7 **(a)** Fig. 7.1 is a graph showing the variation with distance of the displacement of particles in a standing wave, at the instant when the displacement is a maximum.

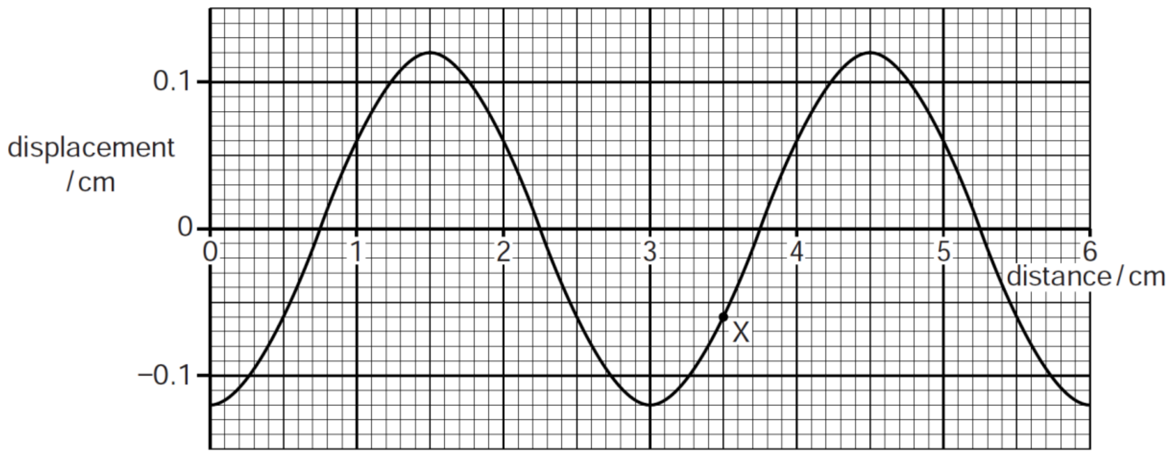

Fig. 7.1

The position of particle X is shown on the wave.

(i) On Fig. 7.1, mark the position of any particle which is π radians out of phase with particle X. Label it O. [1]

(ii) On Fig. 7.1, draw an arrow from particle X showing the direction of its instantaneous acceleration. [1]

(iii) Use the information in Fig. 7.1 to determine the distance moved by particle X during half a cycle.

distance = ... cm [1]

(b)

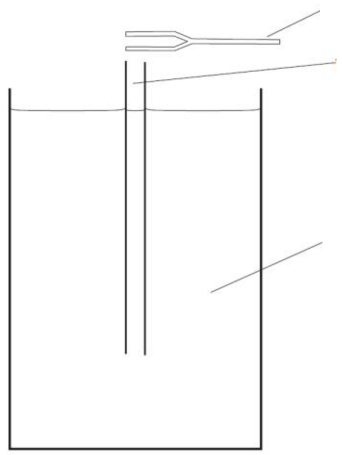

Fig. 7.2

A tube that is open at both ends is placed in a deep tank of water as shown in Fig. 7.2. A tuning fork of frequency 256 Hz is sounded continuously above the tube. The tube is slowly raised out of the water. At one position of the tube, a maximum loudness of sound is heard. The tube is gradually raised from a position of maximum loudness until the next position of maximum loudness is reached. The length of the tube above the water surface is increased by 65.0 cm.

Determine the speed of sound in air of the tube.

speed = ………………………………… m s^{-1} [2]

(c) A laser pointer is placed behind a glass microscope slide that has been painted black. A single vertical slit of width 0.0800 mm has been produced by scratching through the paint with a razor blade.

Light from the laser, of wavelength 633 nm, passes through the slit and hits a wall at 5.12 m from the slit. A light sensor connected to a data logger is moved across the wall and the variation with distance moved by the sensor of the intensity of light is shown in Fig. 7.3.

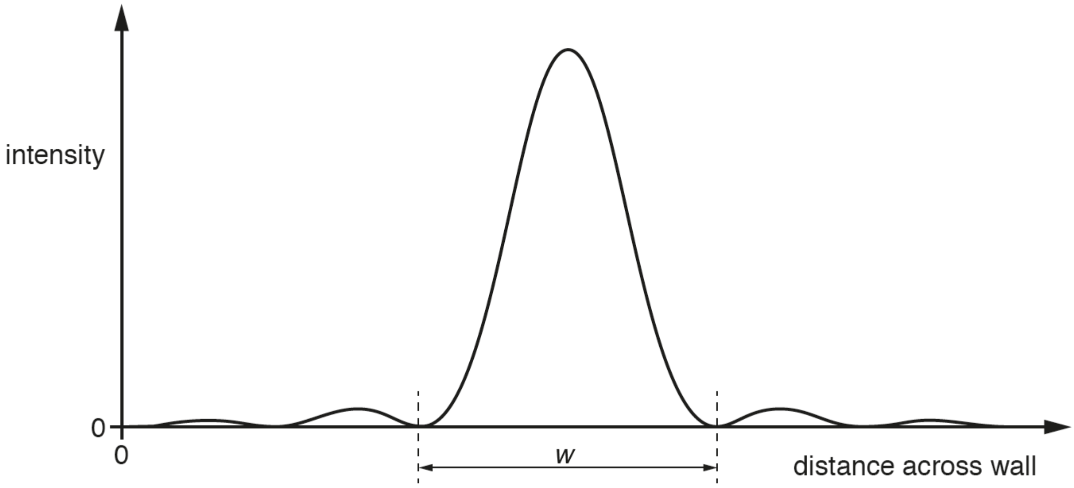

Fig. 7.3

The width *w* of the central patch is equal to the distance between the two minimum points on either side of the central patch where the intensity of the light is equal to zero.

