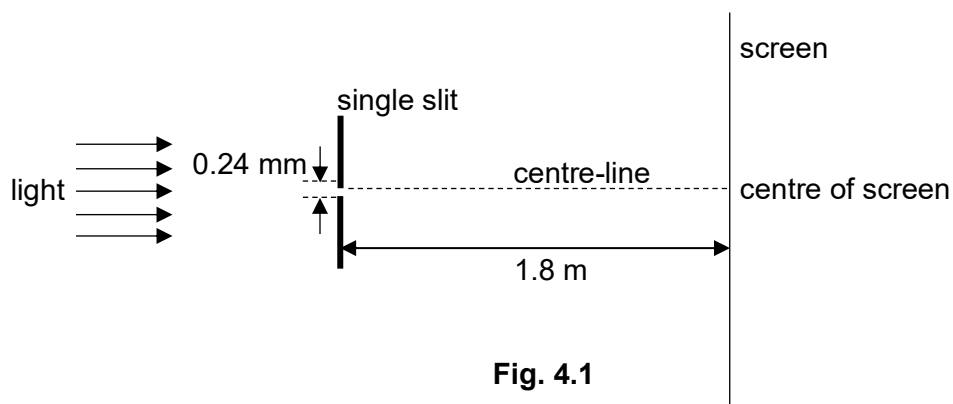**4** **(a)** Light is incident normally on a single slit. A screen is placed 1.8 m away, parallel to the slit, as shown in Fig. 4.1.

Fig. 4.1

The slit has a width of 0.24 mm. The first minimum occurs at an angle of 0.16° to the centre-line.

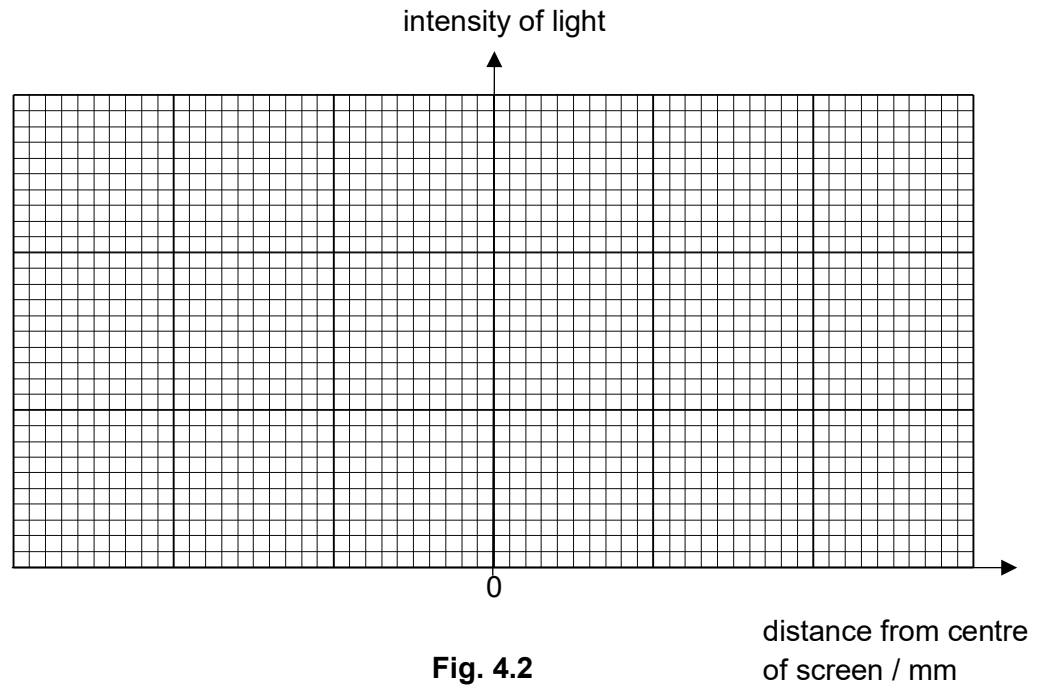**(i)** Calculate the wavelength of the light incident on the single slit.

wavelength = …………………………. m   [1]

(ii) Determine the width of the central maximum on the screen.

width = ………….……………. mm   [2]

(iii) On Fig. 4.2, sketch the variation of the intensity of light on the screen with distance from the centre of screen, up to and including the second minima.

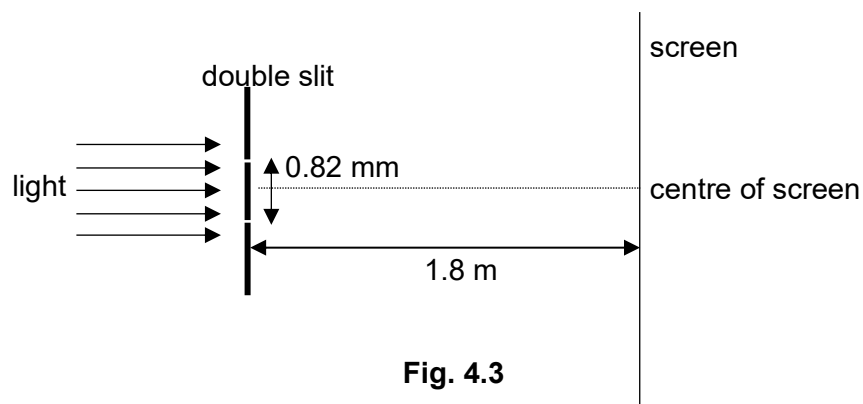Label the horizontal axis with appropriate values for the positions of the minimas.

[2]

intensity of light

Fig. 4.2

0

distance from centre of screen / mm

(iv) If the slit width is reduced, describe two changes to the intensity graph sketched in part **a(iii)**.

…………………………………………………………………………………………….

…………………………………………………………………………………………….

………………………………………………………………………………………….... [2]

(b) The single slit is now replaced with a double slit as shown in Fig. 4.3.

Fig. 4.3

Light of wavelength 638 nm is incident on the double slit. The double slit has a slit separation of 0.82 mm.

The light emerging from both slits can be considered to be coherent sources of light. A series of bright and dark fringes are formed on the screen.

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

………………………………………………………………………………………….

……………………………………………………………………………………….... [1]

(ii) Determine the distance of the second dark fringe from the centre of the screen.

distance = …………………………. mm [3]

(iii) The light incident on the screen due to one of the slits has an intensity of I and amplitude of A.

Show that the intensity of the central bright fringe is $4I$.

[2]

(iv)   A student commented:

"By conservation of energy, the light energy incident on the screen should be the sum of the light energies from each of the slits, hence the intensity of the central bright fringe should be $2I$ instead of $4I$. I conclude that the principle of conservation of energy is violated in this double slit experiment."

Explain why the student's conclusion is wrong.

…………………………………………………………………………………….

…………………………………………………………………………………….

…………………………………………………………………………………….

……………………………………………………………………………....   [2]