Question			Expected Answers	Marks	Additional Guidance
1	(a)		(Force is 1 N) when a **1 kg** mass has an acceleration of **1 m s^{-2}**	**B1**	**Not**: '1 kg and 1 m s^{-1}' **Allow**: (1 N =) **1 kg** × **1 m s^{-2}**
	(b)		The mass of particles increases (at its speed gets closer to the speed of light)	**B1**	**Not**: 'weight of particle increases' **Not**: 'mass changes / different'
	(c)	(i)	net force = 120 (N) $a = \frac{120}{900}$ a = 0.13 (m s^{-2})	**C1** **A1**	 **Note**: Bald answer scores 2 marks; answer must be 2 sf or more
		(ii)	The drag force changes with speed / acceleration is not constant	**B1**	
	(d)		$F = 72 \times 1.4$ (= 100.8 N) / weight = 72 × 9.81 (= 706.32 N) T = (72 × 9.81) + (72 × 1.4) T = 807 (N) or 810 (N)	**C1** **C1** **A1**	**Note**: Bald 101 (N) or 706 (N) scores 1 mark **Note**: Bald answer scores 3 marks Bald 605.52 to at least 2 sf scores 1 mark
			Total	**8**	

Question			Expected Answers	Marks	Additional Guidance
2	(a)		torque of a couple = one of forces × perpendicular distance (between forces)	B1	**Not**: 'force × perpendicular distance'
	(b)		Torque and moment are to do with 'distance multiplied by force'	B1	
	(c)	(i)	moment = 6.0 × 0.40 moment = 2.4 (N m)	B1	
		(ii)	Weight / force acts through the pivot Or (perpendicular) distance from pivot is (reduced to) zero (wtte)	B1	**Allow**: weight is 'vertically below' / 'directly below' the pivot Reference to pivot / point **P** (wtte) is essential
	(d)		Any three from: 1. (Suspend plate from a point and then) mark a vertical line on the plate (wtte) 2. Plumb line / 'pendulum' (used to find the vertical line) 3. Hang from another point / place (and draw another vertical line) (wtte) 4. Where the lines intersect gives position of centre of gravity (wtte)	B1×3	**Note**: For 1st point accept 'mark line of string' **Allow**: 1 mark for 'By trial and error find a position where the plate balances'
	(e)		(sum of) clockwise moment(s) = (sum of) anticlockwise moment(s) $(18 \times 0.14) + (60 \times 0.32) = 0.035F$ $F \approx 620$ (N)	C1 C1 A1	**Not**: 'CWM = ACWM' **Allow**: working in consistently in cm **Note**: Bald answer scores 3 marks **Allow**: 1 mark for 21.72 (N m) or 2172 (N cm)
			Total	10	

Question			Expected Answers	Marks	Additional Guidance
3	(a)		$F_H = 20\cos 38 = 15.76 \approx 15.8$ (N)	B1	**Allow**: 2 sf answers of 16 (N) and 12 (N)
			$F_V = 20\sin 38 = 12.31 \approx 12.3$ (N)	B1	**Allow**: 1 mark if vertical and horizontal components have been interchanged
	(b)	(i)	net force vertically = 0 / weight = upward forces	C1	
			weight = 12.3 + 12.3	C1	Possible ecf from F_V value from **(a)**
			weight = 24.6 (N) ≈ 25 (N)	A0	
			---------- Or ----------		
			correct triangle of forces diagram	C1	At least one label needed (e.g: 20, correct angle, etc) – arrows not needed
			correct determination of weight	C1	Weight in the range 22 – 27 (N)
			weight = 24.6 (N) ≈ 25 (N)	A0	
		(ii)	mass = $\frac{25}{9.81} = 2.55$ (kg)	C1	**Note**: 2.51 kg if 24.6 N is used
			density = $\frac{2.55}{2.9\times10^{-4}}$	C1	
			density = 8.8×10^3 (kg m^{-3})	A1	**Note**: 'weight/volume' scores zero **Note**: Answer is 8.7×10^3 if 2.51 kg is used **Allow**: 2 marks if g = 10 used and 25 N → 2.5 kg $\therefore \rho$ = 8620 (kg m^{-3}) **Note**: Bald 8.7×10^3 or 8.8×10^3 scores 3 marks **Allow**: 1 mark if 20 N is used instead of 25 N – this gives 7030 (kg m^{-3})
			Total	**7**	

