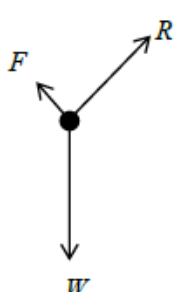


Mark Scheme

Q1.

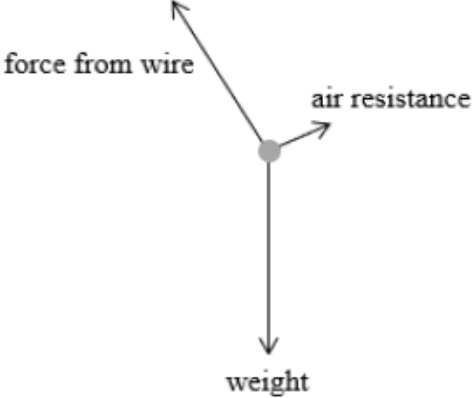
Question Number	Answer	Mark
(a)	- Weight/W/mg labelled (1) (Normal) reaction/contact force (accept $R/N/C$) (1) - Friction/F (1) - Lengths $R < W$ and $F < W$ (1) (-1 off total for each additional arrowed line and MP4 conditional on MP1, 2 and 3) (do not accept components of forces, even if both given and accept correct direction/size by eye) 	4
(b)(i)	- Initially friction/drag negligible/small/less (as the velocity is low) (1) - See $mg \sin \theta$ Or $W \sin \theta$ (1) $mg \sin \theta = ma$ and the masses cancel (so a independent of m) (1)	3
(b)(ii)	- As velocity increases, air resistance increases (1) - Until frictional forces = component of weight down slope (1) - Resultant force = 0 and there is no more acceleration (at max velocity) (1) (MP2 allow frictional forces = $mg \sin \theta$)	3
(b)(iii)	- A larger person would have a greater area/volume (1) - The air resistance would be greater (1) (accept drag)	2

(c)(i)	See $\theta = \tan^{-1} 0.2$ and $\theta = 11.3^\circ$ Or see $\tan \theta = 0.2$ and $\theta = 11.3^\circ$	(1)	1
(c)(ii)	Either (Energy) Use of $E_k = \frac{1}{2}mv^2$ (1) Use of trig to determine the component of weight along the slope or the vertical height in terms of L (1) Use of $E_{\text{grav}} = mg\Delta h$ (to determine E_{grav}) Or use of $W = F\Delta s$ (1) Use of $E_k = E_{\text{grav}} + W$ (to determine (1) $L = 120 \text{ m}$ (1) Or (forces) Use of trig to determine the component of weight along the slope or the vertical height in terms of L (1) Use of resultant force $= mg\sin 11.3^\circ + 240 \text{ N}$ (1) Use of $\Sigma F = ma$ to determine a (1) Use of $v^2 = u^2 + 2as$ with their a (not 9.81) to determine s (1) $L = 120 \text{ m}$ (1) <u>Example of calculation</u> $E_k = \frac{1}{2} \times 95 \text{ kg} \times (33 \text{ m s}^{-1})^2 = 51728 \text{ J}$ $51728 \text{ J} = (95 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times \sin 11.3^\circ \times L) + (240 \text{ N} \times L)$ $L = 122 \text{ m}$	5	5
Total for question			18

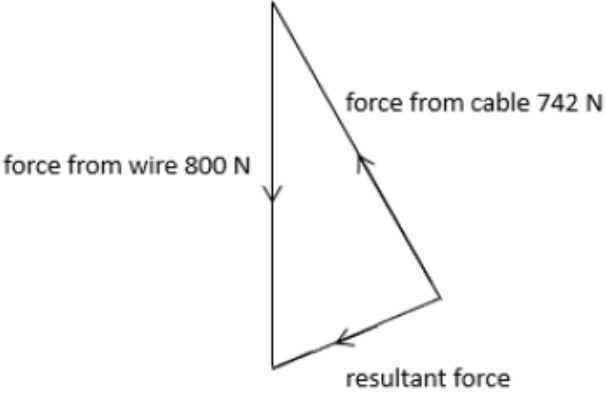
Q2.

