Edexcel Maths M1

Mark Scheme Pack

2001-2013

Stewart House 32 Russell Square London WC1B 5DN

FINAL

January 2001

4MK

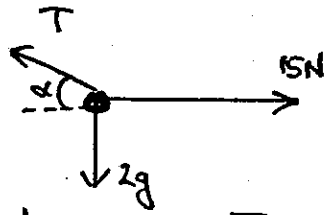
17-01-01

Advanced Supplementary/Advanced Level

General Certificate of Education

Subject MECHANICS 6677

Paper No. M1

Question number	Scheme	Marks
1. (a)	Resolving vertically e.g. $R_P + R_Q = 70$ $R_P = 20 \Rightarrow R_Q = 50$	M1 A1 (2)
(b)	A valid moments equation e.g. $R_P \times 0.5 + R_Q \times x = 70 \times \frac{3}{2}$ $20 \times 0.5 + 50 \times x = 70 \times \frac{3}{2}$ Completing method to find AQ AQ = 1.9	M1 A1ft DM1 A1 cao (4)
2		
(a)	ONE resolution equation e.g. $T\cos\alpha = 15$ OR $T\sin\alpha = 2g$ are most likely but $T = 15\cos\alpha + 2g\sin\alpha$, $2g\cos\alpha = 15\sin\alpha$ also possible as is also Lami's theorem. One equation correct; second independent eqn. correct (omission of g loses A1 only) $\tan\alpha = \frac{2g}{15}$ or $\frac{2}{15}$ [$\tan\alpha = \frac{15}{2g}$ scores M1 A0] Answer for α as 53° OR 52.6°	M1 A1 + A1 M1 A1ft A1 (6)
(b)	Using valid equation (their 1 M1 required) to extract value of T (or eliminating α from valid eqns) T = 24.7 or 25	M1 A1 (2)

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Question number	Scheme	Marks
3.(a)	For particle A $T - 3mg = 3ma$	M_1
	[Note $T - mg = ma$ or $T - m = ma$ etc scores M_1]	
	$T - 3mg = 3m\left(\frac{2}{5}g\right) \rightarrow T = \frac{21}{5}mg$	$A_1 \rightarrow A_1$ (3)
(b)	String is inextensible	B_1 (1)
(c)	For particle B $kmg - T = kma$	M_1
	[(or system) $kmg - 3mg = (km + 3m)a$]	
	$kg - \frac{21}{5}g = \frac{2}{5}kg$ (or equivalent equation in k only)	A_1 f.t.
	Solving DM1 dependent on first M1 in (c)	DM1
	$k = 7$	A1 cao (4)
(d)	Tension is of same magnitude throughout the string	B_1 (1)
4.(a)	At $t = 0$ $\underset{\sim}{r}_P = 2\underset{\sim}{i} - \underset{\sim}{j}$; At $t = 2$, $\underset{\sim}{r}_P = 6\underset{\sim}{i} + \underset{\sim}{j}$	
	Velocity of P constant $\Rightarrow \underset{\sim}{v}_P = \frac{(6\underset{\sim}{i} + \underset{\sim}{j}) - (2\underset{\sim}{i} - \underset{\sim}{j})}{2}$	M_1A_1
	$\underset{\sim}{v}_P = 2\underset{\sim}{i} + \underset{\sim}{j}$ (one slip in $\underset{\sim}{i}$ or $\underset{\sim}{j}$ only)	A1 f.t. (3)
(b)	$\arctan\frac{1}{2}$ (or $\arctan 2$ allowed for M_1)	M_1
	$26.6°$ only	A_1 (2)
(c)	$\vec{OC} = 2\underset{\sim}{i} - \underset{\sim}{j} + 5(2\underset{\sim}{i} + \underset{\sim}{j})$ OR $6\underset{\sim}{i} + \underset{\sim}{j} + 3(2\underset{\sim}{i} + \underset{\sim}{j})$	M_1
	$\vec{OC} = 12\underset{\sim}{i} + 4\underset{\sim}{j}$	A1 ft
	$\lvert\vec{OC}\rvert = \sqrt{(12^2 + 4^2)}$	M_1
	$OC = 12.6$ only or equivalent f.t. answer given to 1 decimal place also depends on M1+M1	A1 ft. (4)

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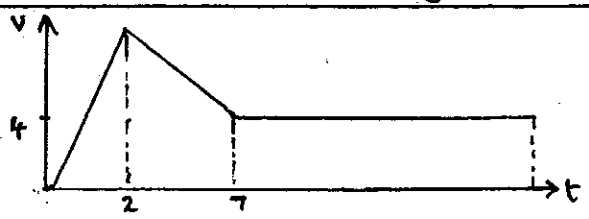
Question number	Scheme	Marks
5.(a)	Before $\rightarrow 4.5$ A (0.6) $\leftarrow 3$ (0.2) B; After $\frac{v}{2}\rightarrow$ $v\rightarrow$. Momentum conserved on system: $0.6\times4.5-0.2\times3=0.6\times\frac{v}{2}+0.2\times v$. Solving for v $\rightarrow$ $v=4.2$	M1 A1 M1 A1 (4)
(b)	Change in momentum of A or B attempted: $0.2(3+4.2)$ OR $0.6(4.5-2.1)\rightarrow$ 1.44 units NS	M1 A1ft B1 (3)
(c)	$R=mg$; $\mu R=\mu mg=$ retarding force or deceleration μg; $v^2=u^2+2as$ applied (or equivalent work) $0=4.2^2-2\mu g\times2$; $\mu=\frac{4.2^2}{4g}=0.45$ (DM1 depends on M1+1)	B1 M1 M1 A1ft DM1 A1 (6)
6 (a)	 G1 2 stages ✓ slope; G2 3 stages ✓ slope; +G1 for 2, 7, 4 on axes.	G3, 2, 1, 0 (3)
(b)	Using $v=u+at\rightarrow v=9.8\times2=19.6$	M1 A1 (2)
(c)	Stage 1 distance $\frac{1}{2}\times9.8\times4$ or $\frac{1}{2}\times2\times19.6=19.6$; Stage 2 distance $\frac{1}{2}(19.6+4)\times5$ (or equivalent two stage method) $=59$ (acceleration = 3.12 M1A1, 59 A1); Minimum height for H $=59+19.6=78.6$ m	B1ft M1A1ft A1 cao A1 f.t. (5)
(d)	From a height of 125m, there are 46.4m to fall at 4 ms^{-1}; Time for stage 3 $=\frac{46.4}{4}$ s $\rightarrow$ (11.6 s); Total time $=2+5+$ (11.6) $\rightarrow$ 18.6s	M1 M1A1ft A1 cao (4)
(e)	Air resistance in (a) or equivalent sound reason	B1 (1)

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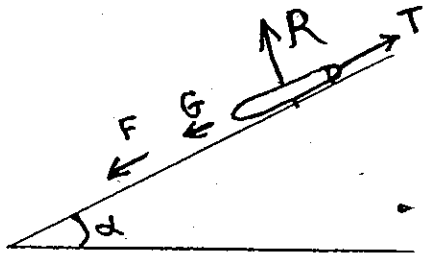
Question number	Scheme	Marks
7. (a)	$\alpha = \arctan \frac{5}{12}$	
	$\cos\alpha = \frac{12}{13}$, $\sin\alpha = \frac{5}{13}$	M1 A1
	α 22.6° ; cos α 0.923 , sin α $\frac{4}{5}$ ·38	
	$R = 78g\cos\alpha$	B1
	$F = 78g\cos\alpha\,(0.25)$	M1 A1 f.t.
	$G = 78g\sin\alpha$	B1
		
	Newton II along slope attempted with T, F, G included	
	$T - F - G = 78(0.5)$	M1
	Solving for T (dependent on M1)	dM1
	$T = 509.4$ (accept this or 510 to 2 s.f. or 509 to 3 s.f. must only)	A1 (9)
(b)	Accelerating force down slope is $G - F$ (or Friction reversed and T no longer included)	M1
	Newton II $G - F = 78a$	M1
		A1
	$a = g\sin\alpha - \mu g\cos\alpha$	M1
	$= 9.8\left(\frac{5}{13} - \frac{3}{13}\right)$ or $\frac{2}{13}g$	
	$= 1.5, 1.50, 1.51$ // Score A2	A2;1;0 (6)
	other answers which round to 1.5 Score A1	

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Question number	Scheme	Marks
1.	3 → 0.5 ● ← 2 ● 0.2 Before → 1.5 ● → v After (Momᵐ eqn. with 4 terms) (a) $0.5 \times 3 - 0.2 \times 2 = 0.5 \times 1.5 + 0.2 \times v$ $\Rightarrow v = \underline{1.75 \text{ ms}^{-1}}$ (b) $I = 0.2(2 + 1.75)$ $= \underline{0.75 \text{ Ns}}$	M1 A1 A1 (3) M1 A1✓ A1 (3) (6)

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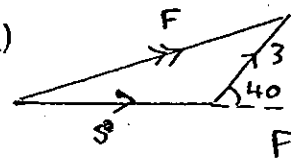
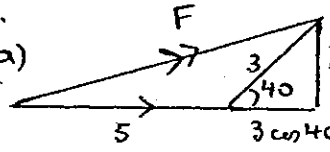
Question number	Scheme	Marks
2.	EITHER	
	(a)  Vector Δ attempt	M1
	Correct	A1
	$F^2 = 5^2+3^2-2.5.3\cos 140$ (cos rule)	M1 A1
	$\rightarrow F \simeq \underline{7.55\ N}$	A1 (5)
	(b) $\frac{F}{\sin 140} = \frac{3}{\sin\theta} \Rightarrow \theta \simeq \underline{14.8^\circ}$	M1 A1, A1 (3)
		(8)
	OR. (a)  Vector Δ attempt	M1
	correct	A1
	$F^2 = (5+3\cos 40)^2 + (3\sin 40)^2$	M1 A1 ✓
	$F \simeq \underline{7.55\ N}$	A1 (5)
	(b) $\tan\theta = \frac{3\sin 40}{5+3\cos 40}$, $\theta \simeq \underline{14.8^\circ}$	M1 A1, ✓ A1 (3)
		(8)
	OR (a) $\underset{\sim}{P} = \begin{pmatrix}5\\0\end{pmatrix}$ or $5\underline{i}$ $\underset{\sim}{Q} = \begin{pmatrix}3\cos 40\\3\sin 40\end{pmatrix}$ or $3\cos 40\underline{i} + 3\sin 40\underline{j}$	M1
	$\Rightarrow \underset{\sim}{F} = \begin{pmatrix}5+3\cos 40\\3\sin 40\end{pmatrix}$	A1
	$\lvert\underset{\sim}{F}\rvert = (5+3\cos 40)^2 + (3\sin 40)^2$	M1 A1 ✓
	$\simeq \underline{7.55\ N}$	A1 (5)
	(b) $\tan\theta = \frac{3\sin 40}{5+3\cos 40}$	M1 A1 ✓
	$\simeq \underline{14.8^\circ}$	A1 (3)
		(8)

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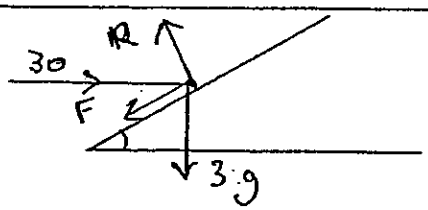
Question number	Scheme	Marks
3.	(a) Distance $= \frac{1}{2} \times (30+17) \times 3, + 4 \times 17$	M1 A1, M1
	$= 138.5$ m.	A1 (4)
	OR $\frac{1}{2} \times 3 \times (30-17) + 3 \times 17 + 4 \times 17$	M1 A1, M1
	$= 138.5$ m	A1
	(b) Sr. line graph $\Rightarrow$ const. decel^n	M1
	"$F = ma$" $\Rightarrow$ F const	A1 cso (2)
	(c) Decel^n $= \frac{30-17}{3}$	M1
	Force $= 1200 \times \left(\frac{30-17}{3}\right) = 5200$ N	M1 A1 (3)
		(9)
4.	(a)  Diag. with 4 forces marked (Allow F & R combined if clear)	B2 −1 e.e. (2)
	(b) R(↑) $R = 3g \cos 30° + 30 \sin 30°$ (3 terms)	M1 A2 −1 e.e.
	$= 40.46\ldots \simeq 40.5$ or 40 N.	A1 (4)
	(c) R(↙) $F = 30 \cos 30° - 3g \sin 30°$ (3 terms)	M1 A1
	$F = \mu R, \Rightarrow \mu = \frac{F}{R} = \frac{11.28}{40.46}$	M1, M1
	$\simeq 0.28$ (or 0.279)	A1 (5)
		(11)

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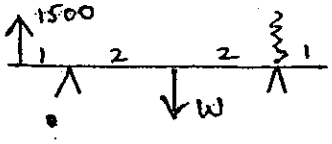
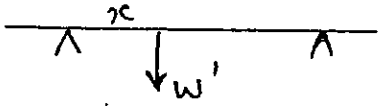
Question number	Scheme	Marks
5.	(a) O	B1 (1)
	(b)  $M(D)$: $2W = 1500.5$ $\Rightarrow W = 3750$ N	M1 A1 A1 (3)
	[If moments about another pt: M1 for a complete method to get W, A1 for a moments equ^2 correct.]	
	(c)  $M(D)$ $1500.5 = W'(4-x)$ $M(C)$ $1000.5 = W'x$ Solve $\rightarrow W' = 3125$ N	M1 A1 M1 A1 M1 A1 (6)
	(d) $x = 1.6$ m	M1 A1 (2)
	(e) AB remains straight line (o.e.)	B1 (1)
		13

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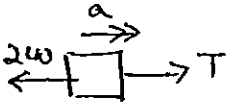
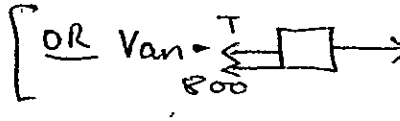
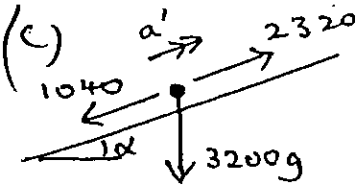
Question number	Scheme	Marks
6.	(a) Car + Van: $3200a = 2320 - 800 - 240$ $a = 0.4\ ms^{-2}$	M1 A1 A1 (3)
	(b) Car:  $1200a = T - 240$ $\rightarrow T = 720\ N$	M1 A2√ −1 e.e. A1 (4)
	[OR Van:  $2000a = 2320 - 800 - T$ $\rightarrow T = 720$]	
	NB If use equ^{2}s for car + van alone, allow M1 A2 for one equ^{2} involving T, then M1 A1 for a second equ^{2} provided it is part of a complete method to find a/T. Then A1 A1 for a + T.	
	(c)  (4 terms) $3200a' = 2320 - 1040 - 3200g \cdot \frac{1}{20}$ $a' = -0.09\ ms^{-2}$ $\Rightarrow$ magn. $0.09\ ms^{-2}$ & speed decreasing	M1 A2 −1 e.e. M1 A1 A1 (6) (13)

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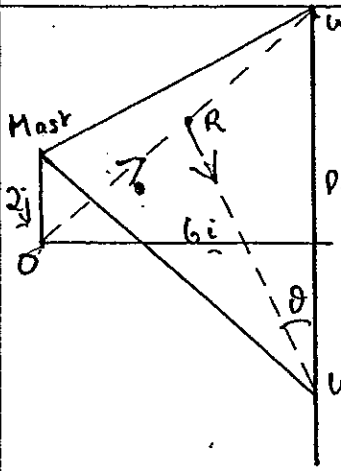
7.		
	(a) $\underset{\sim}{W_1} = 2\underset{\sim}{j} + 6\underset{\sim}{i} + 6\underset{\sim}{j}$	
	$= 6\underset{\sim}{i} + 8\underset{\sim}{j}$	B1 B1 (2)
	(b) $OW_1 = \sqrt{(6^2+8^2)} = 10$ km	M1
	Time $= \frac{10}{5} = 2$ hrs	M1 A1 (3)
	(c) $\underset{\sim}{W_2} = 2\underset{\sim}{j} + 6\underset{\sim}{i} - 6\underset{\sim}{j}$	
	$= 6\underset{\sim}{i} - 4\underset{\sim}{j}$	B1, M1 A1 (3)
	(d) P.v. of rescue party after 1 hour = $\underset{\sim}{R} = 3\underset{\sim}{i} + 4\underset{\sim}{j}$	M1 A1
	$\underset{\sim}{RW_2} = 3\underset{\sim}{i} - 8\underset{\sim}{j}$	M1 A1
	$\tan\theta = \frac{3}{8} = 20.6°$	M1
	$\Rightarrow$ Required bearing $= 180° - 20.6°$	M1
	$= 159.4°$	A1 (7)
		(15)

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Question number	Scheme	Marks
1.	Impulse = Change in momᵐ = 0.3(8+6) = 4.2 Ns	M1 A1 A1 (3)
2.	(a) 4 → 1800 □ □ 1200 → V: $1800.4 = (1800+1200)V$, $V = 2.4\ ms^{-1}$	M1 A1 A1 (3)
	(b) $R.8 = 3000.2.4$, $R = 900$	M1 A1√(V) A1 (3) (6)
3.	(a) "$v = u + at$": $60 = 12 + 4a \rightarrow a = 12\ ms^{-2}$ (*)	M1 A1 (2)
	(b) "$s = ut + \frac{1}{2}at^2$" $OA = 12.4 + \frac{1}{2}.12.4^2$, $= 144m$	M1 A1 A1 (3)
	(c) "$v^2 = u^2 + 2as$" $v^2 = 12^2 + 2.12.72$, $v \simeq 43.3\ ms^{-1}$	M1 A1√(OA) A1 (3)
4.	(a) v, V, 20, 40, 10, T, t	One shape correct B1; 2nd shape correct rel. to first B1; Figs (10, 20, 40) B1 (3)

Contd.

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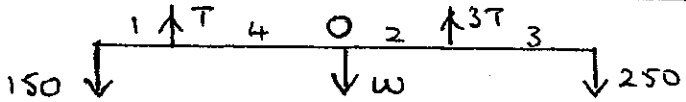
Question number	Scheme	Marks
4.	(b) Scooter: dist travelled = area under graph $850 = \frac{1}{2}T.20 + 20.40$ $\Rightarrow T = \underline{5s}$	M1 A1 A1 (3)
	(c) Van: $850 = \frac{1}{2}V.10 + V(40-5)$ $\Rightarrow V = 21.25\ ms^{-1}$	M1 A1√ (1) A1 (3) (9)
5.	(a) 	B1 B1 (2)
	(b) M(O): $150.5 + 3T.2 = T.4 + 250.5$ Solve $T = \underline{250\ N}$ [Allow M1 A2,1,0 for moments equⁿ abt any pt. Then M1 A1 for complete soln² → T=).	M1 A2,1,0 ↓ M1 A1 (5)
	(c) R(↑) $4T = 400 + W \rightarrow W = \underline{600\ N}$ (M1 needs complete soln² → W=).	M1 A1 (2)
	(d) By having weight act at <u>centre</u>/<u>mid-pt</u>.	B1 (1) (10)
6.	(a) $\underline{F} = (6\underline{i} + 2\underline{j}) + (3\underline{i} - 5\underline{j}) = \underline{(9\underline{i} - 3\underline{j})}\ N$	B1 (1)
	(b)  $\tan\theta = \frac{9}{3} \Rightarrow \theta \simeq 71.6°$ $\phi = \underline{108.4°}$	M1 A1√ (F) A1 (3)
	(c) "$\underline{F} = m\underline{a}$" $\Rightarrow \underline{a} = \underline{(3\underline{i} - \underline{j})\ ms^{-2}}$	M1 A1√ (F) (2)
	(d) $\underline{v} = (-2\underline{i} + \underline{j}) + 2(3\underline{i} - \underline{j}) = 4\underline{i} - \underline{j}$ Speed $= \sqrt{(4^2 + 1^2)} \simeq \underline{4.12\ ms^{-1}}$	M1, M1, A1√ (a) M1 A1 (5) (11)

