4 **(a)** In order that interference between waves from two sources may be observed, the waves must be coherent.

Explain what is meant by

(i) *interference*,

....

....

.... [2]

(ii) *coherence*.

....

.... [1]

(b) Red light of wavelength 644 nm is incident normally on a diffraction grating having 550 lines per millimetre, as illustrated in Fig. 4.1.

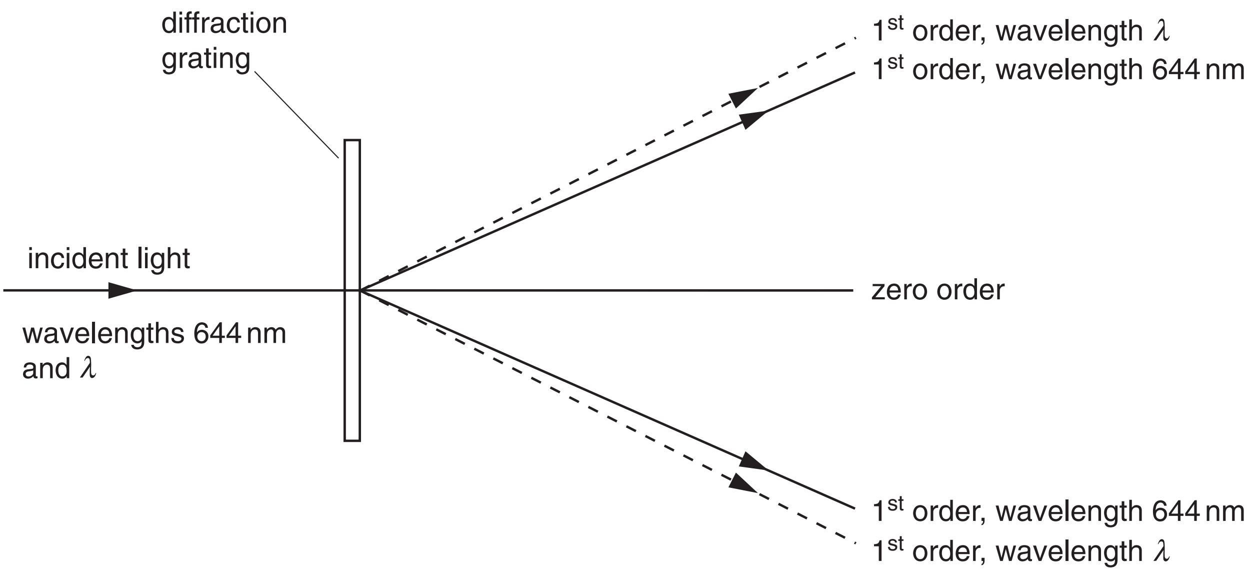

Fig. 4.1

Red light of wavelength λ is also incident normally on the grating. The first order diffracted light of both wavelengths is illustrated in Fig. 4.1.

For Examiner's Use

(i) Calculate the number of orders of diffracted light of wavelength 644 nm that are visible on each side of the zero order.

number = ... [4]

(ii) State and explain

1. whether λ is greater or smaller than 644 nm,

....

.... [1]

2. in which order of diffracted light there is the greatest separation of the two wavelengths.

....

....

.... [2]

6 A long tube, fitted with a tap, is filled with water. A tuning fork is sounded above the top of the tube as the water is allowed to run out of the tube, as shown in Fig. 6.1.

