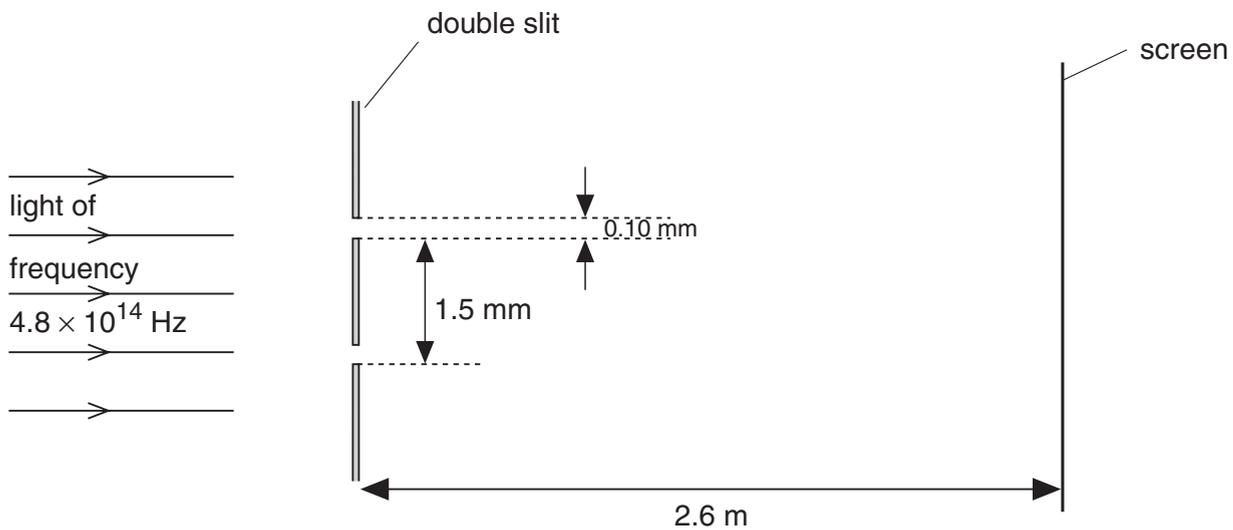


- 1 Light of frequency  $4.8 \times 10^{14}$  Hz is incident normally on a double slit, as illustrated in Fig. 6.1.



**Fig. 6.1** (not to scale)

Each slit of the double slit arrangement is 0.10 mm wide and the slits are separated by 1.5 mm. The pattern of fringes produced is observed on a screen at a distance 2.6 m from the double slit.

- (a) (i) Show that the width of each slit is approximately 160 times the wavelength of the incident light.

[3]

- (ii) Hence explain why the pattern of fringes on the screen is seen over a *limited* area of the screen.

.....  
 .....  
 .....  
 ..... [3]

(b) Calculate the separation of the fringes observed on the screen.

separation = ..... mm [3]

(c) The intensity of the light incident on the double slit is increased. State the effect, if any, on the separation and on the appearance of the fringes.

.....  
.....  
.....  
.....  
.....[3]

- 2 (a) Figs. 7.1(a) and (b) show plane wavefronts approaching a narrow gap and a wide gap respectively.

