1 **(a)** State the principle of superposition.

.....

.....

..... [2]

(b) Coherent light of wavelength 590 nm is incident normally on a double slit, as shown in Fig. 6.1.

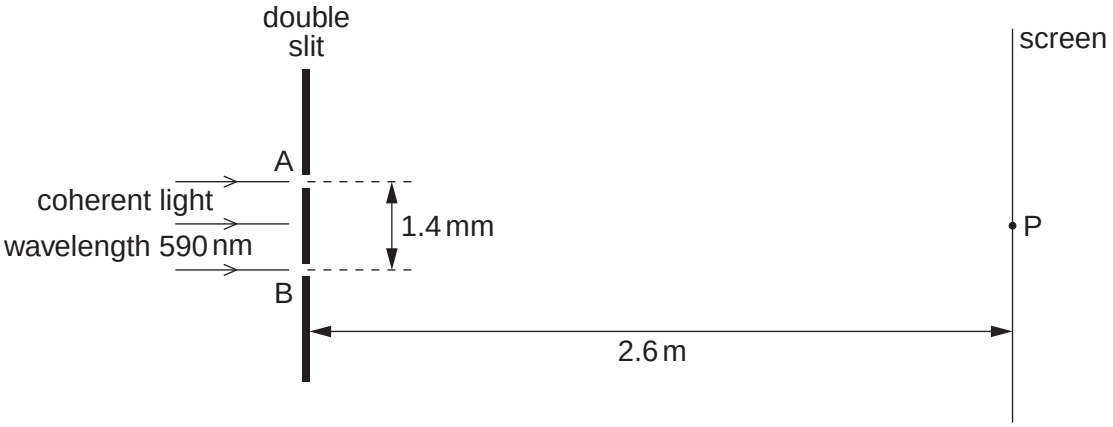

Fig. 6.1 (not to scale)

The separation of the slits A and B is 1.4 mm.
Interference fringes are observed on a screen placed parallel to the plane of the double slit.
The distance between the screen and the double slit is 2.6 m.

At point P on the screen, the path difference is zero for light arriving at P from the slits A and B.

(i) Determine the separation of bright fringes on the screen near to point P.

separation = ... mm [3]

(ii) The variation with time of the displacement *x* of the light wave arriving at point P on the screen from slit A and from slit B is shown in Fig. 6.2a and Fig. 6.2b respectively.

