7 **(a)** A pair of identical speakers, S_1 and S_2, 1.2 m apart makes up a stereo system in a large hall. The voltage input to each speaker is adjustable. The arrangement is shown in Fig. 7.1.

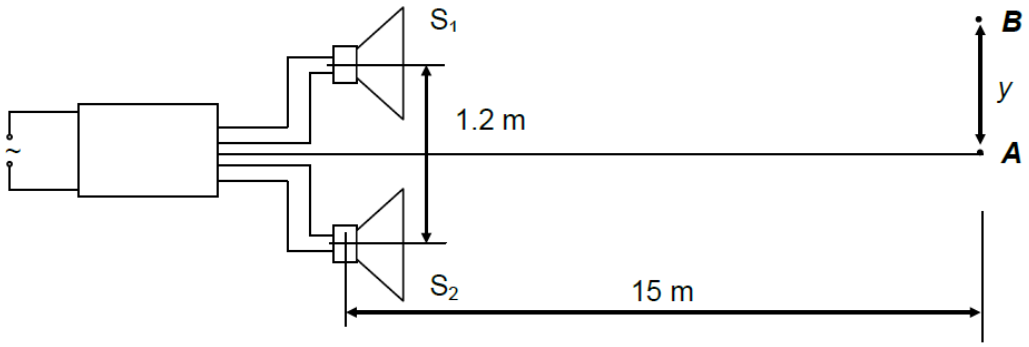

Fig. 7.1

The speakers are initially emitting signals of frequency 1000 Hz which are in phase. Assume that the speed of sound is 330 m s^{-1}. The voltage across each speaker is 6.0 V. An observer holding a sound detector stands on the centre line at point **A**, 15 m away from the point halfway between the speakers and registers a loud sound of intensity I_{max}. As he moves along the line **AB** at right angles to the centre line, the intensity of the sound falls to zero at point **B**, a distance *y* from **A**.

(i) Determine the distance *y*.

distance *y* = ... m [3]

(ii) Calculate the next higher frequency of operation of the speakers such that the point **B** will be a position of maximum intensity.

frequency = ... kHz [2]

(iii) With the speakers emitting the original signal of frequency 1000 Hz, the voltages across S_1 and S_2 are adjusted to 3.0 V and 9.0 V respectively.

Given that the amplitude of the output of each speaker is proportional to the voltage across its terminals, find the new intensity at **A**, expressing your answer in terms of I_{max}.

new intensity at **A** = …… [4]

(b) A *diffraction* grating is to be calibrated by a spectrometer experiment with a source emitting a spectral series of lines of known wavelengths.

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

……

…… [1]

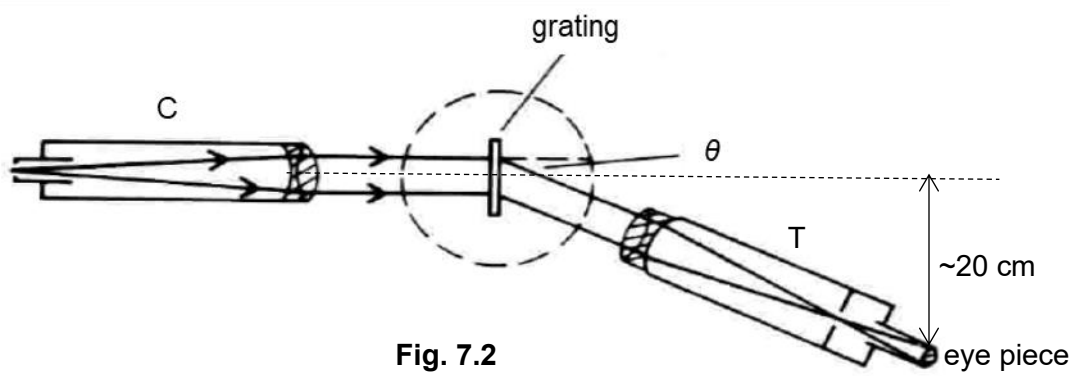

Fig. 7.2

The grating in Fig. 7.2 is set up with light incident normally from a collimator C, with θ, the angle of first order of angular deflections.

(ii) The light from a hydrogen discharge tube contains electromagnetic radiations of wavelengths 660 nm (red) and 490 nm (blue). This light is passed through the grating and observed through a telescope T. The grating has a slit density of 359 lines per mm.

1. The position of the first order blue fringe is observed to be approximately 20 cm from the central maxima.

Estimate the normal distance of the eyepiece in T from the diffraction grating.

normal distance = …… m [3]

2. Determine the angular separation of the red and blue light for hydrogen for the second order diffraction pattern.

angular separation = …… ° [3]

3. Determine the highest order observable for blue light.

highest observable order = …… [2]

4. The diffraction grating may also be used to investigate wavelengths of an unknown source.

Suggest one advantage and one disadvantage of obtaining the wavelength by using observations of the higher order of the diffracted light rather than the first-order diffraction light.

……..

……..

……..

……..

……..

…… [2]