4761 Mechanics 1

Q 1		mark	comment	sub
(i)	N2L $\uparrow$ $1000-100\times9.8=100a$ $a = 0.2$ so 0.2 m s^{-2} upwards	M1 B1 A1	N2L. Accept $F = mga$ and no weight Weight correct (including sign). Allow if seen. Accept ±0.2. Ignore units and direction	3
(ii)	$T_{BA} - 980 = 100\times0.8$ so tension is 1060 N	M1 A1	N2L. $F = ma$. Weight present, no extras. Accept sign errors.	2
(iii)	$T_{BA}\cos30 = 1060$ $T_{BA} = 1223.98...$ so 1220 N (3 s. f.)	M1 A1 A1	Attempt to resolve their (ii). Do not award for **their** 1060 resolved unless all forces present and all resolutions needed are attempted. If start again allow no weight. Allow $\sin \leftrightarrow \cos$. No extra forces. Condone sign errors FT **their** 1060 only cao	3
		8		

Q 2		mark	comment	sub
(i)		B1	Sketch. O, **i**, **j** and **r** (only require correct quadrant.) Vectors must have arrows. Need not label **r**.	1
(ii)	$\sqrt{4^2 + (-5)^2}$ $= \sqrt{41}$ or 6.4031… so 6.40 (3 s. f.) Need $180 - \arctan\left(\frac{4}{5}\right)$ 141.340 so 141°	M1 A1 M1 A1	Accept $\sqrt{4^2 - 5^2}$ Or equivalent. Award for $\arctan\left(\pm\frac{4}{5}\right)$ or $\arctan\left(\pm\frac{5}{4}\right)$ or equivalent seen without 180 or 90. cao	4
(iii)	12**i** – 15**j** or $\begin{pmatrix} 12 \\ -15 \end{pmatrix}$	B1	Do not award for magnitude given as the answer. Penalise spurious notation by 1 mark at most once in paper	1
		6		

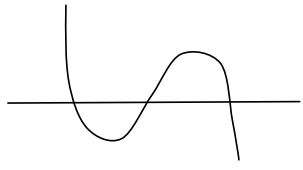| Q 3		mark	comment	sub
(i)	$\mathbf{F} = 5\begin{pmatrix} -1 \\ 2 \end{pmatrix} = \begin{pmatrix} -5 \\ 10 \end{pmatrix}$ so $\begin{pmatrix} -5 \\ 10 \end{pmatrix}$ N	M1 A1	Penalise spurious notation by 1 mark at most once in paper Use of N2L in vector form Ignore units. [Award 2 for answer seen] [SC1 for $\sqrt{125}$ or equiv seen]	
				2
(ii)	$\mathbf{s} = \begin{pmatrix} -2 \\ 3 \end{pmatrix} + 4\begin{pmatrix} 4 \\ 5 \end{pmatrix} + \frac{1}{2} \times 4^2 \times \begin{pmatrix} -1 \\ 2 \end{pmatrix}$ $\mathbf{s} = \begin{pmatrix} 6 \\ 39 \end{pmatrix}$ so $\begin{pmatrix} 6 \\ 39 \end{pmatrix}$ m	M1 A1 B1	Use of $\mathbf{s} = t\mathbf{u} + 0.5t^2\mathbf{a}$ or integration of $\mathbf{a}$. Allow $\mathbf{s}_0$ omitted. If integrated need to consider $\mathbf{v}$ when $t = 0$ Correctly evaluated; accept $\mathbf{s}_0$ omitted. Correctly adding $\mathbf{s}_0$ to a vector (FT). Ignore units. [NB $\begin{pmatrix} 8 \\ 36 \end{pmatrix}$ seen scores M1 A1]	
				3
		5		

Q 4		mark	comment	sub
(i)	The distance travelled by P is $0.5 \times 0.5 \times t^2$ The distance travelled by Q is $10t$	B1 B1	 Accept $10t + 125$ if used correctly below.	
				2
(ii)	Meet when $0.25t^2 = 125 + 10t$ so $t^2 - 40t - 500 = 0$ Solving $t = 50$ (or -10) Distance is $0.25 \times 50^2 = 625$ m	M1 F1 M1 A1 A1	Allow **their** wrong expressions for P and Q distances Allow ± 125 or 125 omitted Award for **their** expressions as long as one is quadratic and one linear. Must have 125 with correct sign. Accept any method that yields (smaller) + ve root of their 3 term quadratic cao Allow –ve root not mentioned cao [SC2 400 m seen]	
				5
		7		

Q 5		mark	comment	sub
	either			
	Overall, N2L $\rightarrow$			
	$135 - 9 = (5 + 4)a$	M1	Use of N2L. Allow $F = mga$ but no extra forces. Allow 9 omitted.	
	$a = 14$ so 14 m s^{-2}	A1		
	For A, N2L $\rightarrow$	M1	N2L on A or B with correct mass. $F = ma$. All	
	$T - 9 = 4 \times 14$		relevant forces and no extras.	
	so 65 N	A1	cao	
	or			
	$135 - T = 5a$	M1	* 1 equation in T and a. Allow sign errors. Allow $F = mga$	
	$T - 9 = 4a$	A1	Both equations correct and consistent	
	Solving	M1	Dependent on M* solving for T.	
	$T = 65$ so 65 N	A1	cao.	4
		4		

