9.3 Interference

Question Paper

Course	DP IB Physics
Section	9. Wave Phenomena (HL only)
Topic	9.3 Interference
Difficulty	Easy

Time allowed: 60

Score: /49

Percentage: /100

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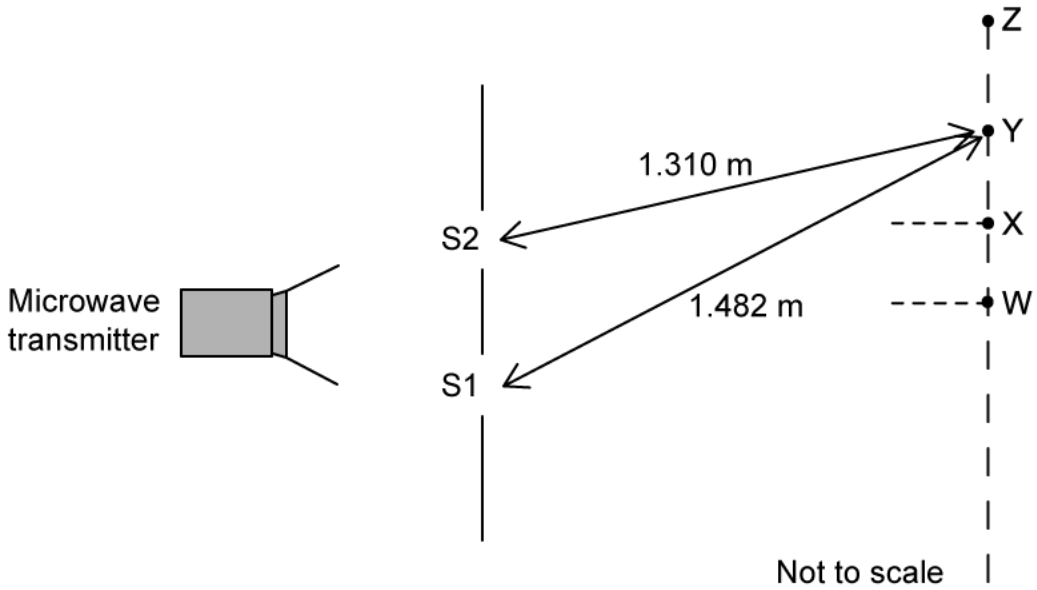
Question 1a

A beam of microwaves is incident normally on a pair of identical narrow slits S1 and S2.



When a microwave receiver is initially placed at W which is equidistant from the slits, a maximum intensity is observed. The receiver is then moved towards Z along a line parallel to the slits. Intensity maxima are also observed at X and Y with one minimum between them. W, X and Y are consecutive maxima.

The distance from S1 to Y is 1.482 m and the distance from S2 to Y is 1.310 m.

(a)

(i) Calculate the path difference at Y.

[1]

(ii) Sketch the path difference on the diagram. Label this P.

[2]

[3 marks]

Question 1b

(b)

State the condition for intensity maxima to be observed at X and Y.

[1]

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[1 mark]

Question 1c

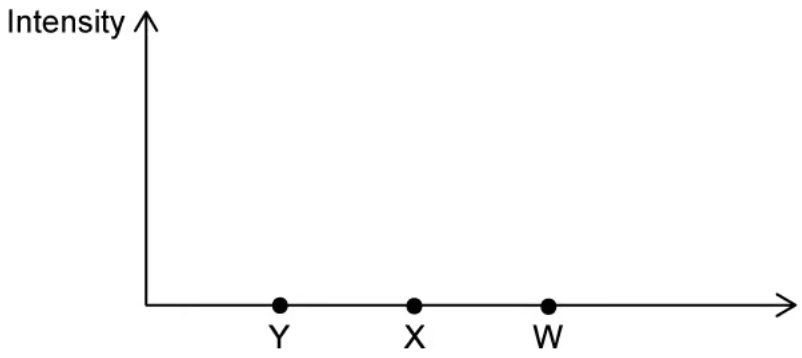
(c)
State what the intensity maxima and intensity minima represent.

