Question			Answer	Marks	Guidance
1	(a)		Difference: Velocity / vector has direction (and speed does not) or speed / scalar does not have direction (velocity has) Similarity: Both have the same unit / both have m s^{-1} (as the unit) / both have magnitudes	B1 B1	**Not** 'velocity is a vector / speed is a scalar' since it is stated in the question
	(b)	(i)	distance = $2 \times \pi \times 0.60$ (= 3.77 m) / speed = $\frac{3.77}{12}$ speed = 0.31 (m s^{-1})	C1 A1	**Note**: Answer to 3 sf is 0.314 (m s^{-1})
		(ii)	$s^2 = 0.60^2 + 0.60^2$ s = 0.85 (m)	C1 A1	**Note**: Answer to 3 sf is 0.849 (m) **Note**: 0.72 scores 1 mark (square root omitted)
		(iii)	The (change in) displacement is zero	B1	
		(iv)	The direction changes (even though the magnitude is the same)	B1	
			Total	**8**	

Question			Answer	Marks	Guidance
2	(a)		a = 3600/1200 a = 3.0 (m s^{-2})	B1	**Allow** 1 sf answer (Ignore sign)
	(b)		$v^2 = u^2 + 2as$ $0 = 18^2 + (2 \times -3.0 \times s)$ / $s = \frac{18^2}{6.0}$ s = 54 (m)	C1 C1 A1	Possible ecf **Allow** '$v^2 = 2as$, $18^2 = 2 \times 3.0 \times s$' **Allow** other approaches, examples: t = 6 (s) C1 $s = (18 \times 6.0) + ½ \times (-3.0) \times 6.0^2$ C1 s = 54 (m) A1 Or $½ mv^2 = Fs$ C1 $½ \times 1200 \times 18^2 = 3600 \times s$ C1 s = 54 (m) A1
	(c)		(The distance is) greater There is a <u>component</u> of the weight of the car acting down the slope / <u>component</u> of weight against the resistive force / reference to $W \sin\theta$ (AW) <u>Net</u> force is less / reference to 3600 – $W \sin\theta$ / (magnitude of) deceleration is smaller	B1 B1 B1	**Allow** the following for the last two B1 marks: • The same force has to do more work • Work done is the sum of initial kinetic energy and change in GPE (due to vertical downward movement)
	(d)		Reference to radio waves or microwaves (transmitted from satellites) There is a 'delay time' of signal from satellite to GPS device / car Distance (between satellite and GPS device / car) calculated using 'delay time $\times$ c' **Trilateration** / intersecting **shells** / **circles** / **spheres** (used to locate position of car)	B1 B1 B1 B1	**Use ticks on Scoris to show where the marks are awarded** **Allow**: 'delay time' of signal between satellite and GPS device / car (**Not** from GPS device / car to satellite) ✎ ***Trilateration*** / ***shell(s)*** / ***circle(s)*** / ***sphere(s)*** must be spelled correctly to gain the mark. **Note**: Allow full range of marks for other sensible alternative approaches
			Total	**11**	

Question			Answer	Marks	Guidance
3	(a)		acceleration = rate of <u>change of velocity</u> (or acceleration = <u>change in velocity</u> / time)	B1	**Allow** '$a = (v - u)/t$' *or* $\Delta v/t$ if v, u and t or Δv and t are defined
	(b)		Mass and (net) force	B1	
	(c)	(i)	**1** acceleration **2** deceleration / negative acceleration Detail mark: Constant used in either 1 or 2 or reaches maximum height at 25 (s) or stops at 25 (s)	B1 B1 B1	**Allow**: velocity / speed increases **Allow**: velocity / speed decreases **Allow**: 'uniform / same' for 'constant'
		(ii)	height = area under graph from 0 to 25 (s) height = ½ × 25 × 200 height = 2500 (m)	C1 C1 A1	**Allow** 1 mark for either 500 (m) or 2000 (m)
		(iii)	A sensible suggestion, for example: • $v^2 = 2 \times g \times 2500$, $v = 220$ (m s^{-1}) – allow $g = 10$ (m s^{-2}) • For 200 (m s^{-1}) at ground, the (maximum) height would only be 2040 (m) (with $g = 9.81$ m s^{-2}) or 2000 (m) (with $g = 10$ m s^{-2}) • (Burning) rocket fuel does work on the rocket (AW)	B1	
			Total	**9**	

