Name	Date started	Target end date

GCE AS / A LEVEL — THE NATURE OF WAVES QUESTION PACK

Legacy PH2 · New spec Unit 2 Topic 4 · AS unit, 20% of A-level

REVISE
.wales

PHYSICS — UNIT 2 · THE NATURE OF WAVES

PH2.4 The nature of waves — transverse / longitudinal, wave equation & polarisation

Distinguishing transverse and longitudinal waves, defining frequency / wavelength / period / amplitude, applying v = fλ, and reasoning about polarisation as a property of transverse waves only.

NEW 2015 SPEC · UNIT 2 TOPIC 4

Estimated time for entire question pack: ~2 h 21 min

Derived from the legacy PH2 paper's pace of 80 marks in 1¼ hours.

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC PH2 papers (2008 modular spec) that maps onto new-spec Unit 2 Topic 4 (2.4).

Questions are ordered chronologically within each section.

INSTRUCTIONS

Use black ink or black ball-point pen. Answer all questions in the spaces provided.

The number of marks is given in brackets at the end of each question or part-question. A calculator is required. The Data Booklet is allowed.

For Examiner's use only

Q	Source	Max	Mark
1	PH2 Jun 10 Q1	5	
2	PH2 Jun 11 Q1	3	
3	PH2 Jan 14 Q1	7	
4	PH2 Jan 11 Q1	10	
5	PH2 Jun 09 Q1	9	
6	PH2 Jan 13 Q1	7	
7	PH2 Jun 13 Q1	8	
8	PH2 Jan 10 Q1	6	
9	PH2 Jun 12 Q1	8	
10	PH2 Jun 15 Q1	12	
11	PH2 Jun 16 Q1	5	
12	PH2 Jun 14 Q2	8	
13	PH2 Jan 12 Q2	13	
	Total	**101**	

The Nature of Waves — what the new spec asks

WJEC GCE AS / A Level Physics (from 2015) · Unit 2: Electricity & Light · Topic 2.4.

Wave types A

- Distinguish transverse and longitudinal waves with examples.
- Particle displacement direction relative to direction of energy travel.

Wave quantities A

- Define amplitude, wavelength, period and frequency.
- Apply $v = f\lambda$ numerically and symbolically.
- Phase, phase difference and in-phase / antiphase oscillations.

Wave representations A

- Read displacement-distance and displacement-time graphs.
- Relate amplitude and frequency to intensity / energy.
- Identify wavelength, amplitude and period from graphs.

Polarisation B

- Only transverse waves can be polarised.
- Plane-polarised light: oscillations confined to one plane.
- Polaroid filters and crossed polarisers.
- Malus's law qualitatively: intensity falls as filters cross.

Crib sheet »

The Nature of Waves in one page

Quick-reference notes — revisit before each section.

Wave types

Transverse: particle motion ⊥ energy travel (water, light, EM, strings).

Longitudinal: parallel (sound, P-waves).

Wave quantities

λ = wavelength (one full pattern length).

T = period; f = 1/T; A = amplitude.

v = fλ — the master equation.

Phase

Two points in phase: separated by nλ.

Antiphase: (n+½)λ.

Phase difference in radians: 2π × (x/λ).

Graph reading

y vs x: snapshot; λ is x-period.

y vs t: history at one point; T is x-period.

Intensity

$I \propto A^2$ (amplitude squared).

Inverse-square law for point sources in 3D.

Polarisation

Only transverse waves can be polarised.

Polaroid filter blocks all but one plane of oscillation.

