

Diffraction & Interference

Question paper 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Superposition
Sub Topic	Diffraction & Interference
Paper Type	Theory
Booklet	Question paper 2

Time Allowed: 66 minutes

Score: /55

Percentage: /100

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A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

- 1 (a) Apparatus used to produce interference fringes is shown in Fig. 6.1. The apparatus is not drawn to scale.

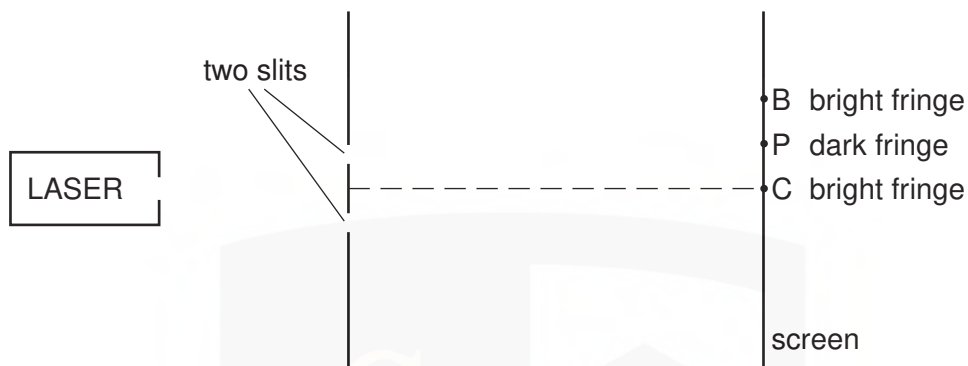


Fig. 6.1 (not to scale)

Laser light is incident on two slits. The laser provides light of a single wavelength. The light from the two slits produces a fringe pattern on the screen. A bright fringe is produced at C and the next bright fringe is at B. A dark fringe is produced at P.

- (i) Explain why one laser and two slits are used, instead of two lasers, to produce a visible fringe pattern on the screen.

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

- (ii) State the phase difference between the waves that meet at

1. B [1]

2. P [1]

- (iii) 1. State the *principle of superposition*.

.....
.....
..... [2]

2. Use the principle of superposition to explain the dark fringe at P.

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

- (b) In Fig. 6.1 the distance from the two slits to the screen is 1.8m. The distance CP is 2.3 mm and the distance between the slits is 0.25 mm.
Calculate the wavelength of the light provided by the laser.

wavelength = nm [3]



2 (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.

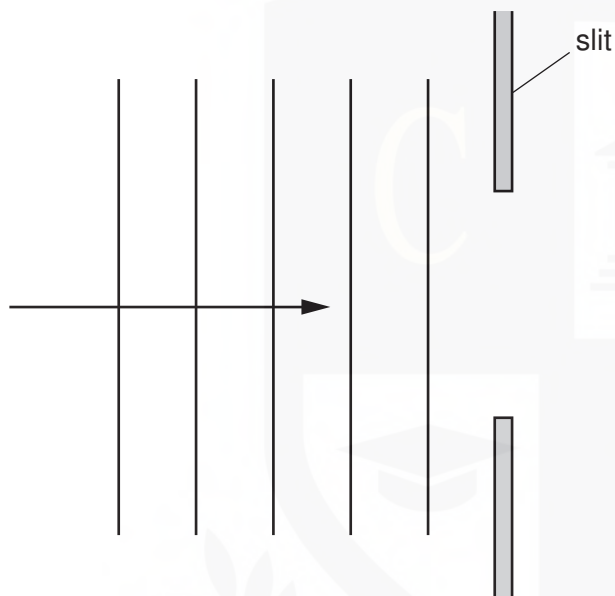


Fig. 5.1

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

[2]