Question			Answers	Marks	Guidance
4	(a)		acceleration = rate of <u>change</u> of <u>velocity</u>	B1	**Allow**: $a = \frac{v-u}{t}$ where v = final velocity, u = initial velocity and t = time **Allow**: 'acceleration = change in <u>velocity</u> over time' **Not**: 'acceleration = rate of change of <u>speed</u>' **Not**: mixture of quantity and unit, e.g. 'change of velocity per second'
	(b)	(i)	$a = \frac{v-u}{t}$ (Any subject) $a = \frac{0-6.0}{2400}$ a = (-) 2.5 × 10^{-3} (m s^{-2})	C1 C1 A1	**Allow**: $a = 6.0/2400$ Ignore sign
		(ii)	distance = <u>av speed</u> × time or $v^2 = u^2 + 2as$ distance = 3.0 × 2400 or $0 = 6.0^2 - (2 \times 2.5 \times 10^{-3} \times s)$ distance = 7200 (m)	C1 A1	Possible ecf. from **(b)(i)** **Allow**: $v^2 = u^2 + 2as$ with v = 6.0, u = 0 and a = 0.0025 **Allow**: Full credit for correct use of $s = ut + ½ at^2$ **Note**: Bald 7200 (m) scores 2 marks **Allow**: 1 mark for 's = (6 × 2400) + ½ × 0.0025 × 2400^2 = 21600 (m)'
		(iii)	Correct shape of curve of <u>decreasing</u> gradient starting from 0,0 Graph passes through 40, 7.2	M1 A1	Possible e.c.f. from **(b)(ii)** **Allow** the A1 mark if x is between 5-10 km at 40 min
	(c)	(i)	It has (constant) acceleration / It accelerates (down the ramp)	B1	**Allow**: Its velocity / speed increases
		(ii)	The time taken by ball to travel between (successive) bells is the same / 'same as first trolley' / 'there is no change' (AW) Acceleration is independent of mass / acceleration is the same (for the heavier trolley) (AW)	B1 B1	
			Total	**11**	

5	Expected Answers	Marks	Additional Guidance
a	The <u>distance</u> travelled (by the car) from when the driver sees a problem and the brakes are applied	B1	**Note**: There must be reference to 'stimulus' and brakes. **Not**: 'speed × reaction time'
b	Distance / displacement	B1	
c(i)	distance = 20 × 0.5 distance = 10 (m)	B1	
c(ii)	distance = area under graph distance = ½ × 20 × 3.5 distance = 35 (m)	 C1 A1	 **Allow** 1 mark if stopping distance of 45 m quoted No marks for an answer of '20 × 3.5 = 70 (m)'
d(i)	gradient = 'acceleration' / $a = \frac{v-u}{t}$ / $a = \frac{\Delta v}{\Delta t}$ $a = (-)\frac{20}{3.5}$ deceleration = 5.71(4) ≈ 5.7 (m s^2)	C1 A1	The first mark is for selecting correct equation or stating a = gradient **Note**: Ignore negative sign
d(ii)	force = 910 × 5.71 force ≈ 5200 (N)	C1 A1	 Possible ecf from **(d)(i)**
e	Increases by a factor of 4 Braking distance ∝ $speed^2$ / '$Fx = ½ mv^2$' / speed doubles <u>and</u> time doubles	B1 B1	

	Expecte d Answer	Marks	Additional Guidance
f			**Must use ticks on Scoris to show where the marks are awarded**
	Large deceleration / rapid decrease in speed (triggers the air bag)	B1	**Not** 'quick / sudden / rapid deceleration' **Not** 'large acceleration'
	Prevent collision with steering wheel / windscreen / dashboard	B1	
	Time (for stopping) is more / distance (for stopping) is more	B1	
	Smaller deceleration / acceleration (of person)	B1	**Allow**: 'smaller rate of change of momentum' **Not** 'smaller rate of deceleration'
	Total	**15**	