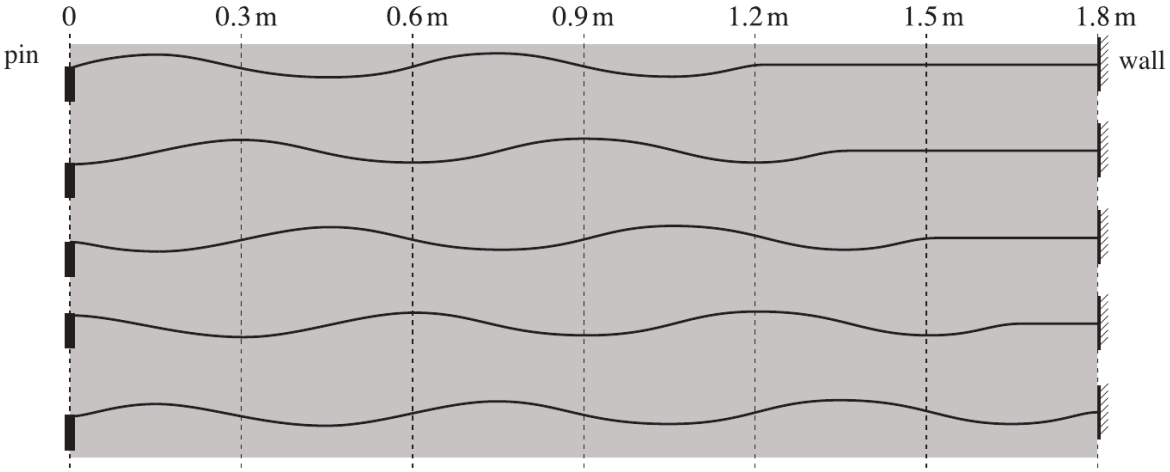
Crossed polarisers ⇒ zero transmitted intensity.

Section index

Use this index to jump straight to the section you need.

Examiner only

1. A piece of string 1.8 m long is attached at one end to the pin of a vibration generator and, at the other end, to a rigid wall. The diagrams show the string at intervals of 0.0030 s, starting from shortly after the generator has been connected to the signal generator (so the wave has not yet reached the wall).



(a) Calculate

(i) the *speed* of the waves, [2]

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(ii) the *frequency.* [3]

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Question 2 *WJEC PH2 June 2011 · Q1(a)* 3 marks · Section A

Examiner only

1. *(a)* (i) Sound waves in air are *longitudinal*. Explain what this means. [2]

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(ii) What is meant by the *wavelength* of a progressive sound wave? [1]

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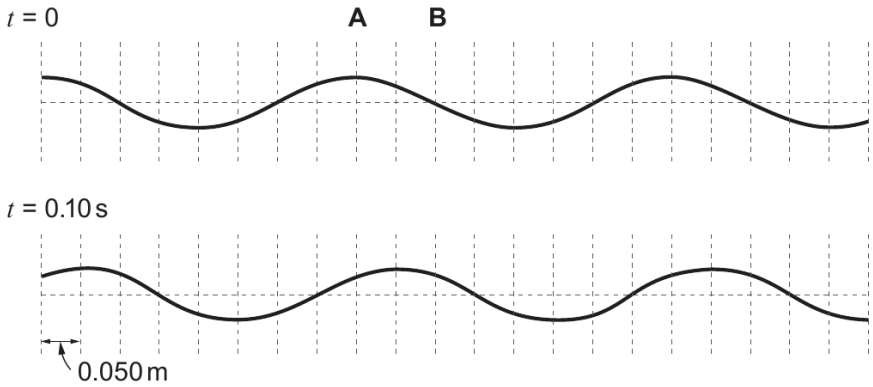
Examiner only

Answer all questions.

1. A string carrying a progressive transverse wave is photographed against a background of lines spaced 0.050 m apart. The diagrams below are based on two photographs, taken at $t = 0$ and $t = 0.10$ s. The wave is moving from left to right.



