Question number	Answer	Notes	Marks
4 (a) (i)	use of acceleration = change in velocity / time; substitution; evaluation; e.g. acceleration = change in velocity / time acceleration = (-)30 / 6.2 (acceleration =) (-)4.8 (m/s^2)	seen anywhere in working allow clear indication that acceleration is gradient ignore minus sign allow (-)4.8 to (-)5.0 (m/s^2)	3
(ii)	clear indication that distance is area under line; understanding braking distance is area of triangle section only; evaluation; e.g. distance = area distance = 0.5 × 30 × 6.2 (distance =) 93 (m)	 54 (m) = 1 mark 147 (m) = 2 marks accept alternative method using ecf answer from (a)(i) and $v^2 = u^2 + 2as$ giving 93.75 (m)	3
(iii)	thinking distance: increase in thinking distance; (due to) increased reaction time; braking distance: no effect on braking distance; (due to) no effect on braking time / braking force;	 allow idea that braking distance does not depend on human factors	4
(b)	A; B is incorrect because it does not show deceleration C is incorrect because the distance cannot change abruptly and the car is moving throughout D is incorrect because the first portion shows that the car is not moving		1

Total for Question 4 = 11 marks

	Answer	Notes	Marks
6 (a)	any four from: MP1. water near heater is heated; MP2. (heated) water expands; MP3. density of (heated) water decreases; MP4. lower density / warm water rises; MP5. cooler / denser water sinks; MP6. process repeats / is continuous;	allow clear annotations on diagram accept 'particles move apart from each other'/'particles spread out' reject particles expand	4
(b) (i)	temperature increases with time; idea that rate of temperature increase reduces;	 allow 'temperature increases at a decreasing rate'/ EQ for 2 marks	2
(ii)	temperature rise is quicker when container is empty; with any two explanations from: • particles move around quicker/have more KE in gases; • convection current is faster in gases; • energy transfer (by convection) is quicker; • mass of air in empty container less than mass of water in full container; • specific heat capacity of air is lower than water;	allow empty container reaches higher temperature ignore comments about conduction allow particles in gases are more free to move allow less particles in empty container allow RA	3

Total for Question 6 = 9 marks

Question number	Answer	Notes	Marks
11 (a) (i)	line drawn in top-right quadrant; correct angle by eye;	accept if drawn on diagram 1 instead of diagram 2 DOP	2
(ii)	32 (degrees);	allow in range 31-33 (degrees)	1
(iii)	refractive index = sin(angle of incidence) / sin(angle of refraction);	allow standard symbols and rearrangements e.g. 'i' for angle of incidence 'r' for angle of refraction 'n' for refractive index	1
(iv)	substitution; evaluation to at least 3s.f.; e.g. n = sin(64) / sin (32) n = 1.70	allow ecf from (ii) allow 1.696…	2
(v)	sin(c) = 1 / n;	allow standard symbols and rearrangements	1
(vi)	substitution OR rearrangement; evaluation; e.g. sin(c) = 1/1.7 OR c = $\sin^{-1}(1/n)$ (c =) 36 (degrees)	allow ecf from (iv) allow 36.03…(degrees)	2
(b)	light undergoes total internal reflection; angle of incidence is above the critical angle; light (would be) going from more (optically) dense to less (optically) dense;	allow TIR for 'total internal reflection' allow idea that light would speed up if it travelled through the boundary / light travels faster in air than in material	3

Total for Question 11 = 12 marks