THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

PHYSICS A

Wave Properties

2823/01

Candidates answer on the question paper

OCR Supplied Materials:
None

Other Materials Required:
- Electronic calculator

Thursday 21 May 2009
Afternoon

Duration: 45 minutes

OCE/T61220

2823 01

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use 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, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks 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.
- This document consists of **12** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Qu.	**Max**	**Mark**
1	**10**	
2	**5**	
3	**6**	
4	**17**	
5	**7**	
TOTAL	**45**	

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

Answer **all** the questions.

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

.....

..... **[1]**

(b) Fig. 1.1 shows a right-angled glass prism with a ray of light incident at 90° to side **AB**.

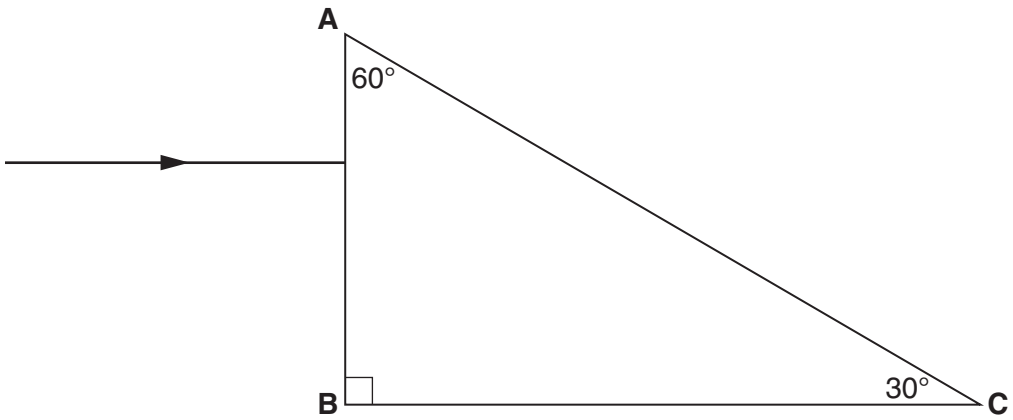

Fig. 1.1

The refractive index of the glass is 1.53.

(i) Calculate the speed of light in the prism.

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

(ii) Calculate the critical angle for a glass/air interface of the prism.

critical angle = ...° **[2]**

(iii) By drawing on Fig. 1.1 show the approximate path of the ray through the prism. There is no need to measure any angles but where the ray meets an interface the normal should be drawn. **[2]**

(c) Fig. 1.2 shows a 45° right-angled glass prism. The refractive index of the glass is also 1.53.

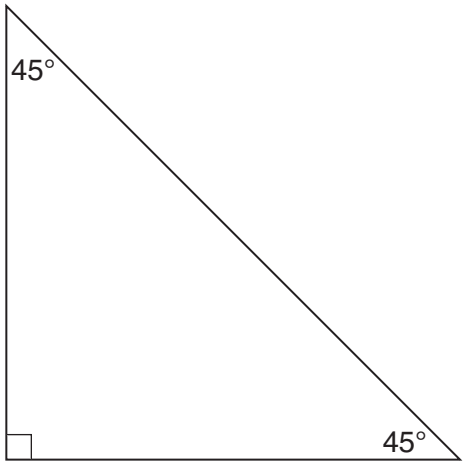

Fig. 1.2

(i) Draw rays on Fig. 1.2 to show how light may be reflected through 180° by this prism. **[2]**

(ii) Suggest a practical application of using this shape of prism to reflect light by 180°.

.....

..... **[1]**

[Total: 10]

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

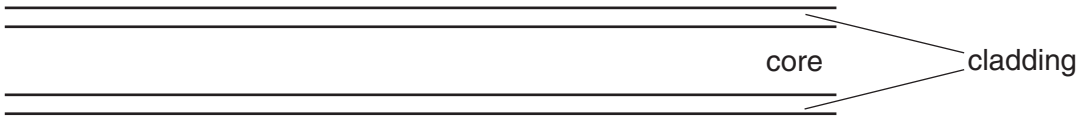

Fig. 2.1

(a) Explain what is meant by *multipath dispersion* in an optic fibre used for data transmission.