(a) Write down the wavelength of the waves. ..... [1]

(b) Calculate the speed of the waves, giving your working and stating any assumption you are making. [2]

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(c) Calculate the frequency of the waves. [1]

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(d) Compare the amplitude of the wave at positions **A** and **B** along the string. [1]

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(e) Compare the phases of the wave at **A** and **B**. [2]

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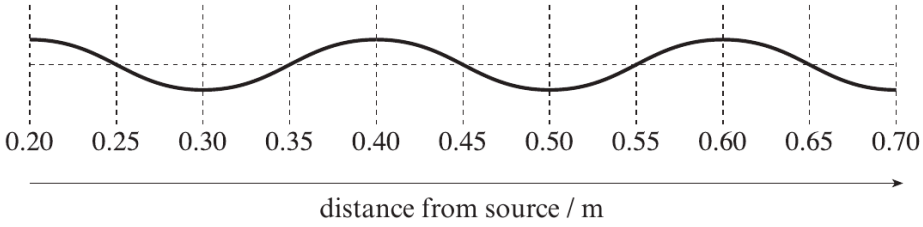
Examiner only

1. *(a)* A transverse progressive wave is travelling from left to right along a stretched string. The diagram shows part of the string at one instant.



(i) Write down the *wavelength*. ..... [1]

(ii) The *frequency* is 50 Hz.

(I) Calculate the *speed* of the waves. [1]

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(II) Calculate the time taken for 1 cycle of oscillation. [1]

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(III) **On the diagram above**, draw the string at a time of 0.005 s later. [2]

(iii) Explain why the waves are called *transverse*. [2]

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(b) It is also possible to set up a *stationary wave* on a stretched string. Describe how progressive waves and stationary waves differ in regard to

(i) transfer of energy along the string, [1]

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(ii) **variation** of *amplitude* with distance along the string. [2]

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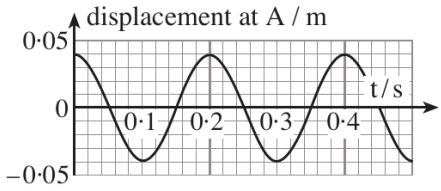
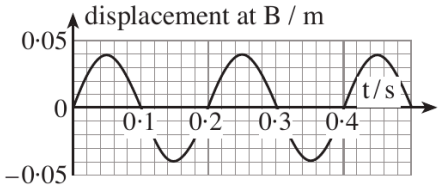
1. A progressive wave is travelling from left to right. Displacement – time graphs are given for the same time interval for two points, A and B, in the path of the wave. B is 0·30 m to the right of A.





(a) (i) Write down the value of the amplitude of the wave. ..... [1]

(ii) Calculate the frequency. [3]

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(b) Show that 6·0 $m s^{-1}$ is a possible speed for the waves, explaining your reasoning carefully. [2]

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(c) (i) Explain what is meant by the wavelength of the waves. [2]

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(ii) Taking the wave speed as 6·0 $m s^{-1}$, calculate the wavelength of the waves. [1]

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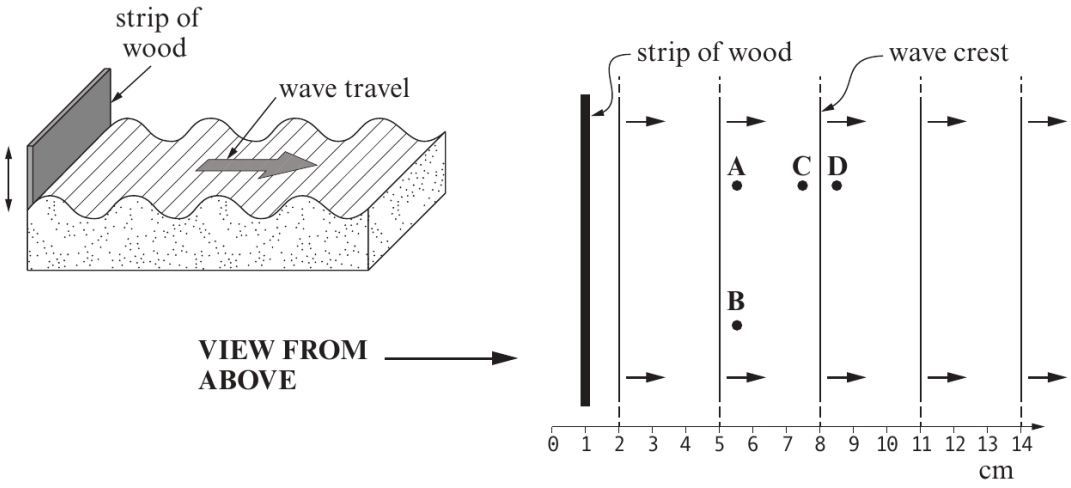
Examiner only

