Question Number	Answer		Mark
13(a)	Use of $n_1\sin\theta_1 = n_2\sin\theta_2$	(1)	
	r for violet light = 31.9° **or** r for red light = 32.3°	(1)	
	Use of trigonometry to calculate horizontal distances whilst in block	(1)	
	For violet, distance = 3.98 cm **or** for red, distance = 4.05 cm	(1)	
	Distance between points = 0.070 cm / 0.70 mm	(1)	**5**
	(If working is only shown to 2 significant figures, the distances will come out to be the same. This can score MP1-4 only if all the working is clearly shown) (For MP1, allow use of n = sin i / sin r) (If candidate has the n values the wrong way round, MP1 can still be awarded if equation used correctly otherwise) <u>Example of calculation</u> $n_1\sin\theta_1 = n_2\sin\theta_2$. In air, n_1 = 1.000 and θ_1 = 54.00° so, for violet light, sin$r$ = sin (54.00°) / 1.532, so r = 31.88° For red light, sin$r$ = sin (54.0°) / 1.513, so r = 32.32° For violet light, tan (31.88°) = x / 6.400 cm, so x = 3.981 cm For red light, tan (32.32°) = x / 6.40 cm, so x = 4.049 cm Distance between points = 4.049 cm − 3.981 cm = 0.068 cm		
13(b)	Use of $n_1\sin\theta_1 = n_2\sin\theta_2$	(1)	
	Calculates $n\sin\theta$ as 0.99 for red **Or** 1.01 for violet	(1)	
	Red light refracts out of the glass as $n\sin\theta < 1$	(1)	
	Violet light undergoes total internal reflection as $n\sin\theta > 1$	(1)	
	(If candidate has the n values the wrong way round, MP1 can still be awarded if equation used correctly otherwise) **OR** Use of sin $C = 1/n$	(1)	
	Critical angle for violet = 40.7° **Or** critical angle for red = 41.4°	(1)	
	Red light refracts out of the glass as $C > i$	(1)	
	Violet light undergoes total internal reflection as $C < i$	(1)	**4**
	<u>Example of calculation</u> $n\sin\theta$ for violet light = 1.532 sin (41.00°) = 1.005. $n\sin\theta$ for red light = 1.513 sin (41.00°) = 0.993.		
	Total for question 13		**9**