LONDON SCIENCE COLLEGE

Name:

Date:

PROPERTIES OF WAVES
TEST 1

AS-Level

Mark

Grade

PHYSICS

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

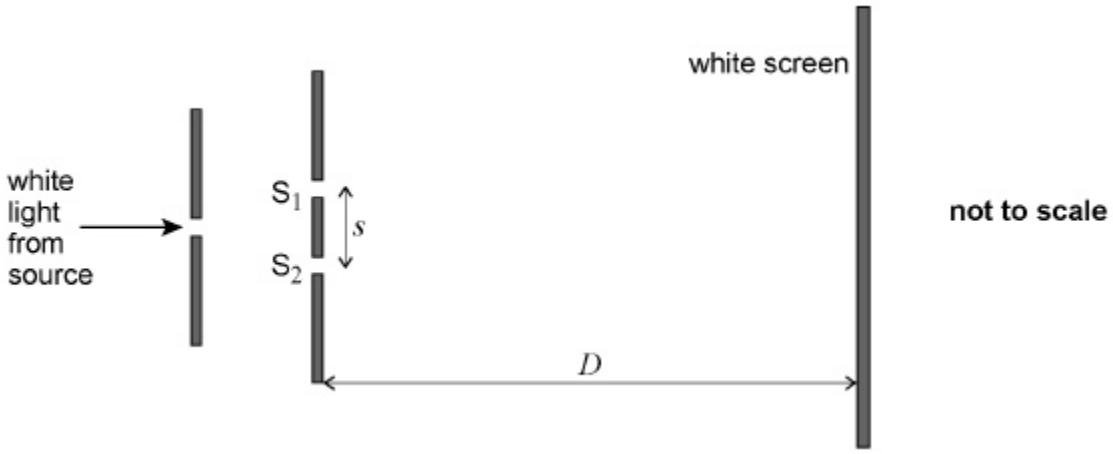
Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets

1 The figure below shows a diagram of apparatus used to demonstrate the formation of interference fringes using a white light source in a darkened room. Light from the source passes through a single slit and then through two narrow slits S_1 and S_2.



(a) Describe the interference pattern that is seen on the white screen.

(2)

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(b) A filter transmits only green light of wavelength λ and red light of wavelength 1.2λ
This filter is placed between the light source and the single slit.

Describe the interference pattern now seen on the white screen.

Use a calculation to support your answer.

(4)

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(c) A student decides to use the apparatus shown in the figure to determine the wavelength of red light using a filter that transmits only red light.

The student suggests the following changes:

- decrease slit separation s
- decrease D, the distance between the slits and the screen.

The student decides to make each change independently.

Discuss the effects each independent change has on the interference pattern, and whether this change is likely to reduce uncertainty in the determination of the wavelength.

(6)

(Total 12 marks)

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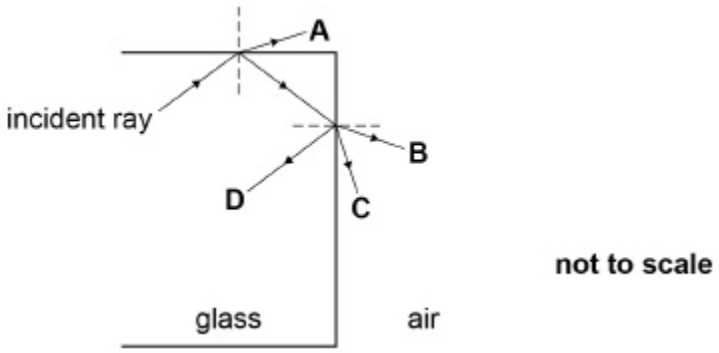
2 A ray of light is incident on a glass–air boundary of a rectangular block as shown.



The refractive index of this glass is 1.5
The refractive index of air is 1.0
The angle of incidence of the light at the first glass–air boundary is 44°

What is the path of the ray of light?

