9 **(a)** State the principle of superposition for waves.

……
……

……
……

……
…… [2]

(b) Two identical radio wave point sources A and B placed 12.0 m apart emit waves which are in phase. An interference pattern is detected along the line AB. Point M is the mid-point between A and B.

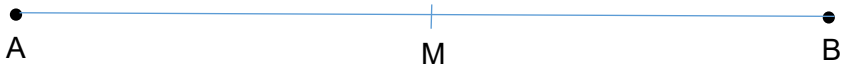

Fig. 9.1

Fig. 9.2 shows the variation with time *t* of the displacement *x* of the signal picked up by a detector placed at M.

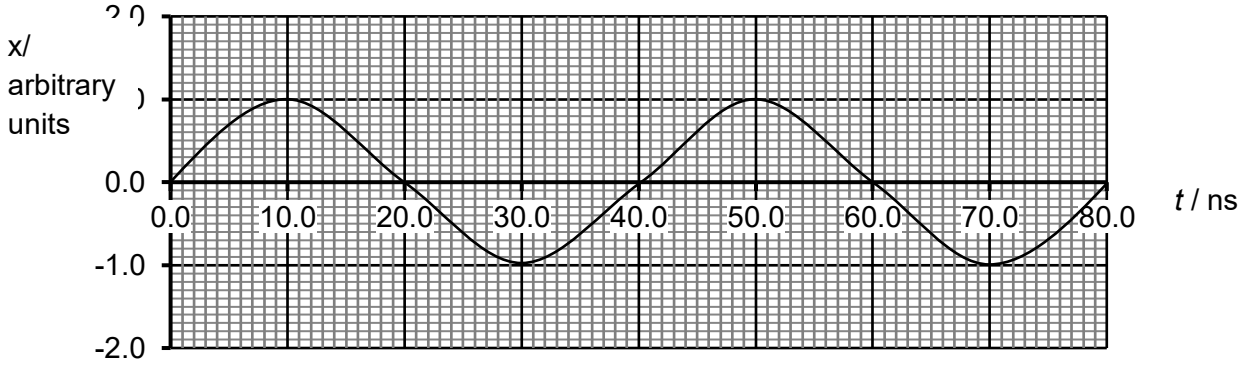

Fig. 9.2

Using the above information,

(i) show that the frequency *f* of the waves from source A and B is 25.0 MHz.

[1]

(ii) Draw in Fig. 9.2 the displacement of the wave which will be detected at point M if source A is switched off while source B remains on.

Label this graph as **Y**.

Explain your answer.

……

……

……

……

[3]

……

……

(iii) With both wave sources A and B switched on, the detector is moved toward the right from M. The first minimum is detected at point N.

Show that MN is 3.00 m.

[2
]

(iv) When the point sources are operated *separately*, the intensity detected at point M is I.

Show that

1. the intensity of the wave from source A arriving at point N, I_A is 0.444 I.
2. the intensity of the wave from source B arriving at point N, I_B is 4.00 I.

[3]

(v) Using the result from **(b)(iv)**, calculate the amplitude of the signal detected at N when both sources are switched on.

amplitude = …….. arbitrary units

[3]

(c) A typical Young's double-slit experiment involves a coherent source of monochromatic light of wavelength λ which is directed at the double slits. The slit separation is *a* and each slit has a width of *b*.

A screen is set up at a distance of *D* away from the double slits as shown in Fig. 9.3. The expected interference pattern to be observed on the screen is regularly spaced bright and dark fringes. The fringe separation is *x*.

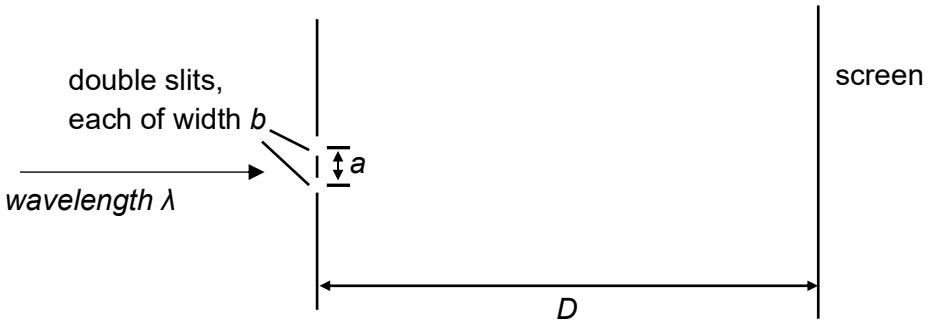

Fig. 9.3

(i) Using the variables defined above, state the two necessary inequality conditions for the set-up such that the detected fringes are regularly spaced.

1. ……
……..

2. ……
……..

[2]

(ii) Write down the expression for the fringe separation *x* using some of the variables defined above.

……
……... [1]

(iii) Fig. 9.4 shows the variation of the intensity of light on a screen at positions around the zeroth order maxima for a particular experiment. The units are arbitrary.

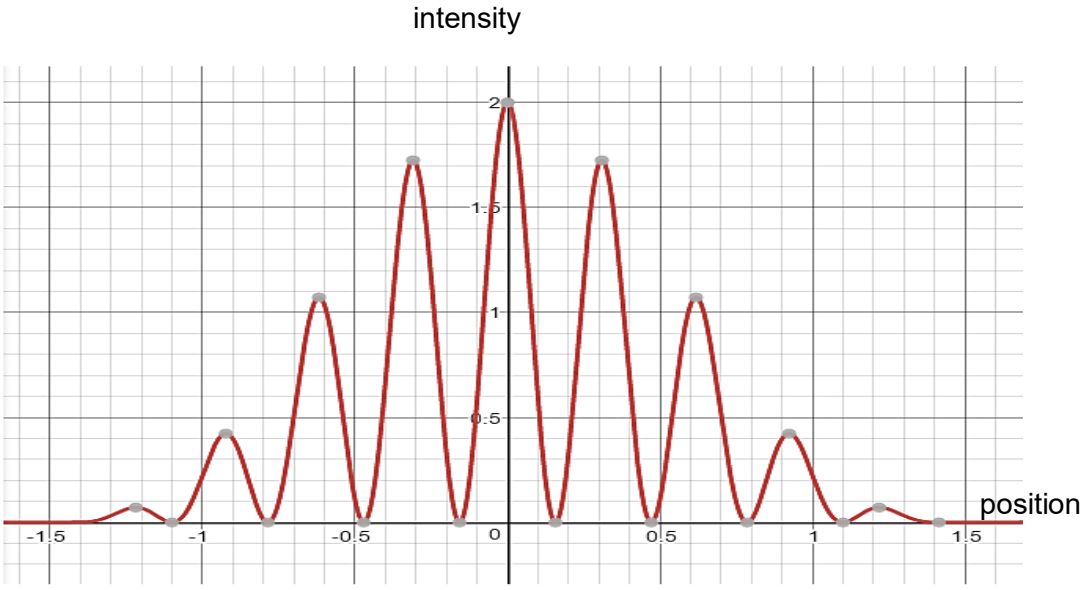

Fig. 9.4

1. Suggest why there is no 5th order maxima detected.

……
……. [1]

……
…….

2. Sketch in Fig. 9.4 the new pattern that will be detected when the slit width *b* is reduced. [2]

[Total: 20]

BLANK PAGE