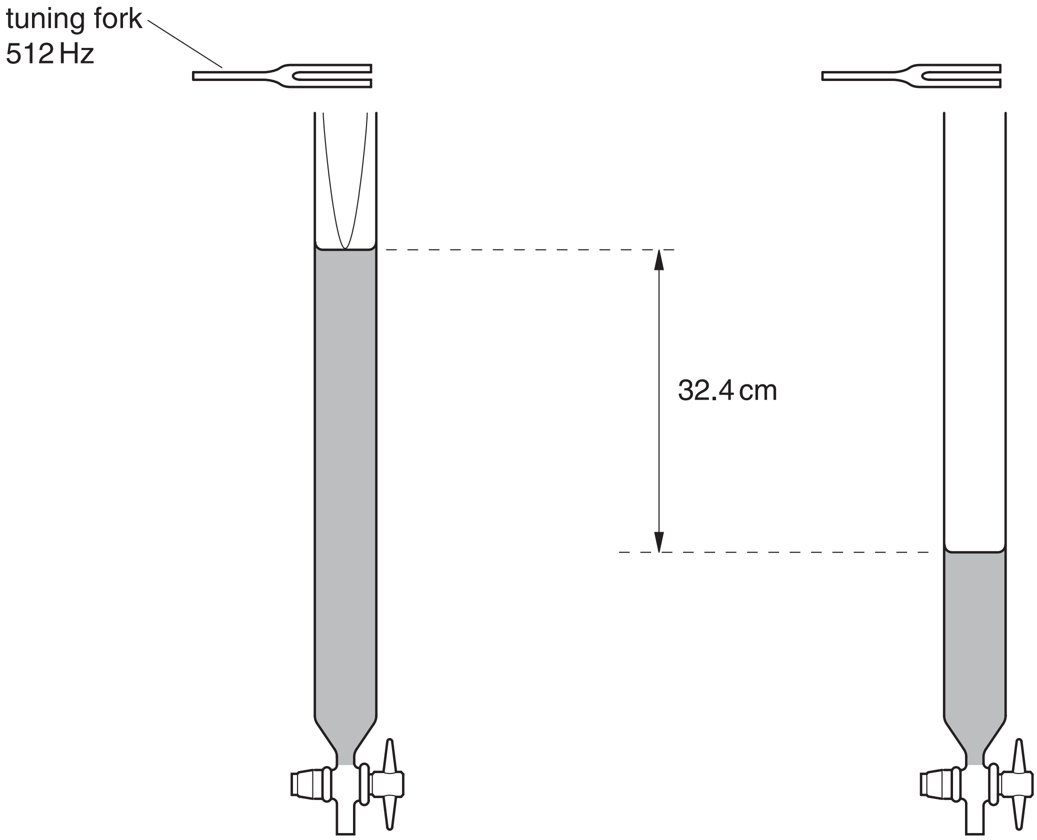

Fig. 6.1 **Fig. 6.2**

A loud sound is first heard when the water level is as shown in Fig. 6.1, and then again when the water level is as shown in Fig. 6.2.

Fig. 6.1 illustrates the stationary wave produced in the tube.

(a) On Fig. 6.2,

(i) sketch the form of the stationary wave set up in the tube, [1]

(ii) mark, with the letter N, the positions of any nodes of the stationary wave. [1]

(b) The frequency of the fork is 512 Hz and the difference in the height of the water level for the two positions where a loud sound is heard is 32.4 cm.

Calculate the speed of sound in the tube.

speed = ... $m\,s^{-1}$ [3]

(c) The length of the column of air in the tube in Fig. 6.1 is 15.7 cm.

Suggest where the antinode of the stationary wave produced in the tube in Fig. 6.1 is likely to be found.

....

....

.... [2]

