OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS A

2823/01

Wave Properties

Friday **10 JUNE 2005** 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	11	
2	10	
3	7	
4	9	
5	8	
TOTAL	45	

This question paper consists of 12 printed pages.

[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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For Examiner's Use

Answer **all** the questions.

1 **(a)** Fig. 1.1 shows a ray of laser light incident on a block of ice at an angle of incidence of 60°.

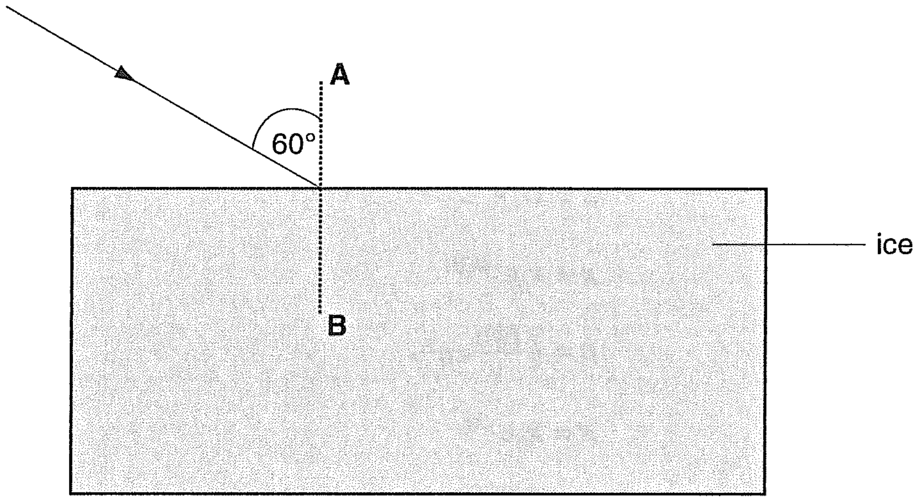


Fig. 1.1

(i) State the name of the line **AB**.

....[1]

(ii) The refractive index of ice is 1.31. Calculate the angle of refraction *r*.

r = ...° [3]

(iii) Sketch on Fig. 1.1 the approximate direction of the ray refracted at the top surface of the block and label the angle of refraction *r*. [2]

(iv) State why the ray of light is refracted when it enters the ice.

....

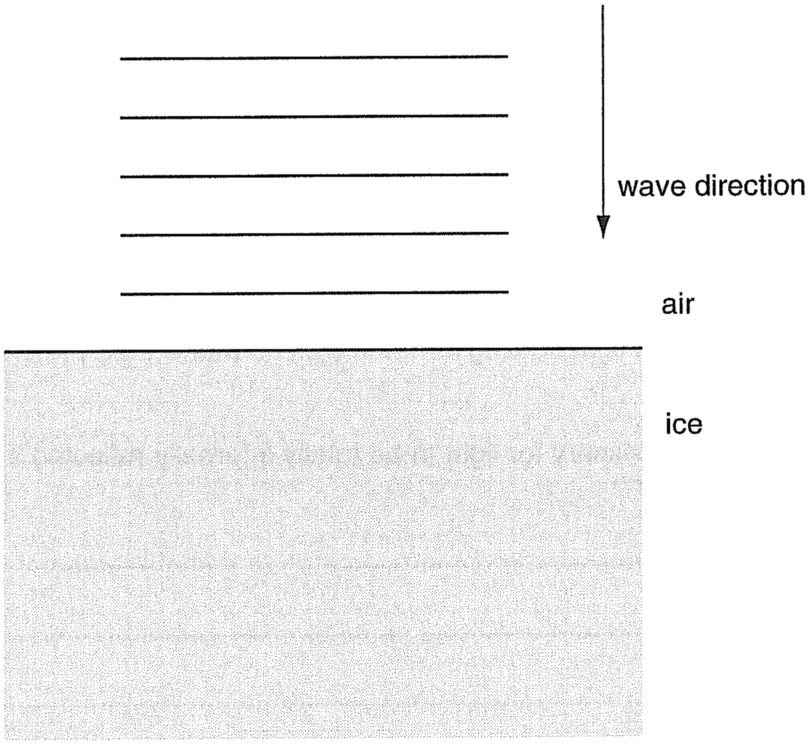
....[1]

(b) The wavelength of the laser light in air is 6.5×10^{-7} m. Calculate the wavelength of the laser light in ice.

wavelength = ...m [2]

For Examiner's Use

(c) Fig. 1.2 shows waves approaching the air/ice interface at an angle of incidence of 0°. Sketch the pattern of the waves inside the ice.



