OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

PHYSICS A — 2823/01

Wave Properties

Wednesday **6 JUNE 2001** Afternoon 1 hour

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

Candidate Name	Centre Number	Candidate Number

TIME 1 hour

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 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	15	
2	17	
3	15	
4	13	
TOTAL	**60**	

This question paper consists of 12 printed pages.

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, $1/C = 1/C_1 + 1/C_2 + \ldots$

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

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

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

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

current, $I = nAve$

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

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

For Examiner's Use

1 (a) The speed of light in air is $3.00 \times 10^8\ m\,s^{-1}$.

(i) Calculate the speed of light in glass of refractive index 1.52.

speed = ... $m\,s^{-1}$ [2]

(ii) Calculate the speed of light in water of refractive index 1.33.

speed = ... $m\,s^{-1}$ [1]

(iii) Calculate the refractive index for light travelling from water into this glass.

R.I. = [2]

(iv) Calculate the critical angle *C* for the water/glass interface.

C = ...° [2]

For Examiner's Use

(v) Fig. 1.1 shows a water/glass interface. On Fig. 1.1, draw a labelled ray diagram to show what is meant by the critical angle for the water/glass interface. (There is no need to measure the critical angle, but it should be labelled as *C*). [3]

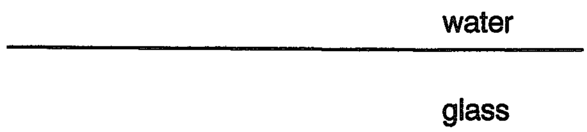

Fig. 1.1

(b) One drawback of using an optic fibre to transmit pulses of light is known as *multipath dispersion.*

(i) Explain what is meant by multipath dispersion.

....

....

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....

.... [3]

(ii) Suggest how multipath dispersion may be minimised.

....

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.... [2]

For Examiner's Use

2 (a) (i) Describe the essential difference between longitudinal and transverse waves.

....

....

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....

.... [2]

(ii) State **three** wave phenomena that apply to both transverse and longitudinal waves.

....

....

.... [3]

(iii) State and describe with the aid of a diagram **one** wave phenomenon that applies to transverse waves only.

[3]

For Examiner's Use

(b) Fig. 2.1 shows the trace produced on the screen of a cathode ray oscilloscope (c.r.o.) when a microphone is connected across its input (y-plates) terminals. The time-base setting of the c.r.o. is 10 ms cm^{-1}.

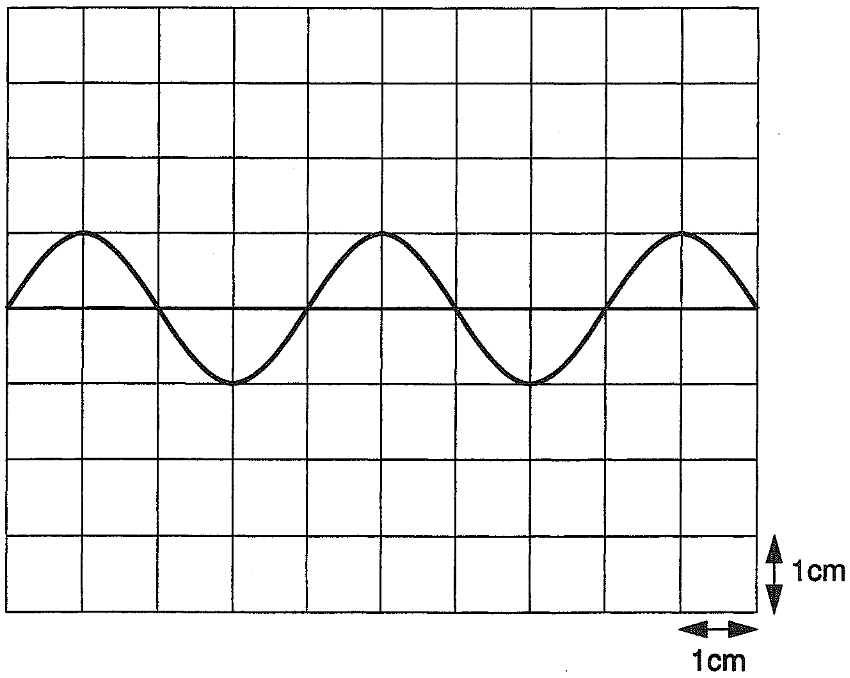

Fig. 2.1

(i) Calculate the frequency of the sound being received by the microphone.

frequency = ... Hz [3]

(ii) State and explain how the c.r.o. trace would change if the time-base setting were adjusted from 10 ms cm^{-1} to 1 ms cm^{-1}.

