Question number	Answer	Notes	Marks
1 (a)	1 mark for each correct line;;;; Point Star classification a white dwaif c red giant Very bright blue star	reject any box from the left with 2 lines	4
(b)	(a measure of) brightness; (of a star) at a {standard / fixed / same} distance;	allow power, luminosity, intensity allow correct distance e.g. 10 parsecs/32(.6) light years	2

Total for Question 1 = 6 marks

estion mber		Answer	Notes	Marks
(a)	(i)	angle of incidence;	ignore incident ray	1
	(ii)	recognising 67 (degrees) as anomalous;	allow 1 mark if anomalous result included e.g. 37, 37.3 (degrees)	2
		evaluation of a mean;		
		e.g. mean angle = (22 + 23) / 2 = 23 (degrees)	allow 22, 22.5 (degrees)	
	(iii)	n calculated for multiple angles; mean value obtained for n ;		2
		OR		
		idea of graph plotted of sin(i) against sin(r); n found from gradient of (sin(i)-sin(r)) graph;		
(b)	(i)	<pre>substitution into n = sin(i) ÷ sin(r) ; evaluation;</pre>	1.3 scores 1 mark only	2
		e.g. refractive index = sin(82) ÷ sin(47) (refractive index =) 1.4	allow 1.35	
	(ii)	sin(c) = 1/n;	allow any correct rearrangement	1
	(iii)	substitution and rearrangement; evaluation;		2
		e.g. $c = \sin^{-1}(1/1.7) = \sin^{-1}(0.588)$ (critical angle =) 36 (degrees)	allow 36.03 (degrees)	
(c)		light undergoes TIR; (because) angle (of incidence) is greater than critical angle;		2
	(a)	(a) (i) (ii) (iii) (iii)	(a) (i) angle of incidence; (ii) recognising 67 (degrees) as anomalous; evaluation of a mean; e.g. mean angle = (22 + 23) / 2 = 23 (degrees) (iii) n calculated for multiple angles; mean value obtained for n; OR idea of graph plotted of sin(i) against sin(r); n found from gradient of (sin(i)-sin(r)) graph; (b) (i) substitution into n = sin(i) ÷ sin(r); evaluation; e.g. refractive index = sin(82) ÷ sin(47) (refractive index =) 1.4 (ii) sin(c) = 1/n; (iii) substitution and rearrangement; evaluation; e.g. c = sin ⁻¹ (1/1.7) = sin ⁻¹ (0.588) (critical angle =) 36 (degrees)	(a) (i) angle of incidence; ignore incident ray allow 1 mark if anomalous result included e.g. 37, 37.3 (degrees) (iii) recognising 67 (degrees) as anomalous; allow 1 mark if anomalous result included e.g. 37, 37.3 (degrees) (iii) n calculated for multiple angles; mean value obtained for n; OR idea of graph plotted of sin(i) against sin(r); n found from gradient of (sin(i)-sin(r)) graph; (b) (i) substitution into n = sin(i) ÷ sin(r); evaluation; e.g. refractive index = sin(82) ÷ sin(47) (refractive index =) 1.4 (ii) sin(c) = 1/n; allow any correct rearrangement (iii) substitution and rearrangement; evaluation; e.g. c = sin¹(1/1.7) = sin¹(0.588) (critical angle =) 36 (degrees) allow 36.03 (degrees)

Total for Question 6 = 12 marks