OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS A

2823/01

Wave Properties

Monday **14 JUNE 2004** Afternoon 45 minutes

Candidates answer on the question paper.
Additional materials:
Electronic calculator

Candidate Name	Centre Number	Candidate Number

TIME 45 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	9	
2	7	
3	9	
4	8	
5	12	
TOTAL	45	

This question paper consists of 12 printed pages.

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Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

refractive index, $n = \frac{1}{\sin C}$

capacitors in series, $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$

capacitors in parallel, $C = C_1 + C_2 + \ldots$

capacitor discharge, $x = x_0 e^{-t/CR}$

pressure of an ideal gas, $p = \frac{1}{3}\frac{Nm}{V}<c^2>$

radioactive decay, $x = x_0 e^{-\lambda t}$

$t_{\frac{1}{2}} = \frac{0.693}{\lambda}$

critical density of matter in the Universe, $\rho_0 = \frac{3H_0^2}{8\pi G}$

relativity factor, $= \sqrt{(1 - \frac{v^2}{c^2})}$

current, $I = nAve$

nuclear radius, $r = r_0 A^{1/3}$

sound intensity level, $= 10 \lg\left(\frac{I}{I_0}\right)$

Answer **all** the questions.

1 Light travels at a speed of $3.00 \times 10^8\,\text{m s}^{-1}$ in air and $2.25 \times 10^8\,\text{m s}^{-1}$ in water.

(a) **(i)** Calculate the refractive index for light travelling from air to water.

refractive index = ... [2]

(ii) Calculate the angle of refraction r for a ray of light entering water from air at an angle of incidence of 40°.

r = ... ° [2]

(b)

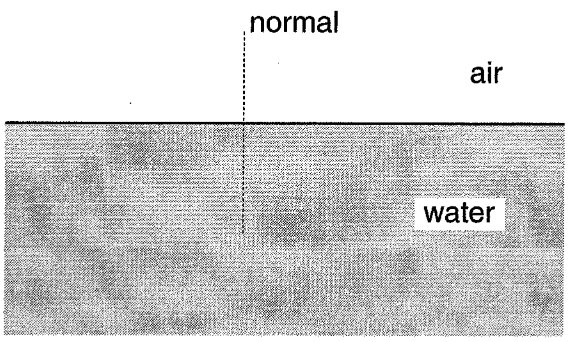

Fig. 1.1

(i) On Fig.1.1, draw a ray diagram to show what is meant by the critical angle for the air/water interface. Show the direction of the ray and label the critical angle C. [3]

(ii) Calculate the value of C for the air/water interface.

C = ... ° [2]

[Total: 9]

For Examiner's Use

2 **(a)** State what is meant by the *diffraction of waves.*

....

.... [1]

(b) Draw diagrams, in the spaces below, to illustrate how plane water waves are diffracted when they pass through a gap

(i) about 2 wavelengths wide

(ii) about 10 wavelengths wide.

[4]

(c) Suggest why the diffraction of light waves cannot usually be observed except under laboratory conditions.

....

....

.... [2]

[Total: 7]

