Worksheet Cam- AS-Level

Waves

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For Examiner's Use

4 **(a)** State what is meant by the *diffraction* of a wave.

....

....

.... [2]

(b) A laser produces a narrow beam of coherent light of wavelength 632 nm. The beam is incident normally on a diffraction grating, as shown in Fig. 4.1.

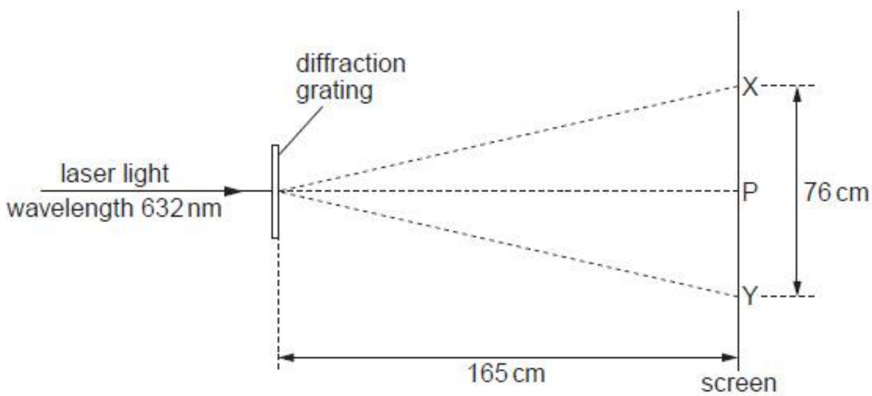

Fig. 4.1

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 a distance of 76 cm.
Calculate the number of lines per metre on the grating.

number per metre = ... [4]

(c) The grating in **(b)** is now rotated about an axis parallel to the incident laser beam, as shown in Fig. 4.2.

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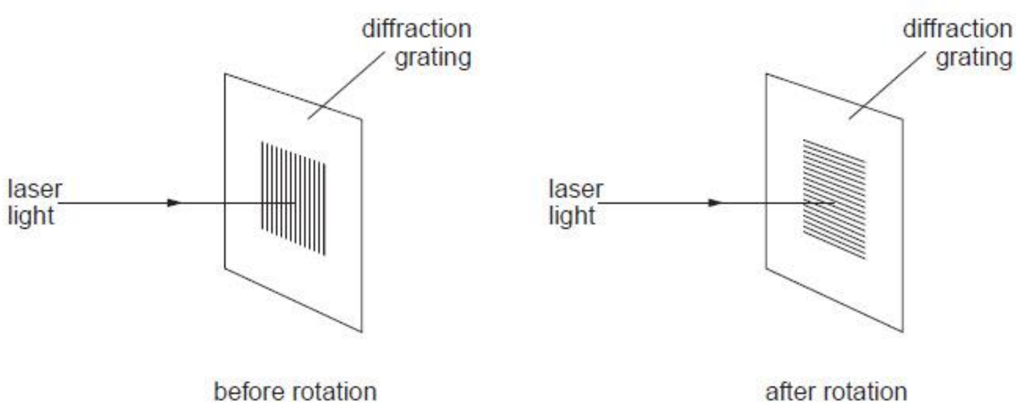

Fig. 4.2

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

....

....

....

....[2]

(d) In another experiment using the apparatus in **(b)**, a student notices that the distances XP and PY, as shown in Fig. 4.1, are not equal.
Suggest a reason for this difference.

....

....[1]

For Examiner's Use

4 **(a)** State two features of a stationary wave that distinguish it from a progressive wave.

1. ....

....

2. ....

....
[2]

(b) A long tube is open at one end. It is closed at the other end by means of a piston that can be moved along the tube, as shown in Fig. 4.1.

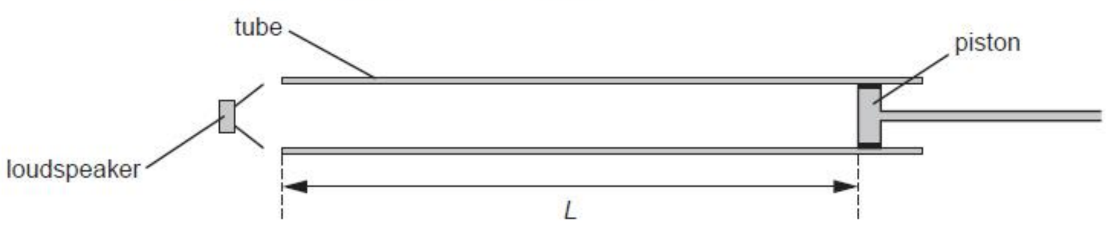

Fig. 4.1

A loudspeaker producing sound of frequency 550 Hz is held near the open end of the tube.
The piston is moved along the tube and a loud sound is heard when the distance L between the piston and the open end of the tube is 45 cm.
The speed of sound in the tube is $330\,\text{m}\,\text{s}^{-1}$.