Question Number	Answer	Mark
(a)(i)	The gradient / steepness of the slide varies (1) (So) the acceleration (of the child) varies (1) The equations of motion require a constant acceleration (1)	3
(a)(ii)	Use of $\Delta E_{\text{grav}} = mgh$ (1) Use of $\Delta E_k = \frac{1}{2}mv^2$ (1) $v = 5.8 \text{ m s}^{-1}$ (1) Do not accept use of equations of motion. <u>Example of calculation</u> $\Delta E_{\text{grav}} = 24 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 1.7 \text{ m} = 400 \text{ J}$ $400 \text{ J} = 0.5 \times 24 \text{ kg} \times v^2$ $v = \sqrt{\frac{2 \times 400}{24}} = 5.77 \text{ m s}^{-1}$	3
(b)	$v_X = v_Y$ (1) Maximum 2 from: $\Delta E_{\text{grav}} = \Delta E_k$ and mass is in both equations (1) (Maximum) speed of child = $\sqrt{2g\Delta h}$ (and g is constant) (1) (Maximum) speed does not depend on mass of child Or (Maximum) speed is (only) dependent on Δh (1)	3
	Total for question	9

Q3.

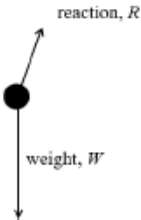
Question Number	Answer	Mark
(a)	Arrow to the left and upwards labelled force from wire / harness (1) Arrow vertically downwards labelled weight / W / mg (1) Arrow to right (and slightly upward) labelled (viscous) drag / D or labelled air resistance (1) <u>Example diagram</u> 	3

(b)(i)	Appropriate trigonometry used (1)	
	742 (N) (1)	2
	<u>Example of calculation</u> $R = 2 \times 1\,200\text{ N} \times \cos(72^\circ) = 741.6\text{ N}$	

(b)(ii)	Straight line at least 8 cm long representing force from wire (800 N), with label (1) Vector triangle drawn with at least two sides labelled, and resultant force on shortest side (1) All 3 arrows in correct relative directions (dependent on MP2) (1) Resultant force = 400 N (Range from 390 to 410) (1) <u>Example diagram</u> 	4
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(c)	(most) E_{grav} transferred to E_{k} and mass is in both equations (1)	3
	(So final) speed does not depend on mass of person Or (So final) speed only depends on change in height Or (So final) speed = $\sqrt{2g\Delta h}$ (and g is constant) (1)	
	(assuming) work done against resistive forces is negligible (1)	
	Total for question	
		12

Q4.

Question Number	Answer	Mark
(a)	Vertical downwards force labelled "weight", or W. (1) Force perpendicular to slope labelled "reaction", "(normal) contact", or R or N. (1) 	2

(b)(i)	Resolves acceleration along slope. Acceleration = 1.2 m s^{-2} <u>Example of calculation</u> $a = 9.81 \text{ m s}^{-2} \times \sin 6.9^\circ = 1.18 \text{ m s}^{-2}$	(1) (1)	2
(b)(ii)	Either Use of $v^2 = u^2 + 2 a s$ Final speed = 12 m s^{-1} (ecf from (i)) Or Use of $E_k = \frac{1}{2}mv^2$ and $\Delta E_{\text{grav}} = mg\Delta h$ Final speed = 12 m s^{-1} (ecf from (i)) <u>Example of calculation</u> $v^2 = 0^2 + 2 \times 1.18 \text{ m s}^{-2} \times 60 \text{ m}$ $v = \sqrt{(0 + 2 a s)} = \sqrt{(2 \times 1.18 \text{ m s}^{-2} \times 60 \text{ m})} = 11.9 \text{ m s}^{-1}$	(1) (1) (1) (1)	2
(b)(iii)	Use of $v = u + a t$ or another valid <i>suvat</i> equation Time = 10 s (ecf from (ii)) (ecf from (i)) <u>Example of calculation</u> $v = u + a t, u = 0$ $11.9 = 0 + 1.18 \text{ m s}^{-2} \times t$ $t = 11.9 \text{ m s}^{-1} \div 1.18 \text{ m s}^{-2} = 10.1 \text{ s}$	(1) (1)	2
Total for question			8

Q5.