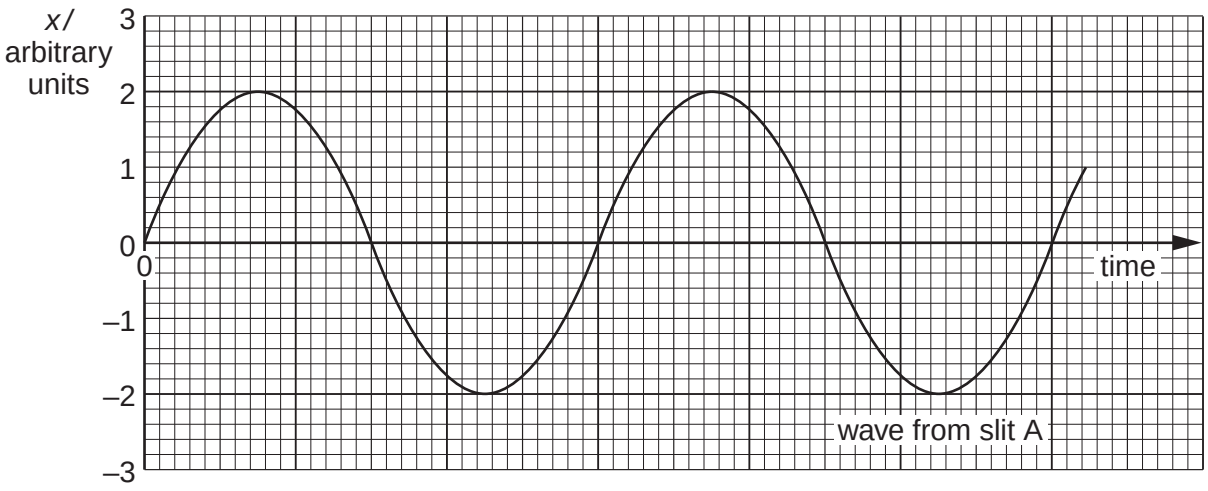

Fig. 6.2a

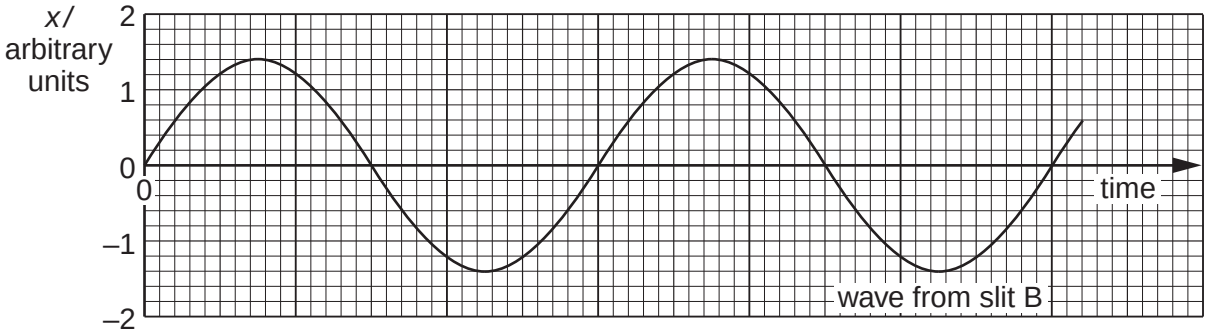

Fig. 6.2b

1. State the phase difference between waves forming the dark fringe on the screen that is next to point P.

phase difference = ... ° [1]

2. Determine the ratio

$$\frac{\text{intensity of light at a bright fringe}}{\text{intensity of light at a dark fringe}}.$$

ratio = ... [3]

2 **(a)** Explain the term *interference*.

.....

.....

..... [1]

(b) A ripple tank is used to demonstrate interference between water waves.

Describe

(i) the apparatus used to produce two sources of coherent waves that have circular wavefronts,

.....

.....

.....

..... [2]

(ii) how the pattern of interfering waves may be observed.

.....

.....

.....

..... [2]

(c) A wave pattern produced in **(b)** is shown in Fig. 7.1.

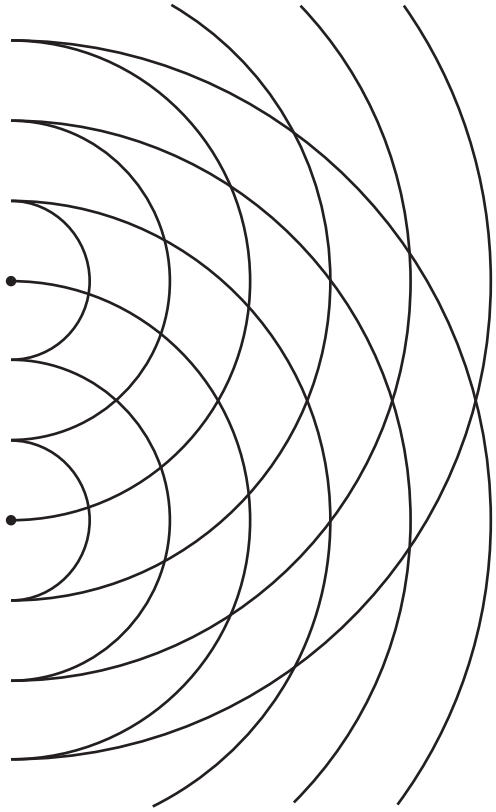

Fig. 7.1

Solid lines on Fig. 7.1 represent crests.