1. *(a)* A strip of wood, in contact with the surface of water in a tank, oscillates up and down at a frequency of 5.0 Hz. The view from above shows the positions of wave crests (where the water height is a maximum) at one instant.



(i) Determine the wavelength of the wave. [1]

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(ii) Calculate the time it takes for a wave crest to travel a distance of 10.5 cm. [3]

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(iii) State whether or not the oscillations at points **B**, **C** and **D** are *in phase* with the oscillations at **A**. Justify your answers. [3]

Point **B** .....

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Point **C** .....

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Point **D** .....

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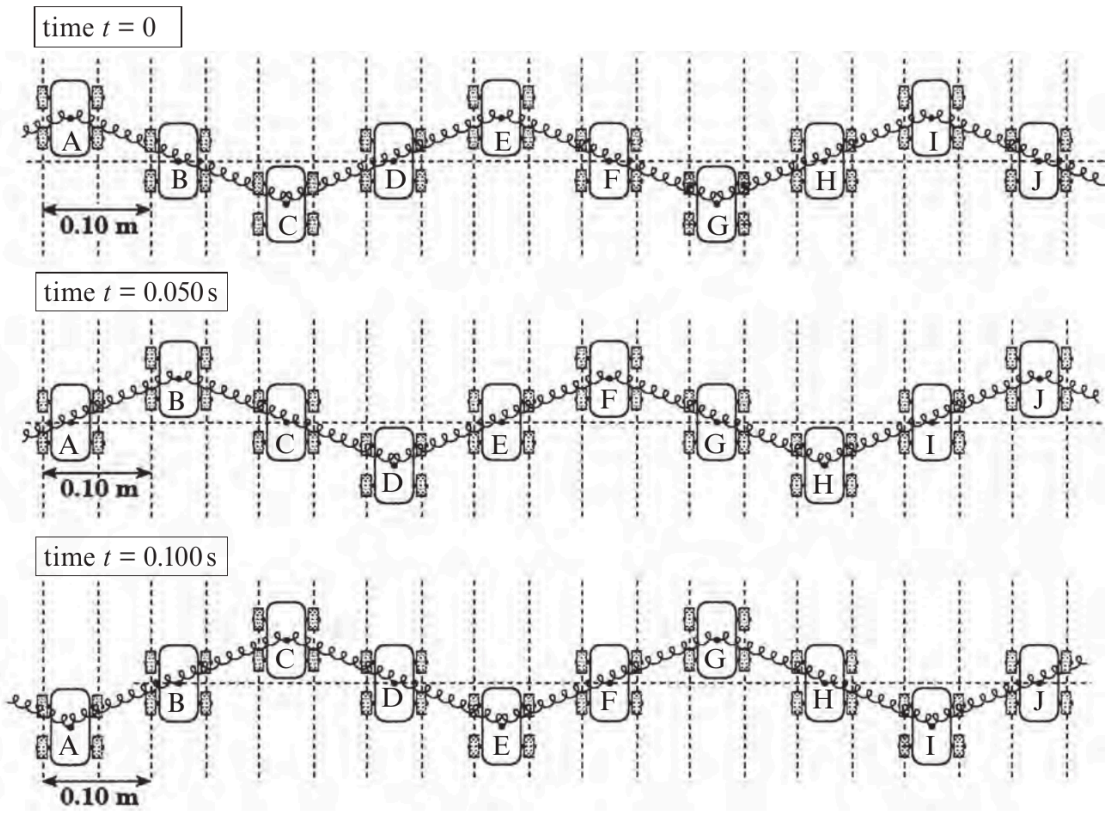
Examiner only

1. Shown below are three 'snapshots' (three diagrams at different times) of a transverse wave travelling from left to right along a line of toy cars joined by springs.



