Mark Scheme

Paper 4761	Name Mechanics 1	Session Jan	Year 2005	

Solutions and mark scheme

Q 1		mark		
(i)	Differentiate $\mathbf{v} = 2t\,\mathbf{i} + (5 - 4t)\,\mathbf{j}$ Differentiate $\mathbf{a} = 2\,\mathbf{i} - 4\,\mathbf{j}$	M1 A1 M1 F1	At least 1 cpt correct Award for RHS seen Do not award if **i** and **j** lost in **v.** At least 1 cpt correct. FT FT from **their** 2 component **v**	4
(ii)	$\mathbf{F} + 12\,\mathbf{j} = 4(2\,\mathbf{i} - 4\,\mathbf{j})$ $\mathbf{F} = 8\,\mathbf{i} - 28\,\mathbf{j}$	M1 A1 A1	N2L. Allow $\mathbf{F} = mg\,\mathbf{a}$. No extra forces. Allow $12\mathbf{j}$ omitted Allow wrong signs otherwise correct with **their** vector **a**. cao	3
	total	7		

Q 2		mark		
(i) (A) (B)	the pulleys are smooth and the string is light the string is inextensible	E1 E1	Accept only 'the pulley is smooth'.	2
(ii)	Diagrams	B1	All forces present with labels and arrows. Acc not reqd.	1
	For X, N2L upwards $T - 2g = 2a$ For Y, N2L downwards $4g - T = 4a$ Solve for a and T $a = \frac{g}{3}$ (3.27 (3 s. f.)) $T = \frac{8}{3}g$ (26.1 (3 s. f.))	M1 A1 A1 A1 F1	N2L. Allow $F = mga$. All forces present Award for equation for X or Y or combined Any form Any form FT second answer	5
	total	8		

Paper 4761	Name Mechanics 1	Session Jan	Year 2005	

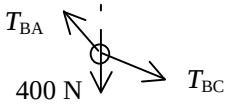
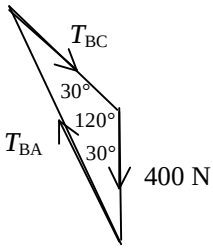
Solutions and mark scheme

Q 3		mark		
(i)	$\begin{pmatrix} x \\ -7 \\ z \end{pmatrix} + \begin{pmatrix} 4 \\ y \\ -5 \end{pmatrix} + \begin{pmatrix} 5 \\ 4 \\ -7 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$ Equating components gives x = -9, y = 3, z = 12	M1 A1 A1 A1	[Allow SC 2/4 if 9, -3, -12 obtained]	4
(ii)	We need $\sqrt{5^2 + 4^2 + (-7)^2}$ = $\sqrt{90}$ or 9.48683… so 9.49 (3 s. f.)	M1 A1	Any reasonable accuracy	2
	total	6		

Q 4		mark		
(i)	Height reached by first particle is given by $0 = 21^2 - 2\times 9.8\times s$ so s = 22.5 so 22.5 m	 M1 A1	 Other methods must be complete. Allow $g = \pm 9.8, \pm 10$ Accept with consistent signs	2
(ii)	**Sol (1)** t seconds after second particle projected its height is $15t - 4.9t^2$ and the first particle has height $22.5 - 4.9t^2$ (or $21t - 4.9t^2$) **either** Sub t = 1.5 to show both have same value State height as 11.475 m **or** $15t - 4.9t^2 = 22.5 - 4.9t^2$ giving t = 1.5 and height as 11.475 m	M1 A1 M1 A1 E1 A1 M1 A1	Allow $g = \pm 9.8, \pm 10$ Allow $g = \pm 9.8, \pm 10$ Award only if used correctly (or sub t = 3.64 into $21t - 4.9t^2$ for 1st & t = 1.5 for 2nd) cao. Accept any reasonable accuracy. Don't award if only one correctly used equation obtained. Both. t shown. Ht cao (to any reasonable accuracy)	
	Sol (2) t seconds after second particle projected its height is $15t - 4.9t^2$ and the first particle has fallen $4.9t^2$ Collide when $15T - 4.9T^2 + 4.9T^2 = 22.5$ so $T = 1.5$ H = $22.5 - 4.9\times 1.5^2 = 11.475$ m	M1 A1 B1 M1 E1 A1	Allow $g = \pm 9.8, \pm 10$ Or other correct method cao. Accept any reasonable accuracy. Don't award if only one correctly used equation obtained.	6
	total	8		

Paper 4761	Name Mechanics 1	Session Jan	Year 2005	

Solutions and mark scheme

Q 5		mark		
(i)		B1	Different labels. All forces present with arrows in correct directions. Condone no angles.	1
(ii)	Using triangle of forces  Triangle isosceles so tension in BC is 400 N Tension in BA is $2\times400\times\cos 30 = 400\sqrt{3}$ N (693 N, (3 s. f.))	M1 B1 A1 F1	Attempt at triangle of forces. Ignore angles and arrows. Accept 90, 60, 30 triangle. Triangle, arrows, labels and angles correct cao FT BC only [If resolution used, M1 for 1 equn; M1 for 2nd equn + attempt to elim; A1; F1. For M marks all forces present but allow $s \leftrightarrow c$ and sign errors. No extra forces. If Lami used: M1 first pair of equations in correct format, condone wrong angles. A1. M1 second pair in correct format, with **correct** angles.F1 FT their first answer if necessary.]	4
(iii)	Resolve at B perpendicular to the line ABC Weight has unbalanced component in this direction	E1 E1	Attempt to argue unbalanced force Complete, convincing argument. [**or** Resolve horiz and establish tensions equal E1 Resolve vert to show inconsistency. E1]	2
	total	7		