For Examiner's Use

5 Fig. 5.1 shows the variation with time t of the displacements x_A and x_B at a point P of two sound waves A and B.

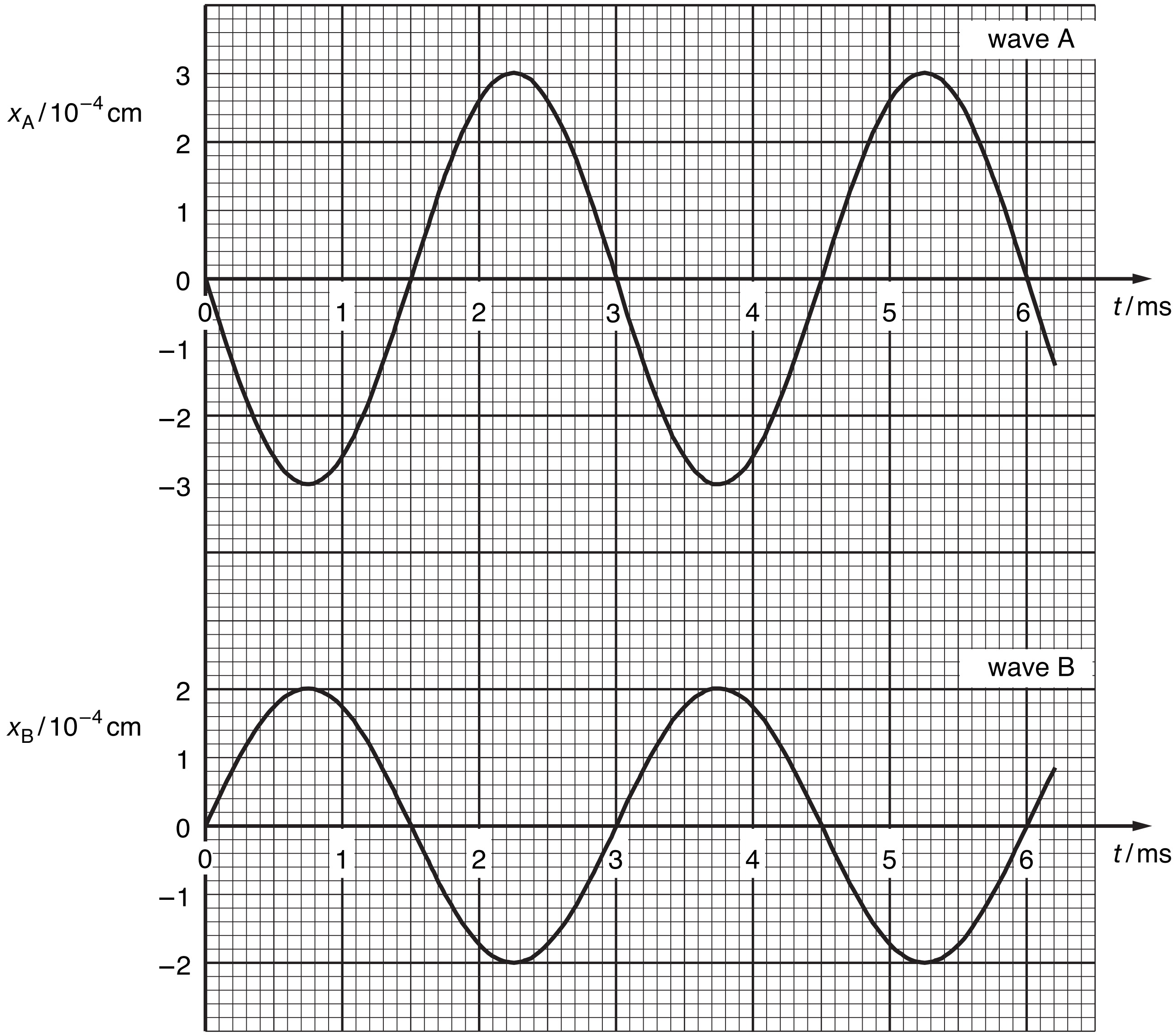

Fig. 5.1

(a) By reference to Fig. 5.1, state one similarity and one difference between these two waves.

similarity: ....

difference: .... [2]

(b) State, with a reason, whether the two waves are coherent.

....

.... [1]

(c) The intensity of wave A alone at point P is I.

For Examiner's Use

(i) Show that the intensity of wave B alone at point P is $\frac{4}{9}I$.

[2]

(ii) Calculate the resultant intensity, in terms of I, of the two waves at point P.

resultant intensity = ... I [2]

(d) Determine the resultant displacement for the two waves at point P

(i) at time $t = 3.0$ ms,

resultant displacement = ... cm [1]

(ii) at time $t = 4.0$ ms.

resultant displacement = ... cm [2]

For Examiner's Use

5 **(a)** Explain what is meant by the *diffraction* of a wave.

....

....

....[2]

(b) Light of wavelength 590 nm is incident normally on a diffraction grating having 750 lines per millimetre.
The diffraction grating formula may be expressed in the form

$$d\sin\theta = n\lambda.$$

(i) Calculate the value of d, in metres, for this grating.

d = ... m [2]

(ii) Determine the maximum value of n for the light incident normally on the grating.

maximum value of n = ... [2]

(iii) Fig. 5.1 shows incident light that is not normal to the grating.