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

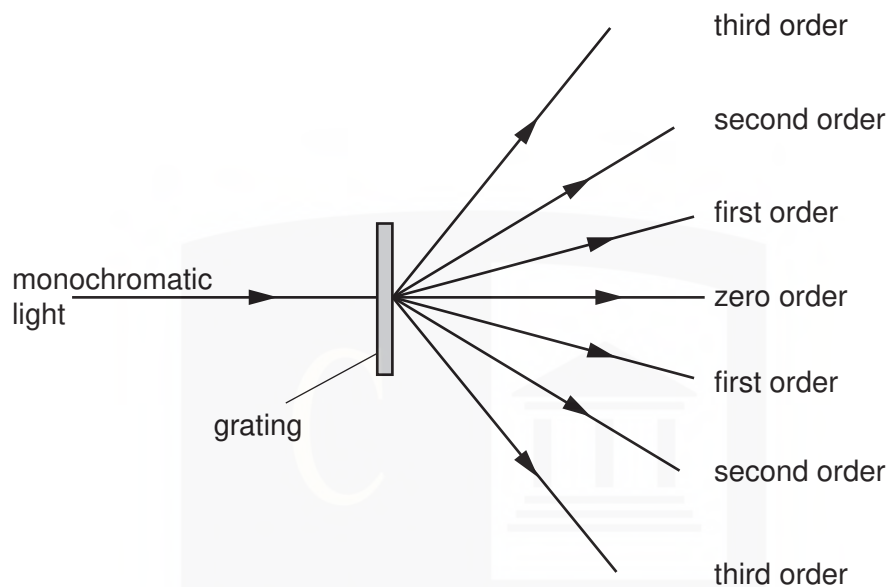


Fig. 5.2

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]

- 3 (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.

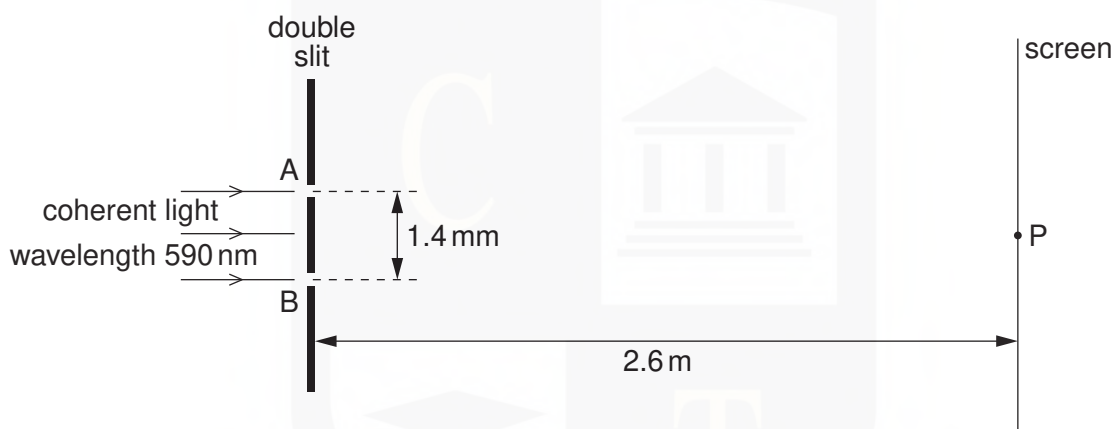


Fig. 6.1 (not to scale)

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.