[2]

[2 marks]

Question 1d

A microwave receiver can be used to detect the interference pattern. This can be visually represented by an intensity graph.



(d)
Sketch the intensity graph for the points W, X and Y.

[3]

[3 marks]

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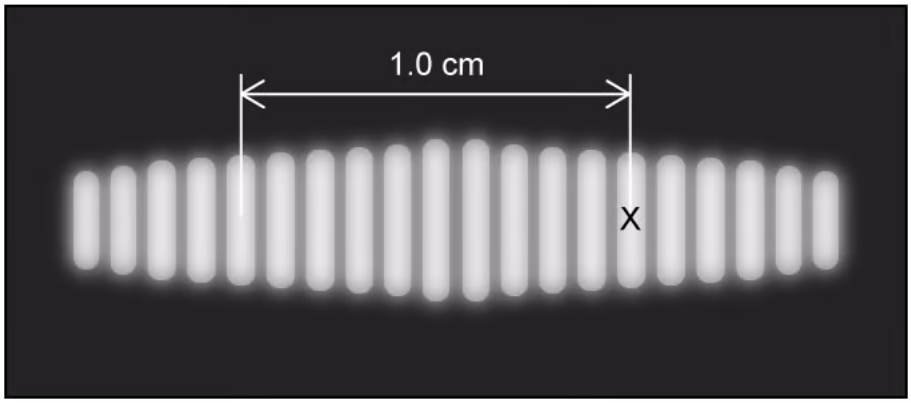
Question 2a

In an investigation into interference, monochromatic light of wavelength 600 nm is incident normally on a double slit. The fringes seen on a screen positioned at a distance $D = 1.5$ m from the slits are shown.



(a)
Determine the order, n of the bright fringe at X.

[1]

[1 mark]

Question 2b

(b)
For the observation in part (a), sketch a diagram to show the triangle formed by the slits, the screen and the bright fringes.

Include the following information, along with any numerical values, on your diagram:

- Maxima, n
- Distance from double slits to screen, D
- Screen width, S
- Angle of diffraction, θ

[4]

[4 marks]

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Question 2c

(c)
Without using the angle of diffraction, calculate the separation between the slits.

[5]

[5 marks]

Question 2d

(d)
Using the diagram from part (b), hence calculate the angle subtended between the slits, the central maxima and the fifth order maxima.

[2]

[2 marks]

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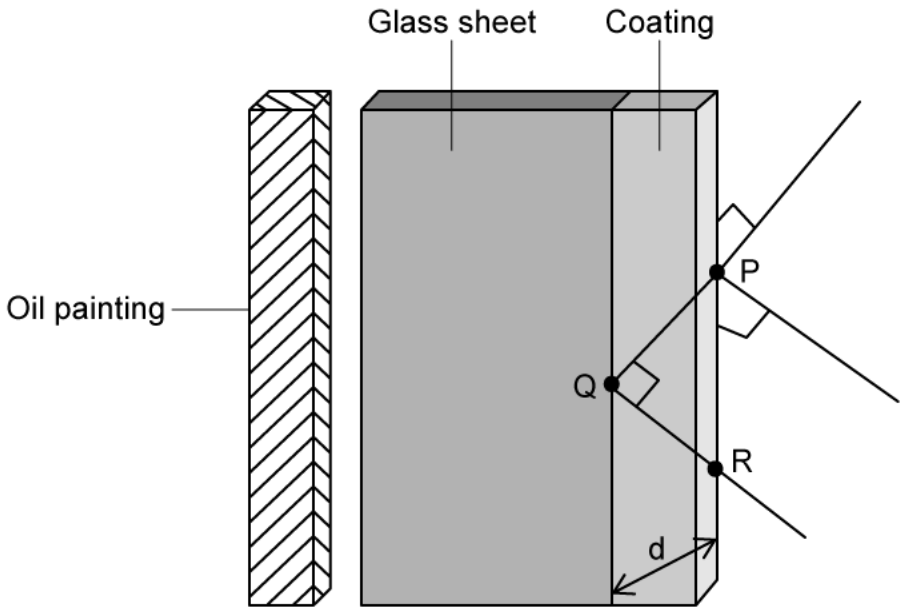
Question 3a

An oil painting is protected behind a sheet of thin transparent glass with a refractive index n_{glass}. A coating of thickness d is added to the glass sheet to reduce reflection. The refractive index of the coating is such that $n_{glass} > n_{coating} > 1$.