Question Number	Answer	Mark
	B is the correct answer This is because the horizontal component is calculated using the equation $v_H = \sqrt{v^2 - v_V^2} = \sqrt{0.5^2 - 0.3^2} = 0.4$	(1)

Q6.

Question Number	Answer	Mark
	The only correct answer is C ($F = W\sin\theta$) A is not correct because $W \cos \theta$ is perpendicular to the slope B is not correct because $W \cos \theta$ is perpendicular to the slope D is not correct because the resultant force must be zero	1

Q7.

Question Number	Answer	Mark
	Use of appropriate trigonometry to determine component of g acting down the slope (1) Use of $v^2 = u^2 + 2as$ with $u = 7.1 \text{ m s}^{-1}$ or Use of other valid suvat method to determine v with $u = 7.1 \text{ m s}^{-1}$ (1) Speed = 11 m s^{-1} (1) OR Use of appropriate trigonometry to determine vertical displacement (1) Use of $\Delta E_{\text{grav}} = \Delta mgh$ Or Use of $E_k = \frac{1}{2}mv^2$ (1) Speed = 11 m s^{-1} (1) <u>Example calculation</u> $a = 9.81 \text{ m s}^{-2} \times \sin(14^\circ) = 2.37 \text{ m s}^{-2}$ $v^2 = (7.1 \text{ m s}^{-1})^2 + 2 \times 2.37 \text{ m s}^{-2} \times 15 \text{ m} = 122 \text{ m}^2 \text{ s}^{-2}$ $v = 11.0 \text{ m s}^{-1}$	3
	Total for question	3

Q8.

Question Number	Answer	Mark
(a)	- Use of $v^2 = u^2 + 2as$ AND $u = 0$ (1) Or $mgh = \frac{1}{2}mv^2$ $v = 3.4 \text{ (m s}^{-1}\text{)}$ (1) <u>Example of calculation</u> $v^2 = 2 \times 9.81 \text{ m s}^{-2} \times 0.60 \text{ m}$ $v = \sqrt{11.77} \text{ m s}^{-1}$ $v = 3.43 \text{ m s}^{-1}$	(2)
(b)	- Horizontal $3.4 \times \sin 70^\circ$ Or $3.4 \times \cos 20^\circ$ Or calculated value. (1) - Vertical $3.4 \times \cos 70^\circ$ Or $3.4 \times \sin 20^\circ$ 1.16 Or calculated value. (1) Allow e.c.f. from part (a)	(2)

(c)	Use of $v = s/t$ to determine time to end of ramp (0.38 s). - Use of $s = ut - \frac{1}{2}gt^2$ to determine drop in altitude after time t (0.27 m). (1) - Ball does not bounce on the ramp. (1) - Justifies conclusion from numbers calculated. e.g. $0.86 - 0.27 > 0.00$ means has not reached ground by end of ramp. (1) <u>Example of calculation</u> (1) $t = \frac{1.23 \text{ m}}{3.4 \text{ m s}^{-1} \times \sin 70^\circ}$ $t = 0.39 \text{ s}$ $s = (3.4 \text{ (m s}^{-1}\text{)} \times \cos 70^\circ \times 0.39 \text{ s}) + (\frac{1}{2} \times (-9.81 \text{ m s}^{-2}) \times (0.39 \text{ s})^2)$ $s = -0.28 \text{ m}$	
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	Or • Use of $s = ut - \frac{1}{2} g t^2$ to determine time to $s = - 0.86$ • Use of $s = vt$ to calculate s (1) • Ball does not bounce on the ramp. (1) • Justifies conclusion from numbers calculated. (1) e.g. $1.23 < 1.79$ Or • Use of $v = u - gt_1$ with $v = 0$ to get time to max height (0.12s) and use of $s = \frac{1}{2} g t_1^2$ to get gain in height (0.07m) and use of $s = ut + \frac{1}{2} g t_2^2$ with $u = 0$ and $s = 0.93$ to get time from there to the ground (0.44s) Total time $t = t_1 + t_2$. (1) • Use of $s = vt$ to calculate s (1) • Ball does not bounce on the ramp. (1) • Justifies conclusion from numbers calculated. (1) e.g. $1.23 < 1.79$	(4)
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