OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE UNIT **2823/01**

PHYSICS A

Wave Properties

FRIDAY 12 JANUARY 2007 Afternoon

Time: 45 minutes

Additional materials:
Electronic calculator
Ruler (cm/mm)

Candidate Name

Centre Number | Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre Number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.

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	**5**	
2	**11**	
3	**10**	
4	**8**	
5	**11**	
TOTAL	**45**	

This document consists of **14** printed pages and **2** blank 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,	$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$
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 **(a)** State what is meant by the *diffraction* of waves.

....

....

.... [1]

(b) **(i)** Draw a labelled diagram to show how plane water waves, in a ripple tank, are diffracted as they pass through a gap whose width is about the same as the wavelength.

[3]

(ii) State what effect, if any, is caused by using a wider gap.

....

....

....

.... [1]

[Total: 5]

2 **(a)** Define the *refractive index* of a transparent material. Identify any symbols used.

....

....

....

.... [2]

(b) Complete the table below by calculating the speed of light in water and the refractive index of diamond.

material	refractive index	speed of light in the material / m s^{-1}
water	1.33	
diamond		1.24×10^8

[3]

(c) Fig. 2.1 shows a ray box and a rectangular glass block placed on a sheet of paper.

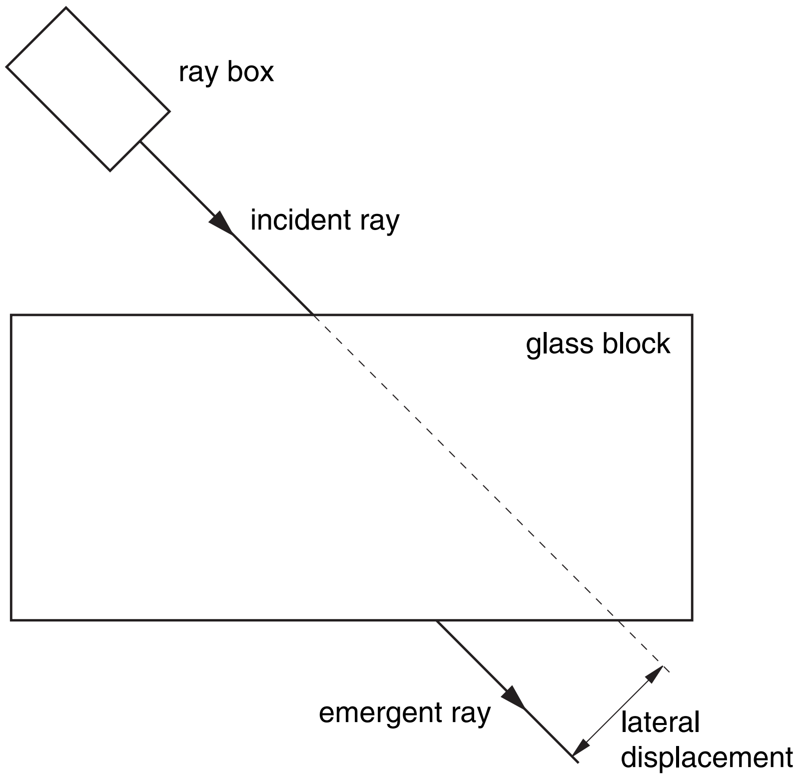

Fig. 2.1

A ray of light enters the block and leaves from the other side as shown. The ray is laterally displaced when it leaves the block.

(i) State why the ray is laterally displaced.

....

....

.... [1]

(ii) Explain why the emergent ray is parallel to the incident ray.

....

....

.... [2]

(iii) Describe how you would use the apparatus shown in Fig. 2.1 to determine the refractive index of the glass. Draw on Fig. 2.1, or in the space below, to help explain your answer.

....

....

....

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....

....

[3]

[Total: 11]

3 An optic fibre is used for the transmission of light signals. It consists of a central core surrounded by cladding.

(a) **(i)** How does the value of the refractive index of the cladding compare with that of the core?

.... [1]

(ii) What condition is necessary for light to be totally internally reflected in the core of the fibre?

....

....

.... [1]

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

....

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.... [3]

(c) The ratio $\frac{\text{refractive index of the cladding}}{\text{refractive index of the core}}$ for a typical optic fibre is 0.98.

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

critical angle = ...° [2]

(ii) By referring to the problem of multipath dispersion, explain why it is an advantage to have a high value for the critical angle.

....

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.... [3]

[Total: 10]