(i) Determine *w*.

w = ………………………………… m [2]

(ii) A second vertical slit of width 0.0800 mm is scratched across the slide. The second slit is parallel to the first and its centre is a horizontal distance of 0.240 mm away from the centre of the first slit.

The slide now acts as a double slit. At the centre of the double-slit interference pattern on the wall, there are bright and dark fringes which are uniformly spaced.

1. Some parts of the screen that were brightly lit when only the first slit was present are now dark, even though the light is still passing through the first slit in the same way.

Explain what causes this to happen.

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

2. Determine the separation *x* of the bright fringes.

x = ………………………………… m [2]

3. Most of the bright fringes are separated from adjacent bright fringes by a distance *x*. In a few places, away from the centre, however, there are separations of 2*x* and there is no light in the middle of the gap where a bright fringe might be expected.

Using the results from **(c)(i)** and **(c)(ii)2**, explain why there is no light at such places.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(d) The same laser pointer is now incident normally on a diffraction grating as shown in Fig. 7.4.

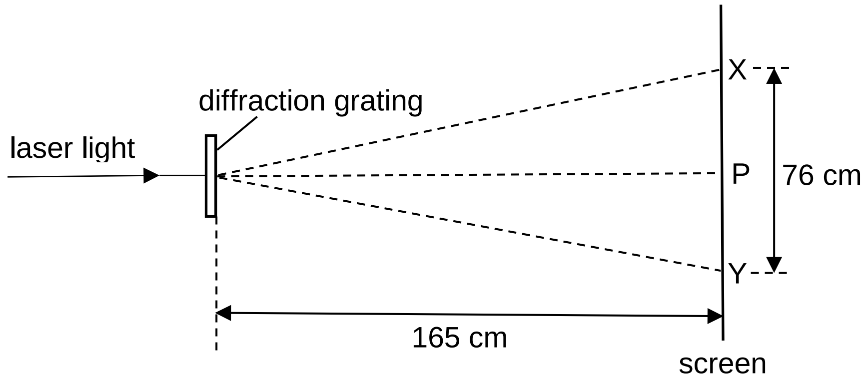

Fig. 7.4

Spots of light are observed on a screen placed parallel to the grating. The distance between the grating and the screen is 165 cm.

The brightest spot is P. The spots formed closest to P and on each side of P are X and Y. X and Y are separated by 76 cm.

(i) Calculate the number of lines per metre on the grating.

number per metre = …………………. [3]

(ii) Light of wavelengths 633 nm and 638 nm is now incident normally on the grating. Two lines are observed in the first order spectrum and two lines are observed in the second order spectrum, corresponding to the two wavelengths.

State two differences between the first order spectrum and the second order spectrum.

1 ………………………………………………………………………………………

………………………………………………………………………………………

2 ………………………………………………………………………………………

……………………………………………………………………………………… [2]

(e) The grating in **(d)** is now rotated about an axis parallel to the incident light, as shown in Fig. 7.5.

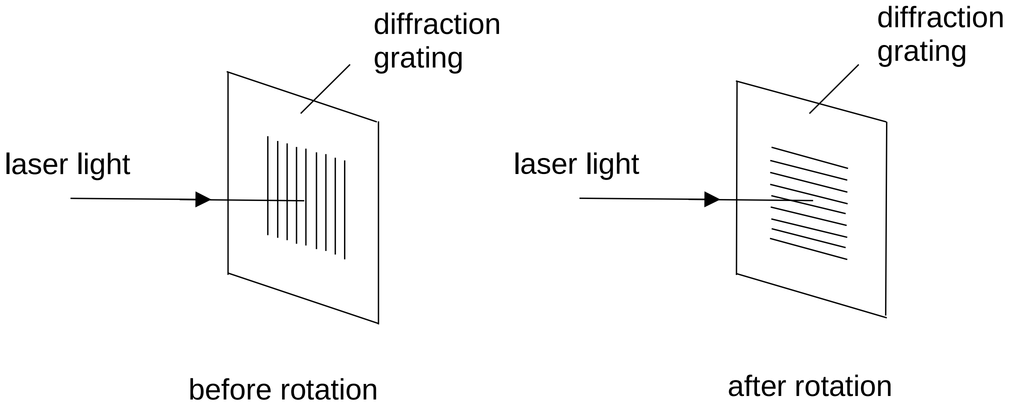

Fig. 7.5

(i) State what effect, if any, this rotation will have on the positions of the spots P, X and Y.

....

....

....

.... [2]

(ii) In another experiment using the apparatus in **(d)**, it was noticed that the distances XP and PY, as shown in Fig. 7.4, are not equal. Suggest a reason for this difference.

....

.... [1]

[Total: 20]