OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

PHYSICS A

2823/01

Wave Properties

Thursday **12 JANUARY 2006** 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, Centre number and candidate number in the boxes above.
- Answer **all** questions.
- Write your answers, in blue or black ink, in the spaces provided on the question paper.
- 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 in the grey area between the pages.
- **DO NOT** WRITE IN THE AREA **OUTSIDE** THE BOX BORDERING EACH PAGE. ANY WRITING IN THIS AREA WILL NOT BE MARKED.

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	11	
2	9	
3	11	
4	5	
5	9	
TOTAL	45	

This question paper consists of 12 printed pages.

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[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,	$p = \frac{1}{3}\frac{Nm}{V}<c^2>$
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 the **two** laws of refraction.

1. ....

....

....

2. ....

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....[2]

(b) Fig. 1.1 shows a ray of light entering a glass prism at an angle of incidence of 50°.

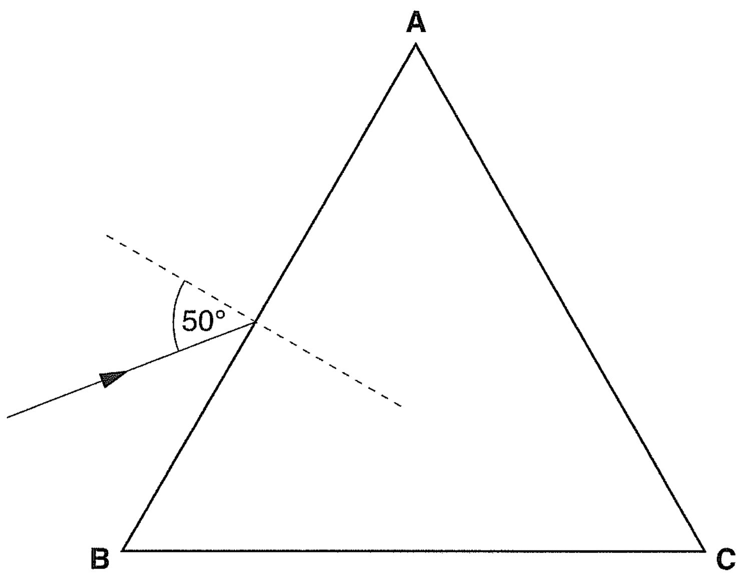

Fig. 1.1

(i) Sketch the approximate path of the ray as it passes through the prism (you do not need to measure any angles). [2]

(ii) State why the ray changes direction at the face **AB**.

....

....

....[1]

(iii) The refractive index of the glass is 1.47. Calculate the angle of refraction of the ray for the angle of incidence of 50°.

angle = ...° [3]

(iv) By changing the angle of incidence, the ray can be made to undergo *total internal reflection* at the face **AC**. Explain the condition required to produce total internal reflection in the prism.

....

....

....[1]

(v) Calculate the critical angle for the glass/air interface for this prism.

critical angle = ...° [2]

[Total: 11]

2 Fig. 2.1 shows an optic fibre used for data transmission.

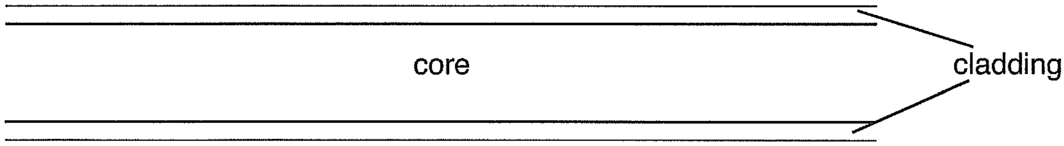

Fig. 2.1

(a) **(i)** The speed of light in a vacuum is $3.0 \times 10^8\,\mathrm{m\,s^{-1}}$. Calculate the speed of light in the core of refractive index 1.52.

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

(ii) Calculate the minimum time taken for a light pulse to travel along a straight optic fibre of length 3000 m and refractive index 1.52.

time = ...s [2]

(b) One drawback of using an optic fibre to transmit pulses of light is known as *multipath dispersion*. State what is meant by multipath dispersion and explain how it may be reduced.

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....[5]

[Total: 9]

3 (a) When waves from two coherent sources meet, they interfere. The principle of superposition of waves helps to explain this interference.
State what is meant by

(i) *coherent sources*

....

....

....[2]

(ii) *principle of superposition of waves*

....

....

....[1]

(b) Fig. 3.1 shows an arrangement to demonstrate interference effects with microwaves. A transmitter, producing microwaves of wavelength 3.0 cm, is placed behind two slits 6.0 cm apart. A receiver is placed 50 cm in front of the slits and is used to detect the intensity of the resultant wave as it moves along the line **AB**.