....

....

....

.... [3]

For Examiner's Use

(iii) The speed of sound in air is 330 m s^{-1}. Calculate the wavelength of the sound received by the microphone.

wavelength = ... m [3]

3 (a) Describe a ripple tank experiment to demonstrate the interference between water waves which have circular wavefronts. Include in your answer

(i) a description of how the circular wavefronts are produced,

....

....

.... [1]

(ii) an explanation of how coherence between the wave sources is achieved,

....

....

....

.... [2]

(iii) a diagram showing the resultant interference pattern formed, labelling **two** points of constructive interference with the letter C and two points of destructive interference with the letter D.

[3]

For Examiner's Use

(b) In order to measure the wavelength of light from a monochromatic light source a double-slit interference experiment is used.

(i) Write down a formula that may be used to determine the wavelength λ of the monochromatic light from observations of the interference pattern.

Identify the other symbols used.

[3]

(ii) List the measurements required to determine λ, and suggest an appropriate measuring instrument for each.

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....

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.... [3]

(iii) State a likely value for each of these measurements.

....

....

.... [3]

For Examiner's Use

4 (a) In terms of the motion of the particles of a medium in which there are sound waves, describe **one** similarity and **two** differences between a progressive sound wave and a standing sound wave.

....

....

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.... [3]

(b) Fig. 4.1 shows the appearance of a standing wave set up on a string stretched between two points 1.2 m apart. The amplitude of the standing wave is 20 cm. The shape of the string is shown at two different times: when t = 0 this is labelled **A**, and when t = 0.02 s this is labelled **B**.

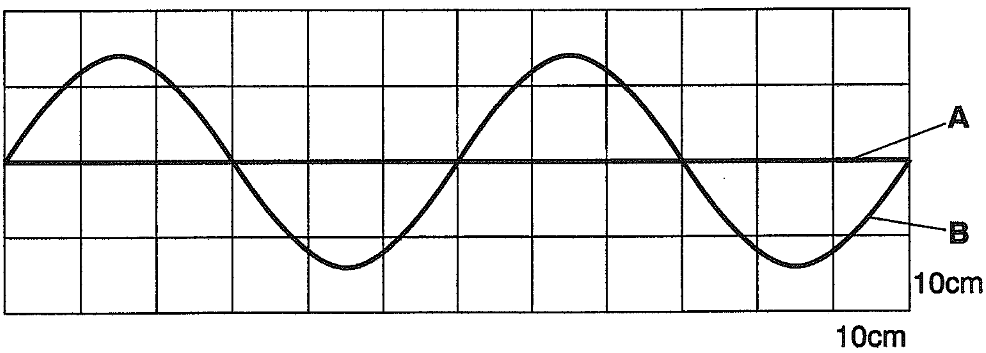

Fig. 4.1

(i) On Fig. 4.1, label with **AN** the positions of two antinodes and with **N** the positions of two nodes. [2]

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For Examiner's Use

(iii) Calculate the wavelength of the standing wave.

wavelength = ... m [2]

(iv) Determine the period of the standing wave.

period = ... s [1]

(v) Calculate the frequency of the standing wave.

frequency = ... Hz [1]

(ii) The string has its maximum displacement at t = 0.04 s. On Figs. 4.2.1 to 4.2.4, draw the appearance of the standing waves at the times t indicated.