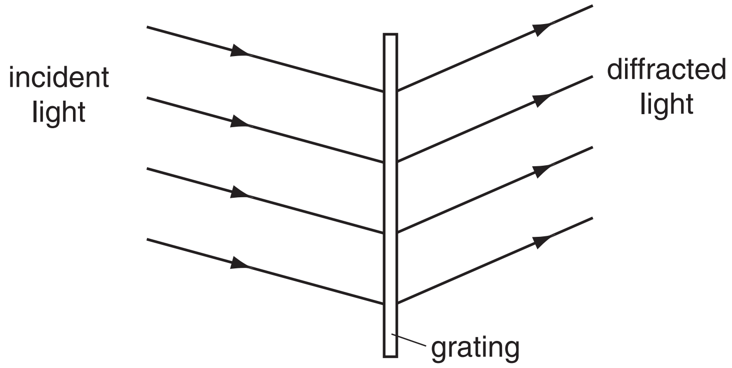

Fig. 5.1

Suggest why the diffraction grating formula, $d\sin\theta = n\lambda$, should **not** be used in this situation.

....

....[1]

(c) Light of wavelengths 590 nm and 595 nm is now incident normally on the grating.
Two lines are observed in the first order spectrum and two lines are observed in the second order spectrum, corresponding to the two wavelengths.
State two differences between the first order spectrum and the second order spectrum.

1. ....

....

2. ....

....[2]

For Examiner's Use

2 The spectrum of electromagnetic waves is divided into a number of regions such as radio waves, visible light and gamma radiation.

(a) State three distinct features of waves that are common to all regions of the electromagnetic spectrum.

1. ....

2. ....

3. .... [3]

(b) A typical wavelength of visible light is 495 nm. Calculate the number of wavelengths of this light in a wave of length 1.00 m.

number = ... [2]

(c) State a typical wavelength for

(i) X-rays,

wavelength = ... m

(ii) infra-red radiation.

wavelength = ... m
[2]

For Examiner's Use

4 A string is stretched between two fixed points. It is plucked at its centre and the string vibrates, forming a stationary wave as illustrated in Fig. 4.1.

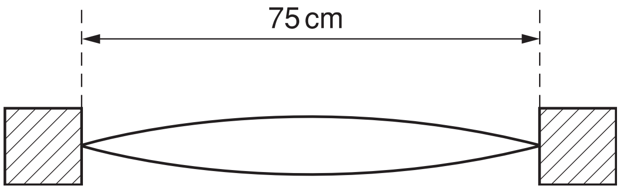

Fig. 4.1

The length of the string is 75 cm.

(a) State the wavelength of the wave.

wavelength = ... m [1]

(b) The frequency of vibration of the string is 360 Hz. Calculate the speed of the wave on the string.

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

(c) By reference to the formation of the stationary wave on the string, explain what is meant by the speed calculated in **(b)**.

....

....

.... [3]