Q 6		mark	comment	sub
(i)	$40 \times 0.6t - 5t^2$	M1	Use of $s = ut + 0.5at^2$ with $a = \pm 9.8, \pm 10$. Accept 40 or 40×0.8 for 'u'.	
	$= 24t - 5t^2$	A1	Any form	2
(ii)	**either**			
	Need zero vertical distance			
	so $24t - 5t^2 = 0$	M1	Equate **their** y to zero. With fresh start must have correct y.	
	so $t = 0$ or $t = 4.8$	A1	Accept no reference to $t = 0$ and the other root in any form. FT **their** y if gives $t > 0$	
	or			
	Time to highest point, T	M1	Allow use of $u = 40$ and 40×0.8. Award even if half range found.	
	$0 = 40 \times 0.6 - 10T$ so $T = 2.4$ and time of flight is 4.8	A1	May be awarded for doubling half range later.	
	range is $40 \times 0.8 \times 4.8 = 153.6$	M1	Horiz cpt. Accept 0.6 instead of 0.8 only if consistent with expression in (i). FT **their** t.	
	so 154 m (3 s. f.)	A1	cao [NB Use of half range or half time to get 76.8… (g = 10) or 78.36… (g = 9.8) scores 2] [If range formula used: M1 sensible attempt at substitution; allow sin2α wrong B1 sin2α correct A1 all correct A1 cao]	4
		6		

Q 7		mark	comment	sub
(i)	Continuous string: smooth ring: light string	E1 E1	One reason Another reason	 2
(ii)	Resolve $\leftarrow$: $\;60\cos\alpha - 60\cos\beta = 0$ (so $\cos\alpha = \cos\beta$) and so $\alpha = \beta$	 M1 E1	[(ii) and (iii) may be argued using Lami or triangle of forces] Resolution and an equation or equivalent. Accept $s \leftrightarrow c$. Accept a *correct* equation seen without method stated. Accept the use of 'T' instead of '60'. Shown. Must have stated method (allow $\rightarrow$ seen).	 2
(iii)	Resolve $\uparrow$ $2\times 60\times\sin\alpha - 8g = 0$ so $\alpha = 40.7933\ldots$ so 40.8° (3 s. f.)	M1 B1 B1 A1 A1	Resolution and an equation. Accept $s \leftrightarrow c$. Do not award for resolution that cannot give solution (e.g. horizontal) Both strings used (accept use of half weight), seen in an equation $\sin\alpha$ or equivalent seen in an equation All correct	 5
(iv)	Resolve $\rightarrow$ $10 + T_{QC}\cos 25 - T_{PC}\cos 45 = 0$ Resolve $\uparrow\; T_{PC}\sin 45 + T_{QC}\sin 25 - 8g = 0$ Solving $T_{CQ} = 51.4701\ldots$ so 51.5 N (3 s. f.) $T_{CP} = 80.1120\ldots$ so 80.1 N (3 s. f.)	M1 M1 A1 M1 A1 M1 A1 F1	Recognise strings have different tensions. Resolution and an equation. Accept $s \leftrightarrow c$. No extra forces. All forces present. Allow sign errors. Correct. Any form. Resolution and an equation. Accept $s \leftrightarrow c$. No extra forces. All forces present. Allow sign errors. Correct. Any form. * A method that leads to at least one solution of a pair of simultaneous equations. cao either tension other tension. Allow FT only if M1* awarded [Scale drawing: 1ˢᵗ M1 then A1, A1 for answers correct to 2 s.f.]	 8
		17		

Q 8		mark	comment	sub
(i)	10	B1		1
(ii)	$v = 36 + 6t - 6t^2$	M1 A1	Attempt at differentiation	2
(iii)	$a = 6 - 12t$	M1 F1	Attempt at differentiation	2
(iv)	Take $a = 0$ so $t = 0.5$ and $v = 37.5$ so 37.5 m s^{-1}	M1 A1 A1	Allow table if maximum indicated or implied FT **their** a cao Accept no justification given that this is maximum	3
(v)	**either** Solving $36 + 6t - 6t^2 = 0$ so $t = -2$ or $t = 3$ **or** Sub the values in the expression for v Both shown to be zero A quadratic so the only roots **then** $x(-2) = -34$ $x(3) = 91$	M1 B1 E1 M1 E1 B1 B1 B1	A method for two roots using **their** v Factorization or formula or … of **their** expression Shown Allow just 1 substitution shown Both shown Must be a clear argument cao cao	5
(vi)	$\lvert x(3) - x(0) \rvert + \lvert x(4) - x(3) \rvert$ $= \lvert 91 - 10 \rvert + \lvert 74 - 91 \rvert$ $= 98$ so 98 m	M1 A1 A1	Considering two parts Either correct cao [SC 1 for $s(4) - s(0) = 64$]	3
(vii)	At the SP of v $x(-2) = -34$ i.e. < 0 and $x(3) = 91$ i.e. > 0 Also $x(-4) = 42\ > 0$ and $x(6) = -98 < 0$ so three times	M1 B1 B1	Or any other valid argument e.g find all the zeros, sketch, consider sign changes. Must have some working. If only a sketch, must have correct shape. Doing appropriate calculations e.g. find all 3 zeros; sketch cubic reasonably (showing 3 roots); sign changes in range 3 times seen	3
		19		