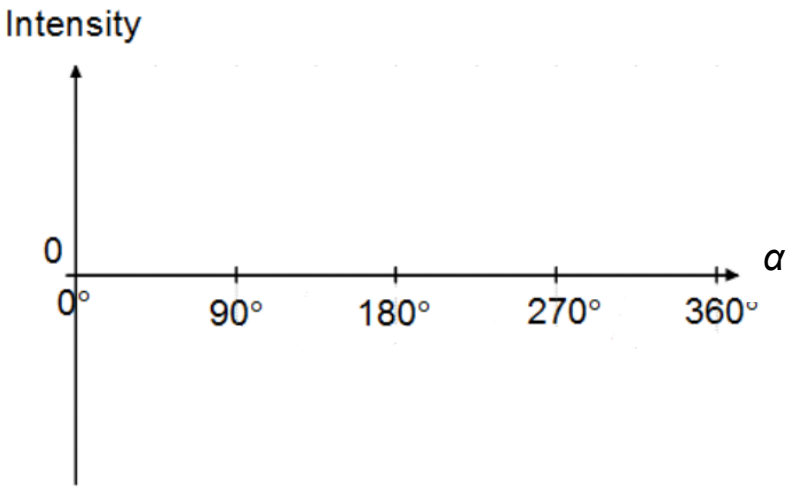


Fig. 9.3

Sketch how the intensity of light that emerged from the second polarising filter varies with the angle α that the polarisers turn through.

Intensity



[3]

(c) Light of wavelength 590 nm passes through a rectangular slit of width 0.20 mm. The light is observed on a screen placed 0.75 m from the slit, as illustrated in Fig. 9.4.

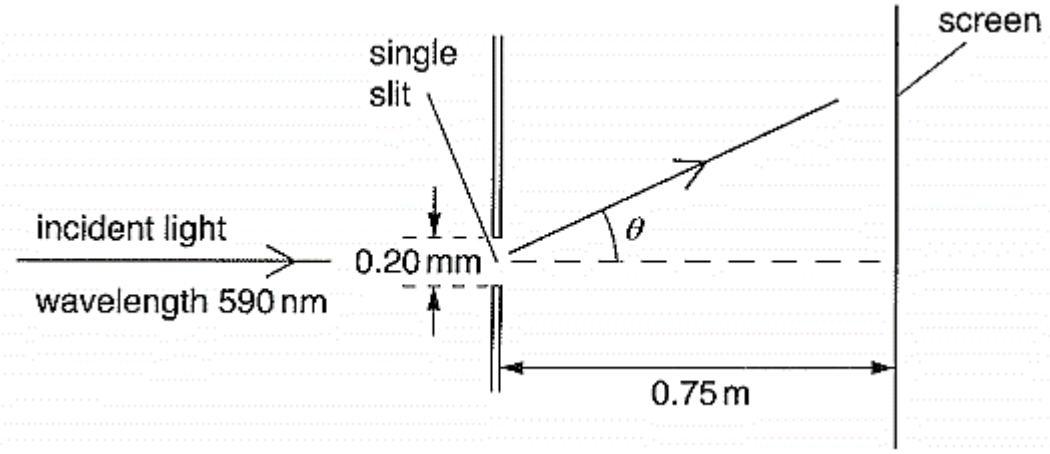


Fig. 9.4 (not drawn to scale)

Light passing through the slit is diffracted through an angle θ.

The variation of the intensity I of the light with the angle θ of the diffraction is shown in Fig. 9.5.

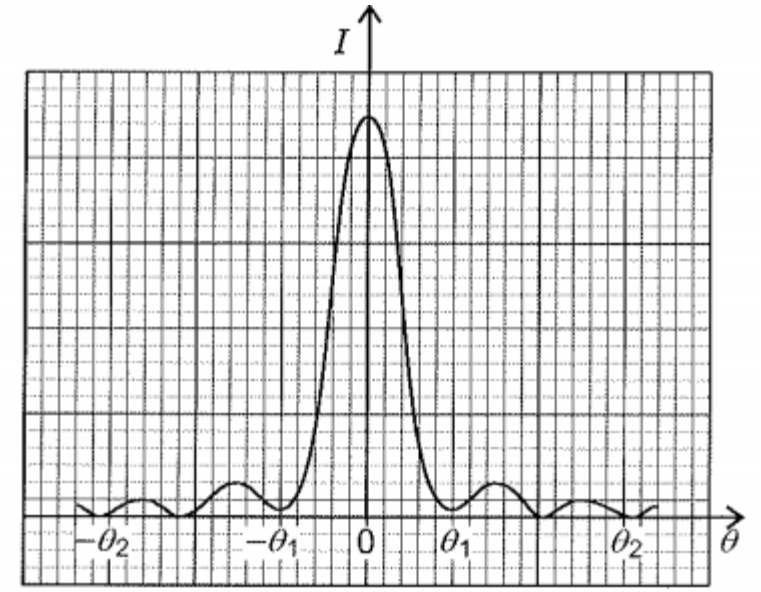


Fig. 9.5

(i) Determine the magnitude of the angle θ_1.

θ_1 = ... rad [2]

(ii) Determine the magnitude of the angle θ_2.

θ_2 = ……. rad [1]

(iii) Calculate the width of the central maximum of the diffraction pattern.

width = ……..……mm [2]

(iv) Determine the angle between two beams of light, each of wavelength 590 nm, incident on the slit such that their diffraction patterns are just resolved.

Explain your working.

angle = ……..…….. rad [2]

(d) In an experiment to measure the wavelength of monochromatic light, a beam of the light was shone onto a double slit with a separation of 2.5 mm. The resulting interference pattern was viewed on a screen placed at a distance of 1.83 m from the double slit. The distance between adjacent maxima of the interference pattern was 0.45 mm.

(i) Calculate the wavelength of the light.

wavelength = …… m [2]

(ii) Describe an experimental advantage and an experimental disadvantage of making the width of each slit larger, without altering the separation of the slits.

advantage……..……..……..……

……..……..…….. [1]

disadvantage……..……..……..

……..……..…….. [1]

[Total: 20]