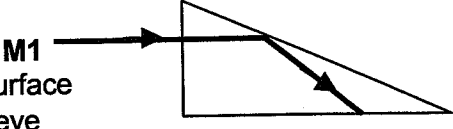
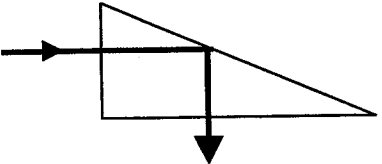



1. (a) **incident ray, refracted ray and normal all lie in same plane** B1
ratio of $\sin i / \sin r$ is constant (WTTE: eg $n = \sin i / \sin r$) B1 [2]
- (b)(i) $n = c_a / c_g$ OR $n = c_i / c_r$ C1
 $= 3.0 \times 10^8 / 2.0 \times 10^8 = 1.5$ A1 [2]
- (ii) recall of $n = 1 / \sin C$ C1
 $C = \sin^{-1}(0.67) = 42^\circ$ (41.8°) A1 [2]
{allow ecf for cand's value of n }
- (iii) no deviation at vertical side M1
total internal reflection at sloping surface
at valid angle – judged roughly by eye A1
- 
- This scores 1 mark (and is very common!)*
- 
- (iv) angle of incidence at **bottom surface** = 30° B1 [1]
If there is no ray at the bottom surface on cand's diagram 0 marks.
Allow ecf from diagram: e.g for above diagram 0° scores 1 mark, but 90° scores 0
Allow 'measured' angles if they are close to 30°
- (v) recall of R.I (or n) = $\sin i / \sin r$ B1
correct substitution $1/1.5$ (OR 0.67) = $\sin 30 / \sin r$ C1
 $\sin r = 0.75$ and hence $r = 49^\circ$ A1 [3]
If cand. uses $n = 1.5$ instead of 0.67 , max^m of 2 marks can be scored:
eg $i = 30^\circ$ leading to $r = 19.5^\circ$ scores 2 marks
Try to allow ecf for all eventualities: the most common will be
angle of incidence = 0° maximum of 2 marks for $r = 0^\circ$
angle of incidence = 90° maximum of 1 mark for stating formula
- (c)(i) total internal reflection occurs (WTTE) B1
OR rays correctly drawn on fig. 1.2b 
- because (angle of incidence = 45° and hence) $i > C$ (WTTE) B1 [2]
- (ii) No T.I.R. OR ray is refracted (into the acid) B1
because critical angle now much greater (WTTE)
OR angle of incidence less than C B1 [2]
OR RI has decreased (allow "changed")

QUESTION TOTAL = 16

2. (a) some light takes a **longer path** (allow "different" path) B1
 some light takes **longer time** (OR gets there faster) (WTTE) B1
 hence pulse is 'distorted'/'spread out'/'smeared'(any WTTE) B1 [3]
- (b) ANY 2 valid points from the following:
 increasing the critical angle **REDUCES** multipath dispersion (WTTE) }
 far fewer reflections (since $i > 88^\circ$) (WTTE) } B1 + B1
 virtually all the rays follow the same path OR take same time } [2]
- QUESTION TOTAL = (5)

3. (a)(i) correct sketch: **same shape** shifted to the **right** B1 [1]
At least one full cycle must be drawn
- (ii) arrows showing $X \uparrow, Z \downarrow$ B1 + B1 [2]
Award marks as shown irrespective of wave drawn by cand. but look for the new positions of X and Z shown on the cand's new wave position.
- (iii) wavelength = $2 \times 0.24 = 0.48\text{m}$ B1
 recall of $v=f\lambda$ C1
 $v = 3.6 \times 0.48 = 1.73 \text{ m s}^{-1}$ A1 [3]
Allow ecf for candidate's value of λ ; eg $\lambda = 0.24\text{m}$ $v = 0.865 \text{ m/s}$ scores 2 marks
- (iv) 1. wave speed **NO CHANGE** B1
 2. wavelength is shortened C1
 to a new value of **0.24 m** OR is halved A1 [3]
{allow ecf for cand's value from (iii)}
- (b)(i) fix one end & vibrate/oscillate other OR fix both ends & pluck }
 (identical) waves travelling in opposite direction (OR reflected) } B1 + B1
 (these waves) interfere or superimpose } [2]
- (ii) phase difference between 1. W and Y = **180°** (or π etc) B1
 EACH HALF (TOP + BOTTOM) **{do not allow $\frac{1}{2} \lambda$ etc}**
 is ... PHASE $\approx \frac{1}{2}$ CYCLE
 BUT COMP TO OTHER SIDE 2. Y and Z = **ZERO** (OR 360 or 2π etc) B1 [2]
- (iii) 1. a node is a point of zero amplitude (allow displacement) B1
{Allow "fixed point" OR "doesn't move/oscillate/vibrate"}
2. an antinode is a point of maximum amplitude (allow displacement) B1 [2]
{Allow "where rope moves/oscillates/vibrates the most"}

- (iv) 1. **V and X** are at nodes B1
 2. **W and Y** are at antinodes B1 [2]
{allow one mark max^m. for ONE correct nodal point AND ONE correct antinodal point provided there are no other errors: e.g 1. V and 2. W}
- QUESTION TOTAL = (17)
4. (a)(i) plane polarised light **vibrates (allow travels) in one plane only** B1 [1]
{Look for reference to 'one plane' of oscillation and reject 'direction'}
- (ii) only transverse waves can be polarised (WTTE) B1
 sound waves are longitudinal OR "not transverse" (WTTE) B1 [2]
- (b) evidence of knowledge of full/max transmission - when polaroid is parallel to the light's plane of polarisation {or vibrations} B1
 no transmission when polaroid is at right angles to light's plane of polarisation {or vibrations} B1 [2]
{Do not allow answers that merely describe the shape of the graph given}
- (c) Any valid example: e.g. Radio waves, microwaves M1
 valid method of detection: e.g. aerial, microwave detector(!) A1 [2]
- QUESTION TOTAL = (7)
-

5. (a) when two waves **meet (OR interfere) (at a point)** B1
 the resultant displacement is **sum** of individual displacements (WTTE) B1 [2]
{allow 'amplitude'}
- (b)(i) same frequency OR wavelength B1
 "in phase" (WTTE) B1 [2]
{n.b. "constant phase difference scores 2 marks}
- (ii) (path difference =) $S_2P - S_1P = (\frac{1}{2})\lambda$ B1 [1]
- (iii) evidence of realisation that "fringe separation" $x = 8\text{mm}$ B1
 recall of $\lambda = ax/D$ (allow candidate's choice of symbol for x) C1
 $a = \lambda D/x = (6.4 \times 10^{-7} \times 1.5)/8 \times 10^{-3} = 1.2 \times 10^{-4} \text{ m}$ A1 [3]
{Allow ecf for cand's x : eg if $x = 4\text{mm}$, $a = 2.4 \times 10^{-4} \text{ m}$ - this scores 2 marks}
- (iv) maximum intensity when $y=0$ AND minima at +4 and -4 B1
 correct 'period' i.e 8 mm with at least 2 full cycles drawn B1 [2]
- QUESTION TOTAL = (10)
-

6. (a) **spreading out** of waves (into a 'shadow region') (WTTE) M1
when the waves meet an aperture or obstacle (WTTE) A1 [2]
- (b) **narrow gap:**
almost full semicircles (no straight section)
with gap at centre B1
- wide gap:**
virtually straight (must have some straight section)
with gap at centre B1
- wavelength** shown to be **constant** – generously judged by eye B1
OR same λ labelled before & after aperture on either diagram [3]

QUESTION TOTAL = 5