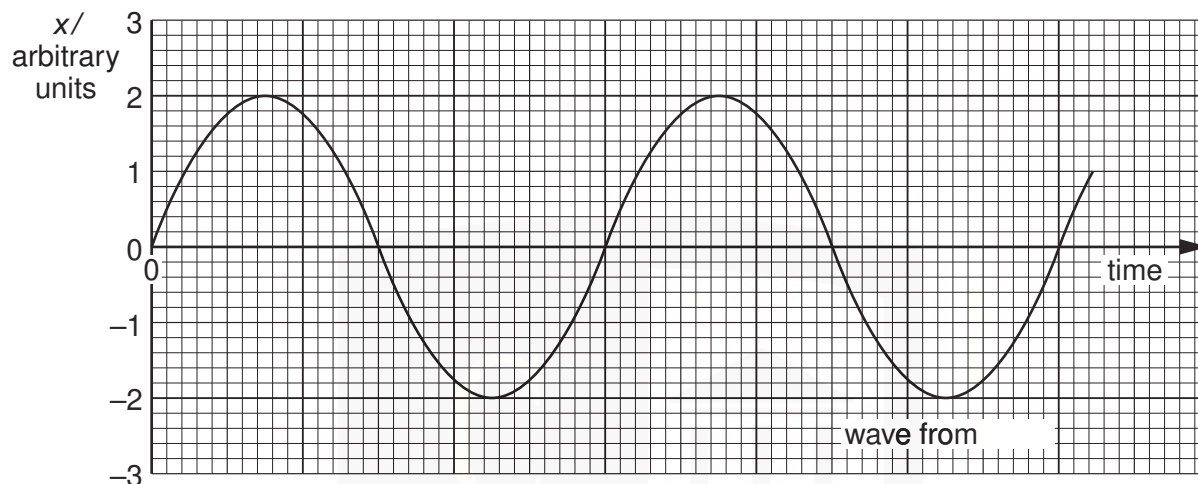


Fig. 6.2a

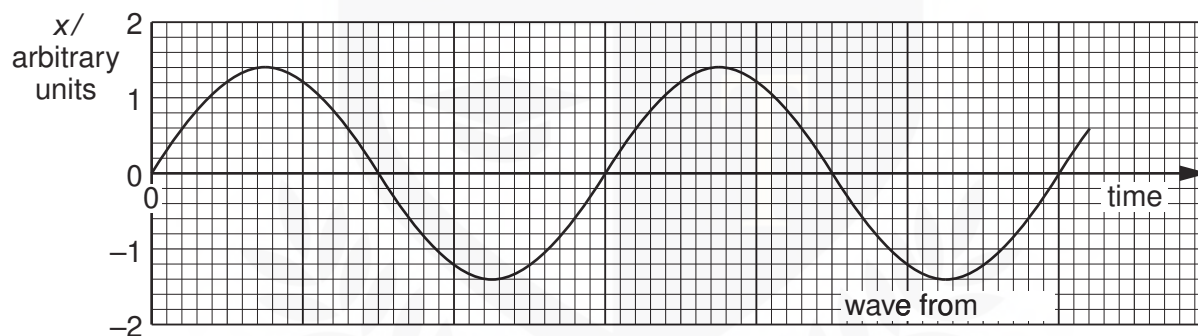


Fig. 6.2b

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

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

- 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.

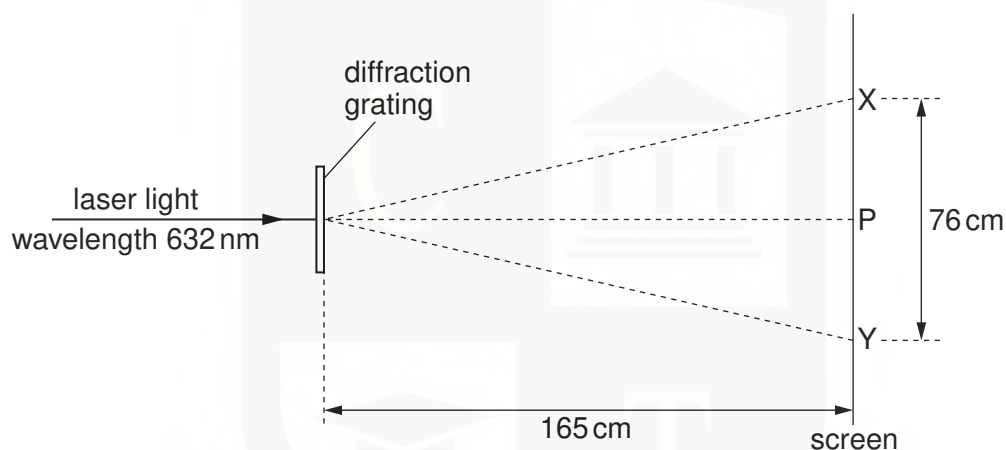


Fig. 4.1

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.

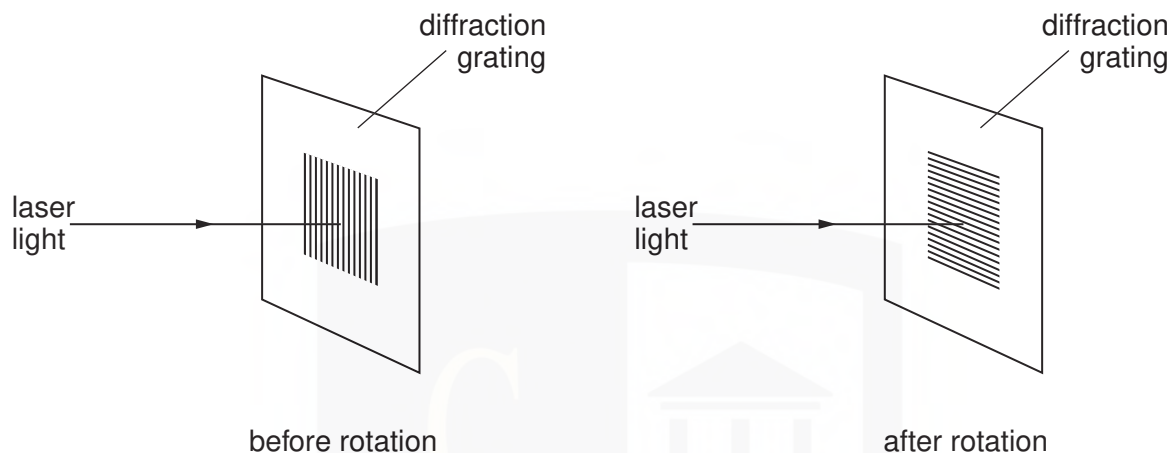


Fig. 4.2

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

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.....