A ⬭

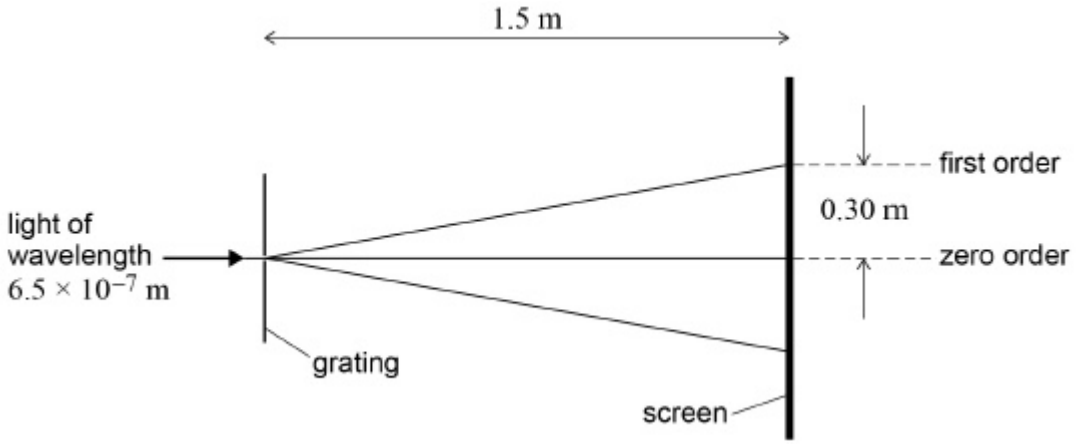
B ⬭

C ⬭

D ⬭

(Total 1 mark)

3 A diffraction grating is illuminated normally with light of wavelength 6.5×10^{-7} m
When a screen is 1.5 m from the grating, the distance between the zero and first-order maxima on the screen is 0.30 m



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What is the number of lines per mm of the diffraction grating?

A 3.3×10^{-6} ⬭

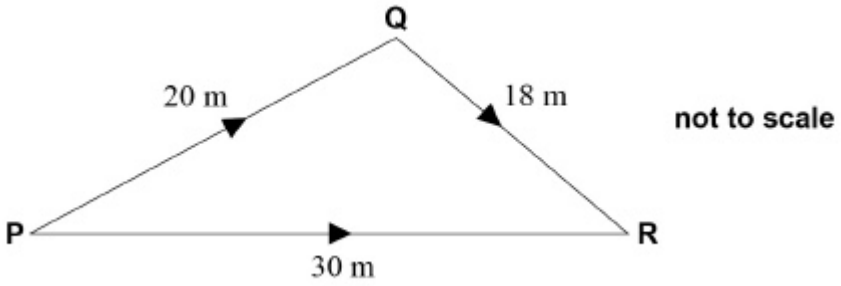
B 3.3×10^{-3} ⬭

C 3.0×10^{2} ⬭

D 3.0×10^{5} ⬭

(Total 1 mark)

4 In the diagram, **P** is the source of a wave of frequency 50 Hz



The wave travels to **R** by two routes, **P** → **Q** → **R** and **P** → **R**. The speed of the wave is 30 m s−1

What is the path difference between the two waves at **R** in terms of the wavelength λ of the waves?

A 4.8λ ⬭

B 8.0λ ⬭

C 13.3λ ⬭

D 20.0λ ⬭

(Total 1 mark)

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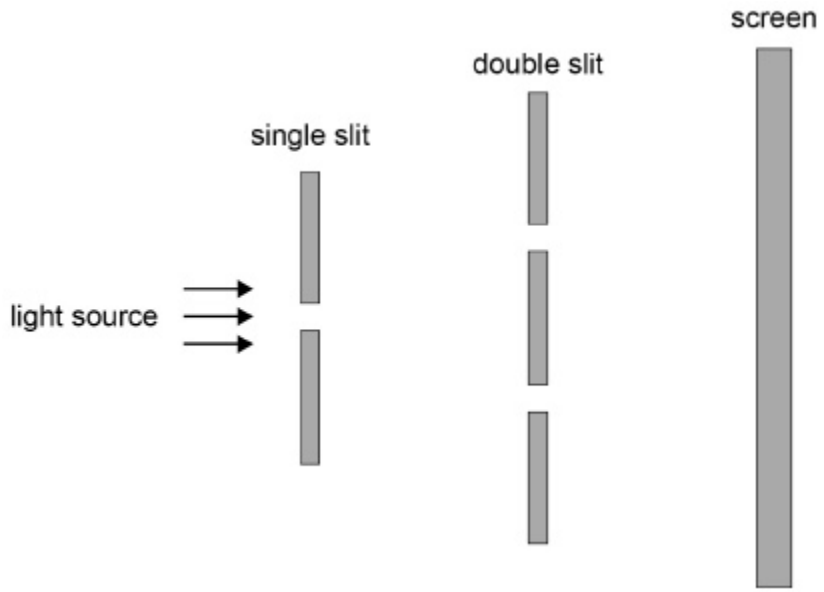
5 Light from a point source passes through a single slit and is then incident on a double-slit arrangement. An interference pattern is observed on the screen.



