1.(a) R.I. or n = sin$i$ / sin$r$ {do not allow n=1/sinC} **B1**
i AND r correctly labelled - i.e between ray and normal **B1**

refracted ray bent towards the normal **B1 [3]**
{for direction look for arrows OR i and r shown OR media labelled}

(b) recall of $n = c_i / c_r$ *OR* n = speed of light in vacuum/speed of light in air **C1**

$c_r = 2.9979 \times 10^8 / 1.0004 = 2.9967 \times 10^8$ m s^{-1} (c.a.o.) **A1**

at least 3 decimal places shown in FINAL ANSWER **B1 [3]**
{n.b. make sure that they divide, not multiply, by 1.0004, final answer is 2.999, still scores 2 marks i.e. the first and the third.}

QUESTION TOTAL = 6

2.(a) light must be travelling from dense to a less dense material (WTTE) **B1**
angle of incidence must be greater than the critical angle (WTTE) **B1 [2]**

(b)(i) use of n = 1/sinC anywhere **C1**
1. sinC = 1/1.5 $\Rightarrow$ C = 42° for glass {expect 41.8} **A1**
2. sin C = 1/2.42 $\Rightarrow$ C = 24° for diamond {expect 24.4} **A1 [3]**
Simple recall of 42° for glass scores 1 mark

(ii) more TIR(s) in diamond, (hence more sparkling possibilities) (WTTE) **B1 [1]**
{allow "greater dispersion of light in diamond" ; reject "C is smaller for diamond"}

(c) Fig. 2.1 correctly completed with refracted ray bent away from the normal **B1**
Fig 2.2 correctly completed with TIR shown **B1**

'quality of drawing mark' for Fig 2.2 if angle of refln = 40^0 judged by eye or stated **B1 [3]**

Look out for ecf from **(b) (i)** for full marks : e.g. if $C_d > C_g$ diagrams will be reversed if $C_g < 40$ TIR in Fig 2.1; if $C_d > 40$ refracted ray in Fig. 2.2; if no TIR shown award quality of diagram mark for a 'realistic' refracted ray being drawn: e.g refracted ray drawn close to interface if critical angle is just greater 40°.

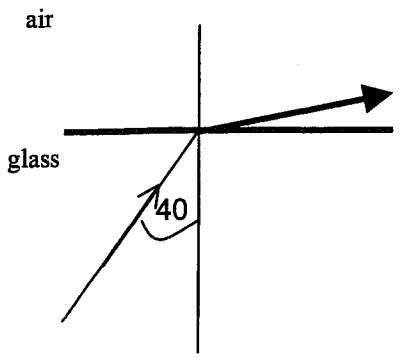

Fig.2.1

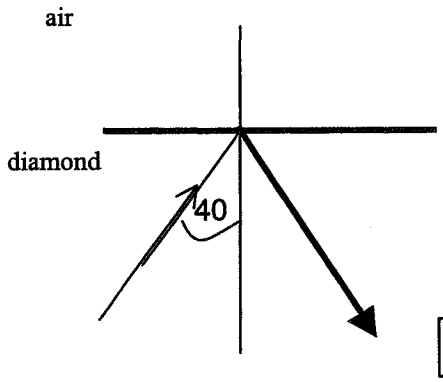

Fig.2.2

QUESTION TOTAL = 9

3.(a)(i) correct substitution into $n = c_i / c_r \Rightarrow$ speed of light in fibre = $3 \times 10^8 / 1.57$ **C1**

speed of light in fibre = 1.91×10^8 ms^{-1}

time = distance/speed = $500/1.91 \times 10^8 = 2.62 \times 10^{-6}$ s **C1**

{allow 'ecf' for 1 mark for simple use of t = dist/vel: e.g. $t = 500/3 \times 10^8 = 1.67 \times 10^{-6}$s} **A1 [3]**

(ii) some light will (undergo TIR and) follow a zig-zag path (WTTE) **B1 [1]**

{do not allow 'multipath dispersion' as an explanation}

(b) Any valid method of correcting multipath dispersion stated: e.g.
monomode (or very thin) fibres
{also allow step index or graded index fibres) **B1**

Valid explanation of chosen method: e.g. monomode fibres are so thin that most of the light follows the same path (WTTE)
{allow all light enters at the same angle} **B1 [2]**

