Question			Expected Answers	Marks	Guidance
1	(a)	(i)	Two equal but opposite forces	B1	
		(ii)	torque = one of the forces × <u>perpendicular</u> distance between the forces	B1	**Use tick or cross on Scoris** ✍ ***perpendicular*** must be spelled correctly to gain the mark
	(b)	(i)	It will rotate / spin / turn Rotation is clockwise / (continue) to travel from left to right/ the rotational speed increases (with time)	B1 B1	
		(ii)	It will accelerate The idea that acceleration is to the right / Suggestion that satellite will 'turn'	B1 B1	**Allow**: 'speed up' / 'speed increases' / 'velocity increases' / 'move faster'
			Total	**6**	

Question			Expected Answers	Marks	Additional Guidance
2	a		density = mass/volume or 'density is mass <u>per</u> (unit) volume'	B1	**Allow**: $\rho = \frac{M}{V}$, where M = mass and V = volume **Not**: mass per m^3
	b	i	Dramatic change(s) in <u>density</u> (at 3.0 Mm and 5.1 Mm) (AW)	B1	**Not**: There are three (distinct) layers / Each layer has different density
		ii	mass = $0.18 \times 6.0 \times 10^{24}$ ($=1.08 \times 10^{24}$ kg) or radius = 1.3×10^6 (m) volume = $\frac{4}{3}\pi \times (1.3 \times 10^6)^3$ density = $\frac{1.08 \times 10^{24}}{9.20 \times 10^{18}}$ density = 1.2×10^5 (kg m^{-3})	C1 C1 A1	**Note**: The first C1 mark is for determining the mass or the radius of core Possible 10^n errors **Bald** answer of 1.2×10^5 (kg m^{-3}) or 1.17×10^5 (kg m^{-3}) scores 3 marks **Allow**: 2 marks for $\frac{6.0 \times 10^{24}}{9.20 \times 10^{18}} = 6.5 \times 10^5$ (factor of 0.18 missed out) **Note**: The <u>last</u> <u>two</u> C1 and A1 marks cannot be scored if incorrect radius is used. Hence no further marks for $\frac{1.08 \times 10^{24}}{\frac{4}{3}\pi \times (6.4 \times 10^6)^3}$ or $\frac{1.08 \times 10^{24}}{\frac{4}{3}\pi \times (5.1 \times 10^6)^3}$, etc
			Total	**5**	

Question			Expected Answers	Marks	Additional Guidance
3	a		Any <u>two</u> from: • area • speed / velocity • viscosity (of air) / temperature / density • (surface) texture / 'aerodynamic' (shape)	B1×2	**Not**: shape / size **Allow**: 'streamlining'
	b	i	Correct <u>directions</u> of arrows *W* and *D*	B1	Award the mark for two arrows in opposite directions as long as <u>one</u> of them is labelled
		ii	weight = 75 × 9.81 weight = 736 (N) or 740 (N)	 B1	**Reminder**: weight can be quoted to more than 2 sf (e.g: 735.75) **Not**: '75 × 10 = 750 N'
		iii	$D = 0.30 \times 20^2$ (= 120 N) $736 - 120 = 75a$ $a = 8.2$ (m s^{-2})	C1 C1 A1	 **Allow**: Answer to 2sf or more **Bald** answer of 8.2 or 8.21 scores 3 marks **Note**: Using 740 (N) gives an answer 8.3 (m s^{-2})
		iv	(*D* and *W* are) equal	B1	**Not**: *D* and *W* are 'balanced/equilibrium'
		v	drag = weight $736 = 0.30 \times v^2$ $v = 49.5$ (m s^{-1}) or 50 (m s^{-1})	 C1 A1	 **Bald** answer of 49.5 (m s^{-1}) or 50 (m s^{-1}) scores 2 marks
			Total	**10**	

4	Expected Answers	Marks	Additional Guidance
a	The (net) force (is a newton) when a 1 kg mass has acceleration of 1 m s^{-2}	B1	**Not**: 1 N = 1 kg m s^{-2} because this is too brief for a definition
b(i)	weight = $1.9 \times 10^6 \times 9.81$ weight = 1.86×10^7 (N)	 B1	**Allow**: 9.8 (m s^{-2}) for *g* but not 10 (m s^{-2}) **Allow**: A bald answer of 1.9×10^7 N, but **not** if 10 (m s^{-2}) is seen
b(ii)	net force = 1.24×10^7 (N) or 1.2×10^7 (N) $a = \frac{F}{m} = \frac{1.24 \times 10^7}{1.9 \times 10^6}$ acceleration = 6.53 (m s^{-2}) or 6.5 (m s^{-2})	C1 A1	**Allow**: The C1 mark for "(net force) = $(3.1 - 1.86) \times 10^7$ (N)" **Allow**: 2 marks for a bald answer **Allow**: Answer of 6.3 (m s^{-2}) if 1.9×10^7 (N) is used for weight or net force of 1.2×10^7 (N) is used **Allow**: 1 mark for '$3.1 \times 10^7 / 1.9 \times 10^6 = 16.3$' **Not:** '$1.86 \times 10^7 / 1.9 \times 10^6 = 9.8$'
b(iii)	The mass / weight (of spaceship) decreases (as it loses fuel)	B1	**Allow**: 'g' / acceleration of free fall / gravitational field strength decreases (but **not** gravity decreases) **Not**: 'less drag / air resistance'
	Total	**5**	