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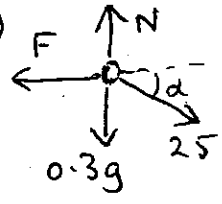
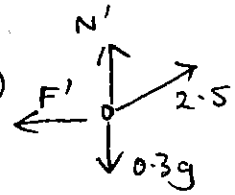
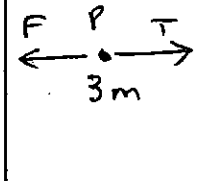
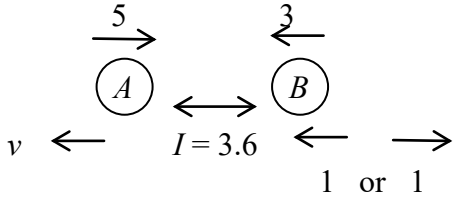
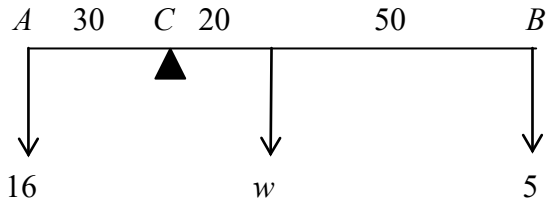
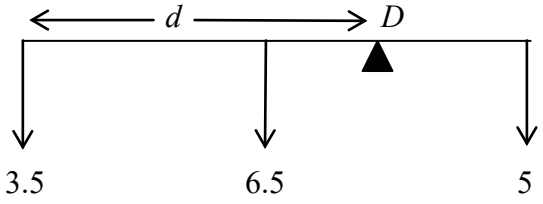
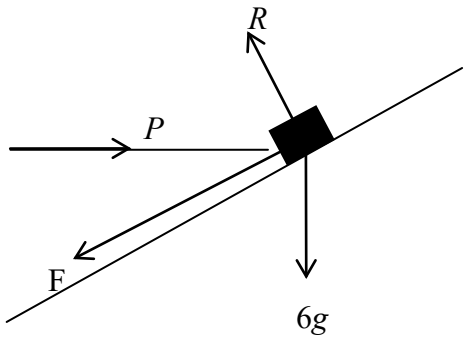
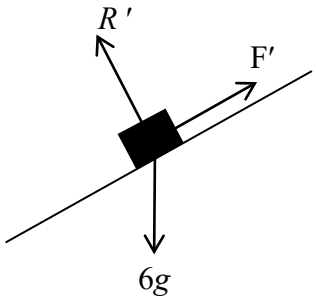
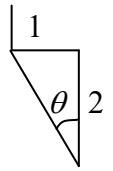
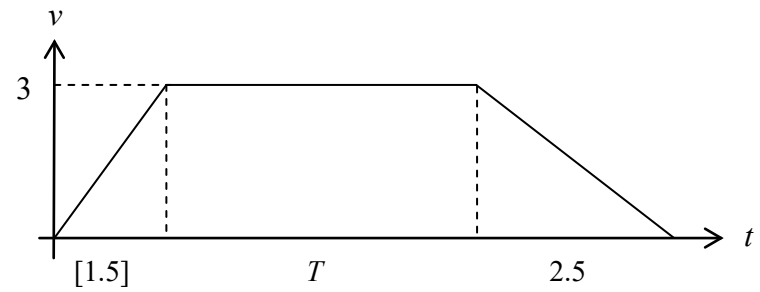
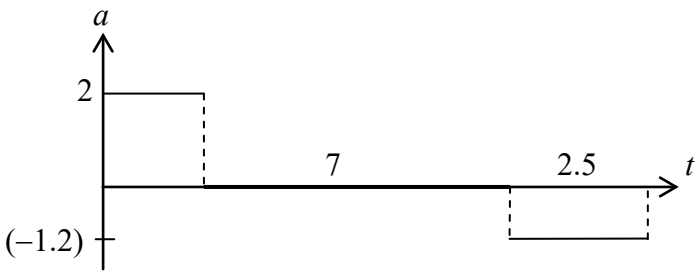
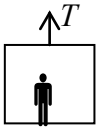
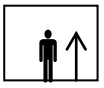
7.	(a)  $R(\uparrow)$ $N = 0.3\times9.8 + 2.5\sin\alpha$ $(= 2.94 + 1.5 = 4.44\ N)$ $R(\rightarrow)$ $F = 2.5\cos\alpha$ $(= 2\ N)$ $F = \mu N \rightarrow \mu = \frac{2}{4.44} \simeq \underline{0.45}$	M1 A2,1,0 M1 A1 M1 M1 A1 (8)
	(b)  $N' = 0.3\times9.8 - 2.5\sin\alpha = \underline{1.44\ N}$ $F' \le \mu N'$. $N' < N \Rightarrow F'_{max}$ less Bar F' must $= 2.5\cos\alpha$ for equilib. Hence equilib. not possible	M1 A1 (2) M1 A1 cso (2) (12)
8.	 (a) P: $T - F = 3ma$ Q: $5mg - T = 5ma$	M1 A1 M1 A1 (4)
	(b) $F = 0.6\times3mg$ $(= 1.8mg)$ Hence $5mg - 1.8mg = 8ma$ $a = \underline{0.4g}$	M1 A1 (4)
	(c) Sub: $T = 3ma + F$ or $5mg - 5ma$ $\rightarrow T = \underline{3mg}$	M1 A1 (2)
	(d) Speed when Q hits floor: $v^2 = 2\times0.4g\times h = \frac{4}{5}gh$	M1 A1√
	Decel^n of P: $3mf = 1.8mg \Rightarrow f = 0.6g$	M1 A1
	Dist moved by P: $\frac{4}{5}gh = 2.\frac{3}{5}g.s$ $\Rightarrow s = \underline{\frac{2}{3}h}$	M1 A1 (6) (16)

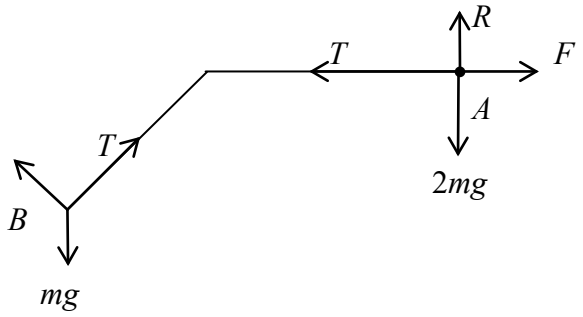
Question Number	Scheme	Marks
1. (*a*)	$s = ut + \frac{1}{2}at^2$: $50 = 5 \times 4 + \frac{1}{2} \times a \times 4^2$	M1 A1
	$\Rightarrow 30 = 8a \Rightarrow a = 3.75$ m s^{-1}	A1 **(3)**
(*b*)	$30^2 = 5^2 + 2 \times 3.75 \times s$	M1 A1 ft
	$\Rightarrow s = 116\frac{2}{3}$ m	A1 **(3)**
		(6 marks)
2.		
	Considering momentum of *A*: $3.6 = 0.5(5 + v)$	M1 A1
	$\Rightarrow v = 2.2$ m s^{-1}	A1 **(3)**
	Considering momentum of *B*: $3.6 = m(3 + 1)$ or $m(3 - 1)$	
	$m = 0.9$ or $m = 1.8$	M1 A1 (one) M1 A1 (both) **(4)**
		(7 marks)
3. (*a*)		
	M(*C*): $16 \times 30 = w \times 20 + 5 \times 70$ (3 terms)	M1 A1
	$\Rightarrow w = 6.5$ N	A1 **(3)**
(*b*)		
	M(*D*): $3.5d + 6.5(d - 50) = 5(100 - d)$	M1 A2ft (–1 eeoo)
	$\Rightarrow d = 55$ cm	A1 **(4)**
(*c*)	Tension equal along string, i.e. tensions = weights throughout *or* no contributions from strings in moments equation	B1 **(1)**
		(8 marks)

(ft = follow through mark; –1eeoo = minus one mark for each error or omission)

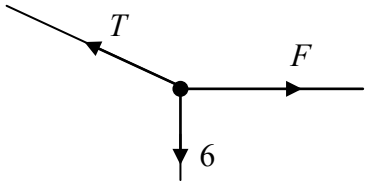
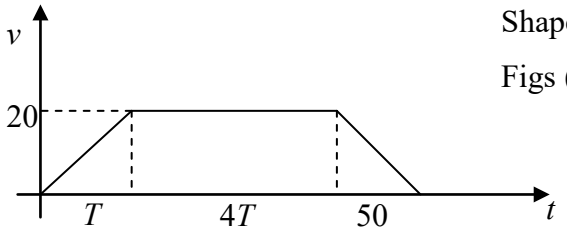
Question Number	Scheme	Marks
4. (*a*)		
	$F = \frac{2}{5}R$	B1
	R(↑): $R\cos 30° - F\cos 60° = 6g$	M1 A1
	$R\frac{\sqrt{3}}{2} - \frac{2}{5}R - \frac{1}{2} = 6g$	
	$\Rightarrow R = 88.3$ N (or 88 N)	A1 **(4)**
(*b*)	R(←): $P = R\cos 60° + F\cos 30°$	M1 A1
	$= 74.7$ N (or 75 N)	A1 **(3)**
(*c*)		
	Component of weight (↙) $= 6g\cos 60°$	
	$= 29.4$ N	B1
	$R' = 6g\cos 30° = 50.9$ N	M1 A1
	$F_{max} = 0.4\,R' = 20.36$ N	M1
	Since $29.4 > 20.36$, the box moves	A1 cso **(5)**
		(12 marks)
5. (*a*)		
	$\tan\theta = \frac{1}{2} \Rightarrow \theta = 26.6°$	M1 A1
	angle required $= 153.4°$	A1 **(3)**
(*b*)	$\mathbf{a} = \frac{1}{3}[(\mathbf{i} - 2\mathbf{j}) - (-5\mathbf{i} + 7\mathbf{j})]$	M1
	$= (2\mathbf{i} - 3\mathbf{j})$ m s^{-2}	A1 **(2)**
(*c*)	$\mathbf{F} = m\mathbf{a} = 4\mathbf{i} - 6\mathbf{j}$	M1
	$\lvert\mathbf{F}\rvert = \sqrt{(16 + 36)} = 7.21$ N	M1 A1 **(3)**
(*d*)	$\mathbf{v} = (-5 + 2t)\mathbf{i} + (7 - 3t)\mathbf{j}$	M1 A1ft **(2)**
(*e*)	$\mathbf{v}$ parallel to $\mathbf{i} + \mathbf{j} \Rightarrow \frac{-5 + 2t}{7 - 3t} = 1$	M1
	$\Rightarrow t = 2.4$ s	M1 A1 **(3)**
		(13 marks)

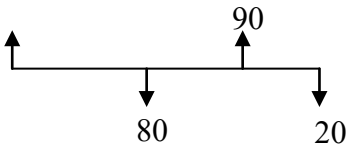
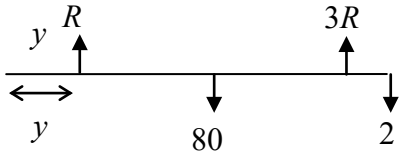
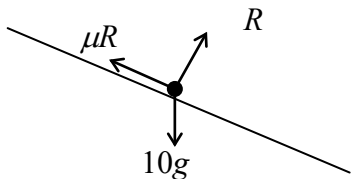
(cso = correct solution only)

Question Number	Scheme	Marks
6. (*a*)	 shape (3, 2.5)	B1 B1 **(2)**
(*b*)	Area = 27 = $\frac{1}{2}$ × 1.5 × 3 + 3*T* + $\frac{1}{2}$ × 2.5 × 3	M1 A1
	⇒ *T* = 7 s	A1 **(3)**
(*c*)	 shape $0 \le t \le 8.5$ shape $t > 8.5$ (2, 7 (ft), 2.5)	B1 B1 B1 **(3)**
(*d*)	 (System) *T* – 200*g* = 200 × 2 ⇒ *T* = 2360 N	M1 A1 A1 **(3)**
(*e*)	 (Man) *R* – 80*g* = –80 × 1.2 ⇒ *R* = 688 N	M1 A1 A1 **(3)**
		(14 marks)

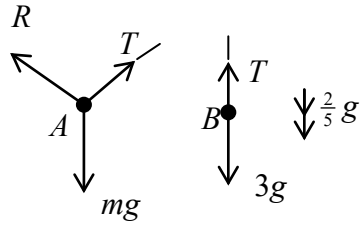
Question Number	Scheme	Marks
7. (*a*)		
	$R = 2mg \Rightarrow F = 2\mu mg$	B1
	$A: T - 2\mu mg = 2ma$	M1 A1
	$B: mg \times \frac{1}{2} - T = ma$	M1 A1
	Eliminating T: $3ma = \frac{1}{2}mg - 2\mu mg$	M1
	$a = \frac{1}{6}(1 - 4\mu)g$ (✱)	A1 **(7)**
(*b*)	$\mu = 0.2 \Rightarrow a = \frac{1}{30}g$	B1
	when string breaks: $v^2 = 2 \times \frac{1}{30}g \times h = \frac{1}{15}gh$	M1 A1
	A decelerating with deceleration $f \Rightarrow 2mf = 2\mu mg$	
	$f = \mu g = \frac{1}{5}g$	B1
	Hence distance travelled during deceleration is given by $\frac{1}{15}gh = 2 \times \frac{1}{5}gd$	M1
	$\Rightarrow d = \frac{1}{6}h$	
	$\therefore$ Total distance $= \frac{7}{6}h$	A1 cso **(6)**
(*c*)	Any two from: weight of pulley; friction at pulley; friction on slope; weight of string; string extensible; 'spin' of particle	B1 B1 **(2)**
		(15 marks)

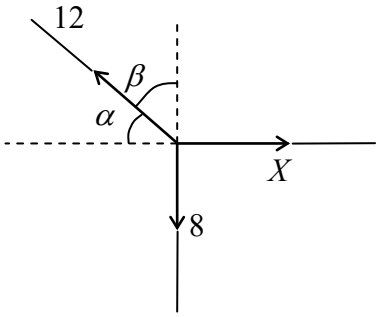
((✱) indicates final line is given on the paper; cso = correct solution only)

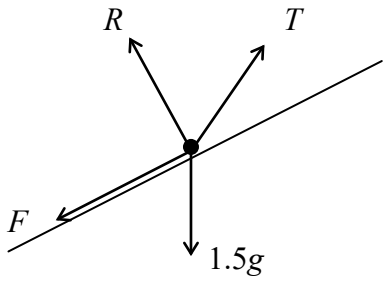
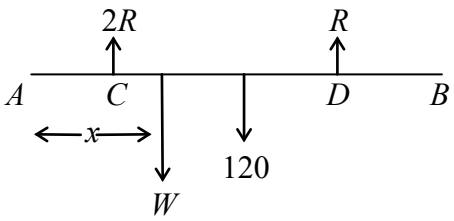
Question Number		Scheme	Marks
1.	(*a*)	 $R(\uparrow)$: $T\cos 30° = 6$	M1 A1
		$T = 6.93$	A1 **(3)**
	(*b*)	$R(\rightarrow)$: 'T' $\sin 30° = F$	M1 A1
		$F = 3.46$	A1 **(3)**
			(6 marks)
2.	(*a*)	$3\mathbf{i} - 7.5\mathbf{j} = 1.5\mathbf{a} \Rightarrow \mathbf{a} = 2\mathbf{i} - 5\mathbf{j}$	M1 A1
		$\lvert\mathbf{a}\rvert = \sqrt{(2^2 + 5^2)} = \sqrt{29} \approx 5.39$ (awrt)	M1 A1 **(4)**
	(*b*)	$\mathbf{v} = (2\mathbf{i} + 3\mathbf{j}) + 4(2\mathbf{i} - 5\mathbf{j})$	M1, A1ft
		$= 10\mathbf{i} - 17\mathbf{j}$	A1 **(3)**
			(7 marks)
3.	(*a*)	 Shape	B1
		Figs (20, 50, T, $4T$/$5T$)	B1
			(2)
	(*b*)	$\frac{1}{2} \times T \times 20 + 4T \times 20 + \frac{1}{2} \times 50 \times 20 = 1220$	M1 A1
		$T = 8$	A1 **(3)**
	(*c*)	Acceleration $= \dfrac{20}{8} = 2.5 \text{ m s}^{-2}$	M1 A1ft **(2)**
			(8 marks)

Question Number		Scheme	Marks
4.	(*a*)	 M(*A*): $80 \times \frac{x}{2} + 20 \times x = 90 \times 2$	M1 A1
		Solve for x: $x = 3$	M1 A1 **(4)**
	(*b*)	By having weight act at *B*.	B1 **(1)**
	(*c*)	 $R(\uparrow)$: $R + 3R = 100$ ($R = 25$)	B1
		M(*A*): $25y + 75 \times 2 = 80 \times 1.5 + 20 \times 3$	M1 A1 ft
		Solve: $y = 1.2$ m	A1 **(4)**
			(9 marks)
5.	(*a*)	$8^2 = 10^2 + 2a \times 5 \rightarrow a = (-)3.6$ m s^{-2}	M1 A1 **(2)**
	(*b*)	 $R = 10g \cos 20°$	B1
		$F = \mu R$ used	B1
		$10g \sin 20° - \mu.10g \cos 20° = 10\ (-3.6)$	M1 A1
		Solve: $\mu. = 0.75$ (or 0.755)	M1 A1 **(6)**
	(*c*)	*AC* maximum if speed at $C = 0$	
		$\therefore 0^2 = 10^2 - 2 \times 3.6 \times s$	M1
		$s \approx 13.9$ m (awrt)	A1 **(2)**
			(10 marks)

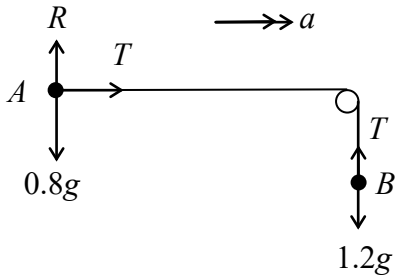
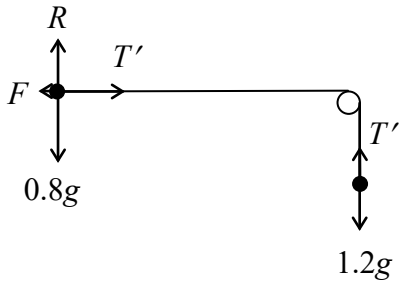
Question Number		Scheme	Marks
6.	(*a*)	$1500 \times 10 + 2500 \times 5 = 1500 \times 4 + 2500 \times v$	M1 A1
		$\rightarrow v = 8.6$ m s^{-1} (*)	A1 **(3)**
	(*b*)	*P*: $1500a = -500$ $(\Rightarrow a = -\frac{1}{3}$ m s$^{-2})$	M1
		$0^2 = 4^2 - 2 \times \frac{1}{3} \times s$ $\Rightarrow s = 24$ m	M1 A1 **(3)**
	(*c*)	*P*: $0 = 4 - \frac{1}{3}t \Rightarrow t - 12$ s	M1
		Q: $s = 8.6 \times 12 = 103.2$ m	M1 A1
		Distance apart = $103.2 - 24 = 79.2$ m	M1 A1 **(5)**
			(11 marks)
7.	(*a*)	$v_P = \frac{(50\mathbf{i} - 25\mathbf{j}) - (20\mathbf{i} + 35\mathbf{j})}{\frac{1}{2}} = 60\mathbf{i} - 120\mathbf{j}$	M1 A1
	(*b*)	$\mathbf{p} = 20\mathbf{i} + 35\mathbf{j} + (60\mathbf{i} - 120\mathbf{j})t$	M1 A1 ft **(2)**
	(*c*)	$v_Q = \frac{120}{5}(4\mathbf{i} - 3\mathbf{j})$ $(= 96\mathbf{i} - 72\mathbf{j})$	M1
		$\mathbf{q} = 96t\mathbf{i} - 72t\mathbf{j}$	M1 A1 **(3)**
	(*d*)	$t = 2$: $\mathbf{p} = 140\mathbf{i} - 205\mathbf{j}$, $\mathbf{q} = 192\mathbf{i} - 144\mathbf{j}$	M1
		Use of $(PQ =)$ $\mathbf{q} - \mathbf{p}$ or $\mathbf{p} - \mathbf{q}$ $(= QP)$ $(=52\mathbf{i} + 61\mathbf{j})$	M1
		$PQ = \sqrt{(52^2 + 61^2)} \approx 80$ km	M1 A1 **(4)**
			(11 marks)

Question Number	Scheme	Marks
8. (*a*)	 B: $3g - T = 3 \times \frac{2}{5}g$	M1 A1
	$\rightarrow T = \frac{9}{5}g = 17.6$ N	A1 **(3)**
(*b*)	A: $17.6 - mg\sin 30° = m \times \frac{2}{5}g$	M1, A1 ft
	Solve: $\rightarrow m = 2$	M1 A1 **(4)**
(*c*)	Speed of B at ground: $v^2 = 2 \times \frac{2}{5}g \times 0.25$ (=1.4)	M1
	$I = 3 \times v = 4.2$ Ns	M1 A1 **(3)**
(*d*)	A: $-mg\sin 30° = ma \Rightarrow a = -\frac{1}{2}g = -4.9$	M1 A1
	$0 = 1.4 - 4.9t$	M1
	$T = 0.29$ s (or 0.286 s)	A1 **(4)**
		(14 marks)

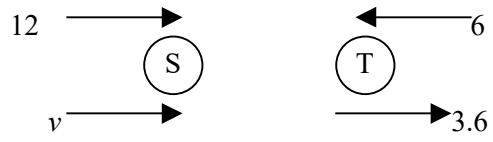
Question Number	Scheme	Marks
1. (*a*)	CLM: $2000 \times 10 = 2000v + 3000 \times 5$	M1, A1
	$v = 2.5$ m s^{-1}	B1 **(3)**
(*b*)	$I = 3000 \times 5$ (or $2000(10 - 2.5)$)	M1
	$= 15\,000$ Ns	A1 **(2)**
		(5 marks)
2. (*a*)	 R(↑) $8 = 12 \cos \beta$ or $12 \sin \alpha$	M1
	$\Rightarrow \beta = 41.8°$ or $\alpha = 48.2°$	A1
	$\Rightarrow \theta = 138.2°$	A1 **(3)**
(*b*)	R(→) $X = 12 \cos 41.8°$ (or $12 \sin 48.2°$)	M1 A1ft
	$= 8.94$	A1 **(3)**
		(6 marks)
3. (*a*)	$\mathbf{a} = [-14\mathbf{i} + 21\mathbf{j} - (6\mathbf{i} - 27\mathbf{j})] \div 4$	M1 A1
	$= (-5\mathbf{i} + 12\mathbf{j})$ m s^{-2}	A1 **(3)**
(*b*)	$\lvert\mathbf{a}\rvert = \sqrt{(5^2 + 12^2)} = 13$	M1
	$\lvert\mathbf{F}\rvert = m\lvert\mathbf{a}\rvert = 0.4 \times 13 = 5.2$ N	M1 A1 **(3)**
		(6 marks)
Alt (*b*)	$\mathbf{F} = 0.4(5\mathbf{i} + 12\mathbf{j}) = 2\mathbf{i} + 4.8\mathbf{j}$	M1
	$\lvert\mathbf{F}\rvert = \sqrt{(2^2 + 4.8^2)} = 5.2$ N	M1 A1 **(3)**

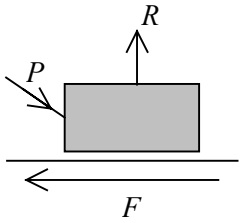
Question Number	Scheme	Marks
4. (*a*)	$\mathbf{p} = 10t\mathbf{j}$	B1
	$\mathbf{q} = (6\mathbf{i} + 12\mathbf{j}) + (-8\mathbf{i} + 6\mathbf{j})t$	M1 A1 **(3)**
(*b*)	$t = 3$: $\mathbf{p} = 30\mathbf{j}$, $\mathbf{q} = -18\mathbf{i} + 30\mathbf{j}$	M1 A1
	$\Rightarrow$ dist. apart = 18 km	A1 **(3)**
Alt. (*b*)	$\mathbf{PQ} = \mathbf{q} - \mathbf{p} = (6 - 8t)\mathbf{i} + (12 - 4t)\mathbf{j}$	M1
	$t = 3$: $\mathbf{PQ} = -18\mathbf{i} + 0\mathbf{j}$ or $\lvert\mathbf{PQ}\rvert^2 = (6 - 8t)^2 + (12 - 4t)^2$	A1
	Dist. = 18 km or $t = 3 \rightarrow \lvert\mathbf{PQ}\rvert = 18$	A1
(*c*)	Q north of $P \Rightarrow 6 - 8t = 0$	M1
	$t = \frac{3}{4}$	A1 **(2)**
		(8 marks)
5.		
	R(↗): $T\cos 20° = F + 1.5g\sin 30°$	M1 A2,1,0
	R(↖): $T\sin 20° + R = 1.5g\cos 30°$	M1 A2,1,0
	Using $F = \frac{1}{3}R$	M1
	Eliminating R, solve T	M1, M1
	$T = 11$ or 11.0 N	A1
		(10 marks)
6.		
(*a*)	M(A): $Wx + 120 \times 1.5 = R \times 2 + 2R \times 1$	M1 A2, 1, 0
	R(↑) $3R = W + 120$	M1 A1
	Hence $Wx + 180 = 3R = W = 120$	M1
	$W(1 - x) = 60$	A1
	$W = \dfrac{60}{1 - x}$	M1 A1cso **(8)**
(*b*)	$W > 0 \Rightarrow x < 1$	M1 A1 **(2)**
		(10 marks)

