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 60º or i, B1
corresponding angle of refraction r correctly labelled must be < 60º OR i,(allow 36º) B1 [3]
{ambiguous diagrams with normal and interface indistinguishable score max of 1 mark}
(ii) recall of n =sini/sinr C1
correct substitution: e.g. 1.48 = sin 60/sinr OR sinr = sin60/1.48 C1
correct determination of r ⇒ r = 36º (35.8, 35)) A1 [3]

(iii) n =$\lambda_{air}/\lambda_{med}$ OR $6.48\times10^{-7}/\lambda_{med}$ OR n= c_1/c_2 AND c = fλ (OR v=fλ) C1
λ_{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_{med} = f_{air} OR f_{med} = 4.63×10^{14} Hz –(allow 4.6) OR 'stays the same'- B1 [3]

[N.B Change of total from question paper] [Total = 11]

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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/sinC : e.g. n = 1/sin44 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]

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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 B1 [1]
{single slit NOT required; no labelling required}
(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 nx measured e.g. 5x = 18mm C1
x = 3.6 mm (OR 3.5 OR 3.7) A1 [2]
{x = 3.4, 3.8, 3.9, 4.0, or 4 mm, implying x is directly measured, and score 1 mark)
(ii) for O path difference = 0 B1
for A path difference = 3(λ) B1
for B path difference = 1.5(λ) B1 [3]

(c) recall of λ= ax/D OR x =λD/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]

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5. (a) ANY valid differences: e.g.
Sound is longitudinal (light is not) OR light is transverse (sound is not) B1 +B1 [2]
OR sound waves have longer wavelengths' OR sound travels much slower
Light can be polarised (sound cannot)
Light can travel though a vacuum, (sound cannot)

(b) (i) a straight object (allow paddle, NOT dipper) B1
vibrating (or oscillating) (WTTE) (in the water) 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) B1
same constant wavelength before and after gap – judged by eye or labelled B1 [2]
this means at least <u>3 wavefronts need to be drawn</u>

(d) for noticeable diffraction $\lambda \approx$ gap size (WTTE) B1
λ for sound much bigger than for light (WTTE) B1[2]

[Total = 10]