(a) Calculate

(i) the wavelength, [1]

.....

(ii) the periodic time (assuming no car changes its direction of motion between one snapshot and the next), [1]

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(iii) the speed of the wave. [2]

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(b) Which cars are oscillating in phase with car B? ..... [1]

Examiner only

(c) (i) Explain why the wave is described as transverse. [2]

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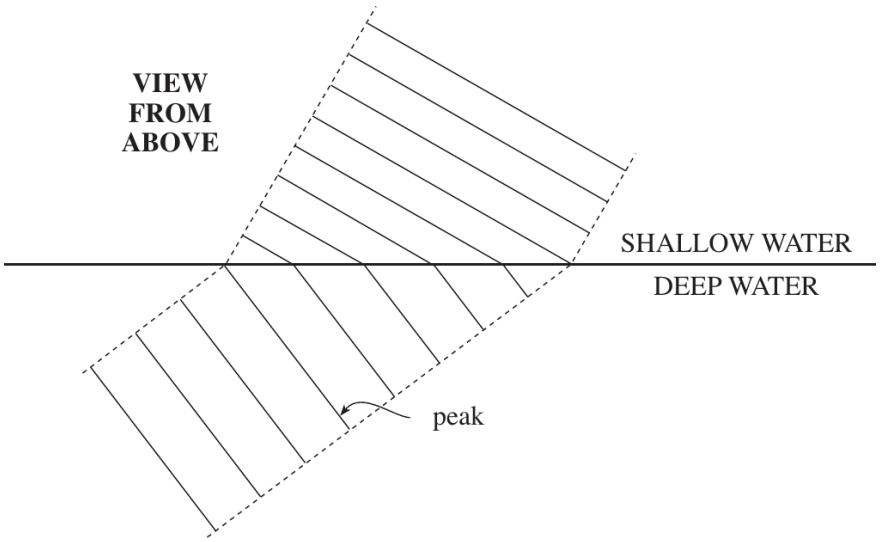
(ii) A *longitudinal* wave can be sent along a line of toy cars linked by springs if the cars are arranged differently. Make a sketch of the arrangement, showing **three** cars. [1]

Question 8 *WJEC PH2 January 2010 · Q1(a)* 6 marks · Section A

Examiner only

1. *(a)* Water waves are travelling into shallow water from deeper water. The actual positions of the wave peaks at one instant are shown on the diagram, **which is full size**.



(i) (I) Add two arrows to the diagram to show the directions of travel of the waves in the deep water and in the shallow water. [1]

(II) Deduce **from the change in direction** whether the waves travel faster or slower in shallow water. Give a reason. Calculations are not wanted. [2]

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(ii) (I) Measure the *wavelength* of the waves in the deep water. [1]

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(II) The *speed* of the waves in the deep water is $0.33\ \text{ms}^{-1}$. Calculate the frequency of the waves. [2]

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(III) Determine the speed of the waves in the shallow water. [2]

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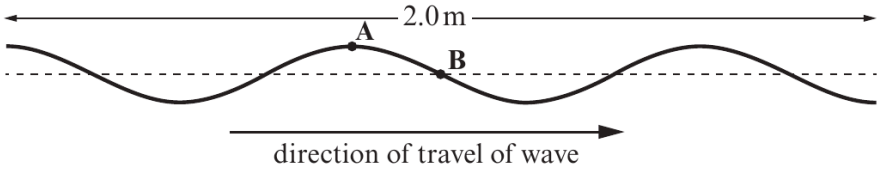
Examiner only

1. *(a)* A water wave is travelling from left to right along a canal. The diagram shows the wave at one instant.