Question Number	Scheme	Marks
7. (*a*)	$v^2 = u^2 + 2as$: $0 = u^2 - 2 \times 9.8 \times 25.6$	M1 A1
	$u^2 = 501.76 \Rightarrow u = 22.4$ **(✶)**	A1cso **(3)**
(*b*)	$-1.5 = 22.4T - 4.9T^2$	M1 A1
	$4.9T^2 - 22.4T - 1.5 = 0$	
	$T = \dfrac{22.4 \pm \sqrt{22.4^2 + 4 \times 1. \times 4.9)}}{9.8}$	M1
	$= 4.64$ s	A1 **(4)**
(*c*)	Speed at ground $v = 22.4 - 9.8 \times 4.64$	M1
	$v = -23.07$	A1
	(or $v^2 = 22.4^2 + 2 \times 9.8 \times 1.5$, $v = 23.05$)	
	$v^2 = u^2 + 2as$: $0 = 23.07^2 + 2 \times a \times 0.025$	M1 A1ft
	($\rightarrow a = -10644.5$)	
	$F - 0.6g = 0.6a$	M1
	$F = 6390$ N (3 sf)	A1 **(6)**
(*d*)	Air resistance; variable F;	B1 **(1)**
		(14 marks)

Question Number	Scheme	Marks
8. (*a*)		
	A: $T = 0.8a$	B1
	B: $1.2g - T = 1.2a$	M1 A1
	Solve: $T = 0.48g = 4.7$ N	M1 A1 **(5)**
(*b*)	$a = 0.6g = 5.88$	M1
	Hence $0.6 = \frac{1}{2} \times 0.6g \times t^2$	M1
	$t = 0.45$ or 0.452 s	A1 **(3)**
		
	$F = \mu R = \frac{1}{5} \times 0.8g$	B1
	A: $T' - F = 0.8a'$	M1 A1
	B: $1.2g - T' = 1.2a'$	B1
	Solve: $a' = 0.52g$	M1 A1
	$0.6 = \frac{1}{2} \times 0.52g \times t^2$	M1
	$t = 0.49$ or 0.485 s	A1 **(8)**
		(16 marks)

PROVISIONAL MARK SCHEME NOVEMBER 2003

Question Number	Scheme	Marks
1.	**(a)** $0^2 = u^2 - 2\times 9.8\times 40$	M1 A1
	$\Rightarrow \quad \underline{u = 28 \text{ ms}^{-1}}$	A1 (3)
	(b) $-28 = 28 - 9.8\times t$	M1 A1$\surd$
	$\Rightarrow \quad \underline{t = 5.7 \text{ or } 5.71 \text{ s}}$	A1 (3) **6**
2.		
	(a) $28800 = 2000\,(12 - v)$	M1 A1
	$v = -2.4\text{ms}^{-1}$ Speed $= \underline{2.4 \text{ ms}^{-1}}$	A1 (3)
	(b) due west / $\leftarrow$ /reversed direction (o.e.)	A1$\surd$ (1)
	(c) T : $28800 = m(6 + 3.6)$	M1 A1
	$\Rightarrow m = \underline{3000 \text{ kg}}$	M1 A1 (4)
	OR $2000\times 12 - 6\times m = -\ 2000\times 2.4 + m\times 3.6$	M1 A1$\surd$
	$\Rightarrow \quad m = 3000\,\text{kg}$	M1 A1 **8**

3.		M1 A2, 1, 0 M1 A1 B1 M1 M1 A1	**9**

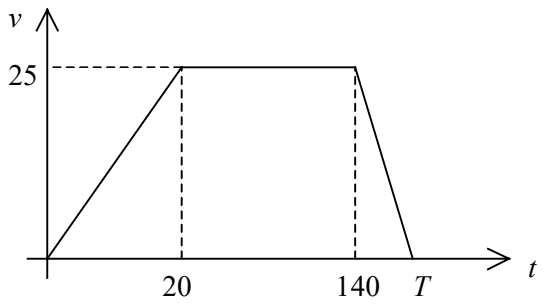
R $\uparrow$: $R = 50g + P\sin 30°$

R $\rightarrow$: $F = P\cos 30°$

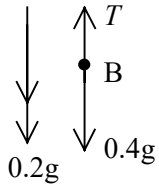
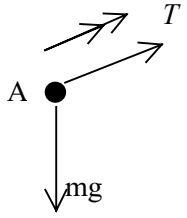
$F = \frac{3}{5}R$ used

$P\cos 30° = \frac{3}{5}(50g + P\sin 30°)$ Elim F, R

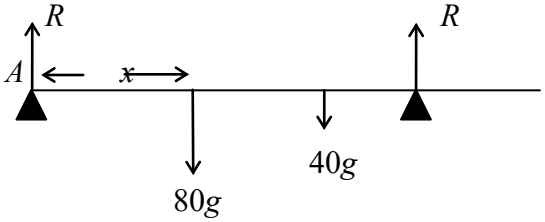
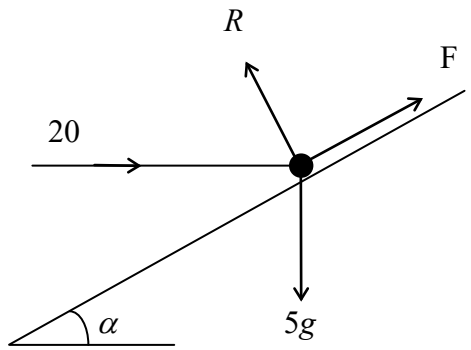
Solve $P = 520$ or 519 N

Question Number	Scheme	Marks
4.	**(a)**	
	Shape	B1
	Figs	B1 (2)
		
	(b) $\frac{1}{2}(T+120)\times 25 = 4000$	M1 A1
	$\left[\textbf{or } \frac{1}{2}.20.25, +120.25+\frac{1}{2}(T-140).25 = 4000\right]$	
	$\rightarrow T = \underline{200\text{ s}}$	A1 (3)
	(c) Car: $\frac{1}{2}.20.25, +25(t-20) = 1500$	M1 A1, A1
	$\rightarrow t = 70\text{s}$	M1
	Hence motorcycle travels for 60s	A1 (5)
	(d) $1500 = \left(\frac{0+v}{2}\right).60$	M1
	$v = \underline{50\,\text{ms}^{-1}}$	A1 (2)
		12
5.	**(a)** $a = \frac{1}{4}\left[(5\mathbf{i}+11\mathbf{j})-(3\mathbf{i}-5\mathbf{j})\right] = -2\mathbf{i}+4\mathbf{j}$	M1 A1 (2)
	(b) $\mathbf{F} = m\,\mathbf{a} = -6\mathbf{i}+12\mathbf{j}$	M1 A1
	$\lvert\mathbf{F}\rvert = \sqrt{180} \simeq 13.4\text{ N}$ (AWRT)	M1 A1 (4)
	[**OR** $\lvert\mathbf{a}\rvert = \sqrt{20} \simeq 4.47 \Rightarrow \lvert\mathbf{F}\rvert = 3\times 4.47 \simeq 13.4\text{ N}$]	

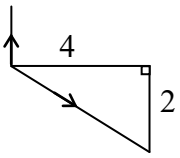
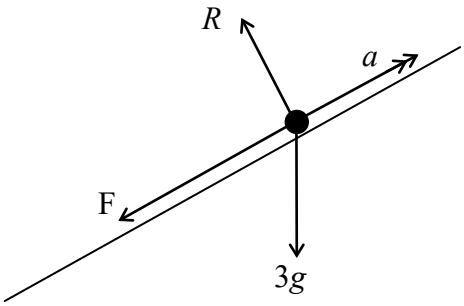
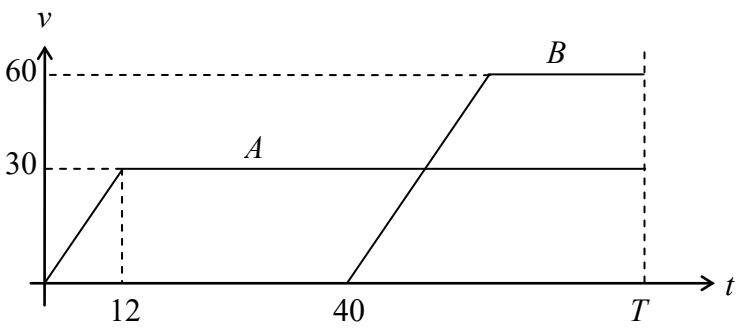
	(c) $t = 6 \quad \mathbf{v} = 3\mathbf{i} - 5\mathbf{j} + 6(-2\mathbf{i} + 4\mathbf{j}) \quad [= -9\mathbf{i} + 19\mathbf{j}]$ At B : $\mathbf{r} = (6\mathbf{i} - 29\mathbf{j}) + 3(-9\mathbf{i} + 19\mathbf{j}) \quad [= -21\mathbf{i} + 28\mathbf{j}]$ $\text{OB} = \sqrt{(21^2 + 28^2)} = \underline{35\,\text{m}}$	M1 A1√ M1 A1√ M1 A1√	(6) **12**

Question Number	Scheme	Marks
6.	**(a)** M(D): $160 \times 2.5 = W \times 4 + 200(4 - x)$	M1 A2, 1, 0
	$400 = 4W + 800 - 200x$	
	$200x - 4W = 400 \Rightarrow 50x - W = 100$ *	M1 A1 (5)
	(b) M(D): $50 \times 2.5 + W \times 1 = 200(4 - x)$	M1 A2, 1, 0
	$200x + W = 675$	(3)
	(c) Solving $\rightarrow$ $x = \underline{3.1\text{m}}$	M1 A1
	: $W = \underline{55\text{N}}$	M1 A1 (4)
		12
7.	**(a)**  $0.4\text{g} - T = 0.4 \times \frac{1}{5}\text{g}$	M1 A1 (2)
	(b) $T = \underline{\frac{8}{25}g}$ or 3.14 or 3.1 N	M1 A1 (2)
	(c) $T - mg\sin 30° = m \times \frac{1}{5}\text{g}$	M1 A1
	$\rightarrow m = \underline{\frac{16}{35}}$ *	M1 A1 (4)
		
	(d) Same T for A & B	B1 (1)
	(e) $v^2 = 2 \times \frac{1}{5}g \times 1$	M1
	$v = \underline{\sqrt{\frac{2g}{5}} \simeq 1.98 \text{ or } 2 \text{ ms}^{-1}}$	A1 (2)

	(f) A: $-\frac{1}{2}mg = ma \Rightarrow a = -\frac{1}{2}g$	M1 A1	
	$v^2 = \frac{2g}{5} - 2\times\frac{1}{2}g\times 0.4$	M1 A1$\surd$	(5)
	$\Rightarrow v = 0$	A1	**16**

Question Number	Scheme	Marks
1. (*a*)		
	$R(\uparrow)$: $2R = 80g + 40g$	M1
	$R = 60g$ or 588 N	A1 (2)
(*b*)	M(*A*): $80g \times x + 40g \times 2 = 60g \times 3$	M1 A2 ft (−1 eeoo)
	$\Rightarrow x = 1\frac{1}{4}$ m	A1 (4)
		(6 marks)
2. (*a*)	$I = 0.12 \times 3 = 0.36$, Ns	B1, B1 (2)
(*b*)	$0.12 \times 3 = 0.12 \times 1.2 + 0.08v$	M1 A1
	$\Rightarrow v = 2.7$ m s^{-1}	A1 (3)
(*c*)	$I = 0.12 \times (3 - 1.2)$ or 0.08×2.7	M1
	$= 0.216$ Ns	A1 (2)
		(7 marks)
3. (*a*)	"$v^2 = u^2 + 2as$": $v^2 = 4^2 + 2 \times g \times 5$	M1 A1
	$v \approx 10.7$ m s^{-1} (accept 11 m s^{-1})	A1 (3)
(*b*)	"$v = u + at$": $-10.7 = 4 - gt$	M1 A1 ft
	$t = \dfrac{14.7}{g} = 1.5$ s	A1 (3)
(*c*)	Air resistance; 'spin'; height of diver; hit board again; horizontal component of velocity (any two)	B1 B1 (2)
		(8 marks)
4.		
	$R(\nwarrow)$: $R = 5g \cos\alpha + 20 \sin\alpha$	M1 A1
	$R(\nearrow)$: $F + 20 \cos\alpha = 5g \sin\alpha$	M1 A1
	Using $\cos\alpha = \frac{4}{5}$ or $\sin\alpha = \frac{3}{5}$	B1
	[$\Rightarrow R = 51.2$ N; $F = 13.4$ N]	
	Using $F = \mu R$	M1
	Solving: $\mu = 0.262$ (accept 0.26)	M1 A1 (8)
		(8 marks)

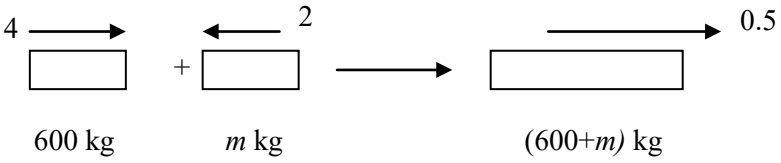
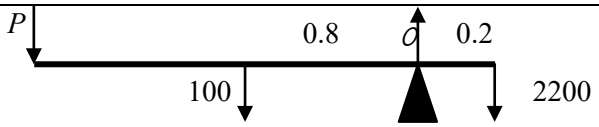
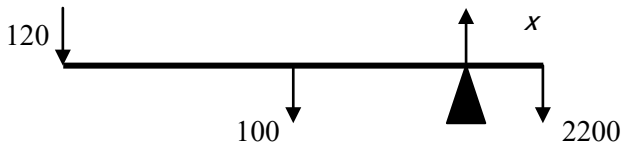
(ft = follow through mark; −1eeoo = minus one mark for each error or omission)

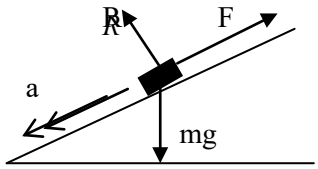
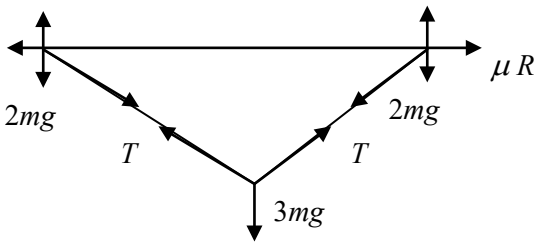
Question Number		Scheme	Marks
5.	(*a*)	"$v = u + at$": $\mathbf{v} = (-2 + 2t)\mathbf{i} + (7 - 3t)\mathbf{j}$	M1 A1
		$\mathbf{v}$ parallel to $\mathbf{i}$ $\Rightarrow 7 - 3t = 0$ $\Rightarrow t = 2\frac{1}{3}$ s	M1 A1 (4)
	(*b*)	$t = 3$, $\mathbf{v} = 4\mathbf{i} - 2\mathbf{j}$	M1
		$\lvert\mathbf{v}\rvert = \sqrt{20} \approx 4.47$ m s^{-1}	M1 A1 (3)
	(*c*)	 Angle = (arctan $\frac{2}{4}$), + 90° = 116.6° (accept 117°)	M1, M1 A1 (3)
		[or 180° – (arctan $\frac{4}{2}$)]	[M1 M1 A1]
			(10 marks)
6.	(*a*)	$R(\nwarrow)$: $R = 3g\cos 30°$ (= 25.46 N)	M1 A1
		F = 0.4R ≈ 10.2 N (accept 10 N)	M1 A1 (4)
	(*b*)	 $R(\nearrow)$: $-F + 3g\sin 30° = 3a$	M1 A2 (–1 eeoo)
		$\Rightarrow a \approx 8.3$ m s^{-2}	M1 A1
		"$v^2 = u^2 + 2as$": $6^2 = 2 \times a \times s$	M1
		$\Rightarrow s \approx 2.17$ m (accept 2.2 m)	A1 (7)
			(11 marks)
7.	(*a*)	 Shape for A	B1
		Shape for B with parallel slope	B1
		Figures	B1 (3)
	(*b*)	Distance moved by $A = \frac{1}{2} \times 12 \times 30, + 30(T - 12)$	B1, M1 A1
		B accelerates for 24 s	B1
		Distance moved by $B = \frac{1}{2} \times 24 \times 60, + 60(T - 64)$	B1, M1 A1
		$\frac{1}{2} \times 12 \times 30, + 30(T - 12) = \frac{1}{2} \times 24 \times 60, + 60(T - 64)$	M1
		$\Rightarrow T = 98$ s	A1 (9)
			(12 marks)

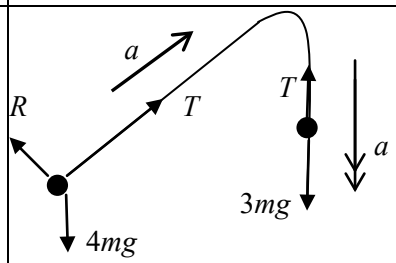
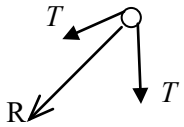
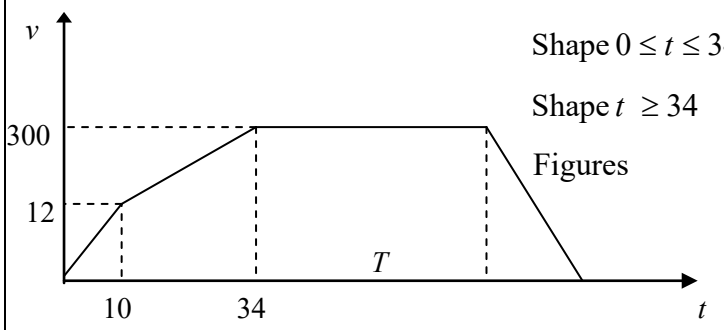
(ft = follow through mark; –1 eeoo = minus one mark for each error or omission)

Question Number	Scheme	Marks
8. (*a*)	Car + truck: $2000a = 2400 - 600 - 400$	M1 A1
	$a = 0.7$ m s^{-2}	A1 (3)
(*b*)	Car only: $T - 400 = 800 \times 0.7$	M1 A1 ft
	[*or* truck only: $2400 - T - 600 = 1200 \times 0.7$]	
	$T = 960$ N	A1 (3)
(*c*)	New acceleration of truck a' given by $1200\,a' = 2400 - 600$	M1
	$a' = 2400 - 600 = 1.5$ m s^{-1}	A1
	Time to reach 28 m s^{-1} $= \dfrac{28 - 20}{1.5} = 5.33$ s	M1 A1
	Time to reach 28 m s^{-1} if rope had not broken $= \dfrac{28 - 20}{0.7} = 11.43$ s	M1 A1
	Difference = 6.1 s $\approx$ 6 s (*)	A1 (7)
		(13 marks)

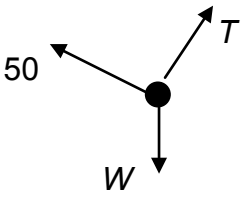
(ft = follow through mark; (*) indicates final line is given on the paper)

Question Number	Markscheme	Marks
1		
(a)	CLM: $600\times 4 - m\times 2 = (600+m)\times 0.5$	M1 A1 ↓
	$\Rightarrow \quad m = \underline{840\text{kg}}$	M1 A1 (4)
(b)	$I = 600(4-0.5)$	M1 → M1
	$= \underline{2100\text{ Ns}}$	A1 (3)
2 (a)		
	M(C): $P\times 1.8 + 100\times 0.8 = 2200\times 0.2$	M1 A2, 1, 0
	$\Rightarrow \quad P = \underline{200\text{ N}}$	A1 (4)
(b)		
	M(C): $120(2-x)+100(1-x)=2200\,x$	M1 A2, 1, 0 ↓
	$\Rightarrow 340 = 2420x \Rightarrow x \approx \underline{14\text{ cm}}$ (Solve x)	M1 A1 (5)

Question Number		Markscheme	Marks
3	(a)		
		R	
		R( ): $R = mg\cos 30$	B1
		R( ): $ma = mg\sin 30 - F$	M1 A1
		$F = 0.4\,R$ used	B1
		Eliminate R $ma = mg\sin 30 - 0.4.mg\cos 30$	M1
		Solve: $a = 4.9 - 0.4\times 9.8\times\sqrt{3}/2$	M1
		$\approx \underline{1.5 \text{ or } 1.51\ \text{m s}^{-2}}$	A1
			(7)
	(b)	$v^2 = 2\times 1.51\times 3 \Rightarrow v = \underline{3 \text{ or } 3.01\ \text{m s}^{-1}}$	M1 A1
			(2)
	(c)	$1.5/1.51\ \text{m s}^{-2}$ **(same as (a))**	B1
			(1)
4	(a)		
		R ↑ for C : $2T\sin\theta = 3\,mg$	M1 A1
		$\sin\theta = \frac{3}{5} \Rightarrow T = \frac{5}{2}\,mg$ (*)	A1
			(3)
	(b)	$R\uparrow$ for A or B: $R = 2mg + T\sin\theta$	M1 A1
		$= 2mg + \frac{5}{2}\,mg.\frac{3}{5} = \frac{7}{2}mg$	M1 A1
		R → for A or B : $T\cos\theta = \mu\,R$	M1
		Solve to get μ as number : $\frac{5}{2}\,mg.\frac{4}{5} = \mu.\frac{7}{2}mg \Rightarrow \mu = \frac{4}{7}$ (Accept 0.57 awrt)	M1 A1
			(7)

Question Number		Markscheme	Marks
5	(a)	 A : $T - 4g\sin 30 = 4a$ B : $3g - T = 3a$ $\Rightarrow T = \frac{18g}{7} = \underline{25.2\text{ N}}$	M1 A1 M1 A1 M1 A1 (6)
	(b)	 $R = 2T\cos 30$ $\approx \underline{44 \text{ or } 43.6\text{ N}}$	M1 A1 A1 (3)
	(c)	(i) String has no weight/mass (ii) Tension in string constant, i.e. same at A and B	B1 B1 (2)
6	(a)	After 10 s, speed $= 1.2\times 10 = 12\text{ m s}^{-1}$ After next 24 s, $v = "u + at" = 12 + 0.75\times 24 = 30\text{ m s}^{-1}$	B1 M1 A1 (3)
	(b)	 Shape $0 \le t \le 34$ Shape $t \ge 34$ Figures	B1 B1 B1
	(c)	Distance $= \frac{1}{2}\times 10\times 12, + \frac{1}{2}(30+12)24$ $= 60 + 504 = \underline{564\text{ m}}$	B1, M1 A1 A1 (4)
	(d)	Distance travelled decelerating $= \frac{1}{2}\times 30\times 10$ $564 + 30T + \frac{1}{2}\times 30\times 10 = 3000$ $\Rightarrow \text{T} = \underline{76.2\text{ s}}$	B1 M1 A1√ A1 (4)

Question Number		Markscheme	Marks
7	(a)	$\tan\theta = \frac{3}{5} \Rightarrow \theta = 031^\circ$	M1 A1
			(2)
	(b)	$\mathbf{a} = 9t\,\mathbf{j}$	B1
		$\mathbf{b} = (-10+3t)\mathbf{i} + 5t\,\mathbf{j}$	M1 A1
			(3)
	(c)	B south of A $\Rightarrow -10+3t = 0$	M1
		$t = 3\frac{1}{3} \Rightarrow$ 1520 hours	A1
			(2)
	(d)	$\mathrm{AB} = \mathbf{b} - \mathbf{a} = (3t-10)\mathbf{i} + 5t\,\mathbf{j}$	M1 A1
		$d^2 = \lvert\mathbf{b}-\mathbf{a}\rvert^2 = (3t-10)^2 + 16t^2$	↓ M1
		$= 25t^2 - 60t + 100 \quad (*)$	A1
			(4)
	(e)	$d = 10 \Rightarrow d^2 = 100 \Rightarrow 25t^2 - 60t = 0$	M1
		$\Rightarrow t = (0 \text{ or } 2.4)$	A1
		$\Rightarrow$ time 1424 hours	A1
			(3)

Question Number	Scheme	Marks
1	 (a) R ($\rightarrow$): $T\cos 60 = 50\cos 30$	M1 A1
	$T = \underline{86.6\text{ N}}$	A1 (3)
	(b) R($\uparrow$): $W = 50\sin 30 + T\cos 30$	M1 A1
	$= \underline{100\text{ N}}$	A1 (3)
	or R ($\|\|$ to BC): $W\cos 60 = 50$	M1 A1
	$W = \underline{100\text{ N}}$	A1 (3)

(a) *M1 for a valid equation in T only*
Treat use of tan 30/60 (e.g. tan 30 = T/50) as invalid equation unless there is a triangle of Forces

(b) *M1 for a valid equation involving W (and T if necessary)*

for first A1 in (i), allow for using their T (i.e. effectively f.t.)