For Examiner's Use

3 Fig. 3.1 shows the displacement-time graph for a particle in a medium as a progressive wave passes through the medium.

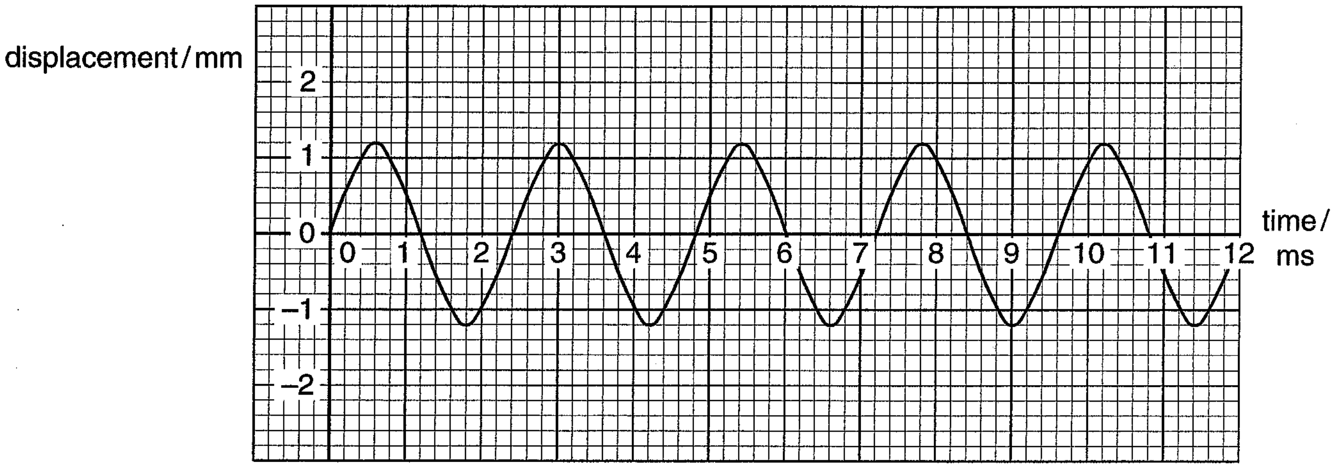

Fig. 3.1

(a) Determine from the graph

(i) the amplitude of the wave

amplitude = ... mm [1]

(ii) the period of the wave.

period = ... ms [1]

(b) **(i)** What is the frequency of the wave?

frequency = ... Hz [2]

(ii) The speed of the wave is 1500 m s^{-1}. Calculate its wavelength.

wavelength = ... m [2]

For Examiner's Use

(iii) Use the grid in Fig. 3.2 to sketch a displacement-position graph for the wave at a particular instant. Mark the scale on the position axis and draw at least two full cycles. [3]

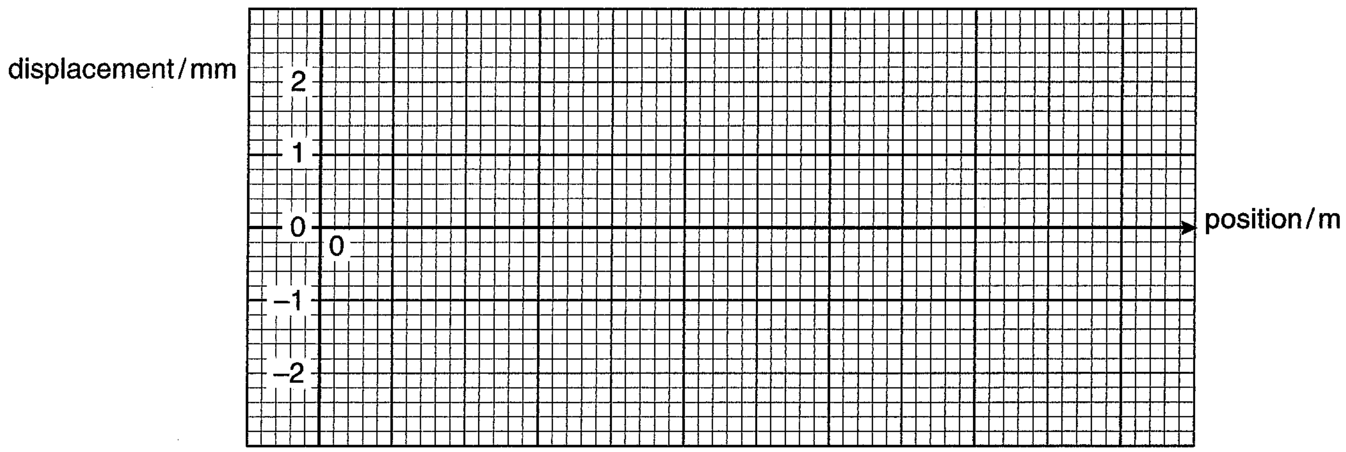

Fig. 3.2

[Total: 9]

[Turn over

For Examiner's Use

4 Fig. 4.1 shows an arrangement where microwaves leave a transmitter **T** and move in a direction **TP** which is perpendicular to a metal plate **P**.