(i) Show that the wavelength of the sound in the tube is 60 cm.

[1]

(ii) On Fig. 4.1, mark all the positions along the tube of

1. the displacement nodes (label these with the letter N),

2. the displacement antinodes (label these with the letter A).

[3]

(c) The frequency of the sound produced by the loudspeaker in **(b)** is gradually reduced.

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Determine the lowest frequency at which a loud sound will be produced in the tube of length L = 45 cm.

frequency = ... Hz [3]

5 **(a)** A source of sound has frequency *f*. Sound of wavelength λ is produced by the source.

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(i) State

1. what is meant by the *frequency* of the source,

....

....[1]

2. the distance moved, in terms of λ, by a wavefront during *n* oscillations of the source.

distance = ...[1]

(ii) Use your answers in **(i)** to deduce an expression for the speed *v* of the wave in terms of *f* and λ.

[2]

(b) The waveform of a sound wave produced on the screen of a cathode-ray oscilloscope (c.r.o.) is shown in Fig. 5.1.

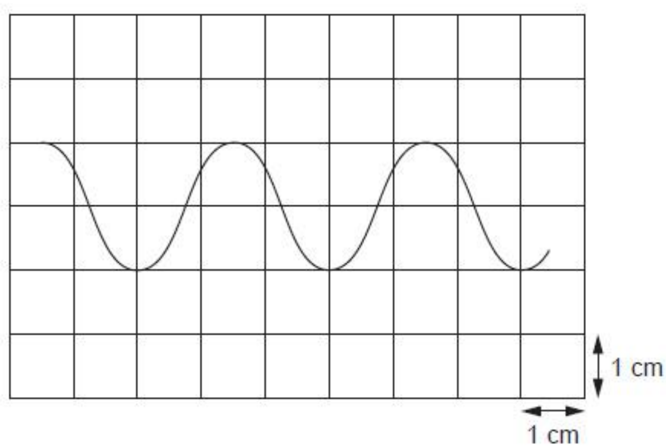

Fig. 5.1

The time-base setting of the c.r.o. is 2.0 ms cm^{-1}.

For Examiner's Use

(i) Determine the frequency of the sound wave.

frequency = ...Hz [2]

(ii) A second sound wave has the same frequency as that calculated in **(i)**. The amplitude of the two waves is the same but the phase difference between them is 90°.

On Fig. 5.1, draw the waveform of this second wave. [1]

5 **(a)** State what is meant by the *diffraction* of a wave.

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....

....

.... [2]

(b) Plane wavefronts are incident on a slit, as shown in Fig. 5.1.

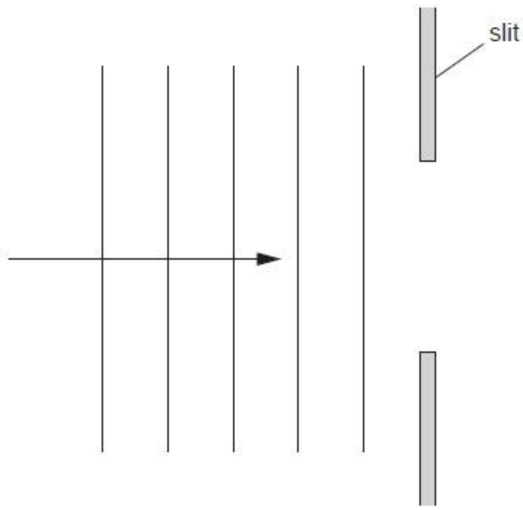

Fig. 5.1

Complete Fig. 5.1 to show four wavefronts that have emerged from the slit. [2]

(c) Monochromatic light is incident normally on a diffraction grating having 650 lines per millimetre, as shown in Fig. 5.2.

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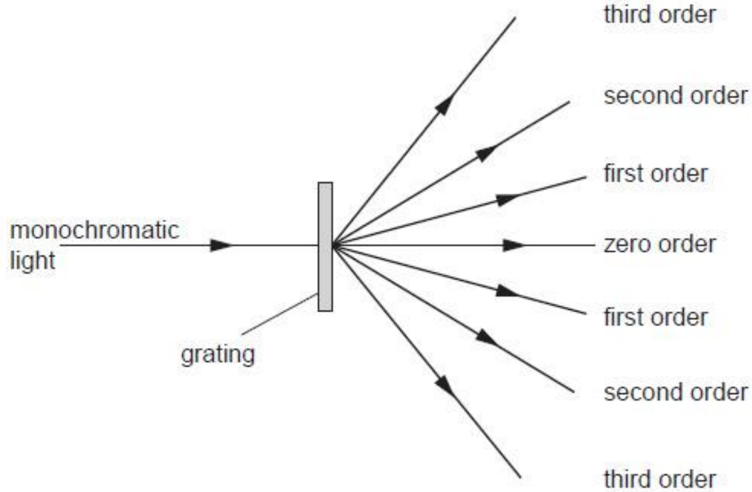

Fig. 5.2

An image (the zero order) is observed for light that has an angle of diffraction equal to zero.