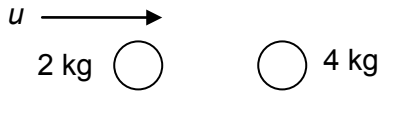
Accept each answer as awrt.

Question Number	Scheme	Marks
2	(a) '$v = u + at$': $9.5 = 5 + 1.5a \Rightarrow a = 3$	M1 A1
	Hence $v^2 = 5^2 + 2 \times 3 \times 24$	↓ M1
	$= 169 \Rightarrow v = \underline{13 \text{ m s}^{-1}}$ (*)	A1 (4)
	(b) '$I = mv - mu$': $-30 = 2(v - 13) \Rightarrow v = (-)\ 2 \text{ m s}^{-1}$	M1 A1
	In direction of CA (o.e.)	A1 (3)

(a) *2nd M1 for equation in v (and numbers) only*
Final A1 is cso

(b) *M1 for valid impulse = momentum change equn with 3 non-zero terms including '30' and '13'*
A1 for '30' and '13' with same sign
A1 for direction as 'CB' or anything convincing!

NB both A's in (b) are cao = cso!

Question Number	Scheme	Marks
3	 CLM: $2u = -2v + 4w$	M1 A1
	Using $w = 3v$ ($\Rightarrow 2u = -2v + 12v$) and solve	M1
	$\Rightarrow v = \frac{1}{5}u$ (*)	A1 cso
		(4)
(b)	$10 = 2a \Rightarrow a = 5$ m s^{-2}	B1
	$0 = \frac{1}{25}u^2 - 2 \times 5 \times 1.6$	M1 A1√
	$\rightarrow u = \underline{20 \text{ m s}^{-1}}$	M1 A1
		(5)

(a) *1st M1 for valid CLM equn*
*2nd M1 for correct equn for 'v' and 'w' and solving for v **or** w.*
Final A1 is cso (dropping u and reinserting loses last A1)

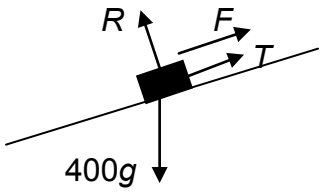
(b) *Allow B1 for $a = \pm 5$*
M1 for using '$v^2 = u^2 + 2as$' with v = 0 and with a value for a
*A1 **f.t.** on their a (provided this is not g), but signs must be correct*

***SC** For using u instead of u/5 ($\rightarrow u = 4$), allow M1 A0 M0.*

Energy: $\frac{1}{2} \times 2 \times (u/5)^2 = 10 \times 1.6$ M1 A1 A1

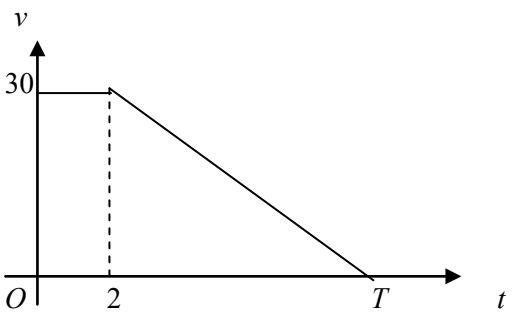
$\rightarrow u = 20$ dep M1 A1

Question Number	Scheme	Marks
4	(a) M(D): $20g \times 1.5 + 10g \times 1 = R_B \times 3$	M1 A1
	$\Rightarrow \quad R_B = \underline{40g/3 \approx 131 \text{ or } 130 \text{ N}}$	M1 A1 (4)
	[NB For moments about another point, allow M1 A1 for moments equation dimensionally correct and with correct number of terms; second M1 is for complete method to find R_B.]	
	(b) R(↑): $R_D + 40g/3 = 20g + 10g$	M1 A1√
	$\Rightarrow \quad R_D = \underline{50g/3 \approx 163 \text{ or } 160 \text{ N}}$	A1 (3)
	or M(B): $20g \times 1.5 + 10g \times 2 = R_D \times 3$	M1 A1
	$\Rightarrow \quad R_D = \underline{50g/3 \approx 163 \text{ or } 160 \text{ N}}$	A1 (3)
	[NB For moments about another point, allow M1 for a complete method to find R_D, A1 for a correct equation for R_D.]	
	(c) $R_B = 0$	M1
	M(D): $20g \times x = 10g \times 1$	M1 A1
	$x = DF = \underline{0.5 \text{ m}}$	A1 (4)
	For weight/mass confusion, A0 A0 in (a) but allow f.t. in (b) (ans 50/3 = 16.7)	
	General rule of deducting max. 1 per question for > 3 s.f	
	(c) *2nd M1: must have correct no. of non=zero terms, and equation in x only* *If use value(s) of R's from (a) or (b): M0.*	

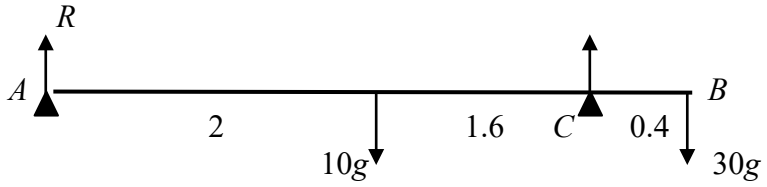
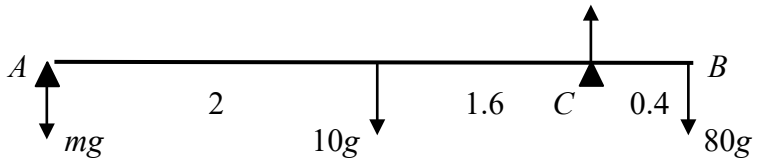
Question Number	Scheme	Marks
5	(a) 	
	$R = 400g\cos 15°$ (≈ 3786 N)	B1
	$F = 0.2R$ used	B1
	$T + 0.2R = 400g\sin 15°$	M1 A1
	$\downarrow$	
	$T \approx$ <u>257 or 260 N</u>	M1 A1
		(6)
	(b) $400g\sin 15° - 0.2 \times 400g\cos 15° = 400a$	M1 A1
	$a = 0.643(\ldots)$	A1
	$50 = \frac{1}{2} \times 0.643 \times t^2$	M1 A1√
	$t =$ <u>12.5 or 12 s</u>	A1
		(6)
	General rule again about > 3 sf	
	Weight/mass confusion: treat as MR [→ T = 26.3/26; a = 0.0656…; t = 39(.0)]	
	(b) *Allow a = 0.64*	
	(*Final M1 not dependent but requires an attempt to find an a which is not assumed to be g*)	

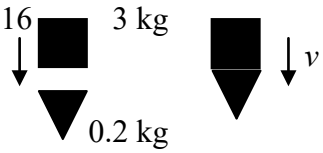
Question Number	Scheme	Marks
6	(a) Direction of $\mathbf{v} = (7\mathbf{i} - 7.5\mathbf{j}) - (4\mathbf{i} - 6\mathbf{j}) = 3\mathbf{i} - 1.5\mathbf{j}$	M1 ↓
	$\tan\theta = \frac{1.5}{3} = 0.5 \Rightarrow \theta = 26.565\ldots$	M1 A1
	Bearing = 117 (accept awrt)	A1 (4)
	(b) $\mathbf{v} = (3\mathbf{i} - 1.5\mathbf{j}) \div \frac{3}{4} = 4\mathbf{i} - 2\mathbf{j}$	B1
	$\mathbf{s} = (4\mathbf{i} - 6\mathbf{j}) + t(4\mathbf{i} - 2\mathbf{j})$	M1 A1√ (3)
	(c) At 1015 $\mathbf{s} = (4\mathbf{i} - 6\mathbf{j}) + \frac{5}{4}(4\mathbf{i} - 2\mathbf{j})$ $(= 9\mathbf{i} - 8.5\mathbf{j})$	M1 A1
	$\mathbf{m} = 0.25(p\mathbf{i} + q\mathbf{j})$	B1 ↓
	$\mathbf{s} = \mathbf{m} \Rightarrow p = 36,\ q = -34$	M1 A1, A1 (6)
	(a) *Forming direction for **v** can be either way round.* *M1 for tan = 'i/j' **or** 'j/i'* *A1 for 26.6 or 63.4 (awrt) from a correct direction for **v*** *A1 cao*	
	(b) *Allow B1 for correct vector for **v** wherever seen (e.g. in (a))*	
	(c) *line 1: **or** $(7\mathbf{i} - 7.5\mathbf{j}) + \frac{1}{2}(4\mathbf{i} - 2\mathbf{j}) = \ldots$* *1st M1 allow for a valid attempt with a value of t.* *2nd M1 using **s** = **m** and equating at least one coefficient*	

Question Number	Scheme	Marks
7		
	(a) $F_1 = \frac{2}{7} \times 4g$ (= 11.2) or $F_2 = \frac{2}{7} \times 6g$ (= 16.8)	B1
	System: $40 - \frac{2}{7} \times 4g - \frac{2}{7} \times 6g = 10a$ (equn in a and not T)	M1 A1
	$\Rightarrow \underline{a = 1.2 \text{ m s}^{-2}}$ (*)	A1 (4)
	(b) P: $T - \frac{8}{7}g = 4 \times 1.2$ **or** Q: $40 - T - \frac{12}{7}g = 6 \times 1.2$	M1 A1
	$\Rightarrow T = \underline{16 \text{ N}}$	A1 (3)
	(c) Accelerations of P and Q are same	B1 (1)
	(d) $v = 1.2 \times 7 = 8.4$	B1
	P: $(-)\frac{8}{7}g = 4a \Rightarrow a = (-)\frac{2}{7}g = 2.8$	M1 A1 ↓
	$0 = 8.4 - 2.8t \Rightarrow \underline{t = 3 \text{ s}}$ (*)	M1 A1 (5)
	(e) Q: $40 - \frac{12}{7}g = 6a$ ($\Rightarrow a \approx 3.867$)	M1 A1 ↓
	$v = 8.4 + 3.867 \times 3 = \underline{20 \text{ m s}^{-1}}$	M1 A1 (4)
	(a) *1st A1 requires values for the F's. (Allow M1 with just 'F''s)* (b) *Allow M1 A1 for one of these equations wherever seen (e.g. in (a))* (c) *extra statement about tensions being equal (with the correct ans): B0* (d) *allow verification* *No g: allow 1st M1 in each of parts (a), (b), (d), (e) as f.t. but other A's are cao*	

Question Number	Scheme	Marks
1 (a)		Shape B1 Figs (2, 30) B1 (2)
(b)	$300 = \frac{1}{2}(2 + T) \times 30$	M1 A1
	$\Rightarrow T = \underline{18\text{ s}}$	A1 (3)
	Or If t is time decelerating (and clear from working):	
	$300 = 30 \times 2 + \frac{1}{2} .30.t$	M1 A1
	$\Rightarrow t = 16\text{ s} \Rightarrow$ total time = 18 s	A1 (3)

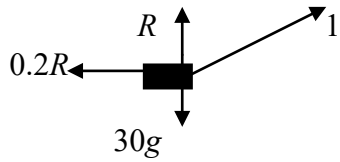
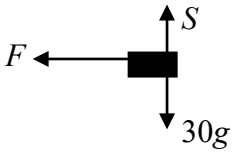
Question Number	Scheme	Marks
2 (a)	3 kg: $3g - T = 3 \times \frac{3g}{7}$	M1 A1
	$\Rightarrow T = \underline{\frac{12g}{7} \text{ or } 16.8 \text{ N or } 17 \text{ N}}$	A1
		(3)
(b)	m kg: $T - mg = m.\frac{3g}{7}$	M1 A1
		↓
	$\frac{12g}{7} = mg + \frac{3mg}{7}$ (Sub for T and solve)	M1
	$\Rightarrow m = \underline{1.2}$	A1
		(4)

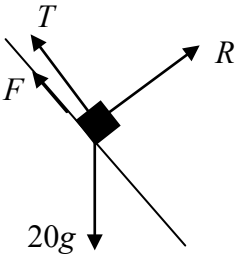
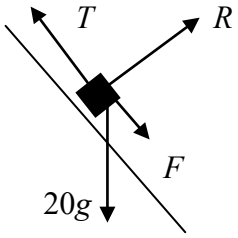
Question Number	Scheme	Marks
3 (a)		
	M(C): R x 3.6 + 30g x 0.4 = 10g x 1.6	M1 A1
	$\Rightarrow$ R = <u>10.9 or 11 or 98/9 N</u>	↓ M1 A1 (4)
(b)		
	Tilting about C $\Rightarrow$ reaction at A = 0	M1
	M(C): mg x 3.6 + 10g x 1.6 = 80g x 0.4	M1 A1
	$\Rightarrow$ m = <u>4.44 or 4.4 or 40/9 kg</u>	A1 (4)

Question Number	Scheme	Marks
4 (a)	 CLM: $3 \times 16 = 3.2 \times v$	M1 A1
	$\Rightarrow v = \underline{15 \text{ m s}^{-1}}$	A1 (3)
(b)	Impulse-momentum: $(R - 3.2g)0.05 = 3.2 \times 15$	M1 A1 A1√
	$\Rightarrow \quad R = 960 + 3.2g \approx \underline{991}$	M1 A1 (5)
	Or: deceleration: $0 = 15 + 0.05a \Rightarrow a = -300 \text{ m s}^{-2}$	
	Hence $3.2g - R = 3.2 \times -300$	M1 A1 A1√
	$\Rightarrow \quad R = 960 + 3.2g \approx \underline{991}$	M1 A1 (5)
	Final M1 needs a three term equation .	

Question Number	Scheme	Marks
5 (a)	$\tan\theta = \frac{3}{2}$ $(\theta = 56.3°)$	M1
	angle between **v** and **j** $= 90 + 56.3 \approx 146°$	M1 A1 (3)
(b)	$\mathbf{v} = 2\mathbf{i} - 3\mathbf{j} + (-\mathbf{i} + 2\mathbf{j})t$	M1
	$= (2 - t)\mathbf{i} + (-3 + 2t)\mathbf{j}$	A1 (2)
(c)	$t = 3$, $\mathbf{v} = -\mathbf{i} + 3\mathbf{j}$	M1
	speed $= \sqrt{(1^2 + 3^2)} = \underline{\sqrt{10 \text{ or } 3.16 \text{ m s}^{-1}}}$	M1 A1 (3)
(d)	**v** parallel to **i** $\Rightarrow$ $-3 + 2t = 0$	M1
	$\Rightarrow t = \underline{1.5 \text{ s}}$	A1 (2)

Question Number	Scheme	Marks
6 (a)	$v^2 = 20^2 + 2 \times 4 \times 78 \Rightarrow v = \underline{32 \text{ m s}^{-1}}$	M1 A1 (2)
(b)	B: $32 = 20 + 4t \Rightarrow t = 3$ s	M1 A1√ ↓
	A: Distance $= 30 \times t = \underline{90 \text{ m}}$	M1 A1 (4)
(c)	$30T = 20T + \frac{1}{2} .4.T^2$	M1 ↓
	$2T^2 - 10T = 0$	M1 A1 ↓
	$\Rightarrow t = (0 \text{ or}) \underline{5 \text{ s}}$	M1 A1 (5)

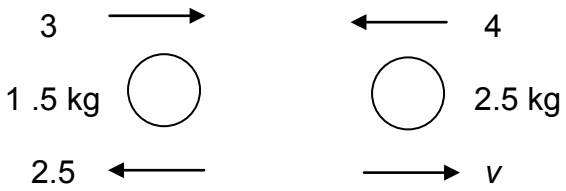
Question Number	Scheme	Marks
7 (a)	 R(↑) $R + 150 \sin 20 = 30g$	M1 A1
	$\Rightarrow R \approx \underline{243 \text{ N}}$	A1 (3)
	R(→): $150 \cos 20 - 0.2R = 30a$	M1 A1
	$\Rightarrow a \approx \underline{3.08 \text{ m s}^{-2}}$	A1 (3)
	 $S = 30g \Rightarrow F = 0.2 \times 30g$	M1 A1
	$30a' = (-)\ 0.2 \times 30g \Rightarrow a' = (-)\ 0.2g\ (= 1.96)$	M1 A1
	$0 = 12^2 - 2 \times 0.2g \times s$ (using new a')	M1
	$\Rightarrow s \approx \underline{36.7 \text{ m}}$	A1 (6)

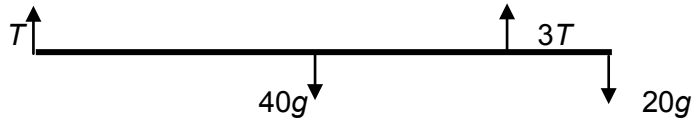
Question Number	Scheme	Marks
8 (a)	 R(perp. to slope): $R = 20g\cos 60$ $(= 10g = 98\text{ N})$	M1 A1
	$F = 0.4R$ (used)	B1
	R(parallel to slope): $T + F = 20g\cos 30$	M1 A2, 1, 0 ↓
	$T = 10\sqrt{3}\,g - 4g \approx \underline{131 \text{ or } 130\text{ N}}$	M1 A1 (8)
(b)	 $R = 10g$ as before	B1 √
	$T - 0.4R = 20g\cos 30$	M1 A1
	$T = 10\sqrt{3}\,g + 4g \approx \underline{209 \text{ or } 210\text{ N}}$	A1 (4)
(c) (i)	Friction acts down slope (and has magnitude $0.4R$)	B1
(ii)	Net force on package = 0 (or equivalent), or 'no acceleration'	B1 (2)

January 2005

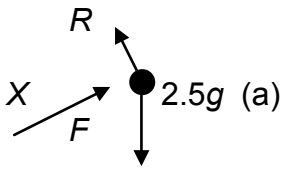
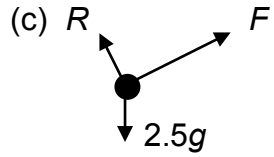
6677 Mechanics M1

Mark Scheme

Question Number	Scheme	Marks
1		
	(a) CLM: $1.5 \times 3 - 2.5 \times 4 = -1.5 \times 2.5 + 2.5 \times v$	M1 A1
	$\Rightarrow v = \underline{-0.7 \text{ m s}^{-1}}$ $\underline{\text{so speed} = 0.7 \text{ m s}^{-1}}$	A1 (3)
	(b) Direction of Q unchanged	A1√ (1)
	(c) Impulse = $1.5 (3 + 2.5)$	M1
	$= \underline{8.25, \text{Ns}}$	A1, B1 (3)

Question Number	Scheme	Marks
2		
	(a) R(↑): $T + 3T = 40g + 20g$	M1
	$T = 15g$, so tension at C is 45g or 441 N or 440 N	A1 (2)
	(b) M(B) $15g \times 3 + 45g \times d = 40g \times 1.5$	M1 A2,1,0√ ↓
	Solve: d = 1/3 or 0.33 or 0.333 m	M1 A1 (5)

Question Number	Scheme	Marks
3	(a) Distance = ½ x 4 x 9 + 16 x 9 **or** ½ (20 + 16) x 9	M1
	= <u>162 m</u>	A1 (2)
	(b) Distance over last 5 s = ½(9 + u) x 5	M1
	162 + ½(9 + u) x 5 = 200	M1 A1√
	$\Rightarrow u$ = <u>6.2 m s^{-1}</u>	A1 (4)
	(c) 6.2 = 9 + 5a	M1 A1√
	a = (–) <u>0.56 m s^{-2}</u>	A1 (3)

Question Number	Scheme	Marks
4	 (a) $R = 2.5g \cos 20$	M1
	$\approx$ <u>23.0 or 23 N</u>	A1 (2)
	(b) $X = 0.4 \times 23.0 + 2.5g \sin 20$	M1 A2,1,0√
	$\approx$ <u>17.6 or 18 N</u>	A1 (4)
	(c)  In equlib. $F = 2.5g \sin 20 \approx 8.38$ or 8.4 N	B1
	$\mu R = 0.4 \times 2.5g \cos 20 \approx 9.21$ or 9.2 N	B1
	$8.4 < 9.2$ (using '$F < \mu R$' **not** $F = \mu R$)	M1
	Since $F < \mu R$ remains in equilibrium (cso)	A1 (4)

Question Number	Scheme	Marks
5	(a) '$s = ut + \frac{1}{2}at^2$' for B: $0.4 = \frac{1}{2}\, a(0.5)^2$	M1 A1
	$a = \underline{3.2 \text{ m s}^{-2}}$	A1 (3)
	(b) N2L for B: $0.8g - T = 0.8 \times 3.2$	M1 A1√ ↓
	$T = \underline{5.28 \text{ or } 5.3 \text{ N}}$	M1 A1 (4)
	(c) A: $F = \mu \times 0.5g$	B1
	N2L for A: $T - F = 0.5a$	M1 A1 ↓
	Sub and solve $\mu = \underline{0.75 \text{ or } 0.751}$	M1 A1 (5)
	(d) Same acceleration for A and B.	B1 (1)

