

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 <i>uvast</i> . 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 <i>uvast</i> .	2
(ii)	Require velocity of -6 so must inc by -20 $-8 \times (t - 2) = -20$ so $t = 4.5$	M1 F1	FT $\pm(6 + \text{their } 14)$ used in any attempt at area/ <i>uvast</i> 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 \mathbf{F} only. Do not accept wrong angle. Accept $360 - \arctan\left(\frac{16}{10}\right)$ cao. Accept 302° (3 s.f.)	2
		6		

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

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

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

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

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