OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **2823/01**

PHYSICS A

Wave Properties

THURSDAY 22 MAY 2008 Afternoon

Time: 45 minutes

Candidates answer on the question paper
Additional materials (enclosed): None

Additional materials (required):
Electronic calculator

CUP/T38283

Candidate Forename		Candidate Surname	
Centre Number		Candidate Number	

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 45.
- 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	**4**	
2	**10**	
3	**12**	
4	**13**	
5	**6**	
TOTAL	**45**	

This document consists of **11** printed pages and **1** blank page.

[Turn over

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

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Answer **all** the questions.

1 **(a)** Define the *refractive index* of a transparent medium.

[1]

(b) The speed of light in air is $3.00 \times 10^8\,\text{m s}^{-1}$. Calculate the speed of light in a liquid of refractive index 1.40.

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

(c) Calculate the angle of refraction r for a ray of light passing from air into a liquid of refractive index 1.40 at an angle of incidence of 60°.

r = ... ° [2]

[Total: 4]

2 **(a)** Describe with the aid of a labelled diagram what is meant by

(i) critical angle

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..... [2]

(ii) total internal reflection.

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..... [1]

(b) In an experiment using a semi-circular plastic block, the critical angle at the plastic/air interface was measured as 39°. Calculate the refractive index of the plastic.

refractive index = ... [2]

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

(i) State and explain what is meant by *multipath dispersion*.

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.....[3]

(ii) State and explain how multipath dispersion can be reduced.

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.....[2]

[Total: 10]

3 **(a)** Complete each of the following statements about progressive waves by writing the most appropriate word or words in each gap.

In longitudinal waves the vibrations are ..... to the direction of the energy transfer.

In transverse waves the vibrations are ..... to the direction of the energy transfer. [1]

(b) **(i)** Name a phenomenon that is only associated with transverse waves.

.....[1]

(ii) Name three phenomena that occur in both transverse and longitudinal waves.

1. .....

2. .....

3. .....[3]

(c) A microphone is connected to the y-input terminals of a cathode ray oscilloscope (c.r.o.). The microphone detects a pure (sinusoidal) sound wave of frequency 250 Hz.

(i) Calculate the period of the sound wave.

period = ... s [1]

(ii) Fig. 3.1 represents the screen of the c.r.o.

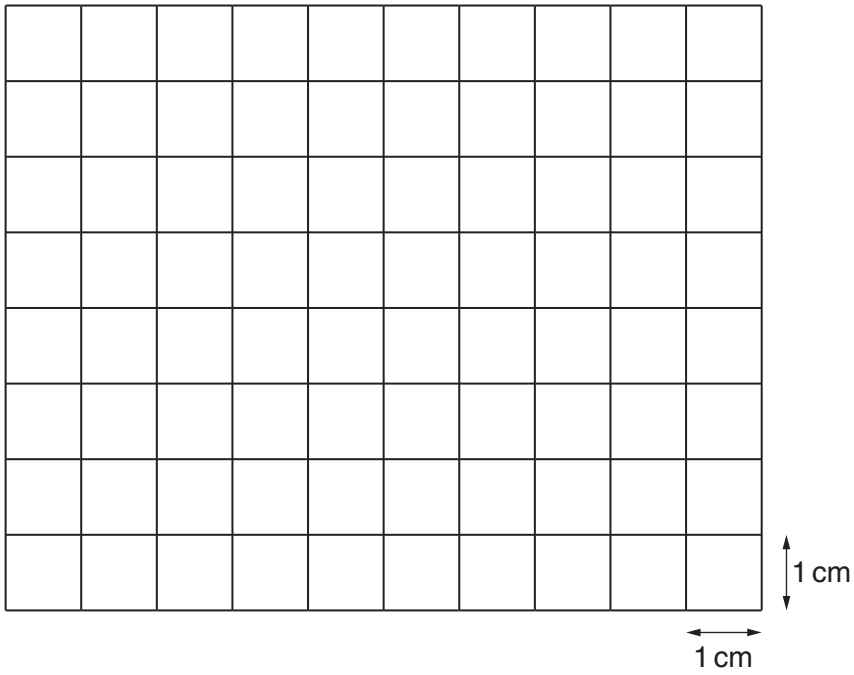

Fig. 3.1

The time-base setting is 1.0 ms cm^{-1} and the voltage (y-gain) setting is 2.0 mV cm^{-1}. The amplitude of the signal from the microphone produced by the note is 6.0 mV. Draw the trace seen on the c.r.o. screen. Draw at least two full cycles of the trace. [2]

(iii) State how the c.r.o. trace changes when the time-base setting is adjusted from 1.0 ms cm^{-1} to 10 ms cm^{-1}, the y-gain remaining the same.

.....

.....[1]

(iv) The speed of sound in air is 330 m s^{-1}. Calculate the wavelength of the sound wave.

wavelength = ... m [3]

[Total: 12]

4 **(a)** Explain what is meant by the *principle of superposition*.

.....

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.....[2]

(b) S_1 and S_2 are two wave sources that are in phase and produce waves of identical amplitude and wavelength λ. P is a point in front of these wave sources.

(i) State what is meant by the *path difference* for the waves from S_1 and S_2 at P.

.....[1]

(ii) **1** State in terms of λ two possible values of path difference that will produce constructive interference at P.

.....

2 State in terms of λ two possible values of path difference that will produce destructive interference at P.

.....[2]

(c) **(i)** Describe an experiment to demonstrate double-slit interference using monochromatic light, i.e. light of one frequency. Include in your description

- a labelled diagram showing how the apparatus is arranged
- a list of the measurements required to determine the wavelength λ of the light for a double-slit of known separation
- the formula, with all symbols identified, used to determine λ.

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.....[6]

(ii) Suggest how the appearance of the interference pattern changes when white light is used instead of monochromatic light.

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.....[2]

[Total: 13]

5 Fig. 5.1 shows a string stretched between two points **P** and **Q**.

Fig. 5.1

(a) Suggest how a standing wave could be created on the string.

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.....[1]

Turn over for question 5 (b) and (c)

(b) (i) Draw on Fig. 5.2 the shape of the standing wave when the string vibrates in its fundamental mode, i.e. the lowest frequency.

Fig. 5.2

.....[1]

(ii) The distance between **P** and **Q** is 1.2 m. Calculate the wavelength of this standing wave.

wavelength = ... m [1]

(c) Draw on Fig. 5.3 the shape of a standing wave whose frequency is 3 times that of the fundamental frequency. Label the position of all nodes (N) and antinodes (A).

[3]

Fig. 5.3

[Total: 6]

END OF QUESTION PAPER