(i) (I) Show that the wavelength of the wave is 0.80 m. [1]

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(II) How do the *amplitudes* compare for water particles **A** and **B**? [1]

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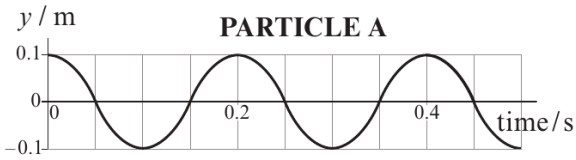
(ii) A graph of displacement, y (vertical component) against time is given alongside for water particle **A**.



(I) Calculate the *frequency*. [1]

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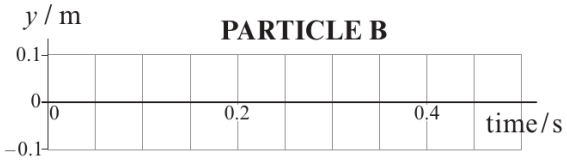

(II) Sketch the corresponding graph for particle **B** on the axes given. [2]

(iii) Calculate the *speed* of the wave. [1]

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Examiner only

(b) When the wave in the first diagram has travelled further, it reaches a length of the canal where the water is shallower. The wavelength in the shallow water is 0.60 m.

Calculate the speed of the wave in the shallow water, **giving your reasoning**. [2]

Examiner only

Answer **all** *questions.*

1. *(a)* A student gives the following **wrong** definition of wavelength.

"The wavelength of a progressive wave is the distance between two successive points which are oscillating *with the same amplitude."*

(i) Write down the words which should replace the words in italics. [1]

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(ii) Explain why the student's original version does not make sense. [1]

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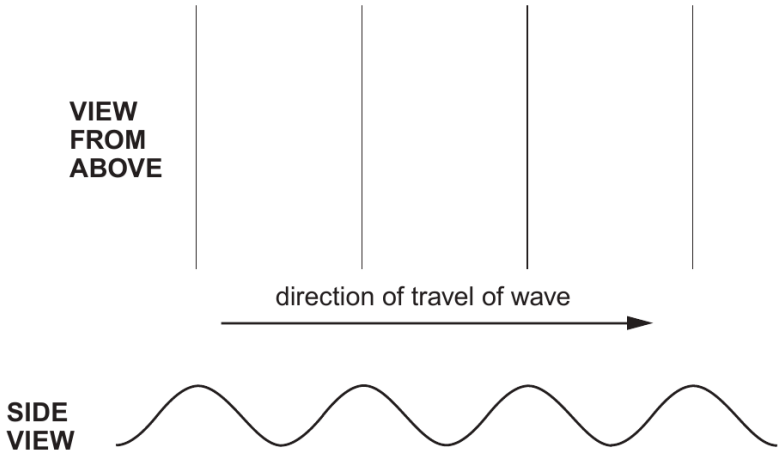
(b) The top diagram is a plan (view from above) showing the positions of the crests of a progressive water wave at time t = 0. Underneath is a vertical section (side view) of the water surface at time t = 0.



(i) By the time t = 0.12 s the wave has travelled 60 mm. The wavelength is 15 mm. Calculate the frequency. [3]