On Fig. 7.1,

(i) draw two lines to show where maxima would be seen (label each of these lines with the letter X), [1]

(ii) draw one line to show where minima would be seen (label this line with the letter N). [1]

3 **(a)** Apparatus used to produce interference fringes is shown in Fig. 6.1. The apparatus is not drawn to scale.

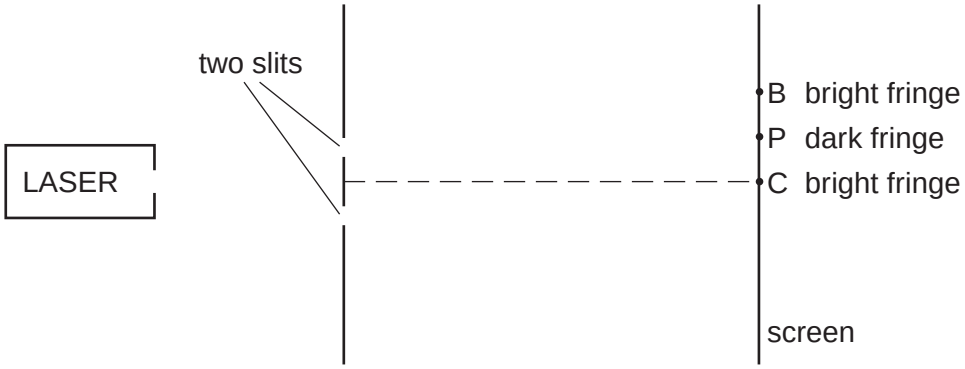

Fig. 6.1 (not to scale)

Laser light is incident on two slits. The laser provides light of a single wavelength. The light from the two slits produces a fringe pattern on the screen. A bright fringe is produced at C and the next bright fringe is at B. A dark fringe is produced at P.

(i) Explain why one laser and two slits are used, instead of two lasers, to produce a visible fringe pattern on the screen.

.....

..... [1]

(ii) State the phase difference between the waves that meet at

1. B ..... [1]

2. P ..... [1]

(iii) **1.** State the *principle of superposition*.

.....

.....

..... [2]

2. Use the principle of superposition to explain the dark fringe at P.

.....

..... [1]

(b) In Fig. 6.1 the distance from the two slits to the screen is 1.8 m. The distance CP is 2.3 mm and the distance between the slits is 0.25 mm.
Calculate the wavelength of the light provided by the laser.

wavelength = ... nm [3]

4 **(a)** A laser is used to produce an interference pattern on a screen, as shown in Fig. 6.1.

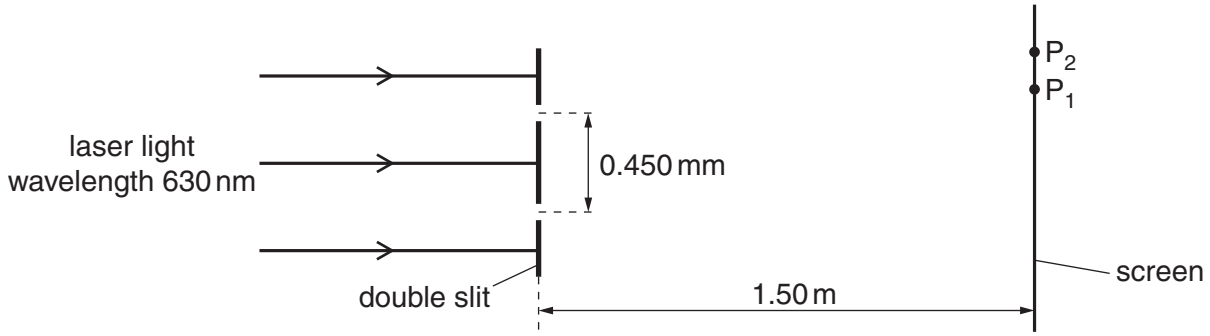

Fig. 6.1 (not to scale)

The laser emits light of wavelength 630 nm. The slit separation is 0.450 mm. The distance between the slits and the screen is 1.50 m. A maximum is formed at P_1 and a minimum is formed at P_2.
Interference fringes are observed only when the light from the slits is coherent.

