

1. (a) c_i = speed of light in air/vacuum/free space (accept speed of incident ray) B1
 {reject 'speed in medium1'}
 c_r = speed of light in medium (allow glass.water/perspex) OR speed of refracted ray B1 [2]
- (b) (i) normal drawn correctly (ignore labelling of normal) B1
 angle of incidence correctly shown with 60° or i , B1
 corresponding angle of refraction r correctly labelled must be $< 60^\circ$ OR i , (allow 36°) B1 [3]
 {ambiguous diagrams with normal and interface indistinguishable score max of 1 mark}
- (ii) recall of $n = \sin i / \sin r$ C1
 correct substitution: e.g. $1.48 = \sin 60 / \sin r$ OR $\sin r = \sin 60 / 1.48$ C1
 correct determination of $r \Rightarrow r = 36^\circ$ (35.8, 35) A1 [3]
- (iii) $n = \lambda_{\text{air}} / \lambda_{\text{med}}$ OR $6.48 \times 10^{-7} / \lambda_{\text{med}}$ OR $n = c_1 / c_2$ AND $c = f\lambda$ (OR $v = f\lambda$) C1
 $\lambda_{\text{med}} = (6.48 \times 10^{-7}) / 1.48 = 4.38 \times 10^{-7}$ m (allow 4.36, 4.37 4.3, 4.4) A1
 $f_{\text{med}} = f_{\text{air}}$ OR $f_{\text{med}} = 4.63 \times 10^{14}$ Hz –(allow 4.6) OR 'stays the same' B1 [3]

[N.B Change of total from question paper]

[Total = 11]

2. (a) (i) C correctly labelled on ray Y B1
 (ii) ray X refracted into the air away from the normal (ignore any reflected ray) B1
 ray Y refracted ALONG INTERFACE (ignore any reflected ray) B1
 ray Z TOTALLY INTERNALLY REFLECTED (at any angle in glass) B1 [3]
 (iii) correct substitution into $n = 1 / \sin C$: e.g. $n = 1 / \sin 44$ C1
 $= 1 / 0.695 = 1.44$ (allow 1.43, 1.45 or 1.4) A1 [2]
- (b) ANY valid practical application of TIR stated and described e.g.: endoscope (telecommunication, periscope, binoculars, SLR camera, cycle reflectors, cats-eyes) B1
 reference to optic fibres OR prisms (allow diagrams) B1 [2]

[Total = 8]

3. Maximum of 2 marks for correctly identifying the 4 errors OR stating the 2 correct notes:
 i.e. errors in notes 1, 2, 3, and 6 (shown anywhere) B2
 {5 or 6 or 2 or 1 notes nominated scores ZERO, 4 correct scores 2, 3 correct scores 1}

Valid corrections score 1 mark each: do not allow "NOT" corrections apart from note 3

Note 1: In longitudinal waves vibrations are parallel to wave direction (WTTE) B1
 {OR in transverse waves vibrations are perpendicular to wave direction (WTTE)}

Note 2 light (or any of the em waves) can travel through a vacuum (WTTE) B1
 {allow sound/longitudinal waves cannot travel thro' a vacuum}

Note 3: waves carry energy/disturbance (not displacement or info) from..... (WTTE) B1
 {allow "waves do not carry the medium" and "the medium carries the waves from....." }

Note 6: wavelength = distance from crest to crest/trough to trough/max to max ((WTTE) B1 [6]

[N.B. Change of total from question paper]

[Total = 6]

4. (a) diagram showing laser/light source placed directly behind double slit AND screen placed in front of slits {single slit NOT required; no labelling required}	B1	[1]
(i) D : allow any value between 30cm and 10m	B1	
(ii) a : allow any value between 0.1mm and 2mm	B1	[2]
(b) (i) evidence of good practice: i.e distance for $n\lambda$ measured e.g. $5x = 18\text{mm}$ $x = 3.6\text{ mm}$ (OR 3.5 OR 3.7)	C1	
$\{x = 3.4, 3.8, 3.9, 4.0, \text{ or } 4\text{ mm, implying } x \text{ is directly measured, and score 1 mark}\}$	A1	[2]
(ii) for O path difference = 0	B1	
for A path difference = $3(\lambda)$	B1	
for B path difference = $1.5(\lambda)$	B1	[3]
(c) recall of $\lambda = ax/D$ OR $x = \lambda D/a$ OR $x \propto \lambda$	B1	
λ is smaller for blue light (than red light) hence x is SMALLER (WTTE)	B1	[2]
[N.B. Change of total from question paper]		[Total = 10]

5. (a) ANY valid differences: e.g. Sound is longitudinal (light is not) OR light is transverse (sound is not) OR sound waves have longer wavelengths' OR sound travels much slower Light can be polarised (sound cannot) Light can travel through a vacuum, (sound cannot)	B1 +B1	[2]
(b) (i) a straight object (allow paddle, NOT dipper) vibrating (or oscillating) (WTTE) (in the water)	B1	
	B1	[2]
(ii) reduce frequency of motor OR reduce speed of motor OR reduce current in motor OR reduce frequency/increase period <u>of vibration</u> (do not accept 'reduce speed of vibration'; 'reduce frequency'; 'increase speed of waves') OR increase depth of water	B1	[1]
(iii) reduce depth of water (WTTE) {no ecf from (ii)}	B1	[1]
(c) circular arcs (penalise anything flat) same constant wavelength before and after gap – judged by eye or labelled this means at least <u>3 wavefronts need to be drawn</u>	B1	
	B1	[2]
(d) for noticeable diffraction $\lambda \approx$ gap size (WTTE)	B1	
λ for sound much bigger than for light (WTTE)	B1	[2]
		[Total = 10]