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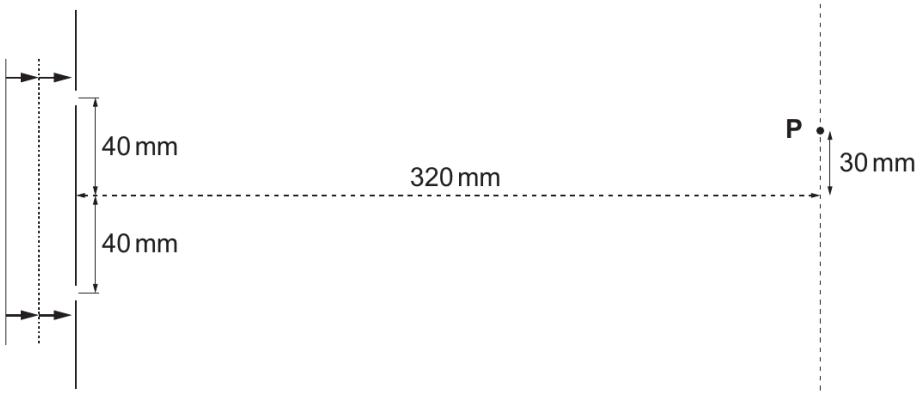
(ii) On the **top** diagram carefully draw in the positions of the crests at t = 0.010 s. [2]
Space for calculations if needed.

Examiner only

(c) A barrier with two narrow slits is placed as shown in the path of water waves of wavelength 15 mm. An interference pattern is observed. *Diagram not to scale.*



(i) Making use of the equation for double slit interference, determine whether there is constructive or destructive interference at point **P**. Give your reasoning. [3]

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(ii) Explain why *diffraction* is essential for the formation of the interference pattern. [2]

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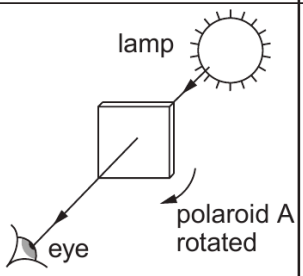
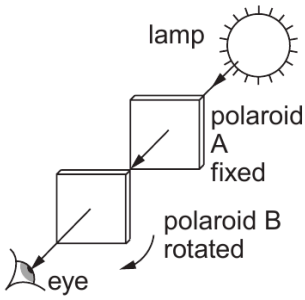
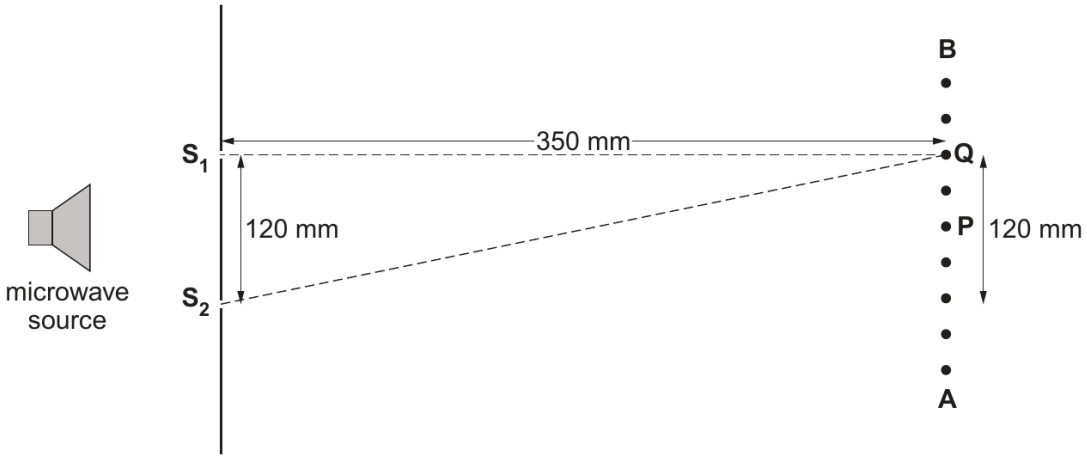
(c) Light from a filament lamp behaves like an *unpolarised, transverse* wave. This can be shown using polarising filters *(polaroids)*. Two experiments are carried out as described briefly in the first column of the table below. In the second column state what is observed and, in the third column, give a brief explanation of what is observed. [5]

What is done	What is observed	Explanation
	.....	.....
	.....	.....

Examiner only

2. *(a)* A microwave source is placed to the left of two narrow slits, S_1 and S_2, so that these slits act as in-phase sources.