[2]

Fig. 1.2

[Total: 11]

2 Fig. 2.1 shows an optic fibre consisting of a transparent core coated with a transparent cladding material.

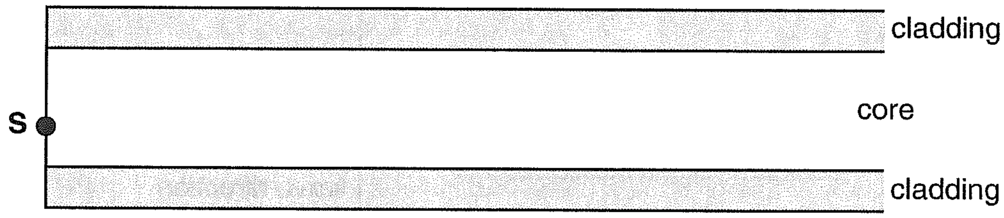


Fig. 2.1

(a) On Fig. 2.1, draw a ray of light coming from the light source **S** that is internally reflected to travel along the fibre. [2]

(b) State **two** conditions necessary for light to be totally internally reflected inside the core of this fibre.

1. ....

....

2. ....

....[2]

For Examiner's Use

(c) The optic fibre is used to transmit digital information.

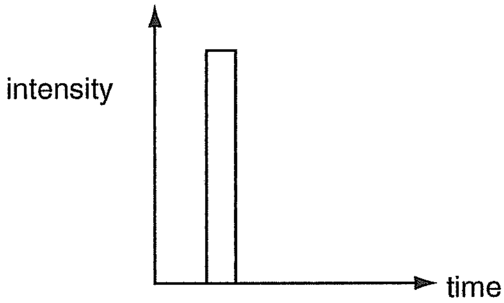


Fig. 2.2a

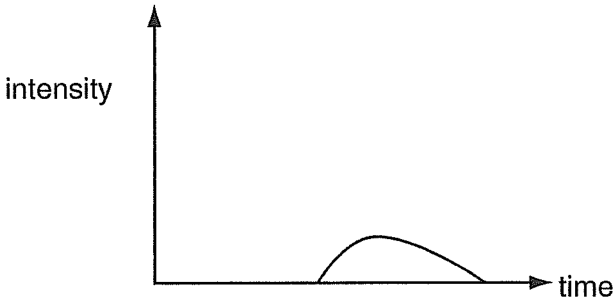


Fig. 2.2b

The intensity-time profile of an input signal of laser light is shown in Fig. 2.2a. This signal is sent into one end of the core.
The output signal for the pulse at the other end of the core, a distance of approximately one kilometre, is shown in Fig. 2.2b. It has become smeared and is not as well defined as the input pulse.
State and explain why the shape of the pulse has changed and how this problem can be overcome.

....

....

....

....

....[4]

(d) The critical angle for the core/cladding interface is 80.0°. Calculate the refractive index *n* for the core/cladding interface.

n = ...[2]

[Total: 10]

For Examiner's Use

3 **(a)** Describe the differences between transverse and longitudinal waves.

....

....

....

....[2]

(b) Fig. 3.1 shows a **progressive** longitudinal wave formed in a slinky spring by an oscillator connected to a signal generator.