What will increase the fringe spacing?

A increasing the separation of the single slit and the double slit ⬭

B increasing the width of the single slit ⬭

C decreasing the distance between the double slits and the screen ⬭

D decreasing the separation of the double slits ⬭

(Total 1 mark)

6 An electromagnetic wave enters a fibre-optic cable from air. On entering the cable, the wave slows down to three-fifths of its original speed.

What is the refractive index of the core of the fibre-optic cable?

A 0.67 ⬭

B 1.33 ⬭

C 1.50 ⬭

D 1.67 ⬭

(Total 1 mark)

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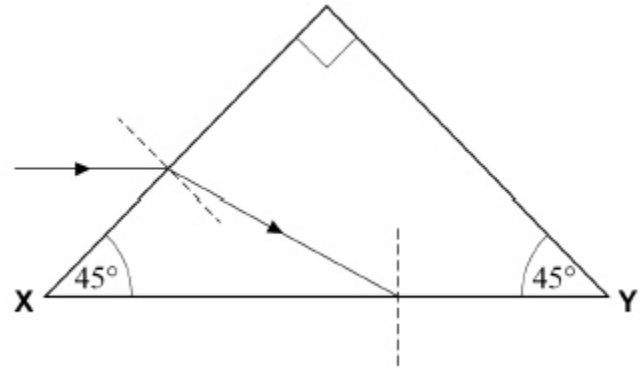
7 The diagram shows part of the path of a ray of light through a right-angled prism.



The prism is made of glass of refractive index 1.5
The incident light ray is parallel to the face **XY**. The ray is refracted towards the face **XY**.

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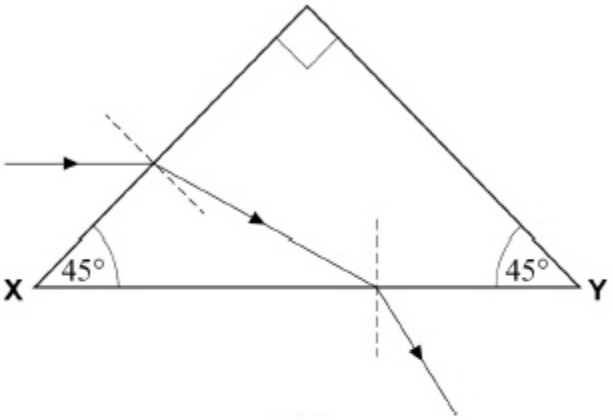
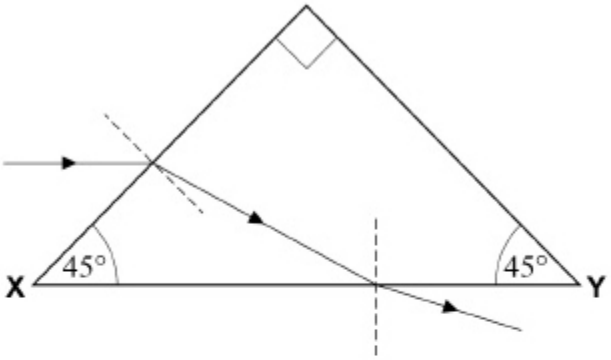
What is the path of the ray after it is incident on face **XY**?