For incident light of wavelength 590 nm, determine the number of orders of diffracted light that can be observed on each side of the zero order.

number = ... [3]

(d) The images in Fig. 5.2 are viewed, starting with the zero order and then with increasing order number.
State how the appearance of the images changes as the order number increases.

....

.... [1]

5 A student is studying a water wave in which all the wavefronts are parallel to one another.
The variation with time t of the displacement x of a particular particle in the wave is shown in Fig. 5.1.

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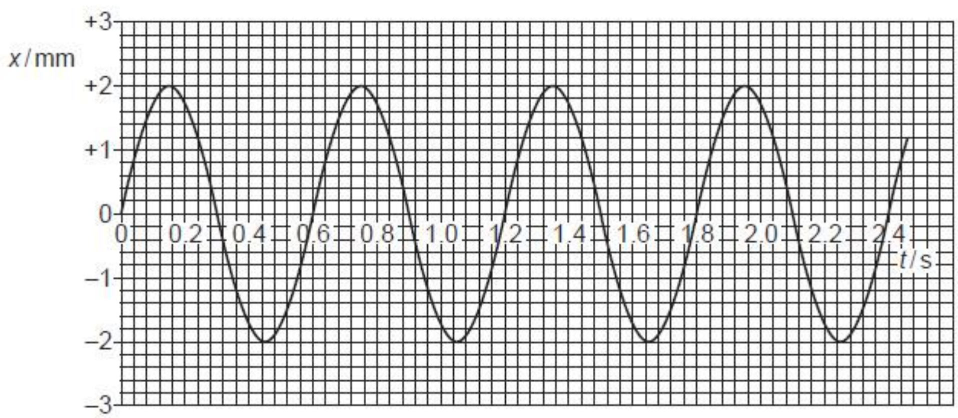

Fig. 5.1

The distance d of the oscillating particles from the source of the waves is measured.
At a particular time, the variation of the displacement x with this distance d is shown in Fig. 5.2.

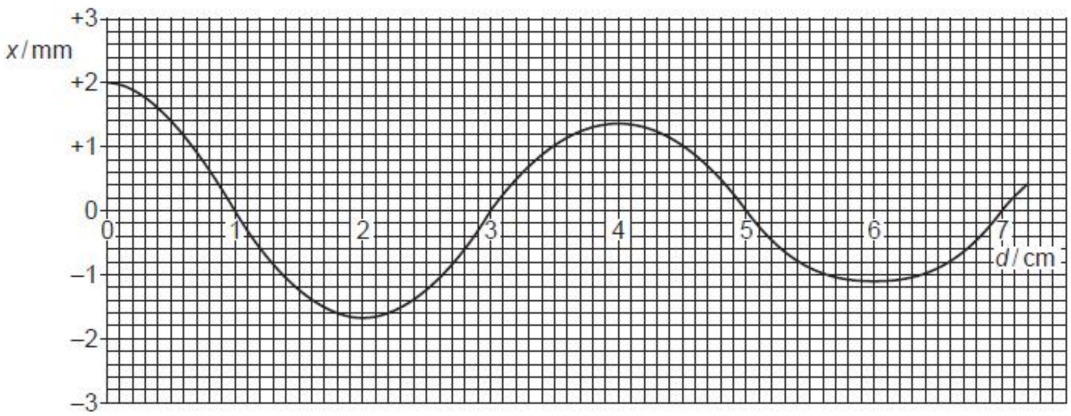

Fig. 5.2

(a) Define, for a wave, what is meant by

(i) *displacement*,

....

....[1]

(ii) *wavelength*.

....

....[1]

(b) Use Figs. 5.1 and 5.2 to determine, for the water wave,

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(i) the period T of vibration,

T = ... s [1]

(ii) the wavelength λ,

λ = ... cm [1]

(iii) the speed v.

v = ... $cm\,s^{-1}$ [2]

(c) (i) Use Figs. 5.1 and 5.2 to state and explain whether the wave is losing power as it moves away from the source.

....

....

.... [2]

(ii) Determine the ratio

$$\frac{\text{intensity of wave at source}}{\text{intensity of wave 6.0 cm from source}}.$$

ratio = ... [3]

6 **(a)** State the principle of superposition.

