Diffraction & Interference

Question paper 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Superposition
Sub Topic	Diffraction & Interference
Paper Type	Theory
Booklet	Question paper 1

Time Allowed: **78 minutes**

Score: **/65**

Percentage: **/100**

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

1 (a) State one difference and one similarity between longitudinal and transverse waves.

difference: .....

.....

similarity: .....

.....

[2]

(b) A laser is placed in front of two slits as shown in Fig. 6.1.

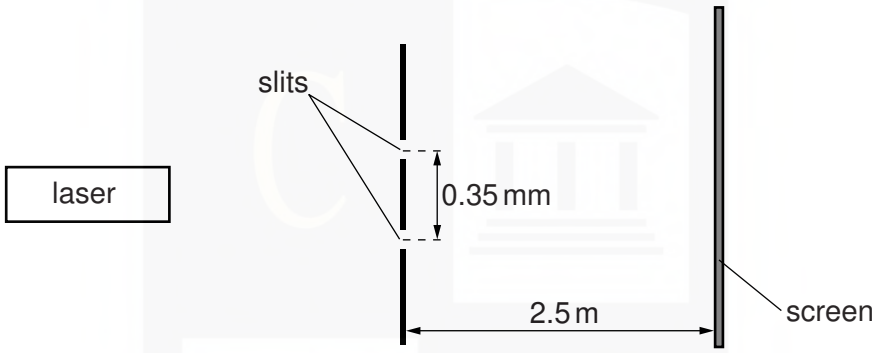

Fig. 6.1 (not to scale)

The laser emits light of wavelength 6.3×10^{-7} m.
The distance from the slits to the screen is 2.5 m. The separation of the slits is 0.35 mm.
An interference pattern of maxima and minima is observed on the screen.

(i) Explain why an interference pattern is observed on the screen.

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.....

.....

.....[2]

(ii) Calculate the distance between adjacent maxima.

distance = ...m [2]

(c) State and explain the effect, if any, on the distance between adjacent maxima when the laser is replaced by another laser emitting ultra-violet radiation.

.....

.....[1]

2 A laser is placed in front of a double slit, as shown in Fig. 7.1.

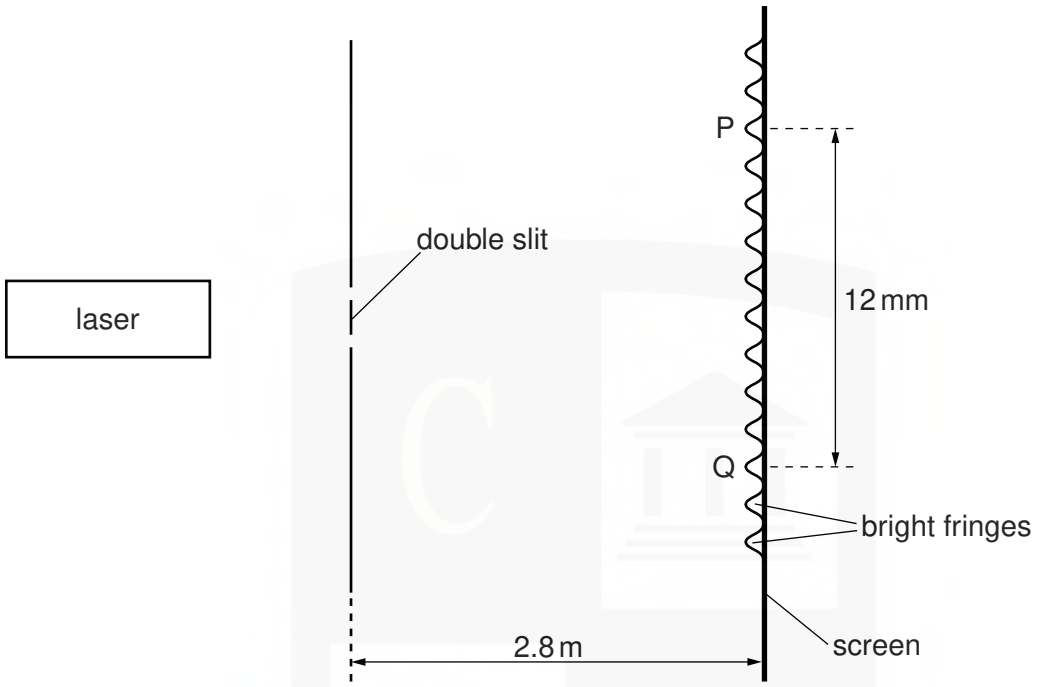

Fig. 7.1 (not to scale)

The laser emits light of frequency 670 THz. Interference fringes are observed on the screen.

(a) Explain how the interference fringes are formed.

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.....

..... [3]

(b) Show that the wavelength of the light is 450 nm.

[2]

(c) The separation of the maxima P and Q observed on the screen is 12 mm. The distance between the double slit and the screen is 2.8 m.

Calculate the separation of the two slits.

separation = ... m [3]

(d) The laser is replaced by a laser emitting red light. State and explain the effect on the interference fringes seen on the screen.