2 Fig. 2.1 shows the variation with distance x along a wave of its displacement d at a particular time.

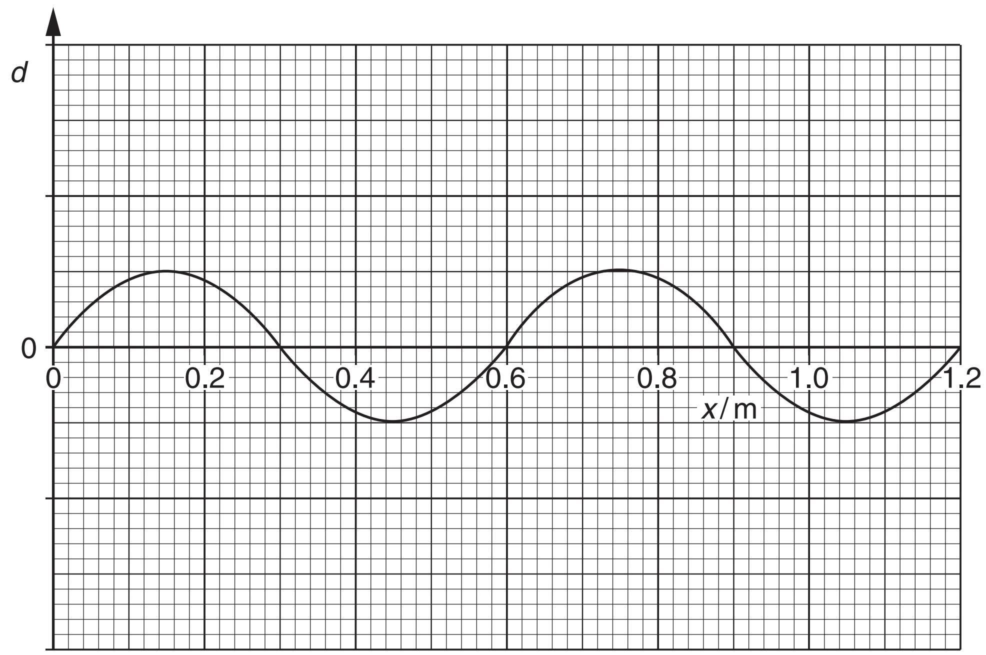

Fig. 2.1

The wave is a progressive wave having a speed of $330\,\mathrm{m\,s^{-1}}$.

(a) (i) Use Fig. 2.1 to determine the wavelength of the wave.

wavelength = ... m

(ii) Hence calculate the frequency of the wave.

frequency = ... Hz
[3]

(b) A second wave has the same frequency and speed as the wave shown in Fig. 2.1 but has double the intensity. The phase difference between the two waves is 180°.

On the axes of Fig. 2.1, sketch a graph to show the variation with distance x of the displacement d of this second wave. [2]