Question Number	Scheme	Marks
6	(a) $16^2 = 20^2 - 2 \times a \times 24 \Rightarrow a = \underline{3 \text{ m s}^{-2}}$	M1 A1 (2)
	(b) $v^2 = 20^2 - 2 \times 3 \times 30$	M1 A1√
	$v = \underline{\sqrt{220} \text{ or } 14.8 \text{ m s}^{-1}}$	A1 (3)
	(c) $0.3 = m \times 3 \Rightarrow m = 0.1$ kg (*)	M1 A1 (2)
	(d) $0.1(w + \sqrt{220}) = 2.4$	M1 A1√
	$w = 9.17$	A1
	↓	
	$0 = 9{,}17 - 3 \times t$	M1 A1√
	$t \approx \underline{3.06 \text{ s}}$	A1 (6)

Question Number	Scheme	Marks
7	(a) $\mathbf{v}_P = \{(29\mathbf{i} + 34\mathbf{j}) - (20\mathbf{i} + 10\mathbf{j})\}/3 = \underline{(3\mathbf{i} + 8\mathbf{j}) \text{ km h}^{-1}}$	M1 A1 (2)
	(b) $\mathbf{p} = (20\mathbf{i} + 10\mathbf{j}) + (3\mathbf{i} + 8\mathbf{j})t$	M1 A1√
	$\mathbf{q} = (14\mathbf{i} - 6\mathbf{j}) + 12t\mathbf{j}$	M1 A1 (4)
	(c) $\mathbf{q} - \mathbf{p} = (-6 - 3t)\mathbf{i} + (-16 + 4t)\mathbf{j}$	M1 A1
	$d^2 = (-6 - 3t)^2 + (-16 + 4t)^2$	↓ M1
	$= 36 + 36t + 9t^2 + 16t^2 - 128t + 256$	↓ M1
	$= 25t^2 - 92t + 292$ (*)	A1 (cso) (5)
	(d) $25t^2 - 92t + 292 = 225$	M1
	$25t^2 - 92t + 67 = 0$	A1
	$(t - 1)(25t - 67) = 0$	↓ M1
	$t = 67/25$ or 2.68	A1
	time $\approx$ 161 mins, or 2 hrs 41 mins, or 2.41 am, or 0241	A1 (5)

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Mechanics M1 (6677)

Summer 2005

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Mark Scheme (Results)

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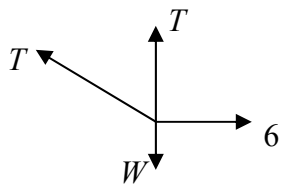
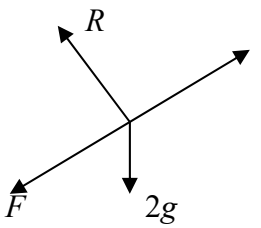
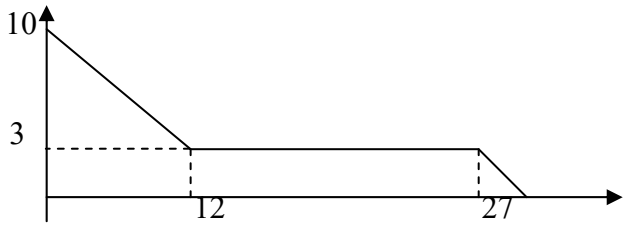
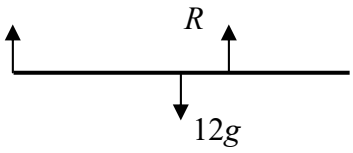
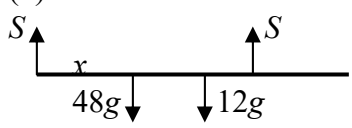
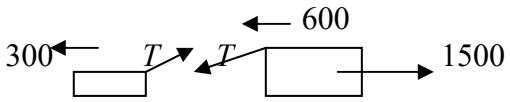
Mechanics M1 (6677)

June 2005
6677 Mechanics M1
Mark Scheme

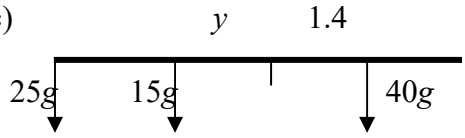
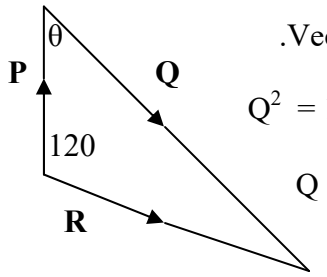
Question Number	Scheme	Marks
1	(a) '$v = u + at$': $74 = 2 + a \times 20 \Rightarrow a = \underline{3.6 \text{ m s}^{-2}}$	M1 A1 (2)
	(b) '$v^2 = u^2 + 2as$': $74^2 = 2^2 + 2 \times 3.6 \times AC$	
	or '$s = ut + \frac{1}{2}at^2$': $AC = 2 \times 20 + \frac{1}{2} \times 3.6 \times 20^2$	M1 A1√
	$\Rightarrow AC = 760$ m	A1
	Hence $BC = 1200 - 760 = \underline{440 \text{ m}}$	B1√ (4)
2	8 → ○ ← ○ 2 (○ v → ○ w →) CLM: $0.6 \times 8 - 0.2 \times 2 = 0.6 \times v + 0.2 \times w$	M1 A1
	Using $w = 2v$ to form equn in v/w only	↓ M1
	Solve to get $v = \underline{4.4 \text{ m s}^{-1}}$	↓ M1 A1 (5)
	(b) Impulse on $B = 0.2(2 + 8.8)$	M1 A1√
	$= \underline{2.16 \text{ Ns}}$	A1 (3)
3	 (a) R(→) $T \cos \alpha = 6$	M1 A1
	$\rightarrow T = \underline{7.5 \text{ N}}$	A1 (3)
	(b) R(↑) $T + T \sin \alpha = W$	M1 A1 ↓ M1
	Using same T's and solving	
	$\rightarrow W = \underline{12 \text{ N}}$	A1 (4)

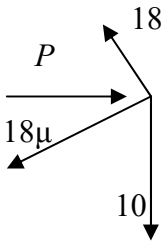
Question Number	Scheme	Marks
4	 (a) R (perp to plane): $R = 2g \cos 20$ $\approx$ 18.4 or 18 N (b) R (// to plane): $18 - 2g \sin 20 - F = 2a$ $F = 0.6\,R$ used Sub and solve: $a =$ 0.123 or 0.12 m s^{-2}	M1 A1 A1 (3) M1 A1 B1 ↓ M1 A1 (5)
5	(a)  Shape $0 < t < 12$ Shape $t > 12$ Figures (b) Distance in 1st 12 s = ½ x (10 + 3) x 12 *or* (3 x 12) + ½ x 3 x 7 = 78 m (c) **either** distance from $t = 12$ to $t = 27 = 15 \times 3 = 45$ $\therefore$ distance in last section = 135 – 45 = 12 m ½ x 3 x t = 12, $\Rightarrow t = 8$ s hence total time = 27 + 8 = 35 s **or** Distance remaining after 12 s = 135 – 78 = 57 m ½ x (15 + 15 + t) x 3 = 57 $\Rightarrow t = 8$ Hence total time = 27 + 8 = 35 s	B1 B1 B1 (3) M1 A1 (2) B1√ M1 A1√ A1 A1 (5) B1√ M1 A1√ A1 A1

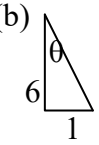
Question Number	Scheme	Marks
6	 (a) M(A): $12g \times 1.5 = R \times 2$	M1 A1
	$R = \underline{9g \text{ or } 88.2 \text{ N}}$	A1 (3)
	(b)  R(↑) $2S = 48g + 12g$	M1 A1
	$S = 30g$	
	M(A): $S \times 2 = 12g \times 1.5 + 48g \times x$	M1 A2,1,0 ↓↓
	Sub for S and solve for x: $x = \underline{7/8 \text{ or } 0.875 \text{ or } 0.88 \text{ m}}$	M1 A1 (7)
7		
	(a) Lorry + Car: $2500a = 1500 - 300 - 600$	M1 A1
	$a = \underline{0.24 \text{ m s}^{-2}}$	A1 (3)
	(b) Car: $T \cos 15 - 300 = 900a$ *OR* Lorry: $1500 - T \cos 15 - 600 = 1600a$	M1 A1 ↓↓
	Sub and solve: $T \approx \underline{534 \text{ N}}$	M1 A1 (4)
	(c) 300  Deceleration of car = 300/900 = 1/3 m s^{-1}	M1 A1
	Hence $6^2 = 2 \times 1/3 \times s \Rightarrow s = \underline{54 \text{ m}}$	M1 A1 (4)
	(d) Vertical component of T now removed	M1
	Hence normal reaction is increased	A1 cso (2)

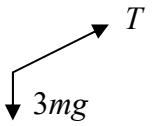
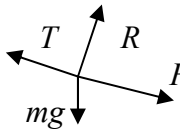
Question Number	Scheme	Marks
8	(a) Speed of ball = $\sqrt{(5^2 + 8^2)}$ $\approx$ $\underline{9.43 \text{ m s}^{-1}}$	M1 A1 (2)
	(b) p.v. of ball = $(2\mathbf{i} + \mathbf{j}) + (5\mathbf{i} + 8\mathbf{j})t$	M1 A1 (2)
	(c) North of B when **i** components same, i.e. $2 + 5t = 10$ $t = \underline{1.6 \text{ s}}$	M1 A1 (2)
	(d) When $t = 1.6$, p.v. of ball = $10\mathbf{i} + 13.8\mathbf{j}$ (or **j** component = 13.8) Distance travelled by 2nd player = $13.8 - 6 = 6.8$ Speed = $6.8 \div 1.6 = \underline{4.25 \text{ m s}^{-1}}$ *or* $[(2 + 5t)\mathbf{i} +] (1 + 8t)\mathbf{j} = [10\mathbf{i} +] (7 + vt)\mathbf{j}$ (pv's or **j** components same) Using $t = 1.6$: $1 + 12.8 = 7 + 1.6v$ (equn in v only) $v = \underline{4.25 \text{ m s}^{-1}}$	M1 A1 ↓ M1 A1 ↓ M1 A1 (6) M1 A1 ↓ M1 A1 ↓ M1 A1
	(e) Allow for friction on field (i.e. velocity of ball not constant) *or* allow for vertical component of motion of ball	B1 (1)
	(a) M1 Valid attempt at speed (square, add and squ. root cpts) (b) M1 needs non-zero p.v. + (attempt at veloc vector) x t. Must be vector (d) 2nd M1 – allow if finding displacement *vector* (e.g. if using wrong time) 3rd M1 for getting speed as a *scalar* (and final answer must be as a scalar). But if they get e.g. '4.25**j**', allow M1 A0 (e) Allow 'wind', 'spin', 'time for player to accelerate', size of ball Do not allow on their own 'swerve', 'weight of ball'.	

Question Number	Scheme	Marks
1.	(a) Distance after 4 s = $16 \times 4 - \frac{1}{2} \times 9.8 \times 4^2$	M1 A1
	$= -14.4 \Rightarrow h = (+)$ <u>14.4 m</u>	A1 (3)
	(b) $v = 16 - 9.8 \times 4$	M1 A1
	$= -23.2 \Rightarrow$ speed = (+) <u>23.2 m s^{-1}</u>	A1 (3)
		6
2.	(a) CLM: $3 \times 4 + 2 \times 1.5 = 5 \times v$	M1 A1
	$\Rightarrow v =$ <u>3 m s^{-1}</u>	A1 (3)
	(b) (i) CLM: $3 \times 4 - m \times 4 = -3 \times 2 + m\,(\times 1)$	M1 A1
	$\Rightarrow m =$ <u>3.6</u>	A1 (3)
	(ii) $I = 3.6(4 + 1)$ [or $3(4 + 2)$]	M1
	= <u>18 Ns</u>	A1√ (2)
		8

Question Number	Scheme	Marks
3.	(a) M(C): $25g \times 2 = 40g \times x$	M1 A1
	$x = \underline{1.25 \text{ m}}$	A1 (3)
	(b) Weight/mass acts at mid-point; or weight/mass evenly distributed (o.e.)	B1 (1)
	(c)  M(C): $40g \times 1.4 = 15g \times y + 25g \times 2$	M1 A1
	Solve: $y = \underline{0.4 \text{ m}}$	M1 A1 (4)
		8
4.	$\mathbf{R} = 10\sqrt{3}/2\,\mathbf{i} - 5\mathbf{j}$	M1 A1
	Using $\mathbf{P} = 7\mathbf{j}$ and $\mathbf{Q} = \mathbf{R} - \mathbf{P}$ to obtain $\mathbf{Q} = 5\sqrt{3}\mathbf{i} - 12\mathbf{j}$	M1 A1
	Magnitude = $\sqrt{[(5\sqrt{3})^2 + 12^2]} \approx \underline{14.8 \text{ N}}$ (AWRT)	M1 A1
	angle with $\mathbf{i}$ = arctan $(12/5\sqrt{3}) \approx 64.2°$	M1 A1
	bearing $\approx \underline{144°}$ (AWRT)	A1 (9)
	Alternative method	
	 .Vector triangle correct	B1
	$Q^2 = 10^2 + 7^2 + 2 \times 10 \times 7 \cos 60$	M1 A1
	$Q \approx \underline{14.8 \text{ N}}$ (AWRT)	A1
	$\frac{14.8}{\sin 120} = \frac{10}{\sin \theta}$	M1 A1 √
	$\Rightarrow \theta = 35.8$, $\Rightarrow$ bearing 144 (AWRT)	M1 A1, A1
		9

Question Number	Scheme	Marks
5.	 (a) R(perp to plane):	
	$P \sin 30 + 10 \cos 30 = 18$	M1 A1
	Solve: $P \approx \underline{18.7 \text{ N}}$	M1 A1 (4)
	(b) R(// plane):	
	$P \cos 30 = 10 \sin 30 + F$	M1 A1
	$F = 18\mu$ used	M1
	Sub and solve: $\mu = 0.\underline{621 \text{ or } 0.62}$	M1 A1 (5)
(c)	Normal reaction now $= 10 \cos 30$	M1 A1
	Component of weight down plane $= 10 \sin 30$ $(= 5 \text{ N})$ (seen)	B1
	$F_{\max} = \mu R_{\text{new}} \approx 5.37 \text{ N}$ (AWRT 5.4)	M1
	$5.37 > 5 \Rightarrow$ does not slide	A1 cso (5)
		14

Question Number	Scheme	Marks
6.	(a) Speed of $A = \sqrt{(1^2 + 6^2)} \approx \underline{6.08 \text{ m s}^{-1}}$	M1 A1 (2)
	(b)  $\tan\theta = 1/6 \Rightarrow \theta \approx 9.46°$	M1 A1
	Bearing $\approx \underline{351}$	A1 (3)
	(c) P.v. of A at time $t = (2 - t)\mathbf{i} + (-10 + 6t)\mathbf{j}$	
	p.v. of B at time $t = (-26 + 3t)\mathbf{i} + (4 + 4t)\mathbf{j}$	B1 (either)
	(E.g.) **i** components equal $\Rightarrow 2 - t = -26 + 3t \Rightarrow t = 7$	M1 A1
	j components at $t = 7$: A: $-10 + 6t = 32$	↓
	B: $4 + 4t = 32$	M1
	Same, so collide at $t = 7$ s at point with p.v. $(-5\mathbf{i} + 32\mathbf{j})$ m	A1 cso (5)
	(d) New velocity of $B = \frac{8}{5}(3\mathbf{i} + 4\mathbf{j})$ m s^{-1}	B1
	P.v. of B at 7 s $= -26\mathbf{i} + 4\mathbf{j} + 1.6(3\mathbf{i} + 4\mathbf{j}) \times 7 = 7.6\mathbf{i} + 48.8\mathbf{j}$	M1 A1
	$\underline{PB} = \mathbf{b} - \mathbf{p} = 12.6\mathbf{i} + 16.8\mathbf{j}$ (in numbers)	↓ M1
	Distance $= \sqrt{(12.6^2 + 16.8^2)} = \underline{21 \text{ m}}$	↓ M1 A1 (6)
		16

Question Number	Scheme	Marks
7.	(a)  A: $3mg\sin 30 - T = 3m.\frac{1}{10}g$	M1 A1
	$\Rightarrow \quad T = \frac{6}{5}mg$	A1 (3)
	(b)  F: R(perp): $R = mg\cos 30$	M1 A1
	R(//): $T - mg\sin 30 - F = m.\frac{1}{10}g$	M1 A2, 1, 0
	Using $F = \mu R$	M1
	$\frac{6}{5}mg - \frac{1}{2}mg - \mu mg\frac{\sqrt{3}}{2} = \frac{1}{10}mg$	↓↓↓ M1
	$\rightarrow \quad \mu = \underline{0.693 \text{ or } 0.69 \text{ or } \frac{2\sqrt{3}}{5}}$	A1 (8)
	(c)  Magn of force on pulley = $2T\cos 60 = \frac{6}{5}mg$	M1 A1 √
	Direction is vertically downwards	B1 (cso) (3)
		14

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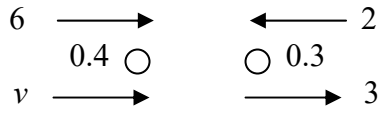
6677 Mechanics M1
Mark Scheme

Question Number	Scheme	Marks
Qu 1	(a) Constant acceleration	B1 (1)
	(b) Constant speed/velocity	B1 (1)
	(c) Distance = ½ (2 + 5) x 3, + (4 x 5)	M1 A1, B1
	= 30.5 m	A1 (4)
	(a) and (b) Accept 'steady' instead of 'constant. Allow 'o.e.' (= 'or equivalent') within reason! But must have idea of constant. 'constant speed and constant acceleration' for (a) or (b) is B0 (c) M1 for valid attempt at area of *this* trap. as area of a trap. Or this trap. as = triangle + rectangle, i.e. correct formula used with at most a slip in numbers. B1 for area of rectangle as 5 x 4 Treating whole as a single const acceln situation, or whole as a single trapezium, is M0. If assume that top speed is 5.1 or 5.2, allow full marks on f.t. basis (but must be consistent)	

Qu 2

. (a)



CLM: $0.4 \times 6 - 0.3 \times 2 = 0.4 \times v + 0.3 \times 3$ M1 A1

$\Rightarrow v = (+)\ \underline{2.25 \text{ m s}^{-1}}$ A1

('+' $\Rightarrow$) direction unchanged A1√

(4)

(b) $I = 0.3 \times (2 + 3) = \underline{1.5, \text{Ns (o.e.)}}$ M1 A1, B1

(3)

(a) M1 for 4 term equation dimensionally correct ($\pm g$). A1 correct
A1 answer must be positive
A1 f.t. – accept correct answer from correct working without justification; if working is incorrect allow f.t. from a clear diagram with answer consistent with their statement; also allow A1 if their ans is +ve and they say direction unchanged.

(b) M1 – need (*one* mass) x (sum *or* difference of the two speeds associated with the mass chosen)
A1 – answer must be positive
B1 allow o.e. e.g. kg m s^{-1}

Question Number	Scheme	Marks
Qu 3	(a) AB: $50 = 2 \times 22.5 + \frac{1}{2} a.4$	M1 A1
	$\Rightarrow a = \underline{2.5 \text{ m s}^{-2}}$	A1 (3)
	(b) $v^2 = 22.5^2 + 2 \times 2.5 \times 100$	M1 A1√
	$\Rightarrow v \approx \underline{31.7(2) \text{ m s}^{-1}}$	A1 (3)
	(c) $v_B = 22.5 + 2 \times 2.5 = 27.5$ (must be used)	M1 ↓
	$31.72 = 27.5 + 2.5t$ OR $50 = 27.5t + \frac{1}{2} \times 2.5t^2$ OR $50 = \frac{1}{2}(27.5 + 31.72)t$	M1 A1√
	$\Rightarrow t \approx \underline{1.69 \text{ s}}$	A1 (4)
	OR $31.72 = 22.5 + 2.5T$ OR $100 = 22.5t + \frac{1}{2} \times 2.5T^2$	M1 A1√ ↓
	$\Rightarrow T \approx 3.69$	
	$\Rightarrow t \approx 3.69 - 2 = \underline{1.69 \text{ s}}$	M1 A1 (4)
	OR $50 = 31.7t - \frac{1}{2} \times 2.5t^2$	M2 A1√
	Solve quadratic to get $t = \underline{1.69 \text{ s}}$	A1 (4)

NB note slight changes to scheme: dependency now in (c) and new rule on accuracy of answers.

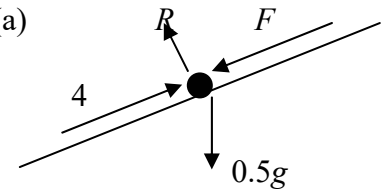
(b) M1 for valid use of data (e.g. finding speed at B by spurious means and using this to get v at C is M0.
Accept answer as AWRT 31.7

In (b) and (c), f.t. A marks are for f.t. on wrong a and/or answer from (b).

(c) M1 + M1 to get to an equation in the required t (normally two stages, but they can do it in one via 3rd alternative above)
Ans is cao. Hence premature approx (–> e.g. 1.68) is A0.
But if they use a 3 sf answer from (b) and then give answer to (c) as 1.7, allow full marks. And accept 2 or 3 s.f. answer or better to (c).

Qu 4

(a)



$R = 0.5g \cos \alpha = 0.4g$

$4 = F + 0.5g \sin \alpha$

$F = \mu R$ used

$4 = 0.4g.\mu + 0.3g$

$\Rightarrow \mu \approx \underline{0.27(0)}$

M1 A1

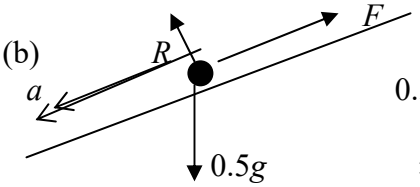
M1 A1

M1

M1 A1

(7)

(b)



$0.5a = 0.3g - 0.27 \times 0.4g$

$\Rightarrow a \approx (+) \underline{3.76 \text{ m s}^{-2}}$ (or 3.8)

M1 A2,1,0√

A1

(4)

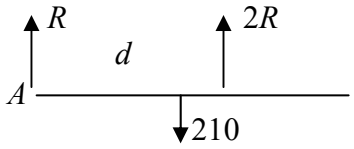
(a) 1st two M1's require correct number of the correct terms, with valid attempt to resolve the correct relevant term (valid 'resolve' = x sin/cos).

4th M1 (dept) for forming equn in μ + numbers only

(b) In first equn, allow their *R* or *F* in the equation for full marks.

