4761 Mechanics 1

Q 1		Mark	Comment	Sub
(i)	6 m s^{-1} 4 m s^{-2}	B1 B1	Neglect units. Neglect units.	2
(ii)	$v(5) = 6 + 4 \times 5 = 26$ $s(5) = 6 \times 5 + 0.5 \times 4 \times 25 = 80$ so 80 m	B1 M1 A1	Or equiv. FT (i) and **their** $v(5)$ where necessary. cao	3
(iii)	distance is 80 + $26 \times (15-5) + 0.5 \times 3 \times (15-5)^2$ = 490 m	M1 M1 A1	Their 80 + attempt at distance with $a = 3$ Appropriate *uvast* . Allow $t = 15$. FT **their** v(5). cao	3
		8		

Q 2		Mark	Comment	Sub
(i)	When $t = 2$, velocity is $6 + 4 \times 2 = 14$	M1 A1	Recognising that areas under graph represent changes in velocity in (i) or (ii) or equivalent *uvast.*	2
(ii)	Require velocity of – 6 so must inc by – 20 $-8 \times (t-2) = -20$ so $t = 4.5$	M1 F1	FT ±(6 + **their** 14) used in any attempt at area/ *uvast* FT **their** 14 [Award SC2 for 4.5 WW and SC1 for 2.5 WW]	2
		4		

Q 3		Mark	Comment	Sub
(i)	$\mathbf{F} + \begin{pmatrix} -4 \\ 8 \end{pmatrix} = 6\begin{pmatrix} 2 \\ 3 \end{pmatrix}$ $\mathbf{F} = \begin{pmatrix} 16 \\ 10 \end{pmatrix}$	M1 B1 B1 A1	N2L. $F = ma$. All forces present Addition to get resultant. May be implied. For $\mathbf{F} \pm \begin{pmatrix} -4 \\ 8 \end{pmatrix} = 6\begin{pmatrix} 2 \\ 3 \end{pmatrix}$. SC4 for $\mathbf{F} = \begin{pmatrix} 16 \\ 10 \end{pmatrix}$ WW. If magnitude is given, final mark is lost unless vector answer is clearly intended.	4
(ii)	$\arctan\left(\frac{16}{10}\right)$ 57.994… so 58.0° (3 s. f.)	M1 A1	Accept equivalent and FT **their F** only. Do not accept wrong angle. Accept 360 - $\arctan\left(\frac{16}{10}\right)$ cao. Accept 302º (3 s.f.)	2
		6		

Q4		Mark	Comment	Sub
	either We need $3.675 = 9.8t - 4.9t^2$ Solving $4t^2 - 8t + 3 = 0$ gives t = 0.5 or t = 1.5 **or** Time to greatest height $0 = 35 \times 0.28 - 9.8t$ so t = 1 Time to drop is 0.5 total is 1.5 s **then** Horiz distance is $35 \times 0.96t$ So distance is $35 \times 0.96 \times 1.5 = 50.4$ m	*M1 M1* A1 F1 M1 A1 A1 A1 B1 F1	Equating given expression or **their** attempt at y to ± 3.675 . If **they** attempt y, allow sign errors, g = 9.81 etc. and u = 35. Dependent. Any method of solution of a 3 term quadratic. cao. Accept only the larger root given Both roots shown and larger chosen provided both +ve. Dependent on 1st M1. [Award M1 M1 A1 for 1.5 seen WW] Complete method for total time from motion in separate parts. Allow sign errors, g = 9.81 etc. Allow u = 35 initially only. Time for 1st part Time for 2nd part cao Use of $x = u\cos\alpha t$. May be implied. FT **their** quoted t provided it is positive.	6
		6		

Q5		Mark	Comment	Sub
(i)	For the parcel ↑ N2L $55 - 5g = 5a$ a = 1.2 so 1.2 m s^{-2}	M1 A1 A1	Applying N2L to the parcel. Correct mass. Allow $F = mga$. Condone missing force but do not allow spurious forces. Allow only sign error(s). Allow –1.2 only if sign convention is clear.	3
(ii)	$R - 80g = 80 \times 1.2$ or $R - 75g - 55 = 75 \times 1.2$ R = 880 so 880 N	M1 A1	N2L. Must have correct mass. Allow only sign errors. FT **their** a cao [NB beware spurious methods giving 880 N]	2
		5		

Q6		Mark	Comment	Sub
	Method 1			
	$\uparrow\ v_A = 29.4 - 9.8T \qquad \downarrow\ v_B = 9.8T$	M1	Either attempted. Allow sign errors and g = 9.81 etc	
		A1	Both correct	
	For same speed $29.4 - 9.8T = 9.8T$	M1	Attempt to equate. Accept sign errors and T = 1.5 substituted in both.	
	so T = 1.5	E1	If 2 subs there must be a statement about equality	
	and V = 14.7	F1	FT T or V, whichever is found second	
	$H = 29.4\times1.5 - 0.5\times9.8\times1.5^2$	M1	Sum of the distance travelled by each attempted	
	$+\ 0.5\times9.8\times1.5^2$			
	$= 44.1$	A1	cao	
	Method 2			
	$V^2 = 29.4^2 - 2\times9.8\times x = 2\times9.8\times(H - x)$	M1	Attempts at V^2 for each particle equated. Allow sign errors, 9.81 etc Allow h_1, h_2 without $h_1 = H - h_2$	
		B1	Both correct. Require $h_1 = H - h_2$ but not an equation.	
	$29.4^2 = 19.6H$ so H = 44.1	A1	cao	
	Relative velocity is 29.4 so	M1	Any method that leads to T or V	
	$T = \dfrac{44.1}{29.4}$	E1		
	Using $v = u + at$	M1	Any method leading to the other variable	
	$V = 0 + 9.8\times1.5 = 14.7$	F1		
			Other approaches possible. If 'clever' ways seen, reward according to weighting above.	
				7
		7		

