1	Expected Answers	Marks	Additional Guidance
a	time = 1.2/8.0 time = 0.15 (s)	M1 A0	**Note**: The mark is for dividing the distance by the speed – hence must be seen
b	$s = ut + \frac{1}{2}at^2$ and $u = 0$ / $s = \frac{1}{2}at^2$ / $h = \frac{1}{2} \times 9.81 \times 0.15^2$ h = 0.11 (m)	C1 A1	
c	They both have same (vertical) acceleration / same acceleration of free fall / acceleration of 9.8 ms^{-2} (and zero initial vertical velocity)	B1	**Note**: Must have reference to both objects
	Total	**4**	

Question			Expected Answers	Marks	Additional Guidance
2	**(a)**		Correct lines from: • joule (J) to N m • watt (W) to J s^{-1} • newton (N) to kg m s^{-2}	B2	**Note**: 2 marks for all correct 1 mark for two correct 0 marks for none or one correct
	(b)	**(i)**	weight in the range 200 to 1200 (N)	B1	
		(ii)	area in the range 0.01 to 0.08 (m^2)	B1	
		(iii)	pressure = (b)(i)/b(ii)	B1	**Allow**: 1 sf answer
			Total	**5**	

Question			Expected Answers	Marks	Additional Guidance
3	(a)		A quantity that has (both) magnitude / size and direction	B1	**Not** 'A quantity that has direction'
	(b)		Circled /underlined quantities are: acceleration, displacement and weight	B1	**Note**: All three need to be identified for a mark
	(c)	(i)	Constant / steady / uniform acceleration (up to 4 s) Or Velocity increases at a steady / constant / uniform rate Or Has acceleration of 3.5 (m s^{-2}) Constant / steady / uniform velocity (after 4 s) Or Zero acceleration Or Travels at a velocity of 24 (m s^{-1})	B1 B1	**Not** Accelerates up to 4 s / 'uniform motion' for the first B1 mark **Not** 'Accelerates at a constant rate'. **Allow**: 'speed' instead of velocity **Allow**: 2 mark for 'Constant acceleration and then constant speed / velocity'
		(ii)	distance = area (under graph) distance = 68 (m)	C1 A1	**Allow**: The C1 mark is for … distance = $\frac{1}{2}(10+24)\times 4.0$ **Allow**: Bald 68 (m) scores 2 marks Bald $\frac{1}{2}(4\times 14)$ or 28 (m) scores 1 mark for 'area of triangle'
		(iii) 1	Answer in the range: 1.1 to 1.2 (s)	B1	
		(iii) 2	Same areas under graphs $14t = 10t + (0.5\times 3.5\times t^2)$ t = 2.28 (s) ≈ 2.3 (s)	 C1 A1	 **Note**: The C1 mark is for substitution **Allow**: Bald 2.3 (s) scores 2 marks **Allow:** Bald '$t = 2\times$ **(iii)1**.' Scores 2 marks
			Total	9	

Question			Expected Answers	Marks	Additional Guidance
4	(a)		Downward arrow at **P**	**B1**	Arrow must be close to or at point **P**
	(b)		From gravitational potential (energy) to kinetic (energy) / KE / E_k (wtte) Any further detail: KE maximum at bottom / Zero (G)PE at bottom / (G)PE is maximum at top / (G)PE and KE at top (wtte)	**B1** **B1**	The term gravitational to be included and spelled correctly in **(b)** to gain the first B1 mark **Not**: Heat / sound at ground
	(c)		The acceleration / force / weight is at right angles to horizontal motion / velocity (wtte)	**B1**	**Allow**: 'In this direction the force / acceleration is zero'
	(d)		time = $\frac{3.6}{7.0}$ (= 0.514 s)	**B1**	**Allow**: time = $\sqrt{(1.3\times 2)/9.81}$ (= 0.515 s) **Allow**: Use of 9.8 (m s^{-2})
	(e)		u = 0 and $v = u + at$ or $v^2 = u^2 + 2as$ 'vertical' velocity = 9.81× 0.5(14) or 'vertical' velocity = $\sqrt{2\times 9.81\times 1.3}$ 'vertical' velocity = 5.0 (m s^{-1}) $v^2 = 7.0^2 + 5.0^2$ $v = 8.6$ (m s^{-1})	**C1** **C1** **C1** **A0**	**Watch out for**: '$v^2 = u^2 + 2as = 7^2 + (2\times 9.81\times 1.3) = 8.6$' – this scores **no** marks because of **wrong** physics. **Note**: Getting an answer 5.0 (m s^{-1}) scores the first 2 marks **Note**: Using t = 0.5 (s) gives 8.55 (m s^{-1}) **Note**: Bald answer scores zero marks – since this is a 'show' question (Allow full marks for correct analysis using the principle of conservation of energy.)
			Total	**8**	