A marks: f.t. on their *R*, *F* etc. Deduct one A mark (up to 2) for each wrong term. (Note slight change from original scheme)

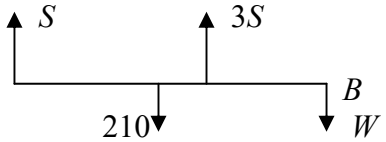
Qu 5

(a) 

$R + 2R = 210 \Rightarrow R = \underline{70\text{ N}}$ M1 A1 (2)

(b) e.g. M(A): $140 \times 90 = 210 \times d$ M1 A1√

$\Rightarrow d = 60 \Rightarrow AB = \underline{120\text{ cm}}$ M1 A1 (4)

(c) 

$4S = 210 + W$ M1 A1

e.g. M(B): $S \times 120 + 3S \times 30 = 210 \times 60$ M1 A2,1,0

Solve $\rightarrow$ ($S = 60$ and) $W = \underline{30}$ M1 A1 (7)

Note that they can take moments legitimately about many points

(a) M1 for a valid method to get R (almost always resolving!)

(b) 1st M1 for a valid moments equation
2nd M1 for complete solution to find AB (or verification)

Allow 'verification', e.g. showing $140 \times 90 = 210 \times 60$ M1 A1
$1260 = 1260$ QED M1 A1

(c) In both equations, allow whatever they think S is in their equations for full marks (e.g. if using $S = 70$).
2nd M1 A2 is for a moments equation (which may be about any one of 4+ points!)
1st M1 A1 is for a second equation (resolving or moments)
If they have two moments equations, given M1 A2 if possible for the best one
2 M marks only available *without* using $S = 70$.

If take mass as 210 (hence use 210g) consistently: treat as MR, i.e. deduct up to two A marks and treat rest as f.t. (Answers all as given = 9.8). But allow full marks in (b) (g's should all cancel and give correct result).

Qu 6	(a) Car + trailer: $2100a = 2380 - 280 - 630$	M1 A1
	$= 1470 \Rightarrow a = \underline{0.7 \text{ m s}^{-2}}$	A1 (3)
	(b) e.g. trailer: $700 \times 0.7 = T - 280$	M1 A1√
	$\Rightarrow T = \underline{770 \text{ N}}$	A1 (3)
	(c) Car: $1400a' = 2380 - 630$	M1 A1
	$\Rightarrow a' = 1.25 \text{ m s}^{-2}$	A1
	distance $= 12 \times 4 + \frac{1}{2} \times 1.25 \times 4^2$	M1 A1√
	$= \underline{58 \text{ m}}$	A1 (6)
	(d) Same acceleration for car and trailer	B1 (1)

(a) M1 for a complete (potential) valid method to get a

(b) If consider car: then get $1400a = 2380 - 630 - T$.
Allow M1 A1 for equn of motion for car or trailer wherever seen (e.g. in (a)).

So if consider two separately in (a), can get M1 A1 from (b) for one equation; then M1 A1 from (a) for second equation, and then A1 [(a)] for a and A1 [(b)] for T.

In equations of motion, M1 requires no missing or extra terms and dimensionally correct (e.g. extra force, or missing mass, is M0). If unclear which body is being considered, assume that the body is determined by the mass used. Hence if '$1400a$' used, assume it is the car and mark forces etc accordingly. But allow e.g. 630/280 confused as an A error.

(c) Must be finding a *new* acceleration here. (If they get 1.25 erroneously in (a), and then simply assume it is the same acceln here, it is M0).

(d) Allow o.e. but you must be convinced they are saying that it is same acceleration for both bodies. E.g. 'acceleration constant' on its own is B0
Ignore extras, but 'acceleration and tension same at A and B' is B0

Qu 7	(a) Speed $= \sqrt{(2.5^2 + 6^2)} = \underline{6.5 \text{ km h}^{-1}}$	M1 A1 (2)
	(b) Bearing $= 360 - \arctan(2.5/6) \approx \underline{337}$	M1 A1 (2)
	(c) $\mathbf{R} = (16 - 3 \times 2.5)\mathbf{i} + (5 + 3 \times 6)\mathbf{j}$ $= \underline{8.5\mathbf{i} + 23\mathbf{j}}$	M1 A1 (2)
	(d) At 1400 $\mathbf{s} = 11\mathbf{i} + 17\mathbf{j}$ At time t, $\mathbf{s} = \underline{11\mathbf{i} + (17 + 5t)\mathbf{j}}$	M1 A1 M1 A1 (4)
	(e) East of $R \Rightarrow 17 + 5t = 23$ $\Rightarrow t = 6/5 \Rightarrow \underline{1512 \text{ hours}}$	M1 A1 (2)
	(f) At 1600 $\mathbf{s} = 11\mathbf{i} + 27\mathbf{j}$ $\mathbf{s} - \mathbf{r} = 2.5\mathbf{i} + 4\mathbf{j}$ Distance $= \sqrt{(2.5^2 + 4^2)} \approx \underline{4.72 \text{ km}}$	M1 M1 A1 (3)
	(a) M1 needs square, add and √ correct components (b) M1 for finding acute angle = arctan (2.5/6) or arctan (6/2.5) (i.e. 67°/23°). Accept answer as AWRT 337. (c) M1 needs non-zero initial p.v. used + 'their 3' x velocity vector (d) Allow 1st M1 even if non-zero initial p.v. not used here (e) A1 is for answer as a time of the day (f) 1st M1 for using $t = 2$ or 4 (but *not* 200, 400, 6, 16 etc) and forming $\mathbf{s} - \mathbf{r}$ *or* $\mathbf{r} - \mathbf{s}$	

Mark Scheme (Results)
January 2007

GCE

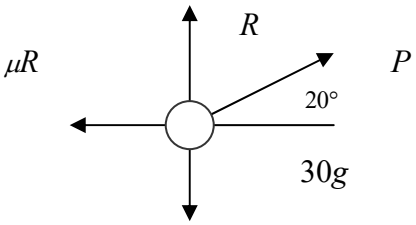
GCE Mathematics

Mechanics M1 (6677)

January 2007
6677 Mechanics M1
Mark Scheme

Question Number	Scheme	Marks
1.	(a) $P\sin 30° = 24$ $P = 48$	M1 A1 A1 3
	(b) $Q = P\cos 30°$ ≈ 41.6 accept $24\sqrt{3}$, awrt 42	M1 A1 A1 3 **6**
2.	(a) M(C) $80 \times x = 120 \times 0.5$ $x = 0.75$ ✱ cso	M1 A1 A1 3
	(b) Using reaction at $C = 0$ M(D) $120 \times 0.25 = W \times 1.25$ ft their x $W = 24$ (N)	B1 M1 A1 A1 4
	(c) i $X = 24 + 120 = 144$ (N) ft their W	M1 A1ft 2
	(d) The weight of the rock acts precisely at B.	B1 1 **10**
3.	(a) $\mathbf{a} = \dfrac{(15\mathbf{i} - 4\mathbf{j}) - (3\mathbf{i} + 2\mathbf{j})}{4} = 3\mathbf{i} - 1.5\mathbf{j}$	M1 A1 2
	(b) N2L $\mathbf{F} = m\mathbf{a} = 6\mathbf{i} - 3\mathbf{j}$ ft their $\mathbf{a}$ $\lvert\mathbf{F}\rvert = \sqrt{(6^2 + 3^2)} \approx 6.71$ (N) accept $\sqrt{45}$, awrt 6.7	M1 A1 M1 A1 4
	(c) $\mathbf{v}_6 = (3\mathbf{i} + 2\mathbf{j}) + (3\mathbf{i} - 1.5\mathbf{j})6$ ft their $\mathbf{a}$ $= 21\mathbf{i} - 7\mathbf{j}$ (m s^{-1})	M1 A1ft A1 1 **9**

Question Number	Scheme	Marks
4.	(a) CLM $0.3u = 0.3\times(-2) + 0.6\times 5$	M1 A1
	$u = 8$	M1 A1 4
	(b) $I = 0.6\times 5 = 3 \quad (\text{Ns})$	M1 A1 2
	(c) $v = u + at \Rightarrow 5 = a\times 1.5 \quad \left(a = \frac{10}{3}\right)$	M1 A1
	N2L $R = 0.6\times\dfrac{10}{3} = 2$	M1 A1 4 **10**
5.	(a) $v^2 = u^2 + 2as \Rightarrow 0^2 = 21^2 - 2\times 9.8\times h$	M1 A1
	$h = 22.5 \quad (\text{m})$	A1 3
	(b) $v^2 = u^2 + 2as \Rightarrow v^2 = 0^2 + 2\times 9.8\times 24$ or equivalent	M1 A1
	$(= 470.4)$	
	$v \approx 22 \quad (\text{m s}^{-1})$ accept 21.7	A1 3
	(c) $v = u + at \Rightarrow -\sqrt{470.4} = 21 - 9.8t$ or equivalent	M1 A2 (1, 0)
	– 1 each error	
	$t \approx 4.4 \quad (\text{s})$ accept 4.36	A1 4 **10**

Question Number	Scheme	Marks
6.	(a) 	
	Use of $F = \mu R$	B1
	↔ $P\cos 20° = \mu R$	M1 A1
	↑ $R + P\sin 20° = 30g$	M1 A1
	$P\cos 20° = \mu(30g - P\sin 20°)$	M1
	$P = \dfrac{0.4\times 30g}{\cos 20° + 0.4\sin 20°}$	M1
	$\approx 110 \quad (\text{N})$ accept 109	A1 8
	(b) ↑ $R + 150\sin 20° = 30g$	M1 A1
	$(R \approx 242.7)$	
	N2L ↔ $150\cos 20° - \mu R = 30a$	M1 A1
	$a \approx \dfrac{150\cos 20° - 0.4\times 242.7}{30}$	M1
	$= 1.5\ (\text{ms}^{-2})$ accept 1.46	A1 6 **14**

Question Number	Scheme	Marks
7.	(a) N2L Q $2g - T = 2a$	M1 A1
	N2L P $T - 3g\sin 30° = 3a$	M1 A1 4
	(b) $2g - 3g\sin 30° = 5a$	M1
	$a = 0.98$ (ms^{-2}) ★ cso	A1 2
	(c) $T = 2(g - a)$ or equivalent	M1
	≈ 18 (N) accept 17.6	A1 2
	(d) The (magnitudes of the) accelerations of P and Q are equal	B1 1
	(e) $v^2 = u^2 + 2as \Rightarrow v^2 = 2\times 0.98\times 0.8$ $(=1.568)$	M1
	$v \approx 1.3$ (m s^{-1}) accept 1.25	A1 2
	(f) N2L for P $-3g\sin 30° = 3a$	
	$a = (-)\frac{1}{2}g$	M1 A1
	$s = ut + \frac{1}{2}at^2 \Rightarrow 0 = \sqrt{1.568}t - \frac{1}{2}4.9t^2$ or equivalent	M1 A1
	$t = 0.51$ (s) accept 0.511	A1 5 **16**
	A maximum of one mark can be lost for giving too great accuracy.	

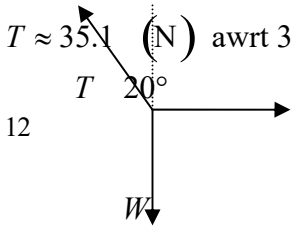
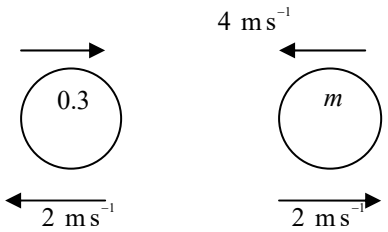
Mark Scheme (Results)
Summer 2007

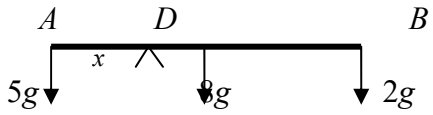
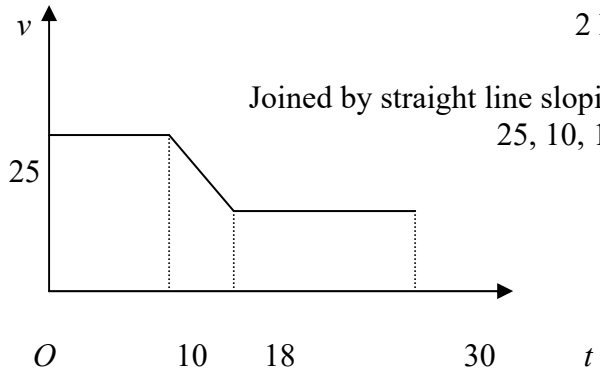
GCE

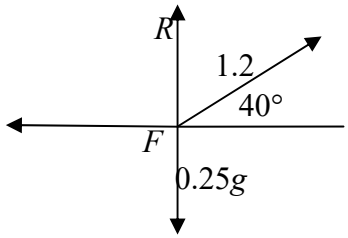
GCE Mathematics

Mechanics M1 6677

June 2007
6677 Mechanics M1
Mark Scheme

Question Number	Scheme	Marks
1.	(a) $\rightarrow T\sin 20° = 12$  $T \approx 35.1 \quad (\text{N})$ awrt 35 (b) $\uparrow W = T\cos 20°$ $\approx 33.0 \quad (\text{N})$ awrt 33	M1 A1 A1 **(3)** M1 A1 DM1 A1 **(4)** **[7]**
2.	 (a) A: $I = 0.3(8+2)$ $= 3 \quad (\text{Ns})$ (b) LM $0.3\times 8 - 4m = 0.3\times(-2) + 2m$ $m = 0.5$ *Alternative to* (b) B: $m(4+2) = 3$ $m = 0.5$ The two parts of this question may be done in either order.	M1 A1 A1 **(3)** M1 A1 DM1 A1 **(4)** **[7]** M1 A1 DM1 A1 **(4)**

Question Number	Scheme	Marks
3.	(a) M(C) $8g \times (0.9 - 0.75) = mg(1.5 - 0.9)$ Solving to $m = 2$ ✱ cso	M1 A1 DM1 A1 **(4)**
	(b)  M(D) $5g \times x = 8g \times (0.75 - x) + 2g(1.5 - x)$ Solving to $x = 0.6$ (AD = 0.6 m)	M1 A2(1, 0) DM1 A1 **(5)** **[9]**
4.	(a)  lines 2 horizontal Joined by straight line sloping down 25, 10, 18, 30 oe	B1 B1 B1 **(3)**
	(b) $25 \times 10 + \frac{1}{2}(25 + V) \times 8 + 12 \times V = 526$ Solving to $V = 11$	M1 A1 A1 DM1 A1 **(5)**
	(c) "$v = u + at$" $\Rightarrow$ $11 = 25 - 8a$ ft their V $a = 1.75$ (m s^{-2})	M1 A1ft A1 **(3)**
		[11]

Question Number	Scheme	Marks
5.	(a) 	
	$\uparrow \quad \pm\ R + 1.2\sin 40° = 0.25g$	M1 A1
	Solving to $R = 1.7 \quad (\text{N})$ accept 1.68	DM1 A1 **(4)**
	(b) $\rightarrow \quad F = 1.2\cos 40° \quad (\approx 0.919)$	M1 A1
	Use of $F = \mu R$	B1
	$1.2\cos 40° = \mu R$ ft their R	DM1 A1ft
	$\mu \approx 0.55$ accept 0.548	A1 cao **(6)**
		[10]

Question Number	Scheme	Marks
6.	(a) $s = ut + \frac{1}{2}at^2 \Rightarrow 3.15 = \frac{1}{2}a \times \frac{9}{4}$ $a = 2.8 \quad \left(\text{m s}^{-2}\right)$ ∗ cso	M1 A1 A1 **(3)**
	(b) N2L for P: $0.5g - T = 0.5 \times 2.8$ $T = 3.5 \quad (\text{N})$	M1 A1 A1 **(3)**
	(c) N2L for Q: $T - mg = 2.8m$ $m = \dfrac{3.5}{12.6} = \dfrac{5}{18}$ ∗ cso	M1 A1 DM1 A1 **(4)**
	(d) The acceleration of P is equal to the acceleration of Q.	B1 **(1)**
	(e) $v = u + at \Rightarrow v = 2.8 \times 1.5$ (or $v^2 = u^2 + 2as \Rightarrow v^2 = 2 \times 2.8 \times 3.15$) $\left(v^2 = 17.64, v = 4.2\right)$	M1 A1
	$v = u + at \Rightarrow 4.2 = -4.2 + 9.8t$ $t = \dfrac{6}{7}$, 0.86, 0.857 (s)	DM1 A1 DM1 A1 **(6)**
		[17]

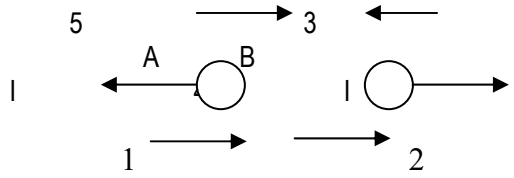
Question Number	Scheme	Marks
7.	(a) $\mathbf{v} = \dfrac{8\mathbf{i} + 11\mathbf{j} - (3\mathbf{i} - 4\mathbf{j})}{2.5}$ or any equivalent	M1 A1
	$\mathbf{v} = 2\mathbf{i} + 6\mathbf{j}$	A1 **(3)**
	(b) $\mathbf{b} = 3\mathbf{i} - 4\mathbf{j} + \mathbf{v}t$ ft their $\mathbf{v}$	M1 A1 ft
	$= 3\mathbf{i} - 4\mathbf{j} + (2\mathbf{i} + 6\mathbf{j})t$	A1cao **(3)**
	(c) **i** component: $-9 + 6t = 3 + 2t$	M1
	$t = 3$	M1 A1
	j component: $20 + 3\lambda = -4 + 18$	M1
	$\lambda = -2$	A1 **(5)**
	(d) $v_B = \sqrt{(2^2 + 6^2)}$ or $v_C = \sqrt{(6^2 + (-2)^2)}$	M1
	Both correct	A1
	The speeds of B and C are the same cso	A1 **(3)** **[14]**

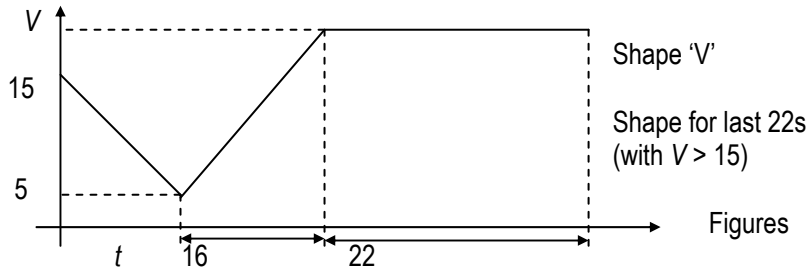
Mark Scheme (Results)
January 2008

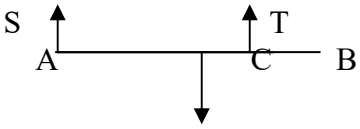
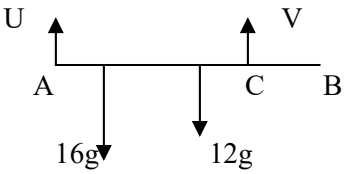
GCE

GCE Mathematics (6677/01)

January 2008
6677 Mechanics M1
Mark Scheme

Question Number	Scheme	Marks
1(a)	 $I = 4(5 - 1) = \underline{16\ \text{Ns}}$	M1 A1 (2)
(b)	CLM: $4 \times 5 - m \times 3 = 4 \times 1 + m \times 2$ $\Rightarrow m = \underline{3.2}$ **or** $16 = m(3 + 2)$ $\Rightarrow \quad m = \underline{3.2}$	M1 A1 DM1 A1 (4) **or** M1 A1 DM1 A1 (4) **6**
2.(a)	$27 = 0 + \frac{1}{2}.a.3^2 \quad \Rightarrow \ a = \underline{6}$	M1 A1 (2)
(b)	$v = 6 \times 3 = \underline{18\ \text{m s}^{-1}}$	M1 A1 f.t. (2)
(c)	From $t = 3$ to $t = 5$, $s = 18 \times 2 - \frac{1}{2} \times 9.8 \times 2^2$ Total ht. $= s + 27 = \underline{43.4\ \text{m},\ 43\ \text{m}}$	M1 A1 f.t. M1 A1 (4) **8**

Question Number	Scheme	Marks
3.(a)		B1 B1 B1 (3)
(b)	$\frac{1}{2}(15 + 5) \times t = 120$ $\Rightarrow t = 12 \rightarrow T = 12 + 16 + 22 = \underline{50 \text{ s}}$	M1 M1 A1 (3)
(c)	$120 + \underline{\frac{1}{2}(V + 5).16} + 22V = 1000$ Solve: $30V = 840 \Rightarrow V = \underline{28}$	M1 B1 A1 DM1 A1 (5) **11**
4.(a)	R (// plane): $49 \cos \theta = 6g \sin 30$ $\Rightarrow \cos \theta = 3/5$ *	M1 A1 A1 (3)
(b)	R (perp to plane): $R = 6g \cos 30 + 49 \sin \theta$ $R \approx \underline{90.1 \text{ or } 90 \text{ N}}$	M1 A1 DM1 A1 (4)
(c)	R (// to plane): $49 \cos 30 - 6g \sin 30 = 6a$ $\Rightarrow a \approx 2.17 \text{ or } 2.2 \text{ m s}^{-2}$	M1 A2,1,0 A1 (4) **11**

Question Number	Scheme	Marks
5.(a)		
	M(*A*): $T \times 4 = 12g \times 2.5$	M1 A1
	$T = \underline{7.5g \text{ or } 73.5 \text{ N}}$	A1
	R(↑) $S + T = 12g$	M1
	$\Rightarrow S = \underline{4.5g \text{ or } 44.1 \text{ N}}$	A1 (5)
(b)		
	M(*A*) $V \times 4 = 16g \times y + 12g \times 2.5$	M1 A1
	$V = \underline{4gy + 7.5g \text{ or } 39.2y + 73.5 \text{ N}}$	A1 (3)
(c)	$V \leq 98 \Rightarrow 39.2y + 73.5 \leq 98$	M1
	$\Rightarrow y \leq 0.625 = 5/8$	DM1
	Hence "load must be no more than 5/8 m from *A*" (o.e.)	A1 (3)
		11
6.(a)	Speed $= \sqrt{(5^2 + 8^2)} \approx \underline{9.43 \text{ m s}^{-1}}$	M1 A1 (2)
(b)	Forming arctan 8/5 or arctan 5/8 oe	M1
	Bearing = 360 – arctan 5/8 or 270 + arctan 8/5 $= \underline{328}$	DM1 A1 (3)
(c)	At $t = 3$, p.v. of $P = (7 - 15)\mathbf{i} + (-10 + 24)\mathbf{j} = -8\mathbf{i} + 14\mathbf{j}$	M1 A1
	Hence $-8\mathbf{i} + 14\mathbf{j} + 4(u\mathbf{i} + v\mathbf{j}) = \mathbf{0}$	M1
	$\Rightarrow \underline{u = 2, \quad v = -3.5}$	DM1 A1 (5)
(d)	p.v. of P t secs after changing course $= (-8\mathbf{i} + 14\mathbf{j}) + t(2\mathbf{i} - 3.5\mathbf{j})$	M1
	$= 7\mathbf{i} + \ldots..$	DM1
	Hence total time = $\underline{10.5 \text{ s}}$	A1 (3)
		13