4 Fig. 4.1 shows a displacement-time graph for a wave source.

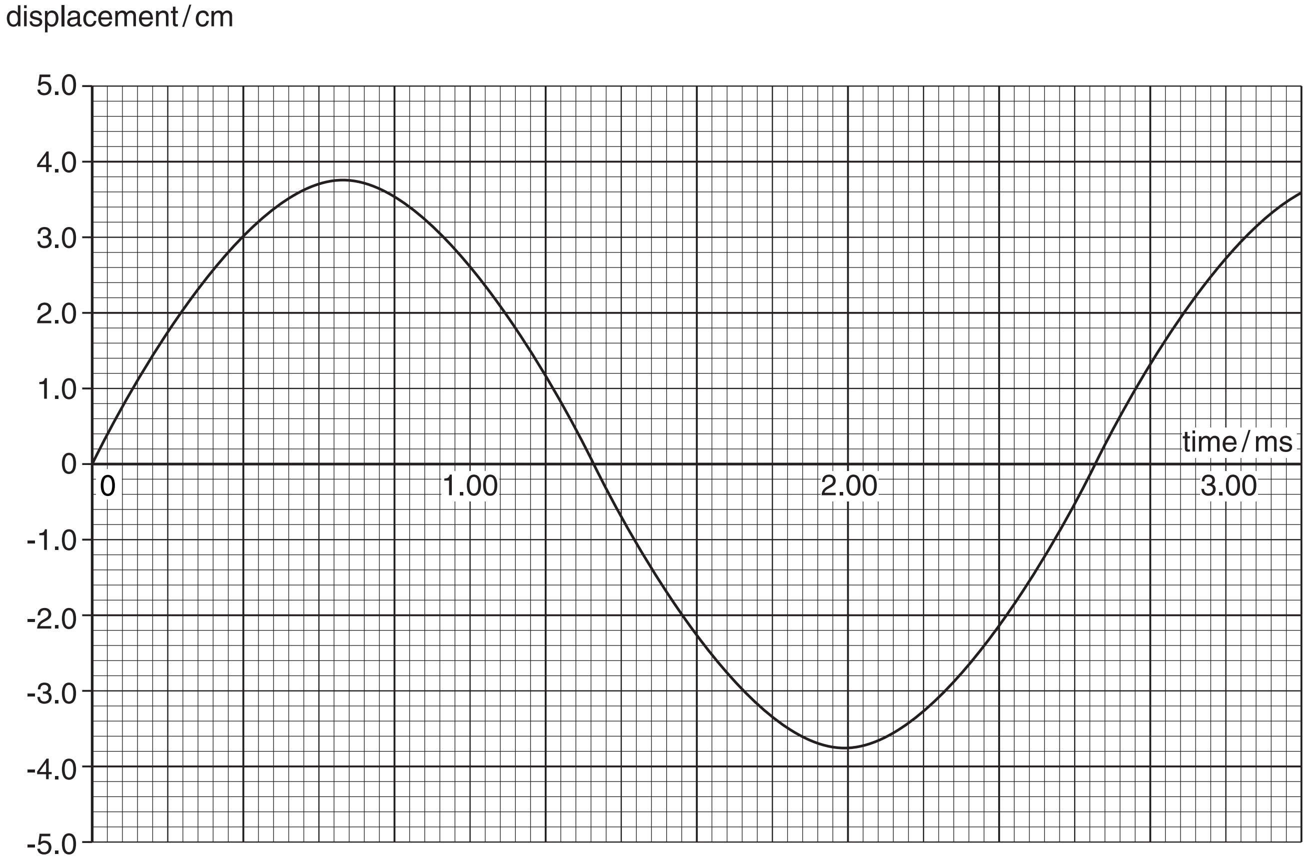

Fig. 4.1

(a) Use Fig. 4.1 to determine for this wave source

(i) the amplitude

amplitude = ... cm [1]

(ii) the displacement when t = 1.80 ms

displacement = ... cm [2]

(iii) the period

period = ... ms [1]

(iv) the frequency.

frequency = ...Hz [2]

(b) The speed of the waves produced by this wave source is $3.0 \times 10^2\,\mathrm{m\,s^{-1}}$. Calculate their wavelength.

wavelength = ... m [2]

[Total: 8]

5 **(a)** **(i)** State **three** phenomena that apply to all transverse and longitudinal waves.

1. ....

2. ....

3. .... [2]

(ii) State a wave phenomenon that applies to transverse waves only.

.... [1]

(b) Fig. 5.1 shows an arrangement that can be used to determine the wavelength of microwaves.

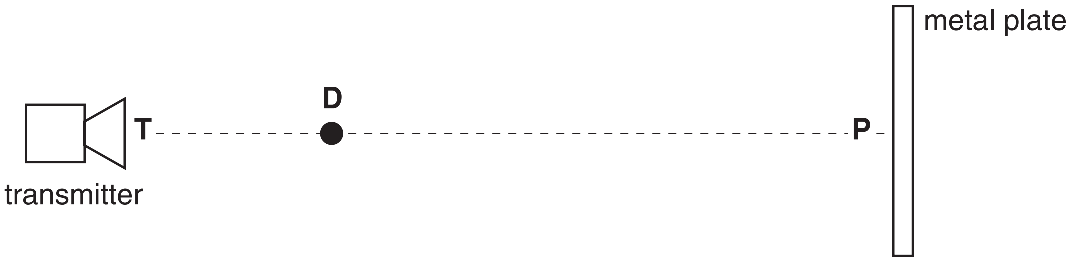

Fig. 5.1

Microwaves leave the transmitter and move in a direction **TP** which is at right angles to the metal plate. A standing (stationary) wave is formed between **T** and **P**.

(i) State what is meant by a *standing wave* and explain how it is formed in this case.

....

....

....

....

....

....

.... [3]

(ii) When a small microwave detector **D** is moved slowly from **T** towards **P** the signal received changes from strong to weak to strong to weak etc. The distance between the positions of neighbouring weak signals is 1.4 cm.

Calculate for these microwaves

1 the wavelength

wavelength = ………… cm [1]

2 the frequency.

frequency = ………… Hz [2]

(iii) Describe how you could test whether the microwaves leaving the transmitter were plane polarised.

....

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.... [2]

[Total: 11]

END OF QUESTION PAPER

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