1. t = 0.04 s (use Fig. 4.2.1)
2. t = 0.06 s (use Fig. 4.2.2)
3. t = 0.08 s (use Fig. 4.2.3)
4. t = 0.10 s (use Fig. 4.2.4)

[4]

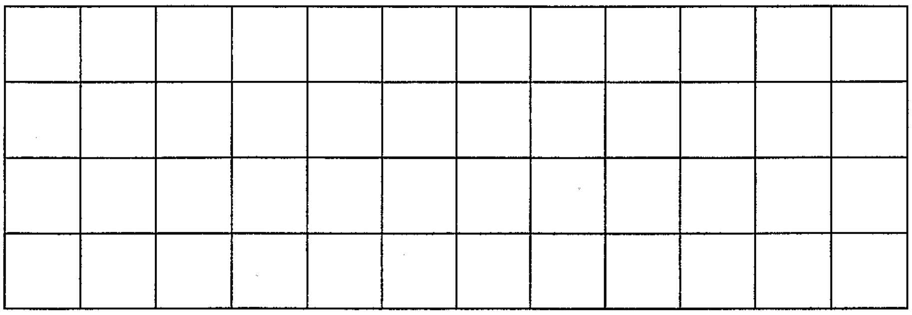

Fig. 4.2.1

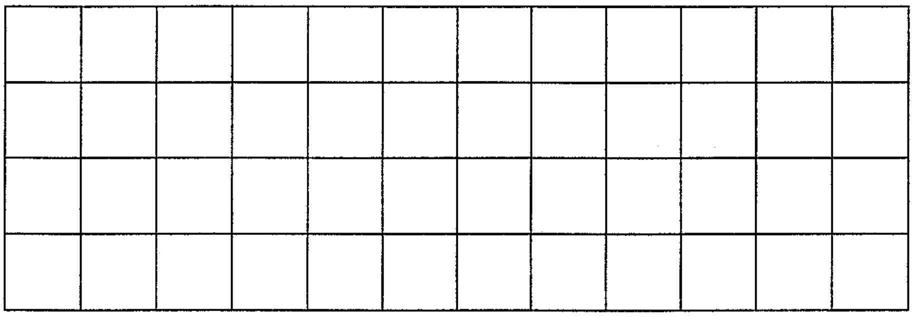

Fig. 4.2.2

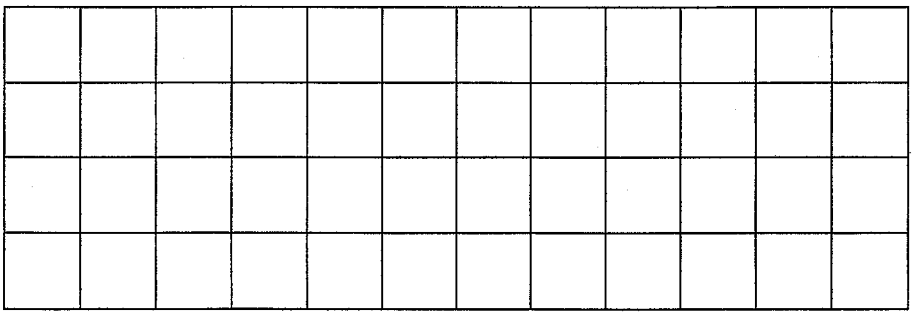

Fig. 4.2.3

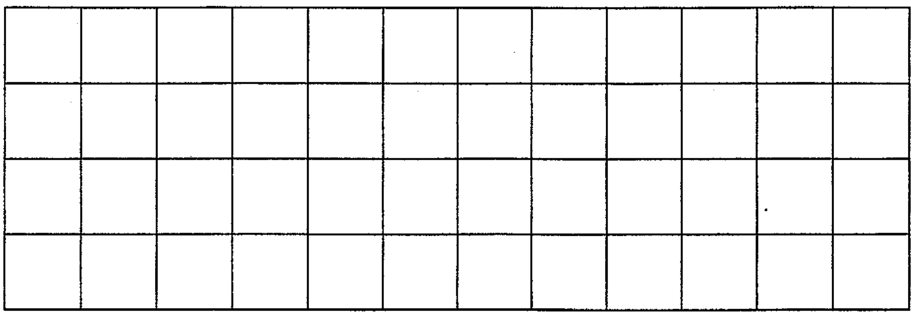

Fig. 4.2.4