..... [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]

- 5 Two sources S_1 and S_2 of sound are situated 80 cm apart in air, as shown in Fig. 5.1.

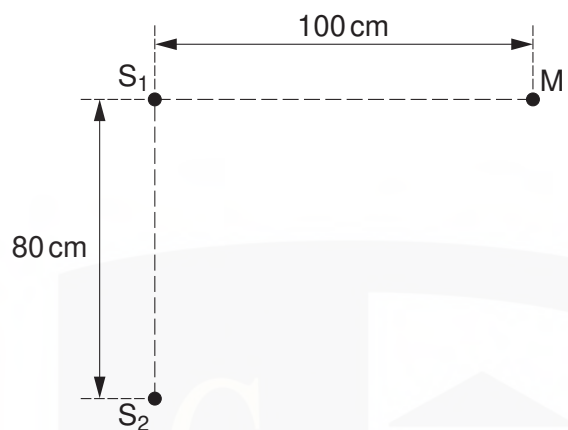


Fig. 5.1

The frequency of vibration can be varied. The two sources always vibrate in phase but have different amplitudes of vibration.

A microphone M is situated a distance 100 cm from S_1 along a line that is normal to S_1S_2 .

As the frequency of S_1 and S_2 is gradually increased, the microphone M detects maxima and minima of intensity of sound.

- (a) State the two conditions that must be satisfied for the intensity of sound at M to be zero.

1.
.....
2.
.....

[2]

- (b) The speed of sound in air is 330 m s^{-1} .

The frequency of the sound from S_1 and S_2 is increased. Determine the number of minima that will be detected at M as the frequency is increased from 1.0 kHz to 4.0 kHz.

- 6 A double-slit interference experiment is set up using coherent red light as illustrated in Fig. 5.1.

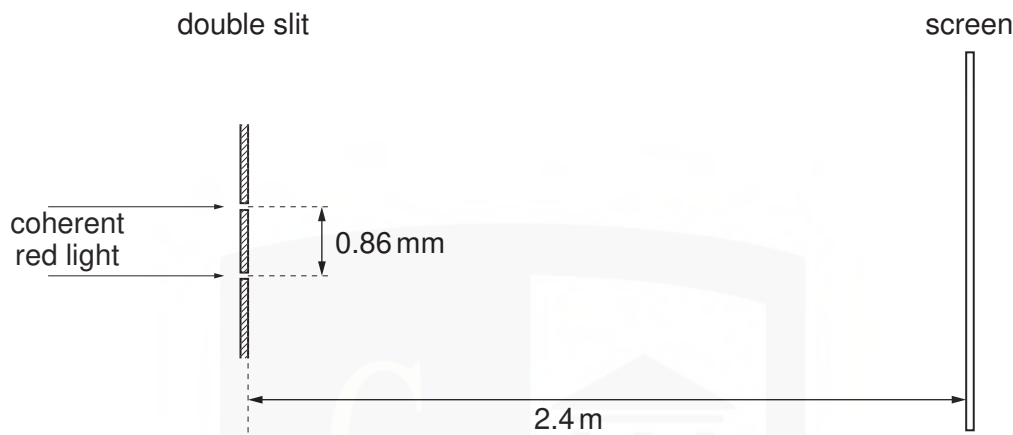


Fig. 5.1 (not to scale)

The separation of the slits is 0.86 mm.

The distance of the screen from the double slit is 2.4 m.

A series of light and dark fringes is observed on the screen.

- (a) State what is meant by *coherent* light.

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

- (b) Estimate the separation of the dark fringes on the screen.

separation = mm [3]

- (c) Initially, the light passing through each slit has the same intensity.
The intensity of light passing through one slit is now reduced.
Suggest and explain the effect, if any, on the dark fringes observed on the screen.

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..... [2]

7 (a) Explain what is meant by the *diffraction* of a wave.

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..... [2]

(b) (i) Outline briefly an experiment that may be used to demonstrate diffraction of a transverse wave.

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..... [3]

(ii) Suggest how your experiment in (i) may be changed to demonstrate the diffraction of a longitudinal wave.

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..... [3]