5	Expected Answers	Marks	Additional Guidance
a	The distance travelled (by the car) whilst the brakes are applied and the car stops (wtte)	B1	**Note**: The answer must have reference to car stopping
b	Any <u>two</u> factors from: mass, brakes, tyres / tread, road (surface) and 'slope' of road Correct description for each factor; see below: 1. Greater mass increases distance / distance $\propto$ mass 2. Worn brakes increases distance 3. Bald tyres increases distance (when wet) 4. Wet / icy /gravel road increases distance 5. An uphill road will decrease the distance (ora)	B1×2 B1×2	**Must use ticks on Scoris to show where the marks are awarded** **Allow:** Reference to just 'distance' since '<u>braking</u> distance' is in the question **Note**: For point 3, allow 'less tread increases (braking) distance (when wet)'.
c	Any <u>three</u> from: 1. Prevent collision with steering wheel / windscreen /dashboard 2. Time for stopping is more / distance for stopping is more / seat belt 'stretches' 3. Smaller deceleration / acceleration (of person) 4. Reference to '$KE = Fs$' or '$\frac{1}{2}mv^2 = Fs$'	B1×3	**Must use ticks on Scoris to show where the marks are awarded** **Allow**: Smaller 'rate of change of momentum' for the third B1 point **Not**: Less pressure (on driver because of larger area of belt)

5	Expected Answers	Marks	Additional Guidance
d(i)1	thinking distance = 0.50×20 thinking distance = 10 (m)	B1	
d(i)2	braking distance = 30 (m) stopping distance = (30 + 10 =) 40 (m)	C1 A1	 **Allow**: 2 marks for a bald answer of 40 (m) **Allow**: 1 mark for 'answer to **(d)(i)1** + candidate's braking distance' if braking distance ≠ 30 (m) Possible ecf from **(d)(i)1**
d(ii)	$\frac{s}{32^2} = \frac{30}{20^2}$ / 'k = 0.075' / 'k = 13.3' (distance =) 77 (m) ---------- Or ---------- At speed of 16 (m s^{-1}), distance = 19 (m) (distance = $2^2 \times 19$ =) 76 (m)	C1 A1 ------- C1 A1	**Allow**: For the C1 any other equivalent and correct substitution into similar equation **Allow**: An answer in the range 76 - 78. Note bald answer in this range can score 2 marks **Allow**: distance in the range 19 to 19.5 (m) Possible ecf
	Total	**13**	

6	Expected Answers	Marks	Additional Guidance
a(i)	torque = 4.0×0.03 torque = 0.12 (N m)	C1 A1	 **Note**: An answer of 12 scores 1 mark (because cm not converted into m) **Allow**: Full marks for if the centi prefix added; that is 12 N cm **Allow**: 2 marks for a bald 0.12 (N m)
a(ii)	 (total moment =) $(x + 0.03) \times 4.0 - 4.0x$ (total) moment = 0.12 (N m) It is the same as the torque (of the couple) / same as **(a)(i)**	 M1 A1 B1	**Condone** the use of 'N cm' in **a(ii)** **Allow**: Equation with x value of 0.06 (m) or 6 cm **Special case**: 1 mark for (anticlockwise moment =) $4.0x$ or (clockwise moment =) $[x + 0.03] \times 4.0$ seen anywhere on the script **Not**: '0.12 (N m)'
b	Net / total / resultant force = 0 Net / total torque / moment = 0	B1 B1	**Not**: 'forces are balanced' or 'force up = force down' **Allow**: clockwise moment(s) = anticlockwise moment(s)
c(i)	$\rho = \frac{M}{V}$ / density = $\frac{45}{0.600 \times 0.600 \times 0.050}$ density = 2.5×10^3 (kg m^{-3})	C1 A1	 **Allow**: 2 marks for a bald answer of 2.5×10^3 (kg m^{-3})
c(ii)	clockwise moment = anticlockwise moment **or** (weight =) 45×9.81 / (weight =) 441.45 $(45 \times 9.81) \times 0.150 = F \times 0.600$ F = 110 (N)	C1 C1 A1	 **Allow**: 3 marks for a bald 110 (N) **Allow**: 2 marks for 11.25 – mass of 45 kg not changed to N
	Total	**12**	