Marking Scheme

#1

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)		Use of Snell's law (1), e.g. $\sin 18.4^\circ = 1.65 \sin\theta_2$ Manipulation or Answer = 11.0° (1) accept $\sin^{-1}\left(\frac{\sin 18.4^\circ}{1.65}\right)$ but not just 10°	1	1		2	1	
	(b)		$\phi = 90 - \theta$ (79 or 80) (1) $n_2 \sin\theta_2 = n_3 \sin 90$ applied (1) or $n_2 \sin 79 = n_3 \sin\theta$ Answer = 73.2° (1) or no solution for θ Conclusion = Yes since ϕ greater than critical (1) [allow ecf on a calculated value of critical angle] or Yes refraction is impossible			4	4	3	
			Question 2 total	**1**	**1**	**4**	**6**	**4**	**0**

#2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				Multimode points 1 – Multiple paths/angles (of propagation) or in diagram 2 – Paths of varying lengths take different times / longer zigzag or in diagram 3 – (Individual) pulses spread out / blurring / smearing / dispersion 4 – Pulses can overlap / not in the same sequence 5 – (Leads to) data loss / pulses unreadable **Monomode points** 1 – Only one path or in diagram 2 – No or minimal dispersion 3 – Cores are very thin or a few wavelengths thick or multimode thicker i.e. by implication 4 – Advantage is greater bandwidth/pulse frequency/greater distance [without data loss] **5-6 marks** 7-9 points made *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** 4-6 points made *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** 1-3 points made *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure.* **0 marks** *No attempt made or no response worthy of credit.*	6			6		
				Question total	**6**	**0**	**0**	**6**	**0**	**0**

#3

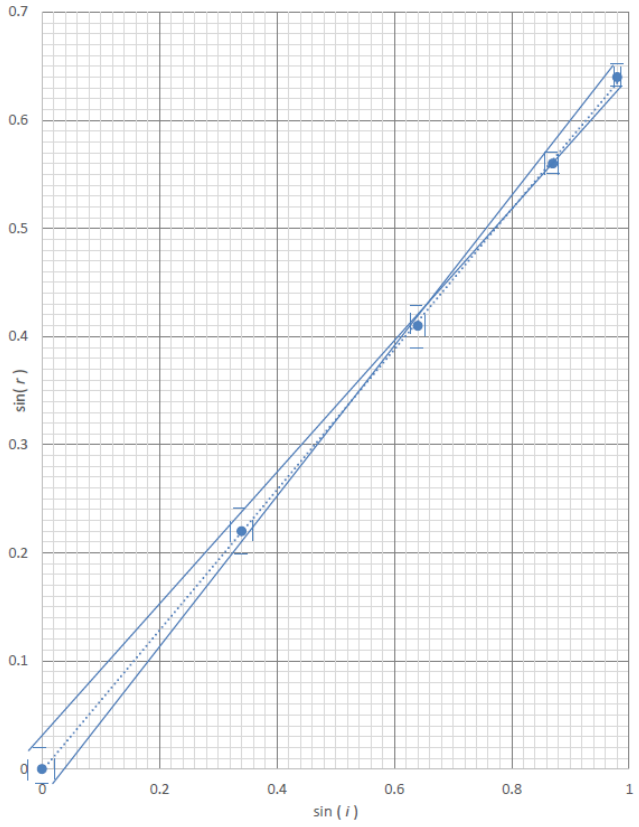
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	(a)		Refraction is a change in direction of the travel of waves (1) Waves travel more slowly in glass than in air (1) Therefore AB is greater than CD (1)	1 1	1		3		
	(b)		Measuring lengths AB = 2.9 cm and CD = 1.8 cm within 0.1 cm (1) Speed = $\frac{BD}{t}$ and $\frac{AC}{t}$ (can be implied) (ecf) (1) Speed = 1.9 [or 1.86] × 10^8 [m s^{-1}] (1)	1	1 1		3	2	
			Question 3 total	**3**	**3**	**0**	**6**	**2**	**0**

#4

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(a)		Use and rearrangement of: $n_1 \sin\vartheta_1 = n_2 \sin\vartheta_2$ (1) Angle θ = 36[°] (1)		2		2	2	
	(b)	(i)	Use and rearrangement of: 1.47 sin θ = 1.33 sin 90 (1) Critical angle = 65[°] (1)		2		2	2	
		(ii)	Angle of incidence [at boundary] less than critical angle (1) Refraction [occurs] (1)		2		2		
	(c)		Use and rearrangement of: $n = \frac{c}{v}$ (1) Speed of light in oil = 2.0×10^8 [m s^{-1}] (1)		2		2	2	
			Question total	**0**	**8**	**0**	**8**	**6**	**0**

#5

Question			Marking details	Marks available AO1	AO2	AO3	Total	Maths	Prac
	(a)		Bending toward the normal in the glass (not along normal) (1) Light comes out approximately parallel to original (by eye) (1)	2			2		2
	(b)	(i)	See graph on next page Most y error bars correct (1) Most x error bars correct (1) All error bars correct (1) Drawing maximum and minimum lines (1)		4		4	4	4
		(ii)	Method for calculating gradient (accept inverse if used correctly) (1) At least 2 gradients correct (0.695, 0.648, 0.606) (1) Refractive index = $\frac{1}{\text{gradient}}$ used or implied (1) n = 1.6 ± 0.1 or 1.56 ± 0.12 needs to be with consistent sig figs allow a max of 2 sig figs for the uncertainty (1) **accept** 0.08 - 0.12 for the uncertainty			4	4	4	4
			Question total	**2**	**4**	**4**	**10**	**8**	**10**



#6

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	(a)	(i)	Rearranging $\sin c = \frac{1.47 \sin 90}{1.52}$ (1) Critical angle = 75.3° (1)		2		2	2	
		(ii)	Substitution into Snell's law i.e. $\sin 15° = 1.52 \sin \theta_r$ (1) Refracted angle = 9.8° (1) A = 80.2° (90 - θ_r) (ecf on θ_r) (1)	1	1 1		3	2	
		(iii)	Angle A is greater than critical angle (ecf on A and critical angle) (1) So total internal reflection and light will travel down the fibre OR technician not correct (1)			2	2		
	(b)		Substituting values in speed = $\frac{\text{distance}}{\text{time}}$ (1) Speed of light in fibre = $\frac{c}{1.52}$ (1) Time = 7.6×10^{-5} s (1)	1	1 1		3	3	
	(c)	(i)	Monomode – parallel to axis/straight – Multimode zig zag paths	1			1		
		(ii)	No spreading of pulses OR only one path for data (1) Each pulse arrives at same time OR No overlapping of pulses (1) Allows faster rate of data transfer (1)	3			3		
			Question 6 total	**6**	**6**	**2**	**14**	**7**	**0**