The diagram illustrates rays normally incident on the coating. The incident angles on the diagram are drawn away from the normal for clarity.



(a)
State the phase change of the ray reflected at Q.

[1]

[1 mark]

Question 3b

Destructive interference occurs between the waves reflected from P and Q.

(b)
State the visual effect this creates and a reason for why this is created.

[2]

[2 marks]

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Question 3c

(c)

Place a tick (✔) in the correct box to identify which of the following statements are true and which are false.

Statement	True	False
Light travelling from a less dense to a more dense medium will travel at a slower speed		
Light travelling from a less dense to a more dense medium will have a longer wavelength		
Light is reflected and transmitted at a boundary from a less dense to a more dense material		
Constructive interference occurs for a whole number multiple of wavelengths		

[4]

[4 marks]

Question 3d

(d)

State the relationships between the thickness of the coating, d and the wavelength of the light λ for both constructive and destructive interference.

[2]

[2 marks]

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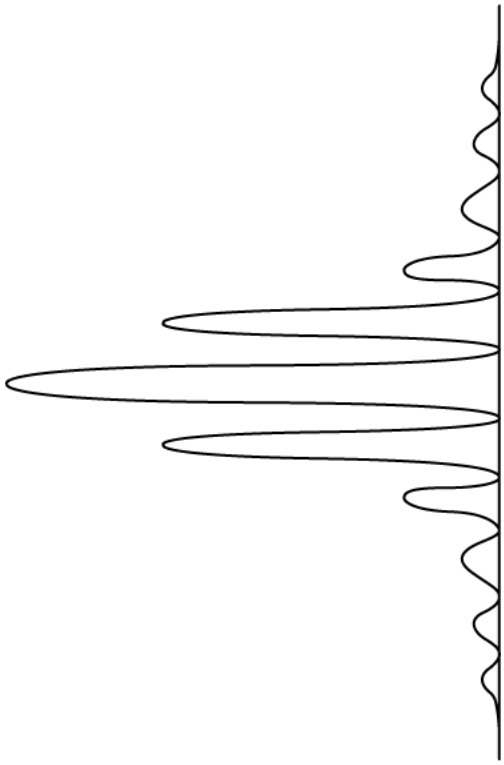
Question 4a

Blue light from a laser is incident at a normal incidence on a diffraction grating. The following pattern is observed on the screen.



(a)
State whether this shows the interference pattern or the diffraction pattern produced by the diffraction grating.

[1]

[1 mark]

Question 4b

(b)
Identify the number of slits on the diffraction grating and give a reason for your answer.

[2]

[2 marks]

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Question 4c

(c)
Identify, by placing a tick (✔) in the correct box, the statements about double slit interference patterns that are true.

Statement	Place a tick (✔) in this box if the statement is true
For two source interference fringes to be observed the sources of the waves must be coherent	
When two waves interfere the resultant wave depends on the path difference	
When two waves interfere the path difference is proportional to the intensity	
Two source interference fringes are observed when light is monochromatic	

[3]

[3 marks]

Question 4d

(d)
State the most important piece of equipment that is needed to be added to the experiment in order to recreate Young's Double slit experiment and give a reason for your choice.

[2]

[2 marks]

Question 5a

A diffraction grating has 8000 lines and is 4 cm wide.

(a)
Calculate the number of lines per meter.

[2]

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[2 marks]

Question 5b

(b)
Hence, use your answer from part (a), to calculate the slit spacing on the diffraction grating and state the units.

[3]

[3 marks]

Question 5c

In an experiment, red light of wavelength 650 nm is incident upon this diffraction grating.

(c)
Calculate the angle of diffraction at the second order maximum.

[4]

[4 marks]

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Question 5d

(d)

Determine the equation for the maximum number of fully formed bright fringes that are visible on the screen.

[2]

[2 marks]

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