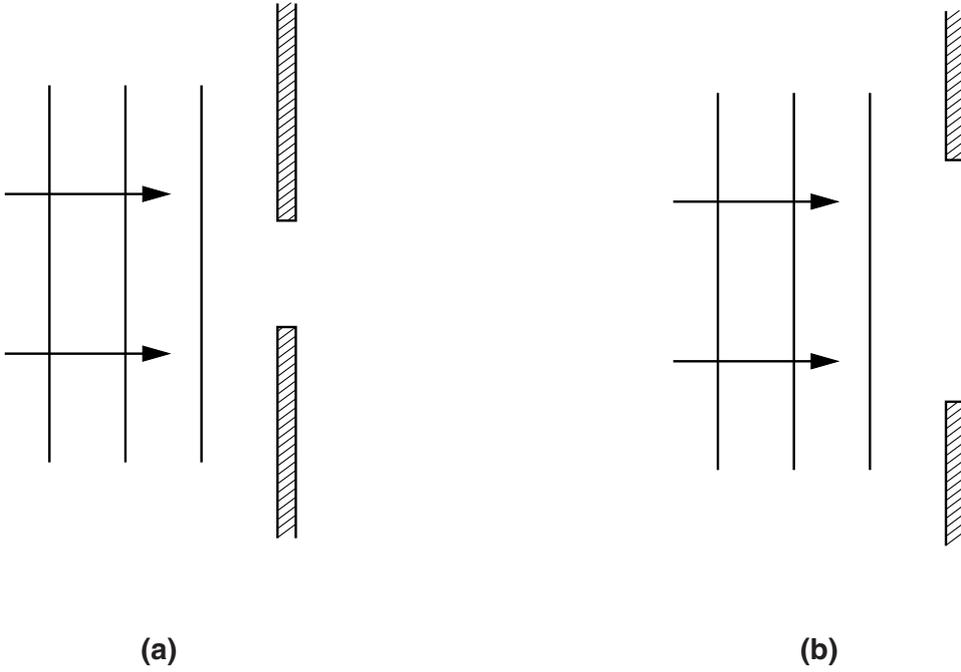
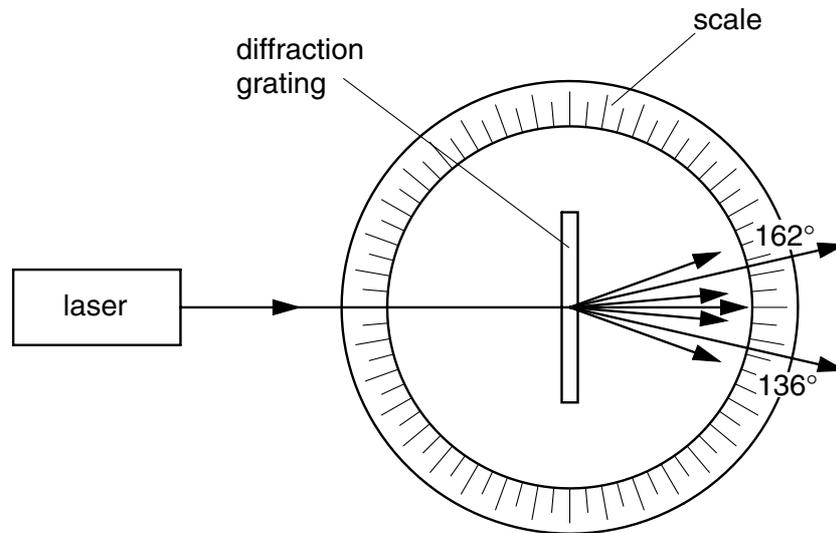


Fig. 7.1

On Figs. 7.1(a) and (b), draw three successive wavefronts to represent the wave after it has passed through each of the gaps. [5]

- (b) Light from a laser is directed normally at a diffraction grating, as illustrated in Fig. 7.2.



**Fig. 7.2**

The diffraction grating is situated at the centre of a circular scale, marked in degrees. The readings on the scale for the second order diffracted beams are  $136^\circ$  and  $162^\circ$ .

The wavelength of the laser light is 630 nm.

Calculate the spacing of the slits of the diffraction grating.