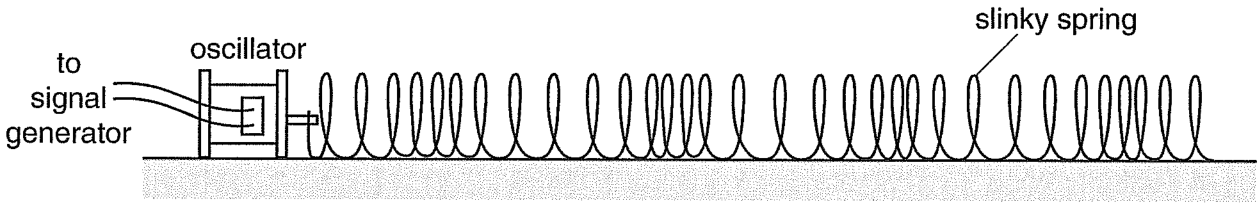


Fig. 3.1

On Fig. 3.1,

(i) draw arrows to show the direction of the vibrations produced by the oscillator – label these **V** [1]

(ii) label with a **C** the centre of a compression on the slinky [1]

(iii) show the wavelength of the wave and label this λ. [1]

(c) State and explain the effect on the wavelength of increasing the frequency of the oscillator.

....

....

....[2]

[Total: 7]

For Examiner's Use

4 Fig. 4.1 shows an arrangement to demonstrate the interference of light.
A double-slit, consisting of two very narrow slits very close together, is placed in the path of a laser beam.

Fig. 4.1

(a) Light spreads out as it passes through each slit. State the term used to describe this.

....[1]

(b) The slits S_1 and S_2 can be regarded as coherent light sources. State what is meant by *coherent*.

....

....[1]

(c) Light emerging from S_1 and S_2 produces an interference pattern consisting of bright and dark lines on the screen. Explain **in terms of the path difference** why bright and dark lines are formed on the screen.

....

....

....

....

....

....[4]

(d) The wavelength of the laser light is 6.5×10^{-7} m and the separation between S_1 and S_2 is 0.25 mm. Calculate the distance between neighbouring dark lines on the screen when the screen is placed 1.5 m from the double-slit.

distance = ...m [3]

[Total: 9]

5 **(a)** In standing waves, there are *nodes* and *antinodes*. Explain what is meant by

(i) a *node*

....

....[1]

(ii) an *antinode*.

....

....[1]

(b) Fig. 5.1 shows a long glass tube within which standing waves can be set up.

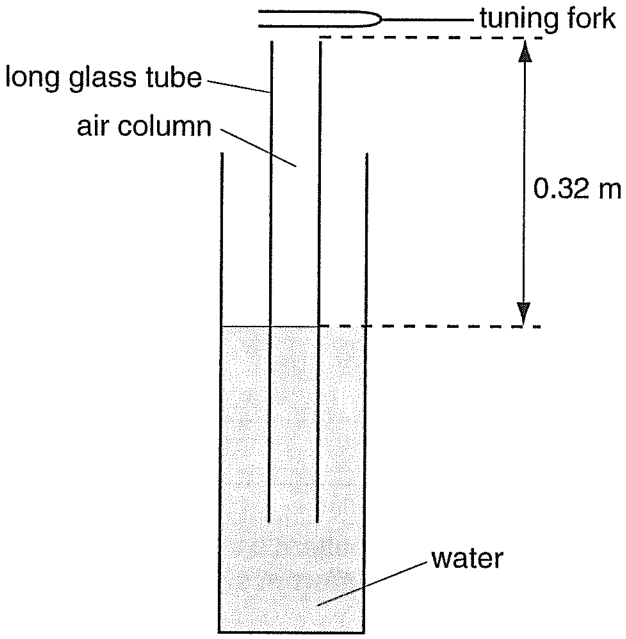


Fig. 5.1

A vibrating tuning fork is placed above the glass tube and the length of the air column is adjusted, by raising or lowering the tube in the water, until a loud sound is heard.

(i) The standing wave formed in the air column is the fundamental (the lowest frequency). Show on Fig. 5.1 the position of a node – label as **N**, and an antinode – label as **A**. [2]

(ii) When the fundamental wave is heard, the length of the air column is 0.32 m. Determine the wavelength of the standing wave formed.

wavelength = ... m [1]

For Examiner's Use

(iii) The speed of sound in air is 330 m s^{-1}. Calculate the frequency of the tuning fork.

frequency = ...Hz [3]

[Total: 8]

END OF QUESTION PAPER