OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

PHYSICS A 2823/01

Wave Properties

Monday **12 JANUARY 2004** Morning 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	6	
2	8	
3	14	
4	11	
5	6	
TOTAL	45	

This question paper consists of 12 printed pages.

Registered Charity Number: 1066969
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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, $p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$

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

[Turn over

Answer **all** the questions.

1 Fig. 1.1 shows a ray of light travelling from medium 1 to medium 2.

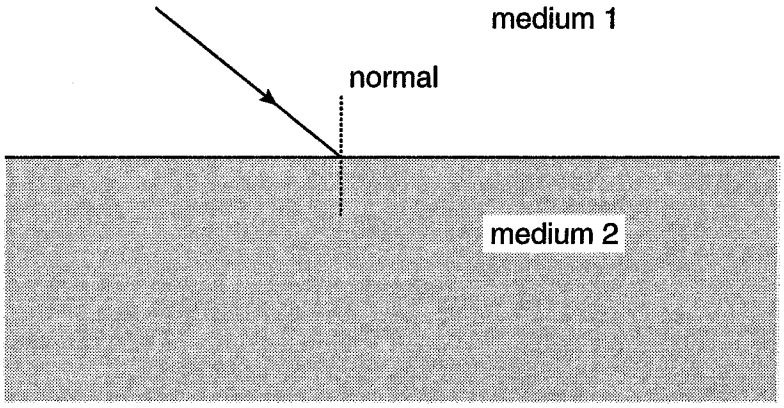

Fig. 1.1

The speed of light in medium 1 is $3.0 \times 10^8 \text{m s}^{-1}$. The speed of light in medium 2 is $1.9 \times 10^8 \text{m s}^{-1}$.

(a) (i) Mark on Fig. 1.1 the angle of incidence *i*. [1]

(ii) Show on Fig. 1.1 the approximate path of the ray in medium 2. [1]

(b) (i) Calculate the refractive index for light passing from medium 1 to medium 2.

refractive index = ... [2]

(ii) Determine the value of *i* that corresponds to an angle of refraction, in medium 2, of 35°.

i = ... ° [2]

[Total: 6]

2 **(a)** State **two** conditions necessary for light to be *totally internally reflected.*

1. .....

.....

2. .....

..... [2]

(b) Fig. 2.1 shows one end of an optic fibre used for data transmission.

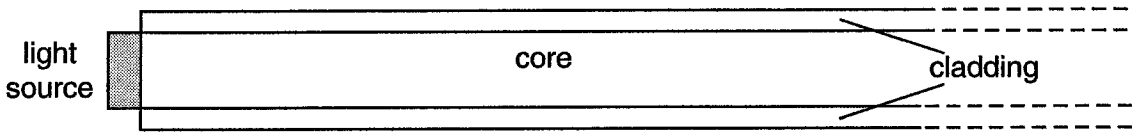

Fig. 2.1

The refractive index for the cladding/core interface is 1.01.

(i) Calculate the critical angle for the cladding/core interface.

critical angle = ...° [2]

(ii) The fibre is to be used for data transmission. Explain why a large critical angle is needed and suggest why a large critical angle results in a weak light pulse travelling down the core.

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.....

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.....

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..... [4]

[Total: 8]

3 **(a)** **(i)** State **three** phenomena that are associated with **all** waves.

1. .....

2. .....

3. ..... [3]

(ii) State a phenomenon that is only associated with transverse waves.

..... [1]

(b) Define the following wave characteristics.

(i) frequency f

.....

.....

(ii) wavelength λ

.....

.....

[2]

(c) Use the definitions of f and λ to deduce the relationship between f, λ and the speed v of a wave. Explain each stage of your deduction.

[2]

(d) Fig. 3.1 represents the screen of a cathode ray oscilloscope (c.r.o.).