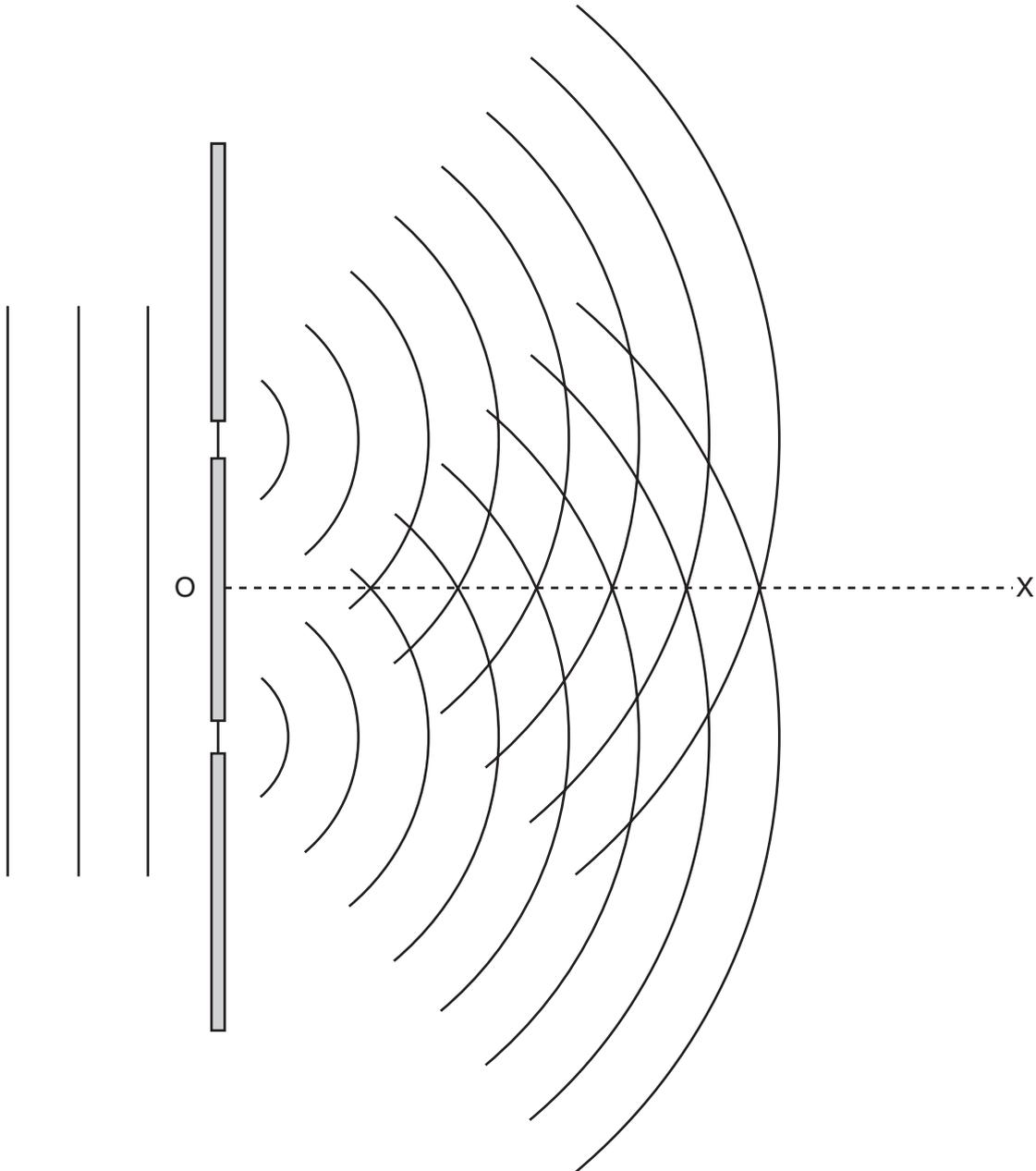
spacing = ..... m [4]

- (c) Suggest one reason why the fringe pattern produced by light passing through a diffraction grating is brighter than that produced from the same source with a double slit.

.....

.....[1]

- 3 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.

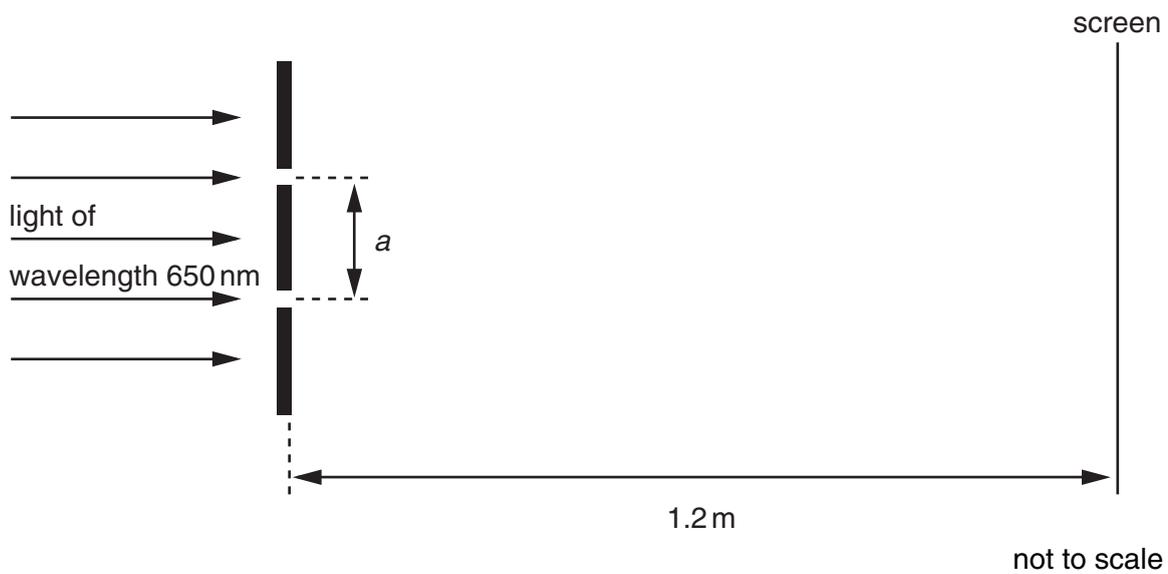


Fig. 6.2

The fringe separation is 0.70 mm.

