4 **(a)** Two coherent light wavetrains having the same plane of polarization meet at a point. State two conditions that must be fulfilled before **totally destructive interference** can occur.

1. .....

.....

2. .....

..... [2]

(b) Fig. 4.1 shows an experiment to demonstrate interference effects with microwaves. A transmitter, producing microwaves of wavelength λ is placed in front of two slits separated by a distance a. A receiver is used to detect the strength of the resultant wave at different points along the line YZ which is at a distance D in front of the slits.

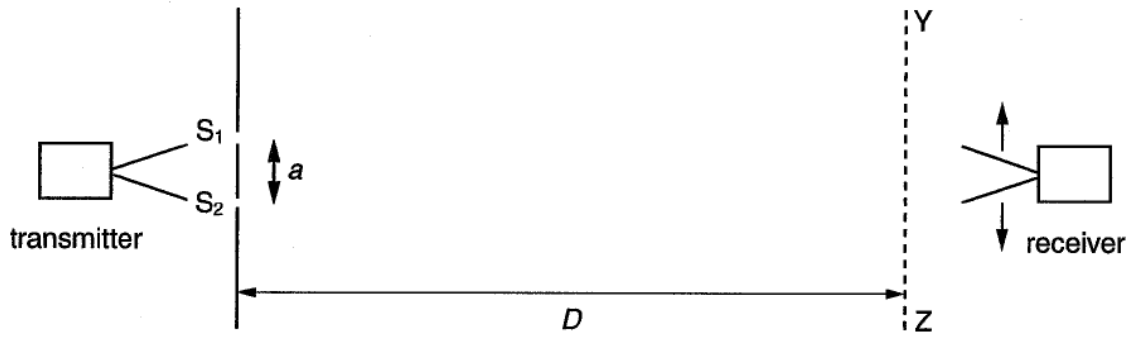

Fig. 4.1

(i) Explain, in terms of the path difference between the wavetrains emerging from the slits S_1 and S_2, why a series of interference maxima are produced along the line YZ.

.....

.....

.....

..... [2]

(ii) State how the distance *x* between neighbouring maxima on the line YZ would change if the distance *a* was doubled while the distance *D* was halved.

.....

..... [1]

(iii) In another experiment using the apparatus in Fig. 4.1, a student notices that the distances between the maxima are not equal. Suggest a reason for this difference.

.....

..... [1]

(iv) Describe how you could test whether the microwaves leaving the transmitter were plane polarised.

.....

.....

.....

..... [2]

(c) The microwave transmitter is now placed in front of a plane reflector as shown in Fig. 4.2 and stationary waves are set up in the space between them.

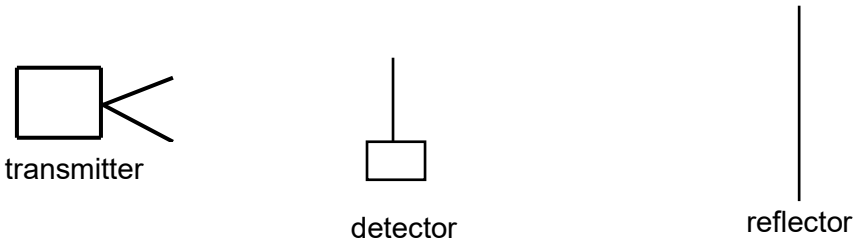

Fig. 4.2

A detector is moved between the transmitter and the reflector at a constant speed of 10 mm s^{-1}. The frequency of detection of minima is 1.5 Hz.

Determine the frequency of the microwave oscillator.

frequency = ... Hz [3]

(d) In a separate experiment, white light is incident on a diffraction grating, as shown in Fig. 4.3.

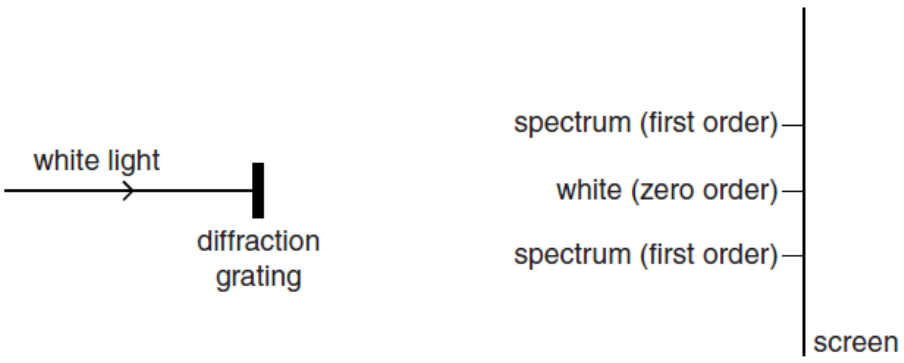

Fig. 4.3

The diffraction pattern formed on the screen consists of a white light band in the zeroth order and coloured spectra in other orders.

Describe how the principle of superposition is used to explain

(i) the presence of white light in the zeroth order.

.....

.....

.....

..... [2]

(ii) the difference in the angular positions of red and blue light in the first-order spectra.

.....

.....

.....

..... [2]

[Total: 15]