6 Fig. 6.1 shows wavefronts incident on, and emerging from, a double slit arrangement.

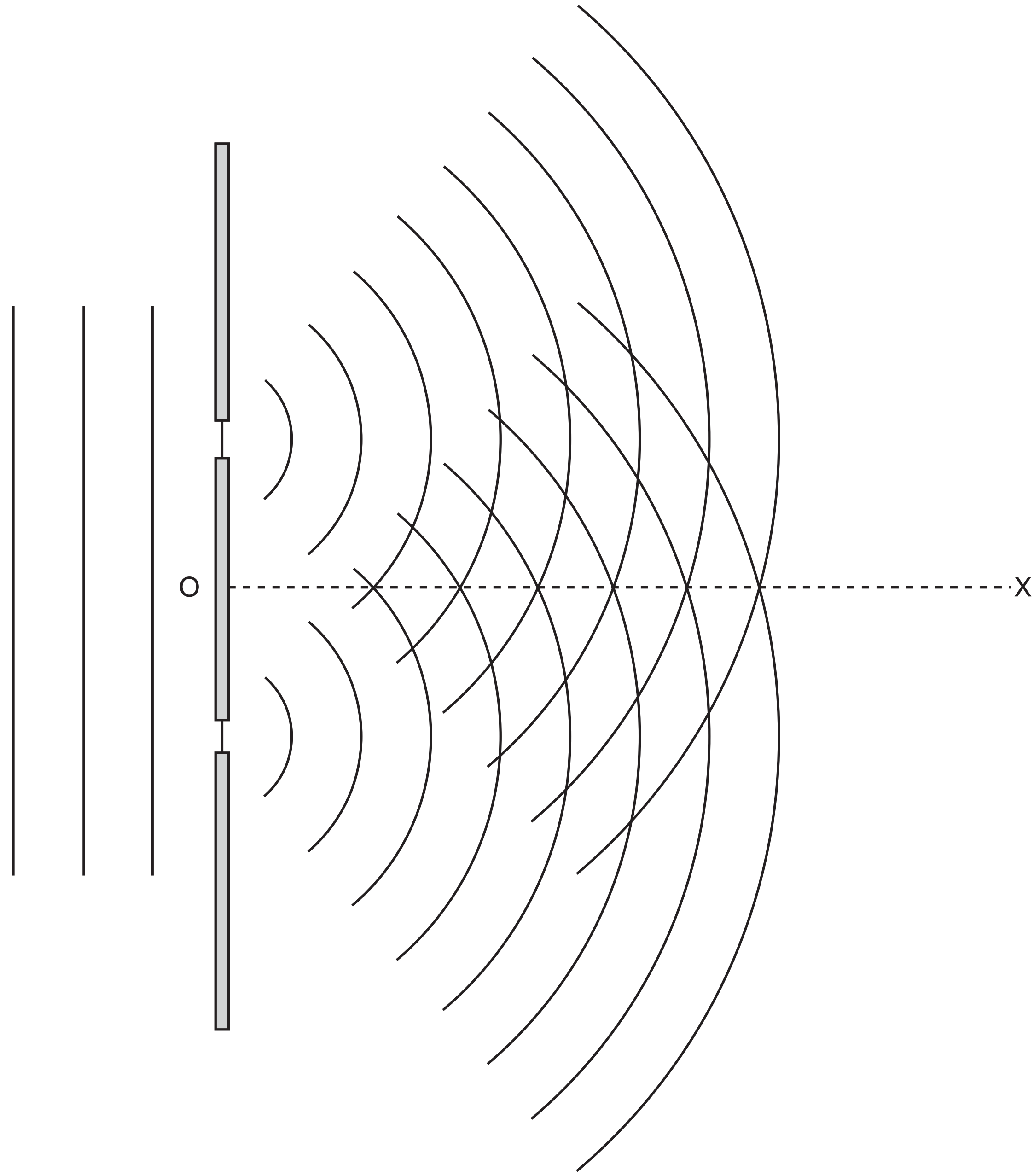

Fig. 6.1

The wavefronts represent successive crests of the wave. The line OX shows one direction along which constructive interference may be observed.

(a) State the principle of superposition.

....

....

.... [3]

(b) On Fig. 6.1, draw lines to show

(i) a second direction along which constructive interference may be observed (label this line CC),

(ii) a direction along which destructive interference may be observed (label this line DD).

[2]

(c) Light of wavelength 650 nm is incident normally on a double slit arrangement. The interference fringes formed are viewed on a screen placed parallel to and 1.2 m from the plane of the double slit, as shown in Fig. 6.2.

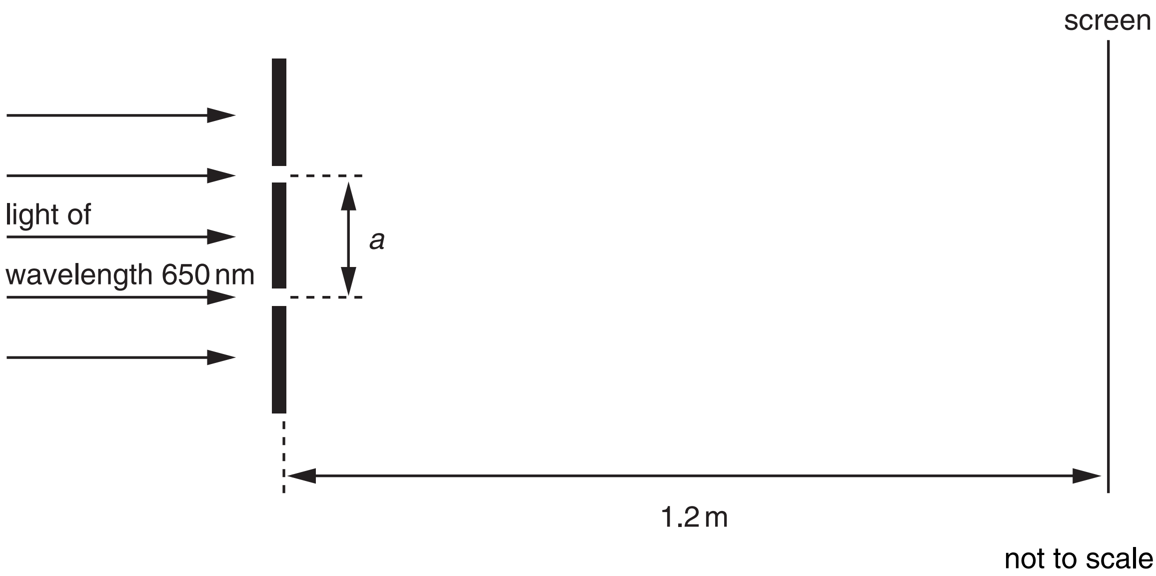

Fig. 6.2

The fringe separation is 0.70 mm.

(i) Calculate the separation *a* of the slits.

separation = ... m [3]

For Examiner's Use

(ii) The width of both slits is increased without changing their separation *a*. State the effect, if any, that this change has on

1. the separation of the fringes,

....

2. the brightness of the light fringes,

....

3. the brightness of the dark fringes.

....
[3]