Question			Answer	Marks	Guidance
5	(a)		velocity = rate of change of <u>displacement</u>	B1	**Allow**: Equation if labels are defined **Not**: velocity = displacement/time **Not**: A mixture of quantity and unit, e.g: 'change in displacement per second'
	(b)		work done = force × distance <u>moved</u> in direction of force	M1 A1	**Allow**: 'force × displacement' for the M1 mark
	(c)	(i)	It is at right angles to motion	B1	**Allow:** It is at right angles to slope / sledge
		(ii)	The component of the weight / *W* / *mg* (down the slope)	B1	**Allow:** *W* sinθ or *mg*sinθ **Not**: 'component of gravity' **Allow**: <u>Resultant</u> of *W* and *N*
	(d)	(	1 acceleration = gradient / $a = (v-u)/t$ a = 3.0/1.5 a = 2.0 (m s^{-2}) 2 $a = g\sin\theta$ $\sin\theta = 2.0/9.81$ θ = 12°	C1 A1 C1 A1	 **Allow**: 1 sf answer Possible ecf from incorrect value of acceleration *a* Answer to 3 sf is 11.8° **Note**: Using 10 m s^{-2} gives an answer of 11.5° - award 2 marks
		(ii)	a = (-) 15/3.5 or a = (-) 4.29 (m s^{-2}) $m = 510/4.29$ mass = 120 (kg)	C1 C1 A1	**Ignore** sign Answer to 3 sf is 119 (kg)
			Total	**12**	

Question			Expected Answers	Marks	Additional Guidance
6	(a)		$W = mg$ weight $= 1.50 \times 9.81 = 14.72$ (N) or 14. 7 (N) or 15 (N)	B1	**Allow**: Use of 9.8 (m s^{-2}) **Allow**: Bald 15 (N); but **not** '1.50 × 10 = 15(N)'
	(b)	**(i)**	Net / resultant force (on **B**) is less / (net) force (on **B**) is less than its weight / there is tension (in the string) / there is a vertical / upward / opposing force (on **B**)	B1	**Note**: Must have reference to force
		(ii)	$s = ut + \frac{1}{2}at^2$ and $u = 0$ $1.40 = \frac{1}{2} \times 1.09 \times t^2$ t = 1.60 (s)	C1 C1 A1	**Allow**: 2 marks for 1.75/1.09' if answer from **(iii)** is used **Allow**: 2 sf answer **Allow**: 2 marks if **2.80 m** is used; time = 2.27 (s)
		(iii)	$v^2 = 2 \times 1.09 \times 1.40$ / $v = 0 + 1.09 \times 1.60$ v = 1.75 (m s^{-1}) / v = 1.74 (m s^{-1})	C1 A1	Possible ecf **Allow**: 1.7 or 1.8 (m s^{-1})
		(iv)	change in velocity = 2.47 + 1.50 (= 3.97 m s^{-1}) acceleration = $\frac{3.97}{0.030}$ acceleration = 132 (m s^{-2})	C1 A1	Ignore sign for change in velocity **Allow**: 130 (m s^{-2}) --- **Special case:** acceleration = $\frac{2.47 - 1.50}{0.030} = 32.3$ or 32 (m s^{-2}) scores 1 mark
			Total	**9**	

Question			Answer	Marks	Guidance
7	(a)		It has **direction** (and magnitude/size)	B1	**Note:** ✍ ***direction*** must be spelled correctly for the mark
	(b)	(i)	perpendicular component = 8.0×10^{-5} cos30 perpendicular component = 6.9×10^{-5} (N) parallel component = 8.0×10^{-5} sin30 parallel component = 4.0×10^{-5} (N) or 4×10^{-5} (N)	B1 B1	**Allow**: 1 mark if the correct numerical values of the components have been swapped **Note**: Penalise POT error once only; eg 6.9 and 4 respectively scores 1 mark **Note**: Calculator in radian mode gives 1.23×10^{-5} and (-) 7.90×10^{-5} (N); this scores 1 mark
		(ii)	(F =) 4.0×10^{-5} (N) The net force parallel to windscreen = 0 or F is equal to the parallel component (of the weight down the windscreen) or parallel forces must be equal and opposite or $F = 8.0 \times 10^{-5}$ sin30	B1 B1	Possible ecf from **(b)(i)** **Allow**: Total force down/up the windscreen/slope is zero **Not**: 'net force = 0' – this is an incomplete answer
			Total	**5**	

Question			Answer	Marks	Guidance
8	(a)		$(s = \frac{1}{2}at^2)$; 0.700 = ½ × 9.81 × t^2	C1	**Allow**: a = 9.8 (m s^{-2})
			$t^2 = \frac{2 \times 0.700}{9.81} (= 0.1427)$	C1	
			t = 0.378 (s) or 0.38 (s)	A1	**Note**: Using a = 10 (m s^{-2}) gives 0.374 (s) or 0.37 (s); this scores 2 marks **Allow** full credit for correct use of $v^2 = 2as$ and $v = at$
	(b)	(i)	acceleration or deceleration displacement or distance	B1	
		(ii)	A tangent drawn on Fig. 4.2 at point **A**	B1	**Note**: This is an independent mark
			Determine the <u>gradient</u> of the tangent	M1	
			Deceleration value in the range 13.0 to 17.0 (m s^{-2})	A1	**Note**: Ignore sign **Special case**: Allow 1 mark for using a chord about t = 0.05 seconds to determine the deceleration <u>and</u> the value lies in the range 13.0 to 17.0 (m s^{-2})
		(iii)	At **A:**		
			Drag > weight	B1	**Allow**: 'friction'/'resistive force' for drag
			The ball is decelerating/'slowing down'	B1	**Allow**: upward/negative acceleration
			At **B**:		
			Drag = weight	B1	
			The ball has zero acceleration/has reached terminal velocity/has reached constant velocity	B1	**Note:** Allow full credit if *upthrust* <u>and</u> *drag* are both mentioned and applied correctly at points **A** and/or **B**
		(iv)	The (gravitational) potential energy/(G)PE (of the ball) is converted into heat/thermal (energy)	B1	
			Total	**12**	