

## 4761 Mechanics 1

Q 1		mark	comment	sub
(i)	$N2L \uparrow 1000 - 100 \times 9.8 = 100a$ $a = 0.2$ so $0.2 \text{ m s}^{-2}$ upwards	M1 B1 A1	N2L. Accept $F = mga$ and no weight Weight correct (including sign). Allow if seen. Accept $\pm 0.2$ . Ignore units and direction	3
(ii)	$T_{BA} - 980 = 100 \times 0.8$ so tension is 1060 N	M1 A1	N2L. $F = ma$ . Weight present, no extras. Accept sign errors.	2
(iii)	$T_{BA} \cos 30 = 1060$  $T_{BA} = 1223.98\dots$ so 1220 N (3 s. f.)	M1 A1 A1	Attempt to resolve their (ii). Do not award for <b>their</b> 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 <b>their</b> 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 $141^\circ$	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)	$12\mathbf{i} - 15\mathbf{j}$ 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		

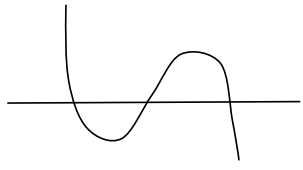
Q 3		mark	comment	sub
(i)	$\mathbf{F} = 5 \begin{pmatrix} -1 \\ 2 \end{pmatrix} = \begin{pmatrix} -5 \\ 10 \end{pmatrix}$ so $\begin{pmatrix} -5 \\ 10 \end{pmatrix}$ N	M1 A1	Penalise spurious notation by 1 mark at most once in paper  Use of N2L in vector form  Ignore units. [Award 2 for answer seen] [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 $\mathbf{s} = \mathbf{u} + 0.5t^2\mathbf{a}$ 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 <b>their</b> wrong expressions for P and Q distances Allow $\pm 125$ or 125 omitted Award for <b>their</b> 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
<b>either</b> Overall, N2L → $135 - 9 = (5 + 4)a$  $a = 14$ so $14 \text{ m s}^{-2}$  For A, N2L → $T - 9 = 4 \times 14$ so 65 N <b>or</b> $135 - T = 5a$  $T - 9 = 4a$ Solving $T = 65$ so 65 N	M1	Use of N2L. Allow $F = mga$ but no extra forces. Allow 9 omitted.	4
	A1		
	M1	N2L on A or B with correct mass. $F = ma$ . All relevant forces and no extras.	
	A1	cao	
	M1	* 1 equation in $T$ and $a$ . Allow sign errors. Allow $F = mga$	
	A1	Both equations correct and consistent	
	M1	Dependent on M* solving for $T$ .	
	A1	cao.	
	4		

Q 6	mark	comment	sub
(i)	M1	Use of $s = ut + 0.5at^2$ with $a = \pm 9.8, \pm 10$ .	2
	A1	Accept 40 or $40 \times 0.8$ for ' $u$ '. Any form	
(ii)	M1	Equate <b>their</b> $y$ to zero. With fresh start must have correct $y$ .	4
	A1	Accept no reference to $t = 0$ and the other root in any form. FT <b>their</b> $y$ if gives $t > 0$	
	M1	Allow use of $u = 40$ and $40 \times 0.8$ . Award even if half range found.	
	A1	May be awarded for doubling half range later.	
	M1	Horiz cpt. Accept 0.6 instead of 0.8 only if consistent with expression in (i). FT <b>their</b> $t$ .	
	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 $\sin 2\alpha$ wrong B1 $\sin 2\alpha$ correct A1 all correct A1 cao]	
	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 <i>correct</i> 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 $\alpha = 40.7933\dots$ so $40.8^\circ$ (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  $T_{CQ} = 51.4701\dots$ so 51.5 N (3 s. f.) $T_{CP} = 80.1120\dots$ 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: 1 <sup>st</sup> 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 $37.5 \text{ m s}^{-1}$	M1 A1 A1	Allow table if maximum indicated or implied FT <b>their</b> $a$ cao Accept no justification given that this is maximum	3
(v)	<b>either</b> Solving $36 + 6t - 6t^2 = 0$  so $t = -2$ or $t = 3$ <b>or</b> Sub the values in the expression for $v$ Both shown to be zero A quadratic so the only roots <b>then</b> $x(-2) = -34$ $x(3) = 91$	M1 B1 E1  M1 E1 B1  B1 B1	A method for two roots using <b>their</b> $v$ Factorization or formula or ... of <b>their</b> expression Shown  Allow just 1 substitution shown  Both shown Must be a clear argument  cao cao	5
(vi)	$ x(3) - x(0)  +  x(4) - x(3) $ $=  91 - 10  +  74 - 91 $ $= 98$ 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		