QUESTION TOTAL = 6

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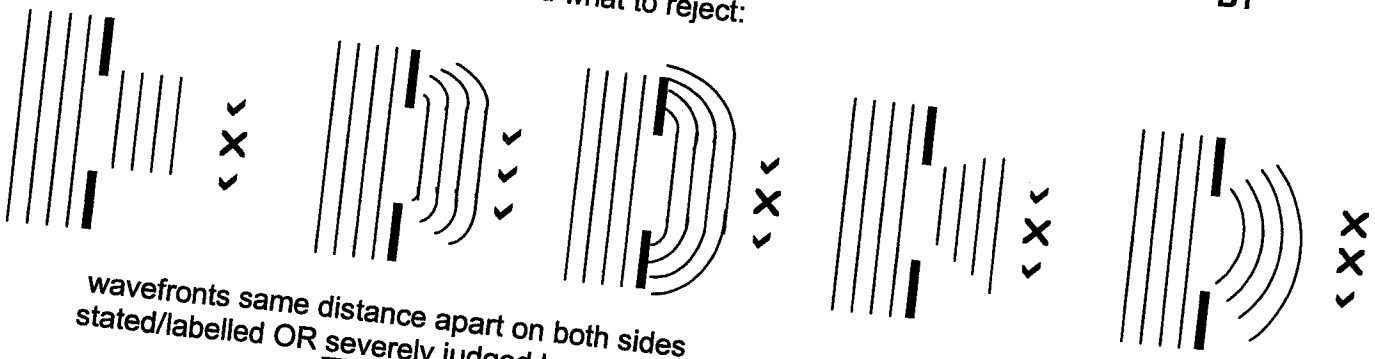
4. (a) diffraction:
spreading out of waves as they go through gap or pass an object (WTTE) - **B1 [1]**
{reject "bending of waves"}

(b) correct diffraction diagram showing:
plane waves approaching AND central plane wavefronts emerging **B1**
limited curved edges **B1**

Examples of what to accept and what to reject:



wavefronts same distance apart on both sides
stated/labelled OR severely judged by eye **B1 [3]**

(c) amount of diffraction increases as slit is reduced

(when $a=\lambda$) no plane waves emerge OR wavefronts become circular/semicircles **B1**
OR waves travel in all (forward) directions OR slit becomes a point source
{allow good diagrams for maximum marks} **B1 [2]**

QUESTION TOTAL = 6

5. (a) principle of superposition: when two waves meet/overlap/interfere/superimpose **B**
resultant amplitude/displacement is sum of the individual amps/disps (WTTE)
{allow correct diagram for the second mark} **C1 A1 [2]**

(b) (i) 1. One cycle represented by 2 cm (stated or implied)
Period = 2 x 0.2ms = 0.4ms = 4.0×10^{-4} s (0.0004) **C1**
{a common mistake is 0.4s and this scores 1 mark} **A1 [2]**

2. Frequency = 1/period
= 1/0.4ms = 2500 Hz
Look for ecf for cand's value for the period **B1 B1 [2]**

(ii) 1. P & Q same distance from speaker OR in phase OR zero path diff. **B1**
hence constructive interference/superposition (WTTE)
{do not allow arguments based on: nodes and antinodes/standing waves
OR "microphones closer to loudspeaker"} **B1**

2. as P is moved path difference changes
minima when P moves odd number of ½ λs
(& maxima if P moves whole number of λs)
OR minima when waves meet out of phase
(& max when waves meet in phase) (WTTE)
Allow convincing explanation of variation reference to max & minimum **[2]**

(iii) 1. First minimum corresponds to ½ λ path difference (stated or implied) **C1**
Wavelength = 2 x 6.8 = 13.6 cm = 0.136 m **A1 [2]**
{cm. used in the question so allow 13.6cm if candidates change unit,
otherwise penalise 13.6m but allow ecf for calculation of v in 2.}

2. use of $v=f\lambda \Rightarrow$ $v = 2500 \times 0.136$ **C1**
$v = 340$ m s^{-1} **A1 [2]**

Give full credit for ecf for cand.'s value of λ and f e.g if λ=13.6m v = 34000m/s
if f = 2.5Hz v = 34m/s both scoring 2 marks. **QUESTION TOTAL = 14**

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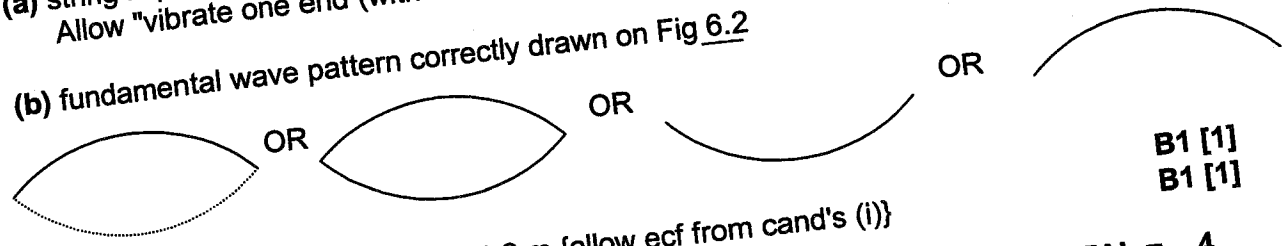
6. (a) string is plucked (WTTE) **B1 [1]**
Allow "vibrate one end (with other end fixed and adjust tension/frequency)"

(b) fundamental wave pattern correctly drawn on Fig 6.2 **B1 [1]**



B1 [1]

(c) (i) 0.6 m **B1 [1]**
(ii) λ/2 = 0.6m and hence λ = 1.2 m {allow ecf from cand's (i)}

QUESTION TOTAL = 4