- (i) Calculate the separation  $a$  of the slits.

separation = ..... m [3]

(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]

- 4 (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

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

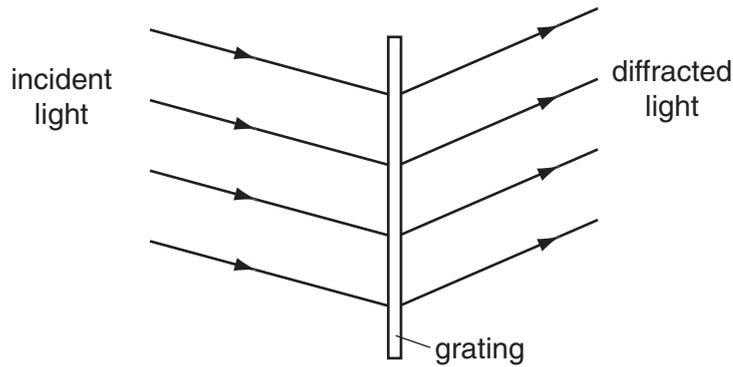
- (i) Calculate the value of  $d$ , in metres, for this grating.

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

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

$$\text{maximum value of } n = \dots\dots\dots [2]$$

(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]

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

Explain what is meant by

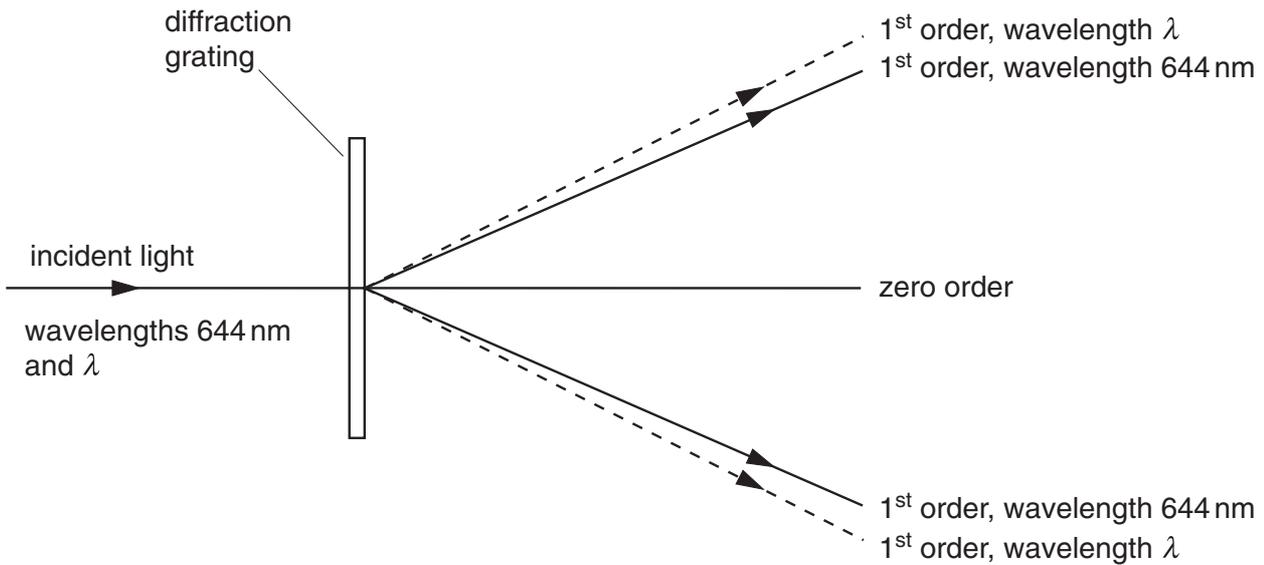
- (i) *interference*,

.....  
 .....  
 ..... [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  $\lambda$  is also incident normally on the grating. The first order diffracted light of both wavelengths is illustrated in Fig. 4.1.

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

For  
Examiner's  
Use

number = ..... [4]

- (ii) State and explain

1. whether  $\lambda$  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]

- 5 (a) Fig. 5.1 shows the variation with time  $t$  of the displacement  $y$  of a wave  $W$  as it passes a point  $P$ . The wave has intensity  $I$ .