A microwave sensor which is moved along the line **AB** detects maxima at the points shown as dots. One of these points, **Q**, is directly in front of S_1.

(i) By considering the right angled triangle S_1S_2Q, show that the path difference, $S_2Q - S_1Q = 20\,\text{mm}$. [2]

(ii) **Hence** determine the wavelength of the microwaves, giving your reasoning. Note that point **P** is equidistant from S_1 and S_2. [2]

(iii) Check your answer to *(a)*(ii) using the equation for double-slit interference, showing your working clearly. [2]

Examiner only

(b) Describe briefly how you would show that microwaves from this source are polarised. [2]

Examiner only

2. *(a)* (i) (I) Light is a transverse wave. Explain what is meant by a *transverse* wave. [1]

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(II) What is meant by *polarised* light? [1]

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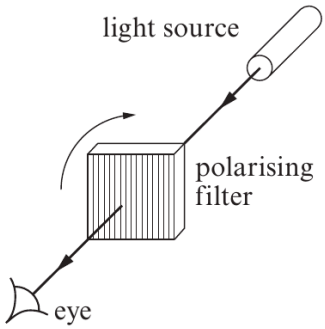
(ii)



Describe what is seen when a source of **polarised** light is viewed through a polarising filter (polaroid) which is rotated slowly as shown through 360°. [2]

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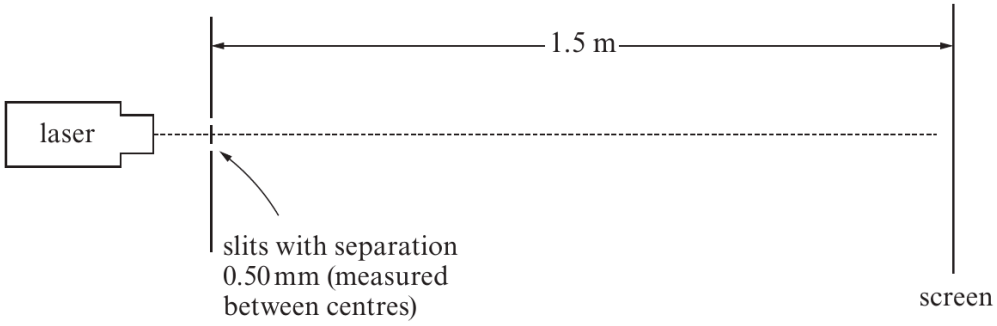
(b) A modern version of Young's *double slit* experiment is set up as shown.



(i) Light *diffracts* at each slit.

(I) What does this statement mean? [1]

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(II) Explain why diffraction at the slits is essential to produce interference fringes. [1]

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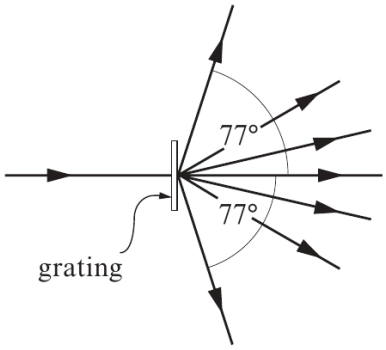
(ii) The fringe separation (the separation of the centres of adjacent bright fringes) is 2.0 mm.

(I) Calculate a value for the wavelength of light from the laser. [2]

(II) The distance from the double slits to the screen is increased to 7.5 m. State **two** ways in which the appearance of the fringes on the screen is changed. [2]

(c)



A diffraction grating with 5.00×10^5 slits per metre is used to measure the wavelength of the laser light, which is shone normally on to the grating. The emerging beams (see diagram) are found to leave the grating as shown.

Calculate the wavelength of the light. [3]

END OF QUESTION PACK

13 questions · 101 marks · ~2 h 21 min
Source: WJEC PH2 (2008 modular spec)
Curated for WJEC Physics 2015 spec AS Unit 2 — Topic 4 (2.4)