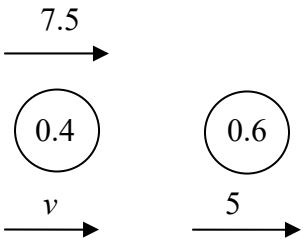
Question Number	Scheme	Marks
7.(a)	B: $2mg - T = 2m \times 4g/9$	M1 A1
	$\Rightarrow T = \underline{10mg/9}$	A1 (3)
(b)	A: $T - \mu mg = m \times 4g/9$	M1 B1 A1
	Sub for T and solve: $\mu = 2/3$ *	DM1 A1 (5)
(c)	When B hits: $v^2 = 2 \times 4g/9 \times h$	M1 A1
	Deceleration of A after B hits: $ma = \mu mg \Rightarrow a = 2g/3$	M1 A1 f.t.
	Speed of A at P: $V^2 = 8gh/9 - 2 \times 2g/3 \times h/3$	DM1
	$\Rightarrow V = \frac{2}{3}\sqrt{(gh)}$	A1 (6)
(d)	Same tension on A and B	B1 (1)
		15

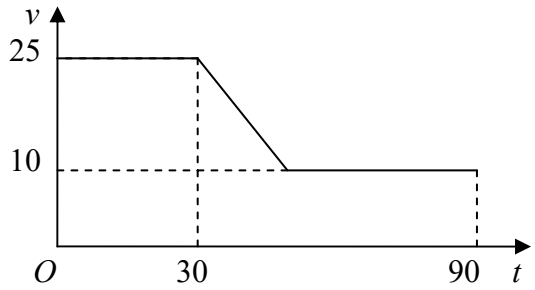
Mark Scheme (Results)
Summer 2008

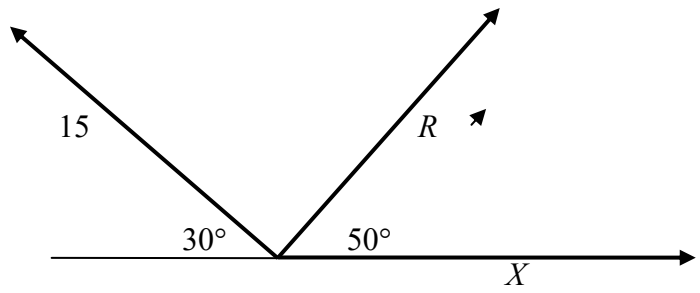
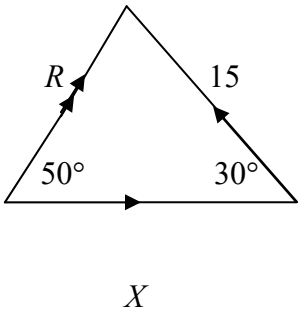
GCE

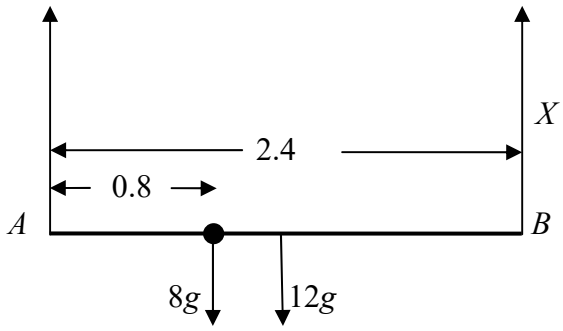
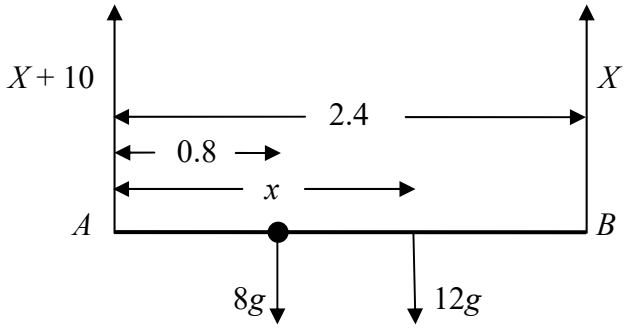
GCE Mathematics (6677/01)

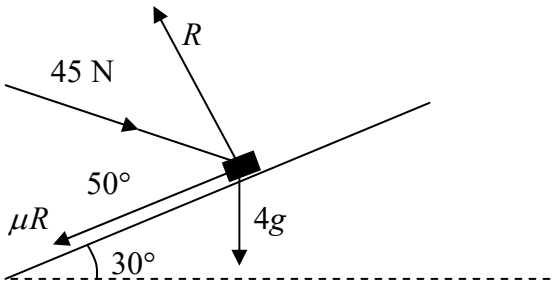
June 2008
6677 Mechanics M1
Final Mark Scheme

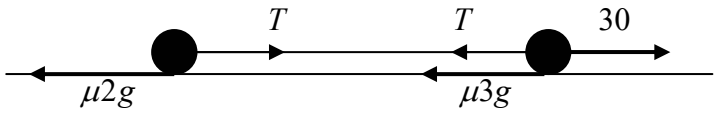
Question Number	Scheme	Marks
1.	(a) $I = mv \Rightarrow 3 = 0.4 \times v$ $v = 7.5 \left(\text{ms}^{-1}\right)$	M1 A1 A1 **(3)**
	(b) 	
	LM $0.4 \times 7.5 = 0.4v + 0.6 \times 5$ $0 = 0.4v \Rightarrow v = 0$ ✱ cso	M1 A1 A1 **(3)** **[6]**
2.	(a) $v^2 = u^2 + 2as \Rightarrow 17.5^2 = u^2 + 2 \times 9.8 \times 10$ Leading to $u = 10.5$	M1 A1 A1 **(3)**
	(b) $v = u + at \Rightarrow 17.5 = -10.5 + 9.8T$ $T = 2\frac{6}{7}$ (s)	M1 A1 f.t. DM1 A1 **(4)**
	Alternatives for (b) $s = (\frac{u+v}{2})T \Rightarrow 10 = (\frac{17.5 + -10.5}{2})T$ $\frac{20}{7} = T$	**[7]** M1A1 f.t. DM1A1 (4)
	OR $s = ut + \frac{1}{2}at^2 \Rightarrow -10 = 10.5t - 4.9t^2$ Leading to $T = 2\frac{6}{7}, \left(-\frac{5}{7}\right)$ Rejecting negative	M1 A1 f.t. DM1 A1 **(4)**
	(b) can be done independently of (a) $s = vt - \frac{1}{2}at^2 \Rightarrow -10 = -17.5t + 4.9t^2$ Leading to $T = 2\frac{6}{7}, \frac{5}{7}$ For final A1, second solution has to be rejected. $\frac{5}{7}$ leads to a negative u.	M1 A1 DM1 A1 **(4)**

Question Number	Scheme	Marks
3.	(a) $\tan\theta = \frac{8}{6}$ $\theta \approx 53°$	M1 A1 **(2)**
	(b) $\mathbf{F} = 0.4(6\mathbf{i} + 8\mathbf{j})\ (= 2.4\mathbf{i} + 3.2\mathbf{j})$ $\lvert\mathbf{F}\rvert = \sqrt{(2.4^2 + 3.2^2)} = 4$ *The method marks can be gained in either order.*	M1 M1 A1 **(3)**
	(c) $\mathbf{v} = 9\mathbf{i} - 10\mathbf{j} + 5(6\mathbf{i} + 8\mathbf{j})$ $= 39\mathbf{i} + 30\mathbf{j}\ (\text{ms}^{-1})$	M1 A1 A1 **(3)** **[8]**
4.	(a)  shape 25, 10, 30, 90	B1 B1 **(2)**
	(b) $30 \times 25 + \frac{1}{2}(25 + 10)t + 10(60 - t) = 1410$ $7.5t = 60$ $t = 8\ (\text{s})$ $a = \frac{25 - 10}{8} = 1.875\ (\text{ms}^{-2})$ $1\frac{7}{8}$	M1 A1 A1 DM1 A1 M1 A1 **(7)** **[9]**

Question Number	Scheme	Marks
5.	(a) 	
	$(\uparrow)\quad 15\sin 30° = R\sin 50°$	M1 A1
	$R \approx 9.79\ (\text{N})$	DM1 A1 **(4)**
	(b) $(\rightarrow)\ X - 15\cos 30° = R\cos 50°$ ft their R	M1 A2 ft
	$X \approx 19.3\ (\text{N})$	DM1 A1 **(5)** **[9]**
	Alternatives using sine rule in (a) or (b); cosine rule in (b)	
	 (a) $\dfrac{R}{\sin 30°} = \dfrac{15}{\sin 50°}$	M1 A1
	$R \approx 9.79\ (\text{N})$	DM1 A1 (4)
	(b) $\dfrac{X}{\sin 100°} = \dfrac{15}{\sin 50°} = \dfrac{R}{\sin 30°}$	M1 A2 ft on R
	$X \approx 19.3\ (\text{N})$	DM1 A1 (5)
	$X^2 = R^2 + 15^2 - 2 \text{ x } 15 \text{ x } R\cos 100^o$	
	OR: cosine rule; any of $R^2 = X^2 + 15^2 - 2 \text{ x } 15 \text{ x } X\cos 30^o$	M1 A2 ft on R
	$15^2 = R^2 + X^2 - 2 \text{ x } X \text{ x } R\cos 50^o$	
	$X \approx 19.3\ (\text{N})$	DM1 A1 (5)

Question Number	Scheme	Marks
6.	(a)  $M(A)$ $8g \times 0.8 + 12g \times 1.2 = X \times 2.4$ $X \approx 85$ (N) accept 84.9, $\frac{26g}{3}$	M1 A1 DM1 A1 **(4)**
	(b)  $R(\uparrow)$ $\underline{(X+10)} + \underline{X} = 8g + 12g$ $(X = 93)$ $M(A)$ $8g \times 0.8 + 12g \times x = X \times 2.4$ $x = 1.4$ (m) accept 1.36	M1 B1 A1 M1 A1 A1 **(6)** **[10]**

Question Number	Scheme	Marks
7.	(a) 	
	$R = 45\cos 40° + 4g\cos 30°$	M1 A2 (1, 0)
	$R \approx 68$ accept 68.4	DM1 A1 (5)
	(b) Use of $F = \mu R$	M1
	$F + 4g\sin 30 = 45\cos 50°$	M1 A2 (1, 0)
	Leading to $\mu \approx 0.14$ accept 0.136	DM1 A1 (6) **[11]**

Question Number	Scheme	Marks
8.	(a) 	
	$s = ut + \frac{1}{2}at^2 \quad \Rightarrow \quad 6 = \frac{1}{2}a \times 9$	M1
	$a = 1\frac{1}{3} \ \left(\text{ms}^{-2}\right)$	A1 **(2)**
	(b) N2L for system $30 - \mu 5g = 5a$ ft their a, accept symbol	M1 A1ft
	$\mu = \frac{14}{3g} = \frac{10}{21}$ or awrt 0.48	DM1 A1 **(4)**
	(c) N2L for P $T - \mu 2g = 2a$ ft their μ, their a, accept symbols	M1 A1 ft
	$T - \frac{14}{3g} \times 2g = 2 \times \frac{4}{3}$	
	Leading to $T = 12 \ \left(\text{N}\right)$ awrt 12	DM1 A1 **(4)**
	Alternatively N2L for Q	
	$30 - T - \mu 3g = 3a$	M1 A1
	Leading to $T = 12 \ \left(\text{N}\right)$ awrt 12	DM1 A1
	(d) The acceleration of P and Q (or the whole of the system) is the same.	B1 **(1)**
	(e) $v = u + at \quad \Rightarrow \quad v = \frac{4}{3} \times 3 = 4$	B1 ft on a
	N2L (for system or either particle)	
	$-5\mu g = 5a$ or equivalent	M1
	$a = -\mu g$	
	$v = u + at \quad \Rightarrow \quad 0 = 4 - \mu gt$	DM1
	Leading to $t = \frac{6}{7} \ \left(\text{s}\right)$ accept 0.86, 0.857	A1 **(4)**
		[15]

Mark Scheme (Results)
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GCE

GCE Mathematics (6677/01)

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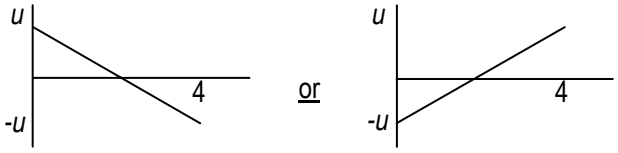
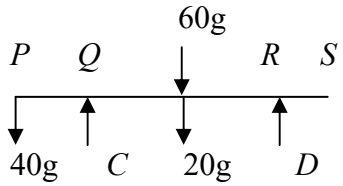
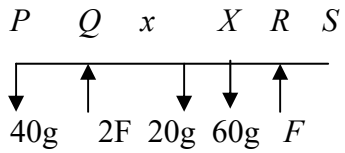
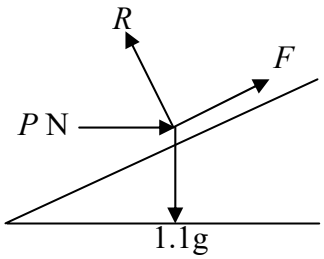
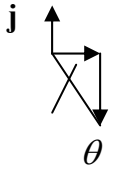
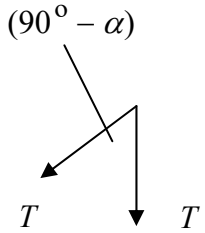
Question Number	Scheme	Marks
1	$-6\mathbf{i}+\mathbf{j}=\mathbf{u}+3(2\mathbf{i}-5\mathbf{j})$ $\Rightarrow \mathbf{u}=-12\mathbf{i}+16\mathbf{j}$ $\Rightarrow u=\sqrt{(-12)^2+16^2}=20$	M1 A1 A1 cso M1 A1 **[5]**
2 (a)	 shape values	B1 B1 (2)
(b)	$19.6=\frac{1}{2}\times 2\times u$ $u=19.6$	M1 A1 A1 (3) **[5]**
3 (a)	$2u \rightarrow \quad \leftarrow 4u$ $km \quad m$ $u \leftarrow \quad \rightarrow v$ $km2u-4mu=-kmu+mv$ $u(3k-4)=v$	M1 A1 A1 (3)
(b)	$k>2\Rightarrow v>0\Rightarrow$ dir^{n} of motion reversed	M1A1A1 cso (3)
(c)	For B, $m(u(3k-4)--4u)$ $=7mu$	M1 A1 f.t. A1 (3) **[9]**

Question Number	Scheme	Marks
4 (a)	 $C + D = 120g$ $M(Q),\ \ 80g.0.8 - 40g.0.4 = D.1.6$ solving $C = 90g; D = 30g$	M1 A1 M1 A1 M1 A1 A1 (7)
(b)	 $2F + F = 40g + 20g + 60g$ $M(Q),\ \ 60gx + 20g.0.8 = 40g.0.4 + F.1.6$ solving $QX = x = \frac{16}{15}\ \text{m} = 1.07\text{m}$	M1 A1 M1 A1 M1 A1 (6) **[13]**

Question Number	Scheme	Marks
5 (a)		B2 -1 e.e.o.o. (labels not needed) (2)
(b)	$F = \frac{1}{2}R$ $(\uparrow),\ R\cos\alpha + F\sin\alpha = mg$ $R = \dfrac{1.1g}{(\cos\alpha + \frac{1}{2}\sin\alpha)} = 9.8\ \text{N}$ $(\rightarrow),\ P + \frac{1}{2}R\cos\alpha = R\sin\alpha$ $P = R(\sin\alpha - \frac{1}{2}\cos\alpha)$ $= 1.96$	B1 M1 A2 M1 A1 (6) M1 A2 M1 A1 (5) **[13]**

Question Number	Scheme	Marks
6 (a)	 $\tan\theta = \frac{2}{1} \Rightarrow \theta = 63.4^{o}$ angle is 153.4^{o}	M1 A1 A1 (3)
(b)	$(4+p)\mathbf{i} + (q-5)\mathbf{j}$ $(q-5) = -2(4+p)$ $2p + q + 3 = 0$ *	B1 M1 A1 A1 (4)
(c)	$q = 1 \Rightarrow p = -2$ $\Rightarrow \mathbf{R} = 2\mathbf{i} - 4\mathbf{j}$ $\Rightarrow \lvert\mathbf{R}\rvert = \sqrt{2^2 + (-4)^2} = \sqrt{20}$ $\sqrt{20} = m8\sqrt{5}$ $\Rightarrow m = \frac{1}{4}$	B1 M1 M1 A1 f.t. M1 A1 f.t. A1 cao (7) **[14]**

Question Number	Scheme	Marks
7 (a)	$T - 5g\sin\alpha = 5a$ $15g - T = 15a$ solving for a $a = 0.6g$ solving for T $T = 6g$	M1 A1 M1 A1 M1 A1 M1 A1 (8)
(b)	For Q : $5g - N = 5a$ $N = 2g$	M1 A1 A1 f.t. (3)
(c)	 $F = 2T\cos(\frac{90^o - \alpha}{2})$ $= 12g\cos 26.56..^o$ $= 105$ N	M1 A2 A1 f.t. A1 (5) **[16]**

Mark Scheme (Results)
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GCE

GCE Mathematics (6677/01)

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Question Number	Scheme	Marks
Q1	$45 = 2u + \frac{1}{2}a2^2 \quad \Rightarrow \quad 45 = 2u + 2a$	M1 A1
	$165 = 6u + \frac{1}{2}a6^2 \quad \Rightarrow \quad 165 = 6u + 18a$	M1 A1
	eliminating either u or a	M1
	$u = 20$ and $a = 2.5$	A1 A1 **[7]**
Q2 (a)	$\tan\theta = \frac{p}{2p} \Rightarrow \theta = 26.6°$	M1 A1 (2)
(b)	$\mathbf{R} = (\mathbf{i} - 3\mathbf{j}) + (p\mathbf{i} + 2p\mathbf{j}) = (1 + p)\mathbf{i} + (-3 + 2p)\mathbf{j}$	M1 A1
	$\mathbf{R}$ is parallel to $\mathbf{i} \Rightarrow (-3 + 2p) = 0$	DM1
	$\Rightarrow p = \frac{3}{2}$	A1 (4) **[6]**
Q3 (a)	For A: $-\frac{7mu}{2} = 2m(v_A - 2u)$	M1 A1
	$v_A = \frac{u}{4}$	A1 (3)
(b)	For B: $\frac{7mu}{2} = m(v_B - -3u)$	M1 A1
	$v_B = \frac{u}{2}$	A1 (3)
	OR CLM:	OR
	$4mu - 3mu = 2m\frac{u}{4} + mv_B$	M1 A1
	$v_B = \frac{u}{2}$	A1 (3) **[6]**

Question Number	Scheme	Marks
Q4	$0.5g\sin\theta - F = 0.5a$	M1 A1 A1
	$F = \frac{1}{3}R$ seen	B1
	$R = 0.5g\cos\theta$	M1 A1
	Use of $\sin\theta = \frac{4}{5}$ or $\cos\theta = \frac{3}{5}$ or decimal equiv or decimal angle e.g 53.1° or 53°	B1
	$a = \frac{3g}{5}$ or 5.88 m s^{-2} or 5.9 m s^{-2}	DM1 A1 **[9]**
Q5	$F = P\cos 50^o$	M1 A1
	$F = 0.2R$ seen or implied.	B1
	$P\sin 50^o + R = 15g$	M1 A1 A1
	Eliminating R; Solving for P ; $P =$ 37 (2 SF)	DM1;D M1; A1 **[9]**
Q6 (a)	For whole system: $1200 - 400 - 200 = 1000a$	M1 A1
	$a = 0.6$ m s^{-2}	A1 (3)
(b)	For trailer: $T - 200 = 200$ x 0.6	M1 A1 **ft**
	$T = 320$ N	A1
	OR:	
	OR: For car: $1200 - 400 - T = 800$ x 0.6	M1 A1 **ft**
	$T = 320$ N	A1 (3)
(c)	For trailer: $200 + 100 = 200f$ or $-200f$	M1 A1
	$f = 1.5$ m s^{-2} (-1.5)	A1
	For car: $400 + F - 100 = 800f$ or $-800f$	M1 A2
	$F = 900$	A1 (7)
	(N.B. For both: $400 + 200 + F = 1000f$)	**[13]**

Question Number	Scheme	Marks
Q7 (a)	$M(Q),\quad 50g(1.4-x)+20g \text{ x } 0.7 = T_P \text{ x } 1.4$	M1 A1
	$T_P = 588 - 350x$ Printed answer	A1 (3)
(b)	$M(P),\quad 50gx + 20g \text{ x } 0.7 = T_Q \text{ x } 1.4$ or R(↑), $T_P + T_Q = 70g$	M1 A1
	$T_Q = 98 + 350x$	A1 (3)
(c)	Since $0 < x < 1.4$, $98 < T_P < 588$ and $98 < T_Q < 588$	M1 A1 A1 (3)
(d)	$98 + 350x = 3\,(588 - 350x)$	M1
	$x = 1.19$	DM1 A1 (3) **[12]**
Q8 (a)	$\lvert\mathbf{v}\rvert = \sqrt{1.2^2 + (-0.9)^2} = 1.5 \text{ m s}^{-1}$	M1 A1 (2)
(b)	$(\mathbf{r}_H =) 100\mathbf{j} + t(1.2\mathbf{i} - 0.9\mathbf{j})$ m	M1 A1 (2)
(c)	$(\mathbf{r}_K =) 9\mathbf{i} + 46\mathbf{j} + t(0.75\mathbf{i} + 1.8\mathbf{j})$ m	M1 A1
	$\overrightarrow{HK} = \mathbf{r}_K - \mathbf{r}_H = (9 - 0.45t)\mathbf{i} + (2.7t - 54)\mathbf{j}$ m **Printed Answer**	M1 A1 (4)
(d)	Meet when $\overrightarrow{HK} = \mathbf{0}$	
	$(9 - 0.45t) = 0$ and $(2.7t - 54) = 0$	M1 A1
	$t = 20$ from both equations	A1
	$\mathbf{r}_K = \mathbf{r}_H = (24\mathbf{i} + 82\mathbf{j})$ m	DM1 A1 cso (5) **[13]**

Mark Scheme (Results) January 2010

GCE

Mechanics M1 (6677)