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..... **[3]**

(b) The refractive index of the core is only slightly greater than that of the cladding so that the critical angle for the core-cladding interface is just less than 90°. State and explain how such a large value for the critical angle improves the quality of the data pulses that are received after being transmitted along the fibre.

.....

.....

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.....

.....

..... **[2]**

[Total: 5]

3 **(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 of the water waves.

[3]

(ii) Describe how the diffraction changes for these waves if the gap is increased to be much bigger than the wavelength.

.....

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..... **[2]**

[Total: 6]

4 Fig. 4.1 shows a graph of displacement y against time t for a point on a wave.

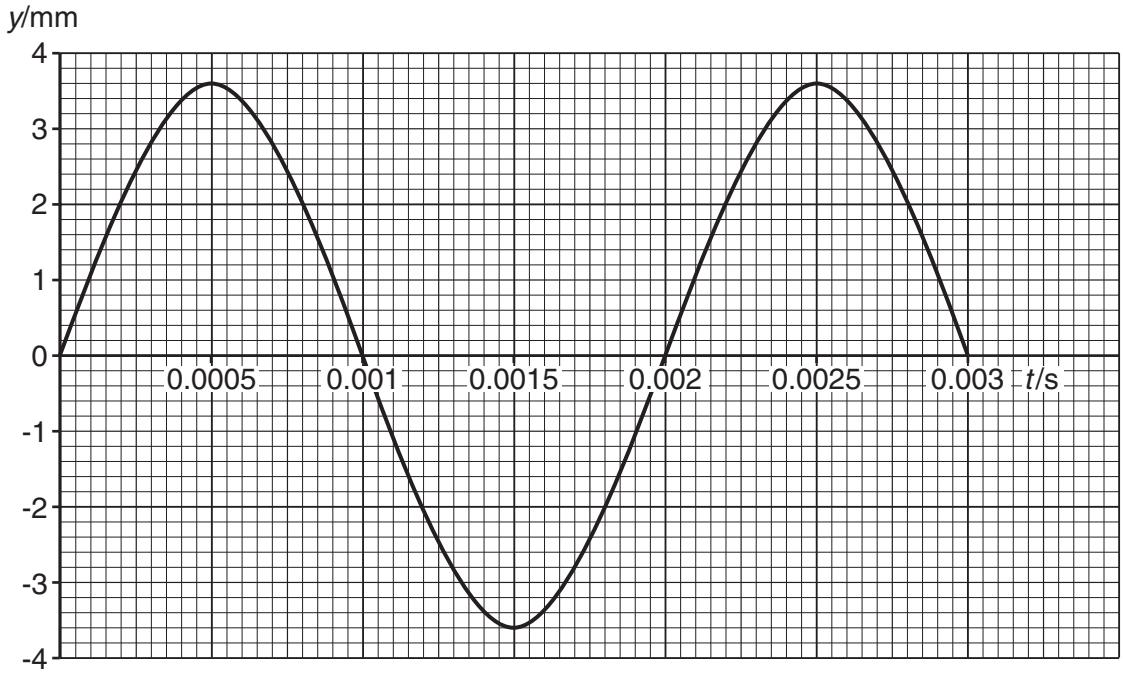

Fig. 4.1

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

(i) the amplitude

amplitude = ... mm **[1]**

(ii) the displacement

1 when $t = 0.40$ ms displacement = ... mm **[1]**

2 when $t = 1.80$ ms displacement = ... mm **[1]**

(iii) the period period = ... ms **[1]**

(iv) the frequency.

frequency = ... Hz **[2]**

(b) Draw on Fig. 4.1 the displacement-time graph, for the time interval of 0.0030 s, for a wave of half the frequency and half the amplitude of the wave shown in Fig. 4.1. **[2]**

(c) Fig. 4.2 shows, at a given instant, the shape of a stretched rope along which a transverse wave is travelling from left to right. **A**, **B**, **C** and **D** are four particles on the rope.