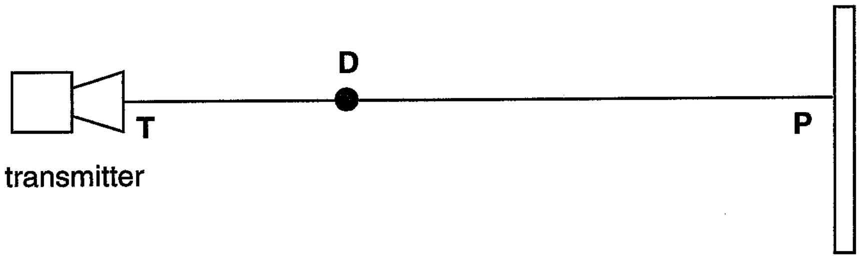

Fig. 4.1

(a) When a microwave detector **D** is slowly moved from **T** towards **P** the pattern of the signal strength received by **D** is high, low, high, low ... etc.

Explain

- why these maxima and minima of intensity occur
- how you would measure the wavelength of the microwaves
- how you would determine their frequency.

....

....

....

....

....

....

....

....

.... [6]

For Examiner's Use

(b) Describe how you could test whether the microwaves leaving the transmitter are plane polarised.

....

....

....

.... [2]

[Total: 8]

[Turn over

For Examiner's Use

5 (a) Explain what is meant by the *principle of superposition* of two waves.

....

....

.... [2]

(b) Fig. 5.1 shows the arrangement for viewing a visible interference pattern on a screen.

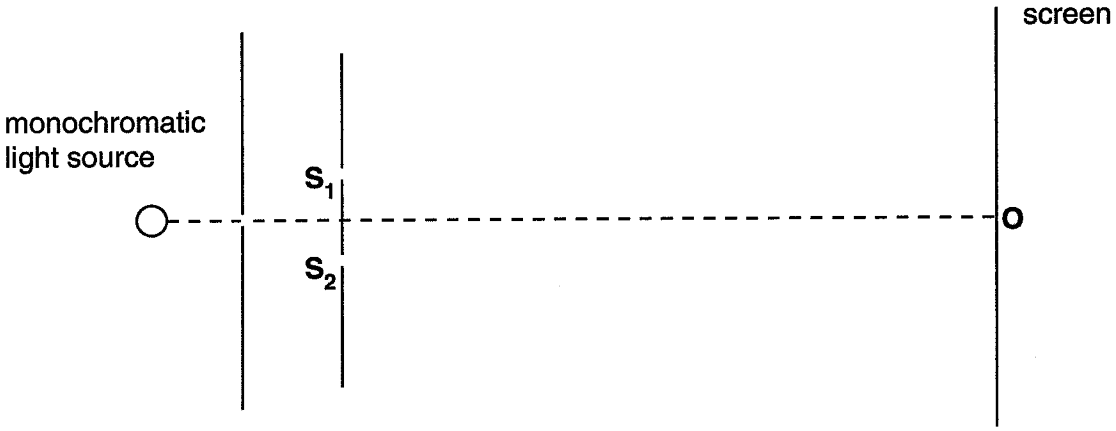

Fig. 5.1

In a darkened room, a double slit (S_1S_2) is placed in front of a narrow single slit situated in front of a monochromatic (one frequency only) light source.

(i) In order to produce a clear interference pattern on the screen, the wave sources must be *coherent*. State what is meant by *coherent*.

....

.... [1]

(ii) Explain how the arrangement shown ensures that the slits S_1 and S_2 act as coherent light sources.

....

....

.... [2]

For Examiner's Use

(iii) The point **O** on the screen is directly opposite the centre of the double slit. State and explain the nature of the interference that occurs at **O**.

....

....

.... [2]

(iv) The distance between slits $\mathbf{S_1}$ and $\mathbf{S_2}$ is 0.6 mm. When the screen is placed 1.8 m from the slits, the distance between neighbouring minima in the interference pattern formed on the screen is 2.0 mm. Calculate the wavelength of the light.

wavelength = ... m [3]

(v) State and explain how the interference pattern changes when light of a shorter wavelength is used in the experiment.

....

....

.... [2]

[Total: 12]

END OF QUESTION PAPER

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