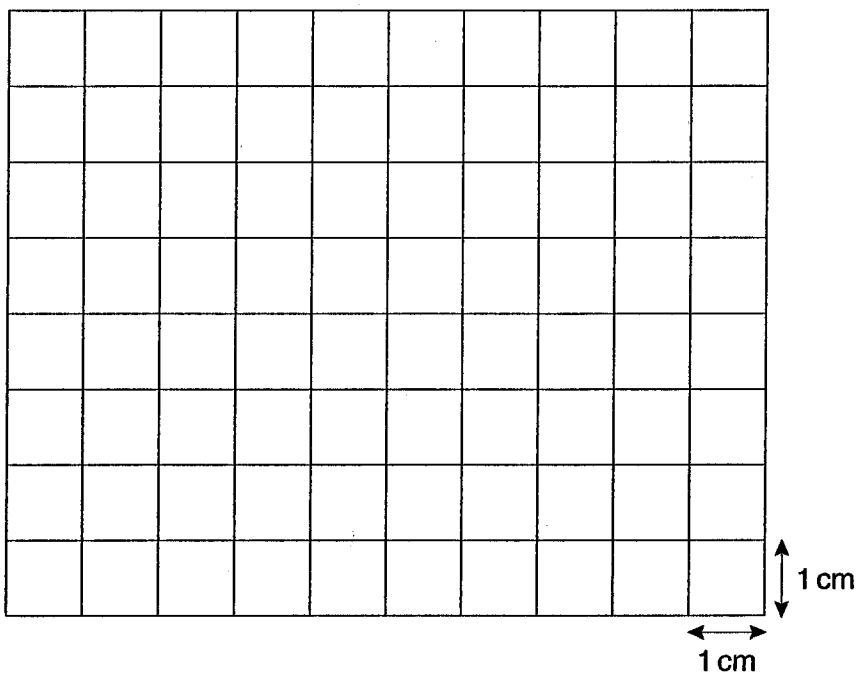

Fig. 3.1

The time-base setting is 0.50 ms cm^{-1} and the voltage (y-gain) setting is 2.0 mV cm^{-1}. A microphone connected to the c.r.o. detects a pure (sinusoidal) sound wave note of frequency 500 Hz.

(i) Calculate the period of the note.

period = ... s [1]

(ii) The amplitude of the signal from the microphone produced by the note is 6.0 mV.

Draw on Fig. 3.1 the trace produced on the c.r.o. screen when the microphone detects the sound wave. Draw at least two full cycles of the wave on Fig. 3.1. [3]

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

wavelength = ... m [2]

[Total: 14]

[Turn over

4 **(a)** State **one** similarity and **one** difference between progressive waves and standing waves.

similarity

.....

.....

difference

.....

..... [2]

(b) A standing sound wave can be produced in an air column by blowing across the open end of a tube as shown in Fig. 5.1.

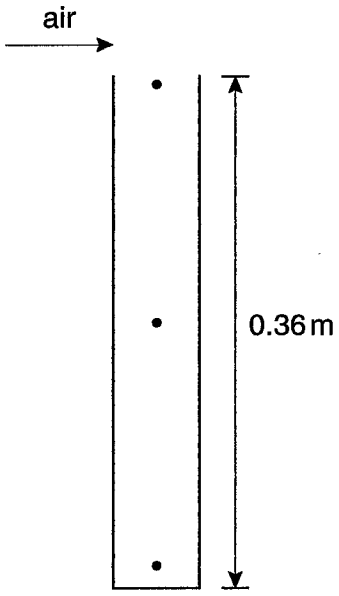

Fig. 5.1

The length of the tube is 0.36 m. The air column in the tube is sounding its lowest (fundamental) frequency note.

(i) Add **arrowed** lines to the dots in Fig. 5.1 to show the direction of movement and relative amplitudes of the air at these positions. [3]

(ii) Calculate the wavelength of the sound produced.

wavelength = ... m [1]

(iii) The speed of sound in air is $330\,m\,s^{-1}$. Determine the frequency of this standing wave.

frequency = ... Hz [2]

(iv) Determine the value of the lowest frequency of the note produced in a tube of this length but open at **both** ends. Show your reasoning.

lowest frequency = ... Hz [3]

[Total: 11]

5 **(a)** **(i)** State what is meant by a *progressive* wave.

.....

..... [1]

(ii) Describe in terms of the motions involved, the essential difference between longitudinal and transverse progressive waves.

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[2]

(b) Describe how

- plane, transverse water waves can be produced in a ripple tank
- the wavelength of these waves could be increased
- the speed of these waves could be reduced.

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..... [3]

[Total: 6]

END OF QUESTION PAPER