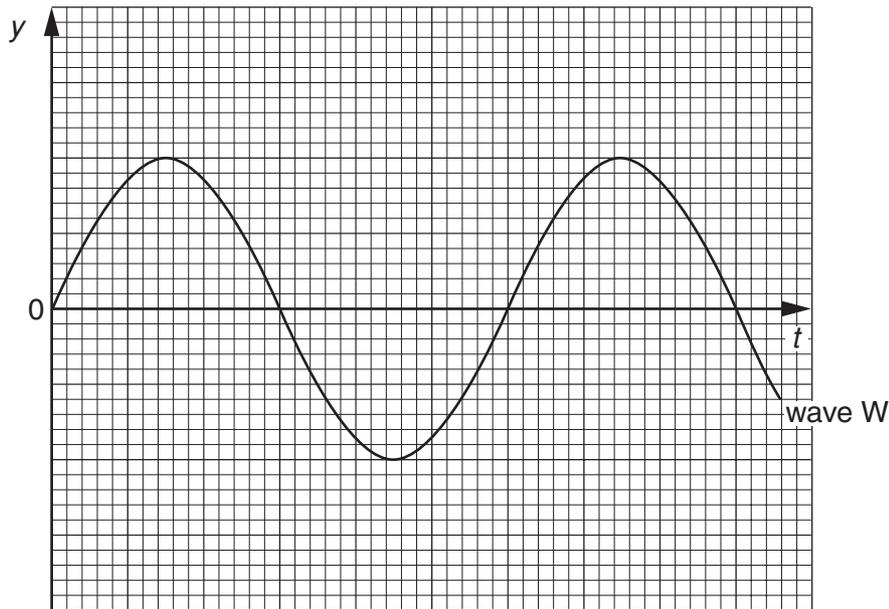


Fig. 5.1

A second wave  $X$  of the same frequency as wave  $W$  also passes point  $P$ . This wave has intensity  $\frac{1}{2}I$ . The phase difference between the two waves is  $60^\circ$ . On Fig. 5.1, sketch the variation with time  $t$  of the displacement  $y$  of wave  $X$ . [3]

- (b) In a double-slit interference experiment using light of wavelength  $540\text{ nm}$ , the separation of the slits is  $0.700\text{ mm}$ . The fringes are viewed on a screen at a distance of  $2.75\text{ m}$  from the double slit, as illustrated in Fig. 5.2 (not to scale).

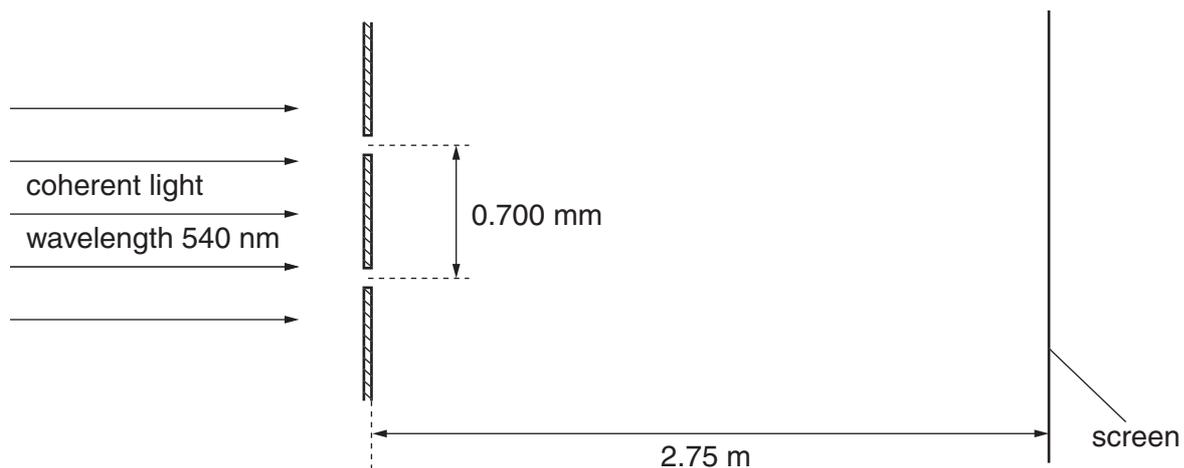


Fig. 5.2

Calculate the separation of the fringes observed on the screen.

separation = ..... mm [3]

(c) State the effect, if any, on the appearance of the fringes observed on the screen when the following changes are made, separately, to the double-slit arrangement in (b).

(i) The width of each slit is increased but the separation remains constant.

.....  
.....  
.....  
..... [3]

(ii) The separation of the slits is increased.

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

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

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

(b) (i) Outline briefly an experiment that may be used to demonstrate diffraction of a transverse wave.

.....  
.....  
..... [3]

(ii) Suggest how your experiment in (i) may be changed to demonstrate the diffraction of a longitudinal wave.

.....  
.....  
..... [3]