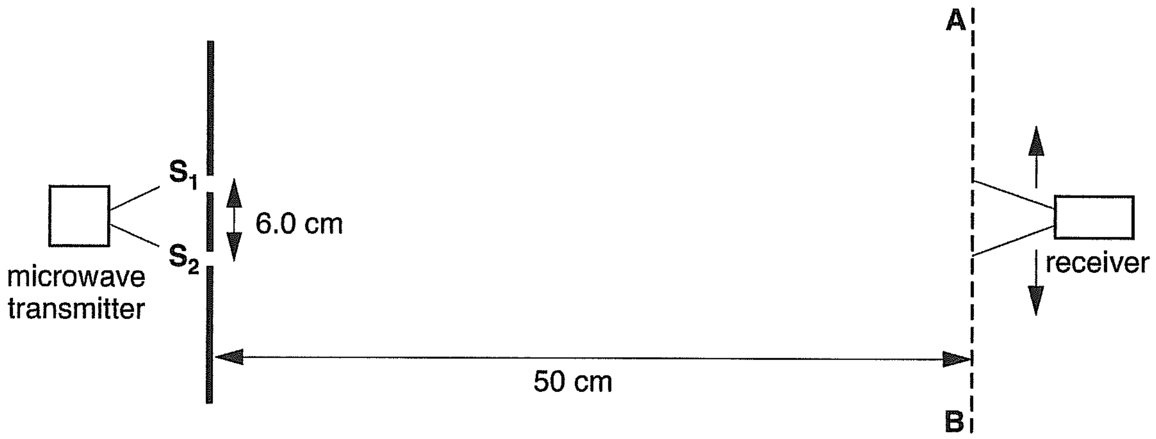

Fig. 3.1

(i) Explain, in terms of the **path difference** between the waves emerging from the slits $\mathbf{S_1}$ and $\mathbf{S_2}$, why a series of interference maxima and minima are produced along the line **AB**.

....

....

....

....

....[3]

(ii) Assuming that the interference of the microwaves is similar to double slit interference using light, calculate the distance between neighbouring maxima along the line **AB**.

distance = ...cm [3]

(iii) The microwaves from the transmitter are *plane polarised*. State what this means and suggest what would happen if the receiver were slowly rotated through 90° while still facing the slits.

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....[2]

[Total: 11]

4 Fig. 4.1 shows a stretched wire held horizontally between supports 0.50 m apart.

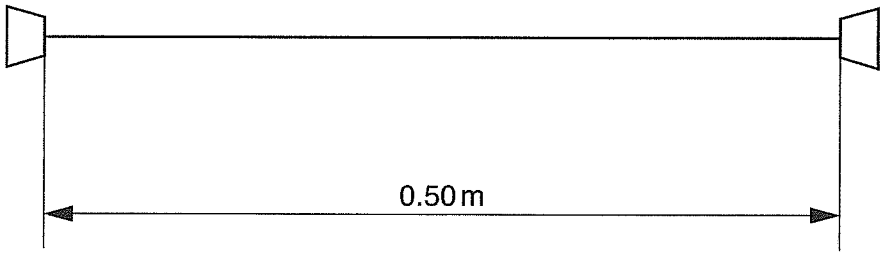

Fig. 4.1

When the wire is plucked at its centre, a standing wave is formed and the wire vibrates in its fundamental mode (lowest frequency).

(a) Explain how the standing wave is formed.

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....[2]

(b) On Fig. 4.1, draw the fundamental mode of vibration. Label the position of any nodes with the letter **N** and any antinodes with the letter **A**. [2]

(c) What is the wavelength of this standing wave?

wavelength = ...m [1]

[Total: 5]

5 **(a)** State what is meant by *diffraction*.

....

....

....[2]

(b) Fig. 5.1 shows plane water waves in a ripple tank approaching a narrow gap the size of which is approximately the same as the wavelength of the waves.

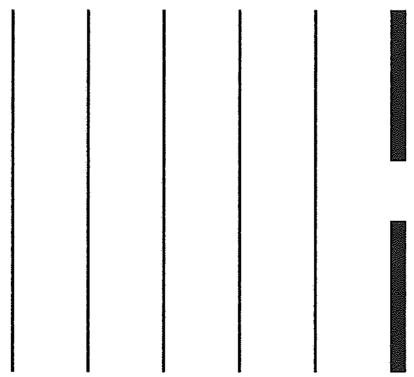

Fig. 5.1

(i) On Fig. 5.1, draw the pattern of the wavefronts emerging from the gap. [2]

(ii) Describe how the pattern of wavefronts emerging from the gap would change if the size of the gap were significantly increased.

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....[2]

(iii) Describe and explain the difference in the amount of diffraction for sound waves and light waves passing through an open door.

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....[3]

[Total: 9]

END OF QUESTION PAPER

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