(i) Explain what is meant by *coherence*.

.....

.....

.....[2]

(ii) Explain how an interference maximum is formed at P_1.

.....

.....[1]

(iii) Explain how an interference minimum is formed at P_2.

.....

.....[1]

(iv) Calculate the fringe separation.

fringe separation = ... m [3]

(b) State the effects, if any, on the fringes when the amplitude of the waves incident on the double slits is increased.

.....

.....

.....

.....[3]

5 **(a)** State three conditions required for maxima to be formed in an interference pattern produced by two sources of microwaves.

1. .....

.....

2. .....

.....

3. .....

.....

[3]

(b) A microwave source M emits microwaves of frequency 12 GHz. Show that the wavelength of the microwaves is 0.025 m.

[3]

(c) Two slits S_1 and S_2 are placed in front of the microwave source M described in **(b)**, as shown in Fig 5.1.

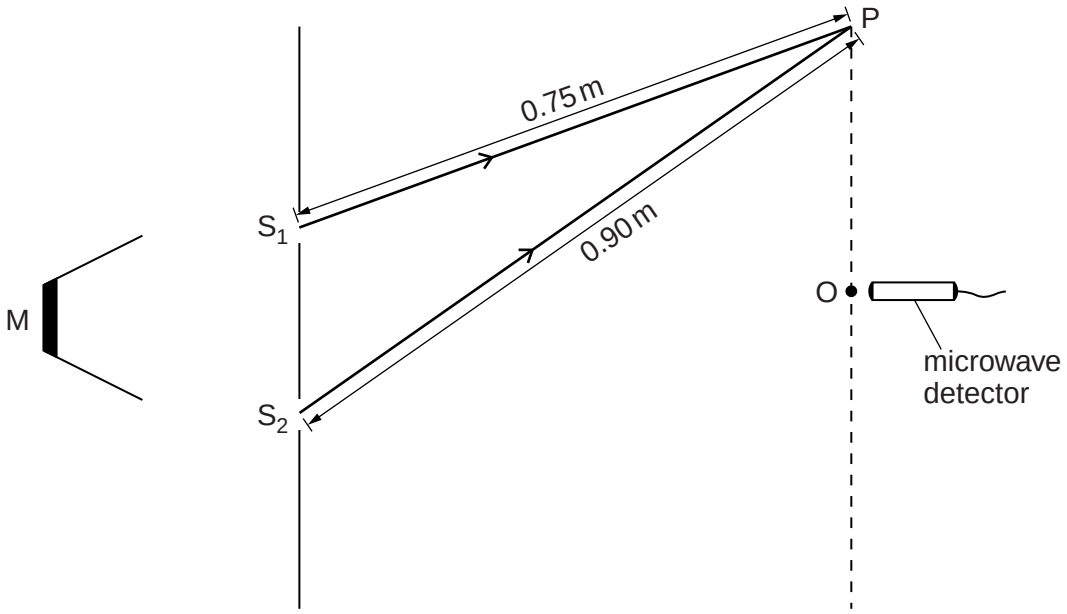

Fig. 5.1 (not to scale)

The distances S_1O and S_2O are equal. A microwave detector is moved from O to P. The distance S_1P is 0.75 m and the distance S_2P is 0.90 m.

The microwave detector gives a maximum reading at O.

State the variation in the readings on the microwave detector as it is moved slowly along the line from O to P.

.....

.....

.....

.....

..... [3]

(d) The microwave source M is replaced by a source of coherent light.

State two changes that must be made to the slits in Fig. 5.1 in order to observe an interference pattern.

1. .....

2. .....
[2]