.....

.....

.....

..... [2]

3 **(a)** State three conditions required for maxima to be formed in an interference pattern produced by two sources of microwaves.

1. .....

.....

2. .....

.....

3. .....

.....

[3]

(b) A microwave source M emits microwaves of frequency 12 GHz. Show that the wavelength of the microwaves is 0.025 m.

[3]

(c) Two slits S_1 and S_2 are placed in front of the microwave source M described in **(b)**, as shown in Fig 5.1.

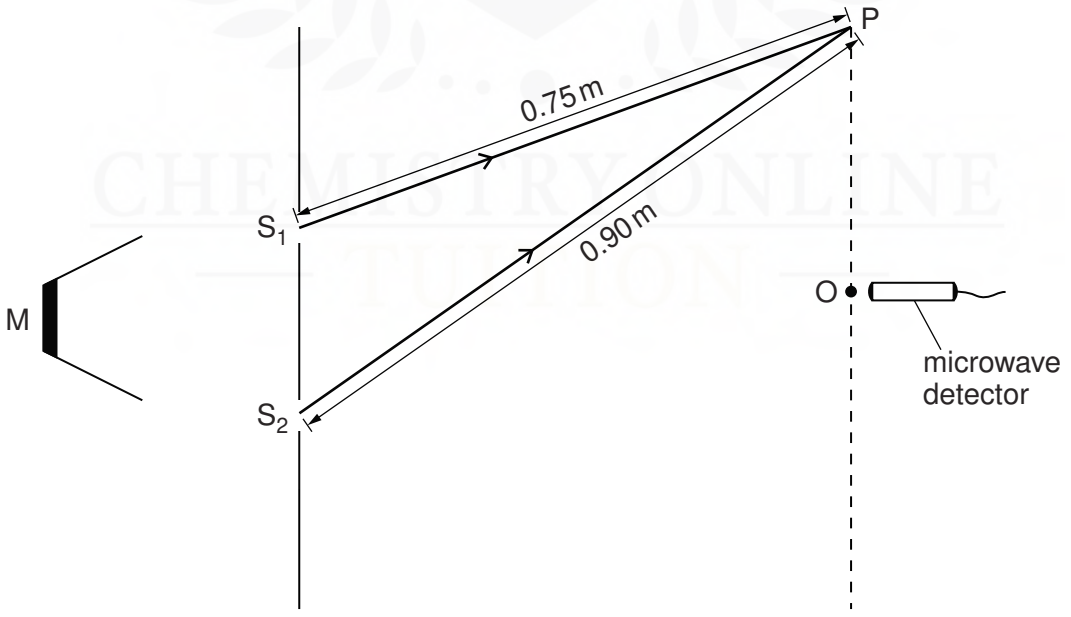

Fig. 5.1 (not to scale)

The distances S_1O and S_2O are equal. A microwave detector is moved from O to P. The distance S_1P is 0.75 m and the distance S_2P is 0.90 m.

The microwave detector gives a maximum reading at O.

State the variation in the readings on the microwave detector as it is moved slowly along the line from O to P.

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.....

..... [3]

(d) The microwave source M is replaced by a source of coherent light.

State two changes that must be made to the slits in Fig. 5.1 in order to observe an interference pattern.

1. .....

2. .....

[2]

4 **(a)** Describe the diffraction of monochromatic light as it passes through a diffraction grating.

.....

.....

..... [2]

(b) White light is incident on a diffraction grating, as shown in Fig. 4.1.

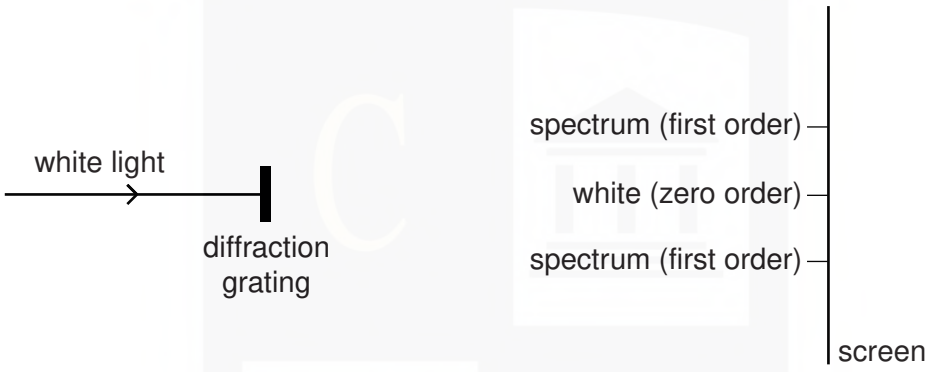

Fig. 4.1 (not to scale)

The diffraction pattern formed on the screen has white light, called zero order, and coloured spectra in other orders.

(i) Describe how the principle of superposition is used to explain

1. white light at the zero order,

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..... [2]

2. the difference in position of red and blue light in the first-order spectrum.

.....

.....

