Question Number	Answer	Mark
1	QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence Identifies two rays of light Two rays have same frequency/come from same source/are coherent Path difference (between the two reflected rays) They superpose (when they meet) /constructive and destructive interference occur If they meet in phase/nλ /λ path difference, constructive interference/ bright fringe If they meet in antiphase / (n+ ½)λ / ½ λ path difference, destructive interference/dark fringe	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(max 5)**
	Total for question	**5**

Question Number	Answer	Mark
2(a)	n = sin 48 / sin 30 n = 1.5 (common answer will be 1.49) (n = 0.67 scores 1 mark for idea of ratio of sin of angles)	**(1)** **(1)**
2(b)(i)	QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence As x increases, y increases **OR** At a certain angle / critical angle, y = 90° / the light travels along the boundary (do not allow reflects at 90°) For angles greater than the critical angle (in glass) total internal reflection occurs (do not accept TIR)	 **(1)** **(1)** **(1)**
2(b)(ii)	Use of sin c = 1/n c = 42^{O} ecf n from (a) unless n= 0.67 which scores 0 here	**(1)** **(1)**
	Total for question	**7**

Question Number	Answer	Mark
3(a)	Ray drawn along edge of prism (labelled X) **(**ignore a reflected ray)	**1**
(b)(i)	$n = 3 \times 10^{8} \div 1.96 \times 10^{8}$ $n = 1.53$ (no unit, ue if one given)	**1** **1**
(b)(ii)	Use of sin (critical angle) = 1/ n **OR** use of sin i/sin r = v_1/v_2 = n $c = 41^{o}$	**1** **1**
(c)	Red light: refraction towards normal at first face but less than refraction for blue light Refracts into air at second face with angle in air > angle in glass	**1** **1**
	Total for question	**7**

Question Number	Answer		Mark
4(a)	Use of sin $i \times v_2 = \sin r \times v_1$ $r = 90$ º at critical angle critical angle = 75º Acceptable alternative: Use of ${}_1\mu_2 = v_1 / v_2$ State sin $c = 1 / \mu$ $c = 75$º ($\mu = 1.036$, but look out for effects of rounding on calculated angle) <u>Example of calculation</u> sin c /1 = 1.96/2.03 $c = 75$º	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
4(b)	It will be reflected (back into the core) / totally internally reflected Reflection back into core may be shown on the diagram (allow e.c.f for value of c from (a))	**(1)**	
4(c)	Most of the light will undergo repeated (total internal) reflection **Or** most light continually strikes at greater than the critical angle **Or** minimal light is lost through refraction Light reaches the bottom of the curtain **Or** Rays hitting the bottom will escape **Or** light hits the bottom at less than the critical angle	**(1)** **(1)**	**2**
	Total for question 18		**6**

Question Number	Answer	Mark
5(a)(i)	Use of $n = v_1/v_2$ with λ proportional to v (1) (seeing 1.53×414 or $414/1.53 = 271$ nm gets 1st mark) Wavelength in disc = 633 nm (1) (Alternative method finds v in plastic, then f of wave, leading to λ in air. Correct answer by this method scores 2 but incorrect answer can score the method mark) <u>Example of calculation</u> n = wavelength in air /wavelength in disc λ in air = $1.53 \times 414 = 633$ nm	**2**
5(a)(ii)	Division of a wavelength by 2 or 4 (414 nm or their λ from (a)(i)) (1) Vertical distance = 104 nm or ¼ their λ from (a)(i) (1)	**2**
5(a)(iii)	<u>Destructive</u> interference / superposition (1) Amplitude/intensity of wave is zero/min **OR** binary value zero **OR** there is min/no light **OR** the waves cancel/almost cancel each other **OR** cancellation	**2**
5(b)(i)	Use of sin critical angle = $1/n$ (1) $c = 40.8^o$ (accept 41 ^{o}) (1) [bald answer of 41° scores zero] <u>example of calculation</u> sin $c = 1/1.53$ $c = 40.8^o$	**2**
5(b)(ii)	Marks can only be scored for answers where the light is only in the plastic Reflection shown at point P (1) Angle of incidence = angle of reflection (judge by eye) and greater than their critical angle from (b)(i) (1) (do not penalise if arrows not drawn . Labels could override poor drawing)	**2**
	Total for question 19	**10**

Question Number	Answer		Mark
6(a)	Credit any sensible limitation Examples include: • blunt pencil, • protractor divisions only to one degree, • protractor of limited radius • method requires rays to be marked and then drawn on Limited precision – linked to limitation	**(1)** **(1)**	**2**
6(b)	Use of refractive index = ratio of speeds Speed = 2.0×10^8 m s^{-1} <u>Example of calculation</u> speed in plastic = 3.0×10^8 m $s^{-1} \div 1.52$ = 1.97×10^8 m s^{-1}	**(1)** **(1)**	**2**
6(b)(ii)	Use of sin $c = 1/\mu$, sin $c = 1/n$ (or equivalent, but must allow full solution if used correctly without further equations) critical angle = 41º <u>Example of calculation</u> sin $c = 1/1.52$ $c = 41$º	**(1)** **(1)**	**2**
***6(c)**	**(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)** The light strikes the sides at an angle greater than the critical angle It undergoes <u>total</u> internal <u>reflection</u> It is reflected again It strikes the other end at less than the critical angle **Or** It is transmitted at the final boundary **Or** the ray has zero angle of incidence at the first end and is transmitted undeviated	 **(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 15		**10**

Question Number	Answer		Mark
7 (a)	change in direction / wavelength (of wave/ray/light) (when entering a medium where) the wave has a different velocity **OR** (when entering a medium where) the density is different the light travels at a lower speed in the air than in a vacuum	**(1)** **(1)** **(1)**	**3**
7 (b)	identify angle of incidence = 64º use of sin i / sin r = refractive index r = 63.9° to at least 3 sf calculation of difference = 0.12º <u>Example of calculation</u> sin r = sin $i \div \mu$ = sin 64° ÷ 1.001 r = 63.88° difference = 0.12º	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 15		**7**