Question			Expected Answers	Marks	Additional Guidance
4	(a)		stopping distance = thinking distance + braking distance	B1	
	(b)		Any <u>two</u> factors from: speed, mass, condition of tyres, condition of brakes, condition of road, gradient of road For each factor, correct description of how braking distance is affected E. • Greater speed means greater distance Or distance $\propto$ speed^2 (ora) • Greater mass means greater distance Or distance $\propto$ mass (ora) • Worn tyres / brakes implies less friction therefore greater distance (ora) • Wet / slippery / icy road means less friction therefore greater distance (ora) • Uphill means shorter distance (ora)	B1×2 B1×2	**Allow**: KE if neither mass nor speed is mentioned. For description marks, reference to 'distance' instead of 'braking distance' is fine For 1st bullet point allow reference to kinetic energy **Allow**: 'more' or 'longer' instead of 'greater' when referring to distance Do not allow 'grip' for friction for 3rd and 4th bullet points
	(c)		1. (Several <u>satellites</u> used 2. Distance from (each) satellite is determined 3. Position / distance is determined using *c* / speed of e.m waves / radio waves / microwaves and delay time (wtte) 4. Trilateration is used to locate the position of the car Or position of car is where circles / spheres cross (wtte)	B1 B1 B1 B1	**Note**: The term 'satellite(s)' to be included and spelled correctly, on all occasions, to gain this first (or second) B1 mark (Deduct this mark only <u>once</u>.) Do not allow this 4th mark for just a diagram of intersecting spheres / circles
			Total	**9**	

Question			Expected Answers	Marks	Additional Guidance
5	a		**Measurements**: height (of wall) time (of fall) **Instruments**: ruler / tape (measure) stopwatch / timer / clock /video $g = \frac{2s}{t^2}$ / g = 2 × gradient of s-t^2 graph **Note**: Allow full credit if candidate has used alternative approaches using $v^2 = u^2 + 2as$ or $v = u + at$. Any <u>two</u> from: g is an estimate because • air resistance / drag ignored • parallax problems with 'landing time' • starting / stopping the clock	 B1 B1 B1 B1 B1 B1×2	**Must use tick or cross on Scoris to show if the mark is awarded** **Allow:** 'distance (of fall)' instead of 'height' ✎ **The 4th B1 can only be scored if *stopwatch* / *timer* / *clock* / *video* (camera) is spelled correctly** **Allow:** Use of 'a' instead of 'g' **Note**: a must be the subject **Allow:** 'wind resistance'/'resistive force' for first bullet point **Allow**: 'reaction time' but **not** 'human error' for the third bullet point
	b	i	Radio (waves) / microwaves	B1	
		ii	Time taken for the signal to travel from satellite to car is determined / 'delay' time for signal is determined distance = c × (delay) time	M1 A1	 **Allow**: speed of light / 3.0×10^8 <u>m s^{-1}</u> instead of c **Note:** Distance must be the subject for the second B1 mark

Question			Expected Answers	Marks	Additional Guidance
		iii	Mention of circles / spheres / shells	B1	**Note**: This mark can be scored if a diagram shows circles / arcs (no label required)
			The position of the car is where the circles intersect / trilateration mentioned	B1	**Note**: This mark can be scored on a diagram if it shows intersecting circles / arcs and the intersection point is marked 'car'
			Total	**12**	

Question			Answer	Marks	Guidance
6	(a)		A point where the (entire) weight of the object (appears to) act	B1	**Not**: 'where the weight of an object acts'
	(b)		moment of force = force × perpendicular distance (of line of force) from point/axis/pivot/fulcrum	B1	
	(c)	(i)	net force = 0 net moment = 0 or net torque = 0	B1 B1	**Allow**: (For this rod) upward force = (sum of the) forces down **Allow**: (For this rod sum of) clockwise moment(s) = (sum of) anticlockwise moment(s)
		(ii)	Evidence of $0.12x$ or $0.35(0.50 - x)$ $0.12x = 0.35(0.50 - x)$ $x = \frac{0.35 \times 0.50}{0.12 + 0.35}$ $x = 0.37$ (m)	C1 C1 A1	
		(iii)	force = 0.47 (N)	B1	
			Total	**8**	