Q7		Mark	Comment	Sub
(i)	Diagram	B1 B1	Weight, friction and 121 N present with arrows. All forces present with suitable labels. Accept *W*, *mg*, 100*g* and 980. No extra forces.	
	Resolve $\rightarrow$ $121\cos 34 - F = 0$ F = 100.313… so 100 N (3 s. f.)	M1 E1	Resolving horiz. Accept $s \leftrightarrow c$. Some evidence required for the *show*, e.g. at least 4 figures. Accept $\pm$.	
	Resolve $\uparrow$ $R + 121\sin 34 - 980 = 0$ R = 912.337… so 912 N (3 s. f.)	M1 B1 A1	Resolve vert. Accept $s \leftrightarrow c$ and sign errors. All correct	7
(ii)	It will continue to move at a constant speed of 0.5 m s^{-1}.	E1 E1	Accept no reference to direction Accept no reference to direction [Do not isw: conflicting statements get zero]	2
(iii)	Using N2L horizontally $155\cos 34 - 95 = 100a$	M1	Use of N2L. Allow $F = mga$, F omitted and 155 not resolved.	
		A1	Use of $F = ma$ with resistance and T resolved. Allow $s \leftrightarrow c$ and signs as the **only** errors.	
	a = 0.335008… so 0.335 m s^{-2} (3 s. f.)	A1		3
(iv)	$a = 5 \div 2 = 2.5$	M1 A1	Attempt to find a from information	
	N2L down the slope $100g\sin 26 - F = 100 \times 2.5$	M1	$F = ma$ using **their** "new" a. All forces present. No extras. Require attempt at wt cpt. Allow $s \leftrightarrow c$ and sign errors.	
		B1	Weight term resolved correctly, seen in an equn or on a diagram.	
	F = 179.603… so 180 N (3 s. f.)	A1	cao. Accept – 180 N if consistent with direction of F on their diagram	5
		17		

Q8		Mark	Comment	Sub
(i)	$v_x = 8 - 4t$	M1	**either** Differentiating **or** Finding '*u*' and '*a*' from *x* and use of $v = u + at$	
		A1		
	$v_x = 0 \Leftrightarrow t = 2$ so at $t = 2$	F1	FT **their** $v_x = 0$	3
(ii)	$y = \int (3t^2 - 8t + 4)\,\mathrm{d}t$	M1	Integrating v_y with at least one correct integrated term.	
	$= t^3 - 4t^2 + 4t + c$	A1	All correct. Accept no arbitrary constant.	
	$y = 3$ when $t = 1$ so $3 = 1 - 4 + 4 + c$	M1	Clear evidence	
	so $c = 3 - 1 = 2$ and $y = t^3 - 4t^2 + 4t + 2$	E1	Clearly shown and stated	4
(iii)	We need $x = 0$ so $8t - 2t^2 = 0$	M1	May be implied.	
	so $t = 0$ or $t = 4$	A1	Must have both	
	$t = 0$ gives $y = 2$ so 2 m	A1	Condone 2**j**	
	$t = 4$ gives $y = 4^3 - 4^3 + 16 + 2 = 18$ so 18 m	A1	Condone 18**j**	4
(iv)	We need $v_x = v_y = 0$	M1	**either** Recognises $v_x = 0$ when $t = 2$ **or** Finds time(s) when $v_y = 0$ **or** States or implies $v_x = v_y = 0$	
	From above, $v_x = 0$ only when $t = 2$ so evaluate $v_y(2)$	M1	Considers $v_x = 0$ **and** $v_y = 0$ with **their** time(s)	
	$v_y(2) = 0$ [$(t - 2)$ is a factor] so yes only at $t = 2$	A1	$t = 2$ recognised as only value (accept as evidence only $t = 2$ used below). For the last 2 marks, no credit lost for reference to $t = \frac{2}{3}$.	
	At $t = 2$, the position is (8, 2)	B1	May be implied	
	Distance is $\sqrt{8^2 + 2^2} = \sqrt{68}$ m (8.25 3 s.f.)	B1	FT from **their** position. Accept one position followed through correctly.	5
(v)	$t = 0, 1$ give (0, 2) and (6, 3)	B1	At least one value $0 \le t < 2$ correctly calc. This need not be plotted	
		B1	Must be *x*-*y* curve. Accept sketch. Ignore curve outside interval for *t*. Accept unlabelled axes. Condone use of line segments.	
		B1	At least three correct points **used** in *x*-*y* graph or sketch. General shape correct. Do not condone use of line segments.	3
		19		