..... [2]

(ii) Light of wavelength 625 nm produces a second-order maximum at an angle of 61.0° to the incident direction.
Determine the number of lines per metre of the diffraction grating.

number of lines = ... m^{-1} [2]

(iii) Calculate the wavelength of another part of the visible spectrum that gives a maximum for a different order at the same angle as in **(ii)**.

wavelength = ……..……..nm [2]

5 **(a)** A laser is used to produce an interference pattern on a screen, as shown in Fig. 6.1.

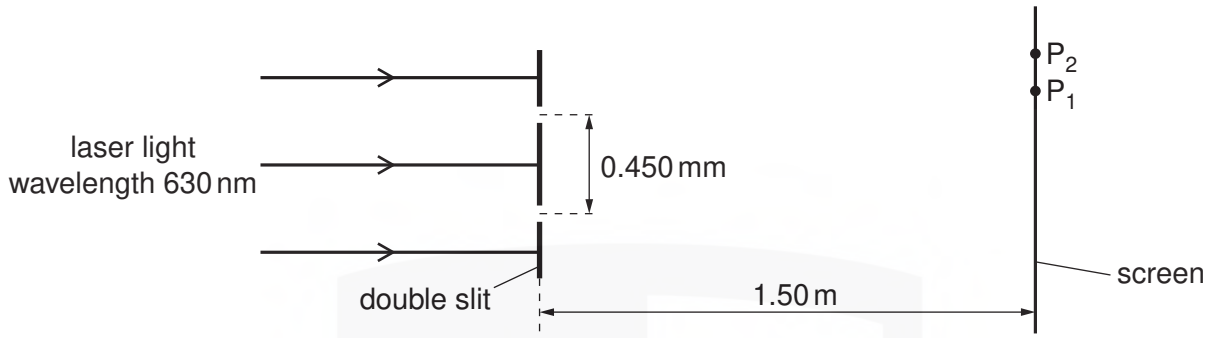

Fig. 6.1 (not to scale)

The laser emits light of wavelength 630 nm. The slit separation is 0.450 mm. The distance between the slits and the screen is 1.50 m. A maximum is formed at P_1 and a minimum is formed at P_2.
Interference fringes are observed only when the light from the slits is coherent.

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

.....

.....

.....[2]

(ii) Explain how an interference maximum is formed at P_1.

.....

.....[1]

(iii) Explain how an interference minimum is formed at P_2.

.....

.....[1]

(iv) Calculate the fringe separation.

fringe separation = ... m [3]

(b) State the effects, if any, on the fringes when the amplitude of the waves incident on the double slits is increased.

.....

.....

.....

.....[3]

6 **(a)** Monochromatic light is diffracted by a diffraction grating. By reference to this, explain what is meant by

(i) diffraction,

.....

.....

.....[2]

(ii) coherence,

.....

.....

.....[1]

(iii) superposition.

.....

.....

.....[1]

(b) A parallel beam of red light of wavelength 630 nm is incident normally on a diffraction grating of 450 lines per millimetre.

Calculate the number of diffraction orders produced.

number of orders = ... [3]

(c) The red light in **(b)** is replaced with blue light. State and explain the effect on the diffraction pattern.

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.....

.....

.....[3]

7 **(a)** Explain the term *interference*.

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..... [1]

(b) A ripple tank is used to demonstrate interference between water waves.

Describe

(i) the apparatus used to produce two sources of coherent waves that have circular wavefronts,

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..... [2]

(ii) how the pattern of interfering waves may be observed.

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..... [2]

(c) A wave pattern produced in **(b)** is shown in Fig. 7.1.

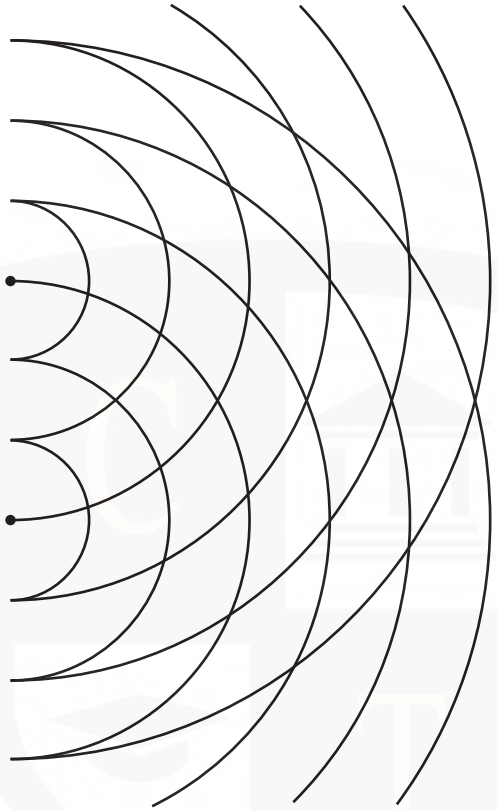

Fig. 7.1

Solid lines on Fig. 7.1 represent crests.

On Fig. 7.1,

(i) draw two lines to show where maxima would be seen (label each of these lines with the letter X), [1]

(ii) draw one line to show where minima would be seen (label this line with the letter N). [1]