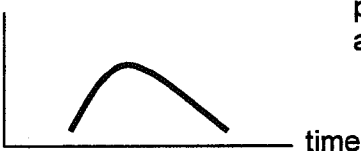


1. (a)(i) i correctly labelled
 r correctly labelled
 {Allow 1 mark if i and r are transposed but ZERO marks if angles labelled from ray to surface} B1
 B1 [2]
- (ii) $n = \sin i / \sin r$
 {correct answer only - i.e. ignore diagram and do not allow error carried forward} B1 [1]
- (b)(i) speed : decreases B1
 frequency: stays the same B1
 wavelength : decreases B1 [3]
- (ii) new speed = v/n (OR $f\lambda/n$ OR c/n OR $3 \times 10^8/n$) B1
 new wavelength = λ/n (OR v/fn) B1 [2]
 {The new speed and new wavelength must be the subject of the equations - i.e do not allow general expressions which appear to contain new values of v and λ . Simply stating $v=f\lambda$ does not score any marks}
- [TOTAL = 8]
2. (a)(i) TOTAL INTERNAL REFLECTION {allow TIR} B1 [1]
- (ii) angle of incidence GREATER than the critical angle B1
 R.I of core > R.I of cladding
 OR density of core > density of cladding }
 OR speed of light in core < speed in cladding } B1 [2]
 {Allow 2 marks if candidate simply states " $\theta > \text{critical angle}$ " provided he defines the meaning of the critical angle in words or in a diagram i.e. B1 + B1}
- (b)(i) recall of $n = c_1 / c_2$ C1
 $c_{\text{core}} = 3 \times 10^8 / 1.48 = 2.03 \times 10^8$ (OR 2×10^8) (m s^{-1}) A1 [2]
- (ii) valid substitution into $t = d/v$: e.g. $t = 900 / 2.03 \times 10^8$ C1
 minimum time = 4.4×10^{-6} s {allow ecf for v from b (i) e.g. 4.5×10^{-6} } A1 [2]
- (iii) valid substitution into $d = v \times t$: e.g. $d = (2.03 \times 10^8) \times (45 \times 10^{-9})$ C1
 extra distance = 9.1 (OR 9) m A1 [2]
 {allow ecf for v from b (i) AND check that $c_{\text{core}} - 2.03 \times 10^8$ -is used }
 {Many are calculating the total distance - $(4.4 \times 10^{-6} + 45 \times 10^{-9}) \times 2.03 \times 10^8 = 902\text{m}$ - this scores the first C1 mark for a 'valid' substitution but they must subtract 900m to score the final mark - it will probably not be 9 m but apply ecf - in the example above it would be 2m}

- (c) (i) intensity  pulse now longer
and lower (ie less intense) M1
A1 [2]
- (ii) different parts of pulse follow **diff. paths** OR ref. to "multipath dispersion" - M1
(hence) pulse spread over longer time (WTTE) A1 [2]
{Allow 1 mark for energy spread over longer time OR energy lost/absorbed B1}
{The words longer and shorter must be defined: eg longer time / longer path. Also allow "area under the graph stays the same"}

[TOTAL = 13]

3. (a) *interfere destructively*: the resultant wave has **reduced** (or zero) **amplitude**
OR "waves cancel each other" OR shown on a diagram B1
conditions: waves must meet **180°** OR π OR $1/2 \lambda$ out of phase B1
OR in ANTI-phase 'crest of one meets trough of other' OR shown on diagram
waves must have **equal amplitude** (not 'coherent' or 'same frequency') B1 [3]
- (b)(i) for maxima **path difference = 0** OR λ OR $n\lambda$ C1
series of maxima occur at pts. where path diff = 0, λ , 2λ , 3λ , 4λ A1 [2]
(OR when $n = 0, 1, 2, 3 \dots$ OR n is an integer)
- (ii) $x = \lambda D/a$ (allow $\lambda = ax/D$ or any valid form) B1 [1]
- (iii) **x DECREASES** C1
to **HALF** previous value A1 [2]
{Allow full ecf from incorrect formula - e.g "x \propto a hence x doubles" gets 2 marks- but give full credit for expected answer even if the candidate has quoted an incorrect formula in (ii)!}
- (c) wavetrains must be **coherent** (OR const phase diff/in phase OR same frequency) C1
an explicit reference to the SLITS or the TRANSMITTERS is needed: e.g. two transmitters would not be coherent (WTTE)
OR **two slits in front of a transmitter** create coherent sources A1 [2]

[TOTAL = 10]

4. (a) **plane wavefronts** approaching a gap B1
'**semicircular**' (allow ANY spreading shape) wavefronts leaving the gap B1
no change of wavelength stated or shown (generously judged by eye) B1 [3]
- (b) sound waves are **diffracted** B1
around the wall (OR spread out on other side of wall) B1 [2]
{Allow 1 mark for "sound is transmitted through the wall but light is not" OR "sound $\lambda \gg$ light λ and hence no diffraction of light"}

[TOTAL = 5]

5. (a) the coil moves at **RIGHT ANGLES** OR across pulse direction and **OSCILLATES** (or **WTTE**)
{Allow 2 marks for fully labelled diagrams } B1 [2]
B1
- (b)(i) (air particles vibrate) **vertically** OR **up & down** OR **along tube** B1 [1]
- (ii) **N** correctly labelled at the **base** AND **A** correctly labelled at the **top** B1 [1]
- (iii) $0.4 = \frac{1}{4} \lambda \Rightarrow \lambda = 1.6 \text{ m}$ B1
recall of $v=f \lambda$ C1
 $f = 320/1.6 = 200 \text{ Hz}$ A1 [3]
{allow ecf for candidate's λ - expect to see 400 Hz or 800 Hz each of which scores 2 marks }
- (iv) any other valid mode of oscillation: **N** at **bottom** AND **A** at **top** B1
all other **Ns** AND **As** correctly labelled *{allow ecf for cand's diagram}* B1 [2]

[TOTAL = 9]



RECOGNISING ACHIEVEMENT

Mark Scheme 2823/03
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