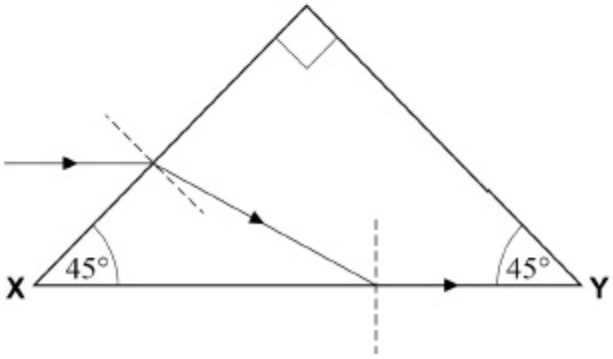
A



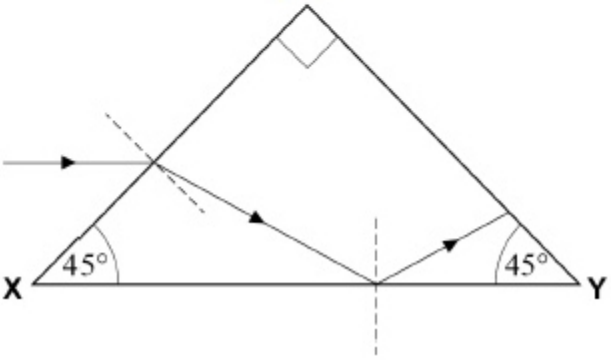
B



C



D



A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

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8 **Figure 1** shows an arrangement used to investigate double slit interference using microwaves. **Figure 2** shows the view from above.

Figure 1

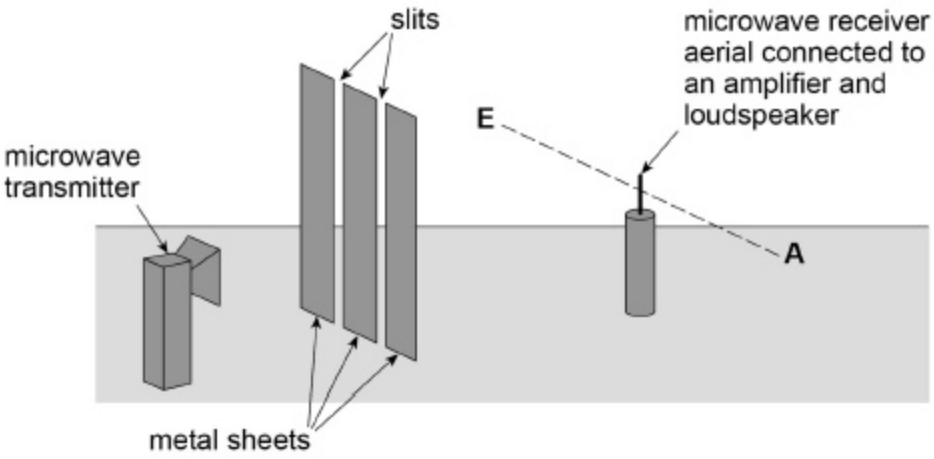
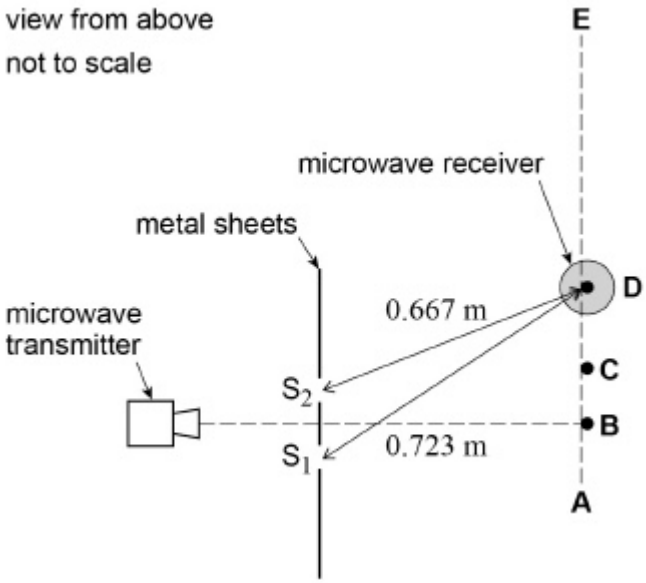


Figure 2



The microwaves from the transmitter are polarised. These waves are detected by the aerial in the microwave receiver (probe). The aerial is a vertical metal rod.