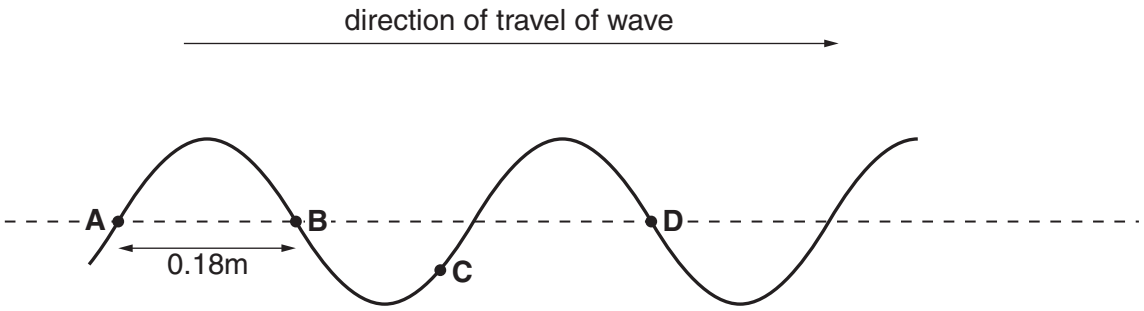

Fig. 4.2

(i) On Fig. 4.2 label the wavelength λ of the wave. **[1]**

(ii) The distance between **A** and **B** is 0.18 m. The frequency of the wave is 5.0 Hz. Calculate the speed of the wave.

speed = ... $m\,s^{-1}$ **[3]**

(iii) On Fig. 4.2 sketch the shape of the rope a very short time later. **[1]**

(iv) On Fig. 4.2 draw arrows to show the directions in which the particles **B** and **C** are moving during this very short time. **[2]**

(v) State the phase difference between the vibrations of particles **A** and **D**.

phase difference = ... unit ..... **[2]**

[Total: 17]

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

.....

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..... **[2]**

(b) In an experiment to produce observable interference fringes, two coherent, monochromatic (one wavelength) light sources, $\mathbf{S_1}$ and $\mathbf{S_2}$, are placed in front of a white screen, as shown in Fig. 5.1.

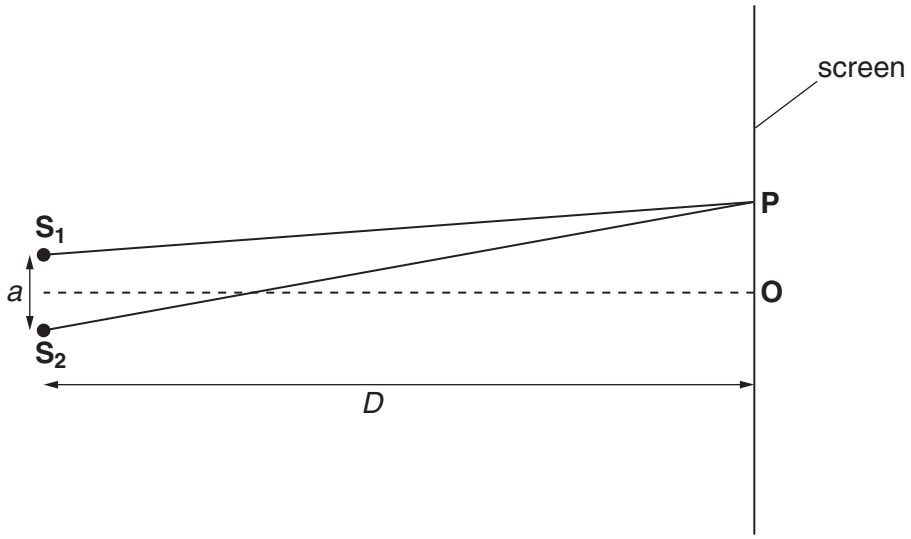

Fig. 5.1

(i) The point **P** is the position of the **first dark** (minimum intensity) fringe closest to the central bright (maximum intensity) fringe at **O**. State, in terms of the wavelength λ, the path difference between $\mathbf{S_1P}$ and $\mathbf{S_2P}$.

path difference = ... **[1]**

(ii) Show on Fig. 5.1 the approximate position of the **first bright** fringe on the screen closest to the central bright fringe at **O**. Label this **B**. **[1]**

(iii) In a particular experiment, the distance D from the sources to the screen is 1.6 m. The wavelength of the light is 6.4×10^{-7} m and the distance between **O** and **P** is 3.6 mm. Calculate the distance a between the sources $\mathbf{S_1}$ and $\mathbf{S_2}$.

a = ... m **[3]**

[Total: 7]

END OF QUESTION PAPER

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