Paper 4761	Name Mechanics 1	Session Jan	Year 2005	

Solutions and mark scheme

Q 6		mark		
(i)	Area under curve $0.5\times2\times20+0.5\times(20+10)\times4+0.5\times10\times1$ = 85 m	M1 B1 A1	Attempt to find any area under curve or use const accn results Any area correct (Accept 20 or 60 or 5 without explanation) cao	3
(ii)	$\frac{20-10}{4}=2.5$ upwards	M1 A1 B1	$\Delta v/\Delta t$ accept ±2.5 Accept – 2.5 downwards (allow direction specified by diagram etc). Accept 'opposite direction to motion'.	3
(iii)	$v=-2.5t+c$ v = 20 when t = 2 v = – 2.5t + 25	M1 M1 A1	Allow **their** a in the form $v=\pm at+c$ or $v=\pm a(t-2)+c$ cao [Allow $v=20-2.5(t-2)$] [Allow 2/3 for different variable to t used, e.g. x. Allow any variable name for speed]	3
(iv)	Falling with negligible resistance	E1	Accept 'zero resistance', or 'no resistance' seen.	1
(v)	$-1.5\times4+9.5\times2+7=20$ $-1.5\times36+9.5\times6+7=10$ $-1.5\times49+9.5\times7+7=0$	E1 E1	One of the results shown All three shown. Be generous about the 'show'.	2
(vi)	$\int_2^7(-1.5t^2+9.5t+7)dt$ $=\left[-0.5t^3+4.75t^2+7t\right]_2^7$ $=\left(-\frac{343}{2}+\frac{19\times49}{4}+49\right)-(-4+19+14)$ = 81.25 m	M1 A1 A1 A1 M1 A1 A1	Limits not required A1 for each term. Limits not required. Condone + c Attempt to use both limits on an integrated expression Correct substitution in **their** expression including subtraction (may be left as an expression). cao.	7
	total	19		

Paper 4761	Name Mechanics 1	Session Jan	Year 2005	

Solutions and mark scheme

Q 7		mark		
(i)	Horiz $(40\cos 50)t$	B1		
	Vert $(40\sin 50)t - 4.9t^2$	M1	Use of $s = ut + 0.5at^2$ with $a = \pm 9.8$ or ± 10. Allow u = 40. Condone s $\leftrightarrow$ c.	
		A1	Any form	3
(ii)	Need $(40\sin 50)t - 4.9t^2 = 0$	M1	Equating **their** y to zero. Allow quadratic y only	
	so $t = \dfrac{40\sin 50}{4.9}$	M1	Dep on 1st M1. Attempt to solve.	
	= 6.2534… so 6.253 s (3 d. p.)	E1	Clearly shown [**or** M1 (allow u = 40 and s $\leftrightarrow$ c) A1 time to greatest height; E1]	
	Range is $(40\cos 50)\times 6.2534...$	M1	Use of **their** horiz expression	
	= 160.78… so 161 m (3 s. f.)	A1	Any reasonable accuracy	5
(iii)	Time AB is given by $(40\cos 50)T = 30$ so T = 1.16679… so 1.17 s	M1 A1	Equating **their** linear x to 30.	
	then **either** By symmetry, time AC is time AD – time AB	M1	Symmetry need not be explicit. Method may be implied. Any valid method using symmetry.	
	so time AC is 6.2534… $-\dfrac{30}{40\cos 50}$ = 5.086…. so 5.09 s (3 s. f.)	A1	cao	
	or height is $(40\sin 50)T - 4.9T^2$ and we need $(40\sin 50)t - 4.9t^2 = (40\sin 50)T - 4.9T^2$ solved for larger root	M1	Complete method to find time to second occasion at that height	
	i.e. solve $4.9t^2 - (40\sin 50)t + 29.08712... = 0$ for larger root giving 5.086…	A1	cao	4
(iv)	$\dot{x} = 40\cos 50$	B1	Must be part of a method using velocities.	
	$\dot{y} = 40\sin 50 - 9.8\times 5.086...$	M1 A1	Use of vert cpt of vel Allow only sign error. FT use of **their** 5.086..	
	Need $\arctan\dfrac{\dot{y}}{\dot{x}}$	M1	May be implied. Accept $\arctan\dfrac{\dot{x}}{\dot{y}}$ but not use of $\dot{y}_0$.	
	So –36.761…° so 36.8° below horizontal (3 s.f.)	A1	Accept ±36.8 or equivalent. Condone direction not clear.	5
	total	17		