....

....

.... [2]

(b) Coherent light of wavelength 590 nm is incident normally on a double slit, as shown in Fig. 6.1.

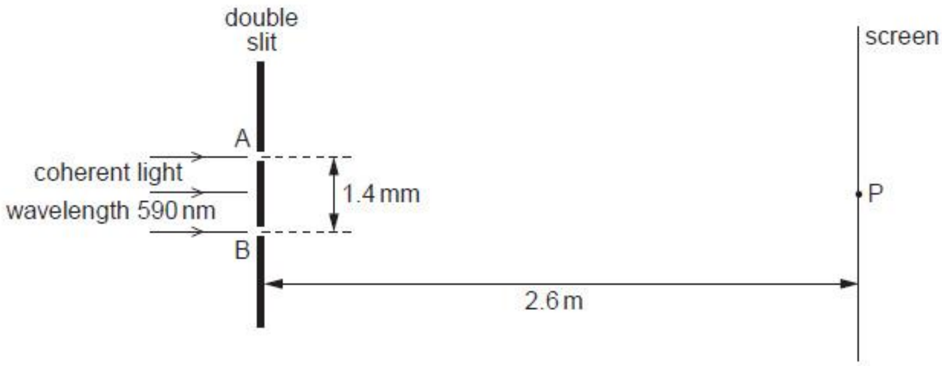

Fig. 6.1 (not to scale)

The separation of the slits A and B is 1.4 mm.
Interference fringes are observed on a screen placed parallel to the plane of the double slit.
The distance between the screen and the double slit is 2.6 m.

At point P on the screen, the path difference is zero for light arriving at P from the slits A and B.

(i) Determine the separation of bright fringes on the screen near to point P.

separation = ... mm [3]

(ii) The variation with time of the displacement *x* of the light wave arriving at point P on the screen from slit A and from slit B is shown in Fig. 6.2a and Fig. 6.2b respectively.

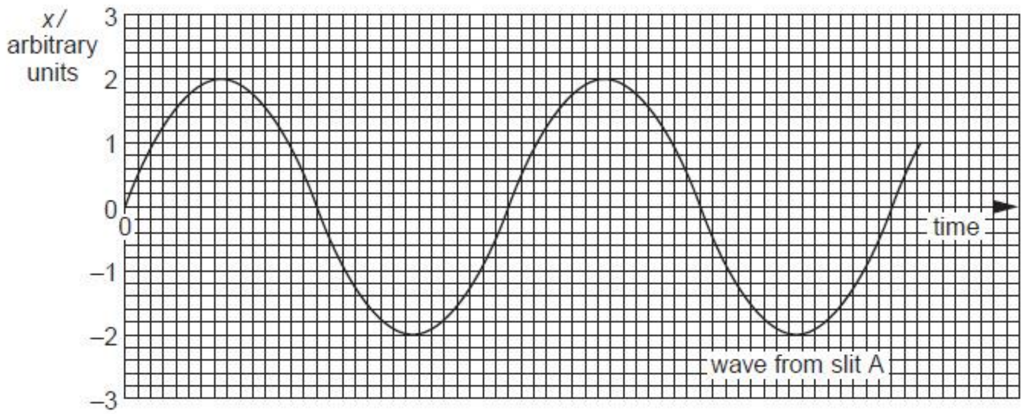

Fig. 6.2a

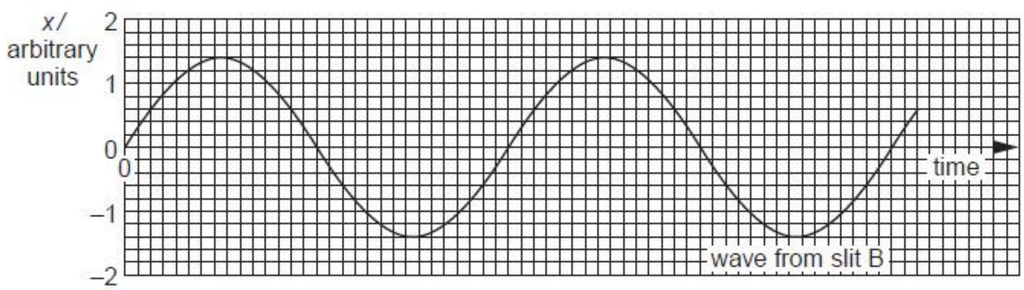

Fig. 6.2b

1. State the phase difference between waves forming the dark fringe on the screen that is next to point P.

phase difference = ... ° [1]

2. Determine the ratio

$$\frac{\text{intensity of light at a bright fringe}}{\text{intensity of light at a dark fringe}}.$$

ratio = ... [3]