**10** **(a)** Sound is propagated in a medium as a longitudinal progressive wave, in which there is a repeated sequence of displacements of the medium particles.

**(i)** Explain what is meant by a *longitudinal progressive* wave.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………… [2]

**(ii)** A loudspeaker emits 20 W of sound waves uniformly in all directions.

Calculate the intensity of the sound wave at 5.0 m from the loudspeaker.

intensity = ………………….. W $m^{-2}$ [2]

**(iii)** Directional loudspeakers are speakers that project sound in a specific direction.

Suggest why directional loudspeakers are preferred in large outdoor concerts, considering the audience and nearby residential areas.

……………………………………………………………………………………………

…………………………………………………………………………………… [1]

**(b)** Fig. 10.1 shows two small loudspeakers $L_1$ and $L_2$ separated by 15 cm. A sound sensor M is moved along a line XY parallel to the line joining the two loudspeakers and at a perpendicular distance 20 m away.

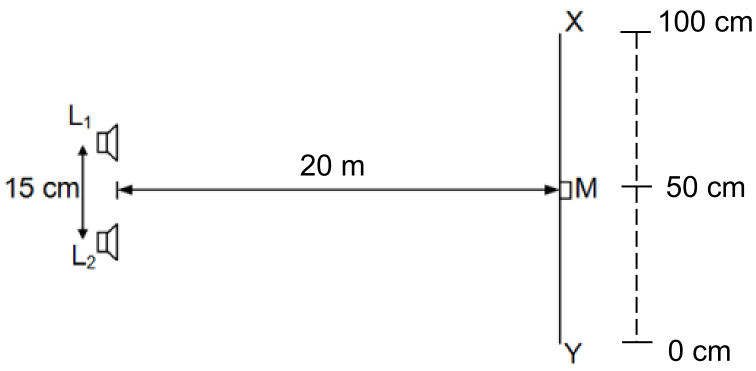


**Fig. 10.1**

The sound intensity detected by the sound sensor varies as shown in Fig. 10.2.

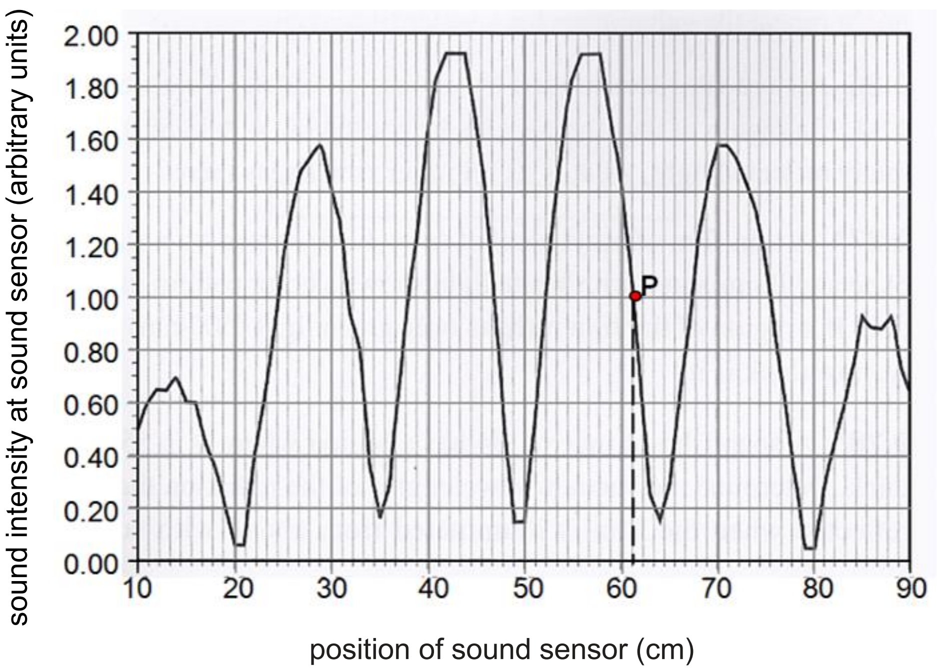


**Fig. 10.2**

**(i)** Explain how it can be deduced that the loudspeakers are coherent sources of waves.

..........................................................................................................

.................................................................................................... [1]

**(ii)** By considering the phase difference of the waves from both speakers, explain how the central minimum in the pattern is formed.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………………………………… [2]

**(iii)** Calculate the approximate frequency at which the speakers were driven. Assume the speed of sound as 343 m $s^{-1}$.

approximate frequency = ………………….. Hz [3]

**(iv)** Estimate the phase angle between the waves from the loudspeakers when the waves meet to produce the intensity at point P on the pattern of Fig. 10.2.

phase angle = ………………….. rad [2]

**(v)** Suggest a reason why the maxima on Fig. 10.2 are not all of the same intensity.

…………………………………………………………………………………………

……………………………………………………………………………………… [1]

**(c)** Fig. 10.3 shows a narrow beam of coherent light of wavelength 589 nm falling normally on a diffraction grating having 500 lines per millimetre. The diffraction grating is situated at the centre of a circular scale.

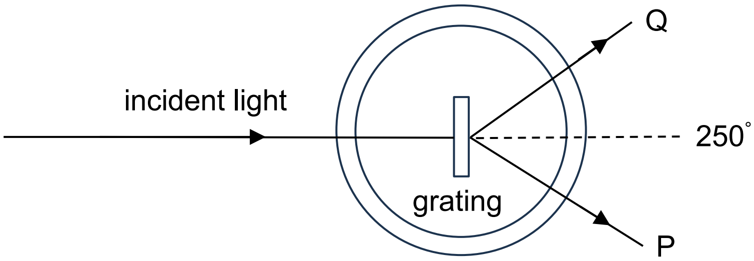


**Fig. 10.3**

The straight through direction is at the reading of 250° on the scale. A detector is placed at P, where the reading on the scale is 210°. The detector is then moved towards Q, where the reading on the scale is 290°.

**(i)** Determine the number of maxima detected as the detector moves from P to Q.

number of maxima detected = ………………….. [2]

**(ii)** State how the angular separation between two maxima of the same order can be increased.

……………………………………………………………………………………

………………………………………………………………………………… [1]

**(iii)** State how the position of the central maximum will change if the light beam does not fall normally on the diffraction grating as shown in Fig. 10.4.

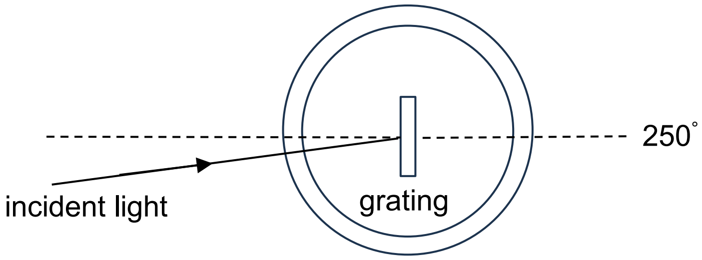


**Fig. 10.4**

…………………………………………………………………………………………

…………………………………………………………………………………… [1]

**(iv)** The light source used in the setup in Fig. 10.3 is replaced with an incident light of unknown wavelength.

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

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………… [2]

**End of Paper**

**BLANK PAGE**