The receiver is moved along the dotted line **AE**. As it is moved, maximum and minimum signals are detected. Maximum signals are first detected at points **B** and **C**. The next maximum signal is detected at the position **D** shown in **Figure 2**.

Figure 2 shows the distances between each of the two slits, S_1 and S_2, and the microwave receiver when the aerial is in position **D**.
S_1D is 0.723 m and S_2D is 0.667 m.

(a) Explain why the signal strength falls to a minimum between **B** and **C**, and between **C** and **D**.

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(3)

(b) Determine the frequency of the microwaves that are transmitted.

frequency = _____ Hz

(3)

(c) The intensity of the waves passing through each slit is the same.

Explain why the minimum intensity between **C** and **D** is not zero.

(2)

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(d) The vertical aerial is placed at position **B** and is rotated slowly through 90° until it lies along the direction **AE**.

State and explain the effect on the signal strength as it is rotated.

(3)

(Total 11 marks)

9 Which row shows the change in velocity, frequency and wavelength of an electromagnetic wave as it travels from an optically less dense to an optically more dense medium?

	Velocity	**Frequency**	**Wavelength**	
A	decreases	decreases	unchanged	⬭
B	increases	unchanged	increases	⬭
C	decreases	unchanged	decreases	⬭
D	increases	increases	unchanged	⬭

(Total 1 mark)

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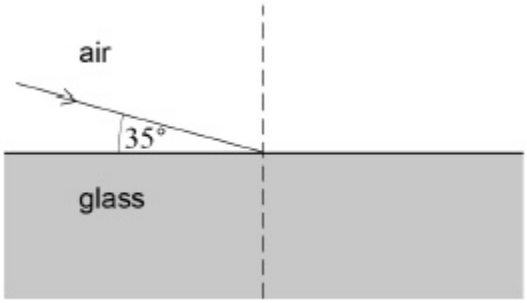
10 The diagram shows a ray of light travelling in air and incident on a glass block of refractive index 1.5



What is the angle of refraction in the glass?

A 22.5° ⬭

B 23.3° ⬭

C 33.1° ⬭

D 59.4° ⬭

(Total 1 mark)

11 Intensity maxima are produced on a screen when a parallel beam of monochromatic light is incident on a diffraction grating. Light of a longer wavelength can be used or the distance from the diffraction grating to the screen can be increased.

Which row gives the change in appearance of the maxima when these changes are made independently?

	Longer wavelength	**Distance from grating to screen increased**	
A	closer together	more widely spaced	⬭
B	more widely spaced	more widely spaced	⬭
C	more widely spaced	closer together	⬭
D	closer together	closer together	⬭

(Total 1 mark)

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12 Light of wavelength 500 nm is passed through a diffraction grating which has 400 lines per mm.

What is the angular separation between the two second-order maxima?

A 11.5° ⬭

B 23.1° ⬭

C 23.6° ⬭

D 47.2° ⬭

(Total 1 mark)

13 When a monochromatic light source is incident on two slits of the same width an interference pattern is produced.

One slit is then covered with opaque black paper.

What is the effect of covering one slit on the resulting interference pattern?

A The intensity of the central maximum will increase ⬭

B The width of the central maximum decreases ⬭

C Fewer maxima are observed ⬭

D The outer maxima become wider ⬭

(Total 1 mark)

14 When light of wavelength 5.0×10^{-7} m is incident normally on a diffraction grating the fourth-order maximum is observed at an angle of 30°.

What is the number of lines per mm on the diffraction grating?

A 2.5×10^{2} ⬭

B 2.5×10^{5} ⬭

C 1.0×10^{3} ⬭

D 1.0×10^{6} ⬭

(Total 1 mark)

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15 Which of the following statements about the behaviour of waves is **incorrect**?

A All waves can be diffracted. ⬭

B All waves can be made to undergo superposition. ⬭

C All waves can be refracted. ⬭

D All waves can be polarised. ⬭

(Total 1 mark)

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