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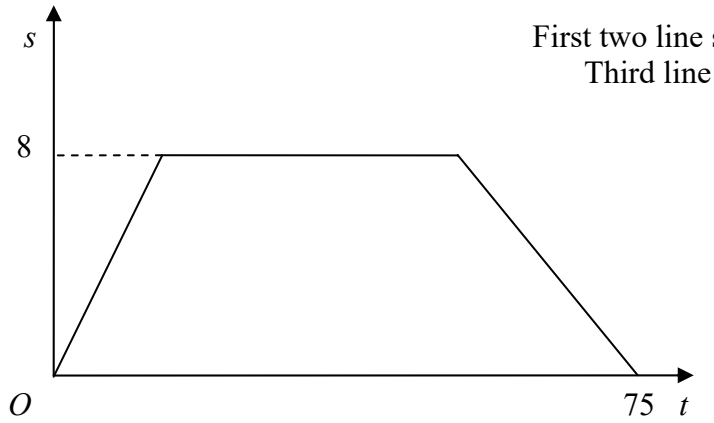
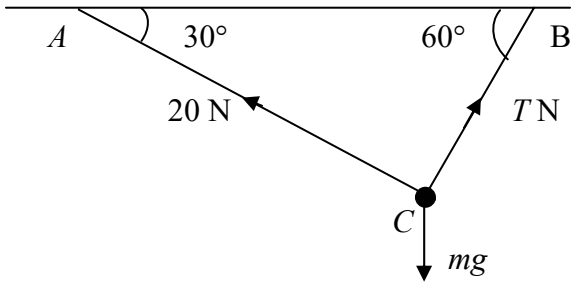
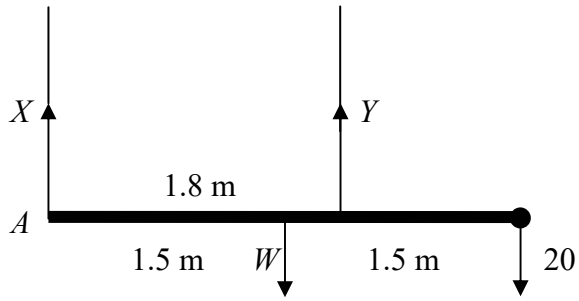
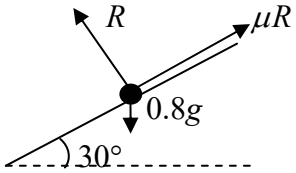
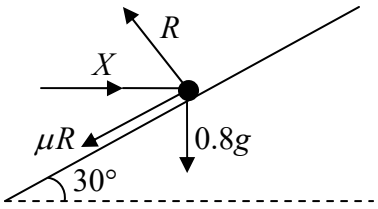
January 2010

Publications Code UA023034

January 2010
6677 Mechanics M1
Mark Scheme

Question Number	Scheme	Marks
Q1.	(a) $I = 2\times12 - 2\times3 = 18 \ (\text{N s})$	M1 A1 (2)
	(b) LM $2\times12 - 8m = 2\times3 + 4m$ Solving to $m = 1.5$	M1 A1 DM1 A1 (4) **[6]**
	Alternative to (b) $I = m\left(4-\left(-8\right)\right) = 18$ Solving to $m = 1.5$	M1 A1 DM1 A1 (4)
Q2.	(a)  First two line segments Third line segment 8, 75	B1 B1 B1 (3)
	(b) $\frac{1}{2}\times8\times\left(T+75\right) = 500$ Solving to $T = 50$	M1 A2 (1,0) DM1 A1 (5) **[8]**

Question Number	Scheme	Marks
Q3.		
	(a) R($\rightarrow$) $20\cos 30° = T\cos 60°$ $T = 20\sqrt{3}$, 34.6, 34.64,…	M1 A2 (1,0) A1 (4)
	(b) R($\uparrow$) $mg = 20\sin 30° + T\sin 60°$ $m = \frac{40}{g} (\approx 4.1)$,4.08	M1 A2 (1,0) A1 (4)
		[8]
Q4.	(a) 	
	M (A) $W\times 1.5 + 20\times 3 = Y\times 1.8$ $Y = \frac{5}{6}W + \frac{100}{3}$ ✱ cso	M1 A2 (1, 0) A1 (4)
	(b) $\uparrow$ $X + Y = W + 20$ or equivalent $X = \frac{1}{6}W - \frac{40}{3}$	M1 A1 A1 (3)
	(c) $\frac{5}{6}W + \frac{100}{3} = 8\left(\frac{1}{6}W - \frac{40}{3}\right)$ $W = 280$	M1 A1 ft A1 (3)
		[10]
	Alternative to (b) M(C) $X\times 1.8 + 20\times 1.2 = W\times 0.3$ $X = \frac{1}{6}W - \frac{40}{3}$	M1 A1 A1

Question Number	Scheme	Marks
Q5.	(a) $s = ut + \frac{1}{2}at^2 \Rightarrow 2.7 = \frac{1}{2}a \times 9$	M1 A1
	$a = 0.6\left(\text{m s}^{-2}\right)$	A1 (3)
	(b)  $\nwarrow \; R = 0.8g\cos 30° \left(\approx 6.79\right)$	B1
	Use of $F = \mu R$	B1
	$\swarrow \; 0.8g\sin 30° - \mu R = 0.8 \times a$	M1 A1
	$\left(0.8g\sin 30° - \mu 0.8g\cos 30° = 0.8 \times 0.6\right)$	
	$\mu \approx 0.51$ accept 0.507	A1 (5)
	(c) 	
	$\uparrow \quad R\cos 30° = \mu R\cos 60° + 0.8g$	M1 A2 (1,0)
	$\left(R \approx 12.8\right)$	
	$\rightarrow \quad X = R\sin 30° + \mu R\sin 60°$	M1 A1
	Solving for X, $X \approx 12$ accept 12.0	DM1 A1 (7)
		[15]
	Alternative to (c)	
	$\nwarrow \; R = X\sin 30° + 0.8 \times 9.8\sin 60°$	M1 A2 (1,0)
	$\swarrow \; \mu R + 0.8g\cos 60° = X\cos 30°$	M1 A1
	$X = \frac{\mu 0.8g\sin 60° + 0.8g\cos 60°}{\cos 30° - \mu\sin 30°}$	
	Solving for X, $X \approx 12$ accept 12.0	DM1 A1 (7)

Question Number	Scheme	Marks
Q6.	(a) N2L A: $5mg - T = 5m \times \frac{1}{4}g$	M1 A1
	$T = \frac{15}{4}mg$ ✱ cso	A1 (3)
	(b) N2L B: $T - kmg = km \times \frac{1}{4}g$	M1 A1
	$k = 3$	A1 (3)
	(c) The tensions in the two parts of the string are the same	B1 (1)
	(d) Distance of A above ground $s_1 = \frac{1}{2} \times \frac{1}{4}g \times 1.2^2 = 0.18g \left(\approx 1.764\right)$	M1 A1
	Speed on reaching ground $v = \frac{1}{4}g \times 1.2 = 0.3g \left(\approx 2.94\right)$	M1 A1
	For B under gravity $\left(0.3g\right)^2 = 2gs_2 \Rightarrow s_2 = \frac{\left(0.3\right)^2}{2}g \left(\approx 0.441\right)$	M1 A1
	$S = 2s_1 + s_2 = 3.969 \approx 4.0$ (m)	A1 (7)
		[14]

Question Number	Scheme	Marks
Q7.	(a) $\mathbf{v} = \dfrac{21\mathbf{i}+10\mathbf{j}-(9\mathbf{i}-6\mathbf{j})}{4} = 3\mathbf{i}+4\mathbf{j}$	M1 A1
	speed is $\sqrt{(3^2+4^2)} = 5\ (\text{km h}^{-1})$	M1 A1 (4)
	(b) $\tan\theta = \dfrac{3}{4}\ (\Rightarrow \theta \approx 36.9°)$	M1
	bearing is 37, 36.9, 36.87, …	A1 (2)
	(c) $\mathbf{s} = 9\mathbf{i}-6\mathbf{j}+t(3\mathbf{i}+4\mathbf{j})$	M1
	$= (3t+9)\mathbf{i}+(4t-6)\mathbf{j}$ ✱ cso	A1 (2)
	(d) Position vector of S relative to L is	
	$(3T+9)\mathbf{i}+(4T-6)\mathbf{j}-(18\mathbf{i}+6\mathbf{j}) = (3T-9)\mathbf{i}+(4T-12)\mathbf{j}$	M1 A1
	$(3T-9)^2+(4T-12)^2 = 100$	M1
	$25T^2-150T+125=0$ or equivalent	DM1 A1
	$(T^2-6T+5=0)$	
	$T = 1, 5$	A1 (6)
		[14]

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GCE

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Summer 2010

Publications Code UA024469

Summer 2010
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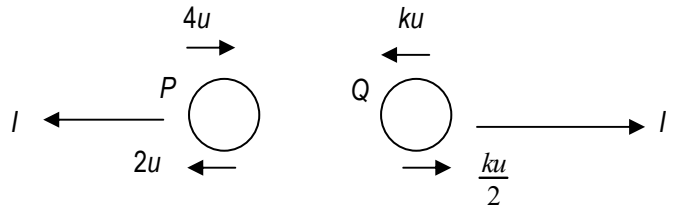
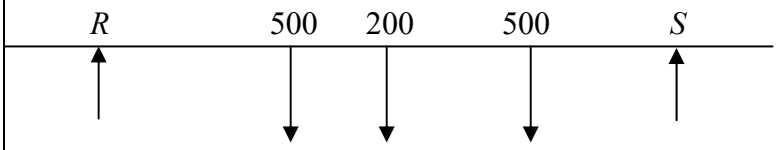
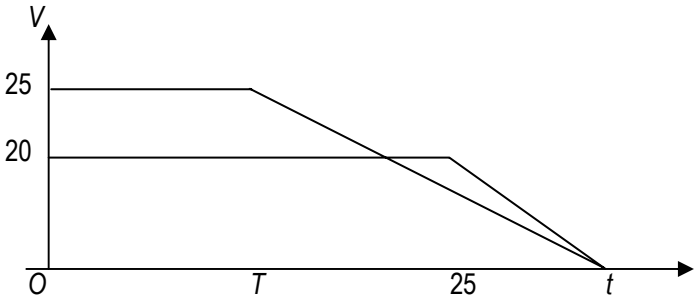
Mark Scheme

Question Number	Scheme	Marks
Q1	$(-4\mathbf{i}-7\mathbf{j})=\mathbf{r}+4(-3\mathbf{i}+2\mathbf{j})$ $\mathbf{r}=(8\mathbf{i}-15\mathbf{j})$ $\lvert\mathbf{r}\rvert=\sqrt{8^2+(-15)^2}=17$ m	M1 A1 A1 M1 A1 ft **[5]**
Q2 (a)	 $4mu-3mku=-2mu+3mk\frac{u}{2}$ $k=\frac{4}{3}$	M1 A1 M1 A1cso (4)
(b)	For P, $I=m\,(2u-\,-4u)$ $=6mu$ **OR** For Q, $I=3m\,(\frac{ku}{2}-\,-ku)$	M1 A1 A1 (3) **(M1A1)** **[7]**
Q3	$(\rightarrow)\ 100\cos 30=F$ $F=0.5R$ *seen* $(\downarrow)\ mg+100\cos 60=R$ $m=13$ kg or 12.6 kg	M1 A1 A1 **(B1)** M1 A1 **DM1** A1 **[7]**

Question Number	Scheme	Marks
Q4	 $M(B)$, $500x + 500.2x + 200\text{x}3 = R\text{x}5 + S\text{x}1$ (or any valid moments equation) $(\downarrow)\ R + S = 500 + 500 + 200 = 1200$ (or a moments equation) solving for x; $x = 1.2$ m	M1 A1 A1 M1 A1 M1 A1 cso **[7]**
Q5 (a)	 Shape (both) Cross Meet on t-axis Figures 25,20,T,25	B1 B1 B1 B1 (4)
(b)	For Q: $20\left(\frac{t+25}{2}\right) = 800$ $t = 55$ For P: $25\left(\frac{T+55}{2}\right) = 800$ solving for T: $T = 9$	M1 A1 **DM1** A1 M1 A1 **DM1** A1 (8) **[12]**

Question Number	Scheme	Marks
Q6 (a)	$(\uparrow) v^2 = u^2 + 2as$ $0 = 14.7^2 - 2\text{x } 9.8 \text{ x } s$ $s = 11.025$ (or 11 or 11.0 or 11.03) m Height is 60 m or 60.0 m **ft**	M1A1 A1 A1ft (4)
(b)	$(\downarrow) v^2 = u^2 + 2as$ $v^2 = (-14.7)^2 + 2\text{x } 9.8 \text{ x } 49$ $v = 34.3$ or 34 m s^{-1}	M1 A1 A1 (3)
(c)	$(\downarrow) v = u + at$ **OR** $(\downarrow) s = ut + \frac{1}{2}at^2$ $34.3 = -14.7 + 9.8t$ $\quad$ $49 = -14.7t + 4.9t^2$ $t = 5$ $\quad$ $t = 5$	M1 A1 A1 (3) **[10]**
Q7 (a)	$F = \frac{1}{3}R$ $(\uparrow)\ R\cos\alpha - F\sin\alpha = 0.4g$ $R = \frac{2}{3}g = 6.53$ or 6.5	B1 M1 A1 M1 A1 (5)
(b)	$(\rightarrow) P - F\cos\alpha - R\sin\alpha = 0$ $P = \frac{26}{45}g = 5.66$ or 5.7	M1 A2 M1 A1 (5) **[10]**

Question Number	Scheme	Marks
Q8 (a) Mark together	$(\downarrow) 0.4g - T = 0.4a$	M1 A1
	$(\uparrow) T - 0.3g = 0.3a$	M1 A1
	solving for T	**DM1**
	$T = 3.36$ or 3.4 or $12g/35$ (N)	A1 (6)
(b)	$0.4g - 0.3g = 0.7a$	**DM1**
	$a = 1.4$ m s^{-2}, $g/7$	A1 (2)
(c)	$(\uparrow) v = u + at$	
	$v = 0.5$ x 1.4	M1
	$= 0.7$	A1 ft on a
	$(\uparrow) s = ut + \frac{1}{2}at^2$	
	$s = 0.5$ x 1.4 x 0.5^2	M1
	$= 0.175$	A1 ft on a
	$(\downarrow) s = ut + \frac{1}{2}at^2$	
	$1.175 = -0.7t + 4.9t^2$	**DM1** A1 ft
	$4.9t^2 - 0.7t - 1.175 = 0$	
	$t = \frac{0.7 \pm \sqrt{0.7^2 + 19.6 \text{ x } 1.175}}{9.8}$	**DM1** A1 cao
	$= 0.5663..$or $-...$	
	Ans 0.57 or 0.566 s	A1 cao (9)
		[17]

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Mark Scheme (Results)
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GCE

GCE Mechanics M1 (6677) Paper 1

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   - **B** marks are unconditional accuracy marks (independent of M marks)
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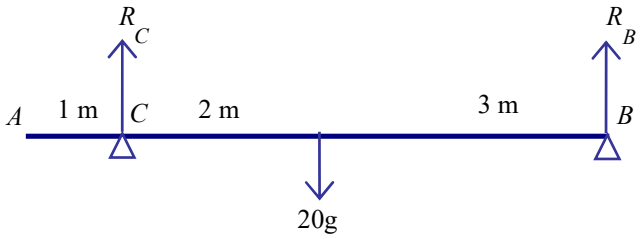
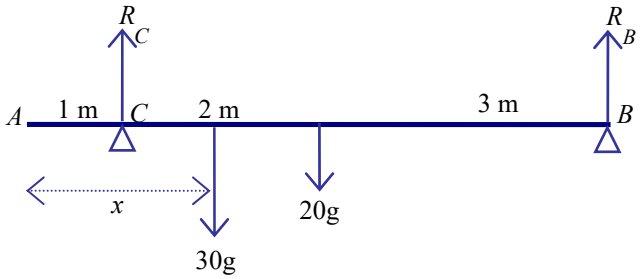
   - isw – ignore subsequent working
   - awrt – answers which round to
   - SC: special case
   - oe – or equivalent (and appropriate)
   - dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - $*$ The answer is printed on the paper
   - $\sqsubset$ The second mark is dependent on gaining the first mark

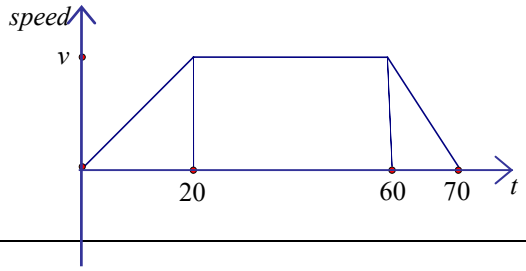
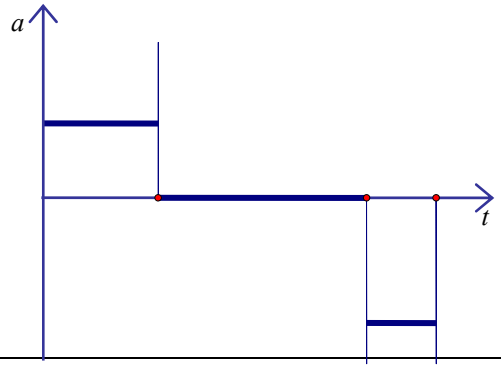
January 2011
Mechanics M1 6677
Mark Scheme

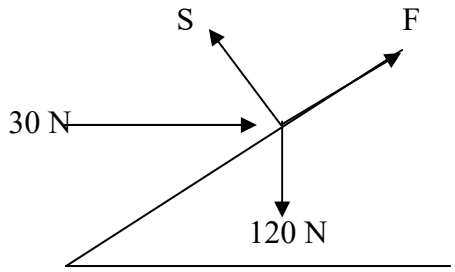
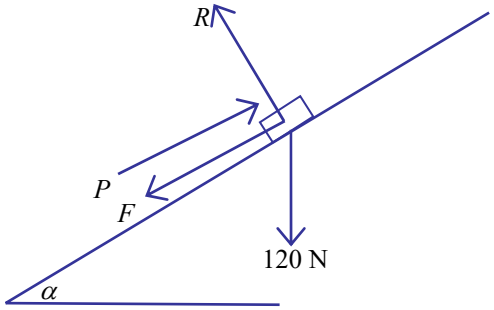
Question Number	Scheme	Marks
1. **(a)**	Conservation of momentum: $4m - 6 = m + 9$ $m = 5$	M1 A1 A1 (3)
(b)	Impulse = change in momentum $= 3\times 3 - (3\times -2) = 15$	M1 A1 (2) **[5]**

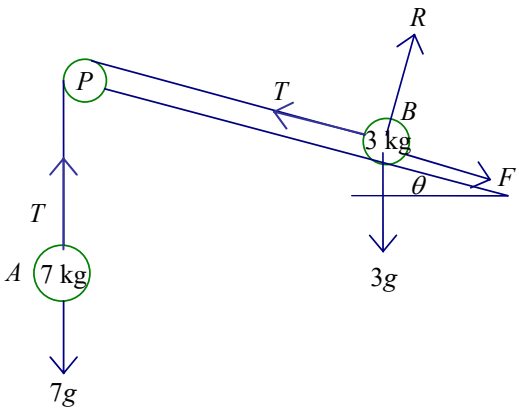
Question Number	Scheme	Marks
2. **(a)**	$-6.45 = u - 9.8 \times 0.75$ $0.9 = u$ **	M1 A1 A1 (3)
(b)	$0 = 0.81 - 2 \times 9.8 \times s$ $s = 0.041$ or 0.0413	M1 A1 (2)
(c)	$h = -0.9 \times 0.75 + 4.9 \times 0.75^2$ $h = 2.1$ or 2.08	M1 A1 A1 (3) **[8]**

Question Number	Scheme	Marks
3. **(a)**	 Taking moments about B: 5 x R_C = 20g x 3 R_C = 12g or 60g/5 or 118 or 120 Resolving vertically: $R_C + R_B = 20g$ R_B = 8g or 78.4 or 78	 M1A1 A1 M1 A1 (5)
(b)	 Resolving vertically: 50g = R + R Taking moments about B: $5\times 25g = 3\times 20g + (6-x)\times 30g$ $30x = 115$ x = 3.8 or better or 23/6 oe	 B1 M1 A1 A1 A1 (5) **[10]**

Question Number	Scheme	Marks
4. **(a)**	speed $= \sqrt{2^2 + (-5)^2}$ $= \sqrt{29} = 5.4$ or better	M1 A1 (2)
(b)	$\left((7\mathrm{i} + 10\mathrm{j}) - (2\mathrm{i} - 5\mathrm{j})\right)/5$ $= (5\mathbf{i} + 15\mathbf{j})/5 = \mathbf{i} + 3\mathbf{j}$ $\mathbf{F} = m\mathbf{a} = 2(\mathbf{i} + 3\mathbf{j}) = 2\mathbf{i} + 6\mathbf{j}$	M1 A1 A1 DM1 A1ft (5)
(c)	$\mathbf{v} = \mathbf{u} + \mathbf{a}t = (2\mathbf{i} - 5\mathbf{j}) + (\mathbf{i} + 3\mathbf{j})t$ $(-5 + 3t)\mathrm{j}$ Parallel to $\mathrm{i} \Rightarrow -5 + 3\mathrm{t} = 0$ $t = 5/3$	M1 A1 M1 A1 (4) **[11]**

Question Number	Scheme	Marks
5. **(a)** **(i)**	 1st section correct 2nd & 3rd sections correct Numbers and v marked correctly on the axes.	B1 B1 DB1
(ii)	 1st section correct 2nd section correct 3rd section correct and no "extras" on the sketch	B1 B1 B1 (6)
(b)	$\frac{70+40}{2}\times v = 880$ $v = 880\times\frac{2}{110} = 16$	M1 A1 DM1 A1 (4) **[10]**

Question Number	Scheme	Marks
6. **(a)**	 Resolving perpendicular to the plane: $S = 120\cos\alpha + 30\sin\alpha$ $= 114$ *	 M1 A1 A1 A1 (4)
(b)	 Resolving perpendicular to the plane: $R = 120\cos\alpha$ $= 96$ $F_{\max} = \frac{1}{2}R$ Resolving parallel to the plane: In equilibrium: $P_{\max} = F_{\max} + 120\sin\alpha$ $= 48 + 72 = 120$	 M1 A1 A1 M1 M1 A(2,1,0) A1 (8)
(c)	$30 + F = 120\sin\alpha$ **OR** $30 - F = 120\sin\alpha$ So $F = 42\text{N}$ acting up the plane.	M1 A1 A1 (3) **[15]**

Question Number	Scheme	Marks
7. **(a)**	 $\tan\theta = \frac{5}{12}$ $\sin\theta = \frac{5}{13}$ $\cos\theta = \frac{12}{13}$	
	For A: $7g - T = 7a$	M1 A1
	For B: parallel to plane $T - F - 3g\sin\theta = 3a$	M1 A1
	perpendicular to plane $R = 3g\cos\theta$	M1 A1
	$F = \mu R = 3g\cos\theta = 2g\cos\theta$	M1
	Eliminating T, $7g - F - 3g\sin\theta = 10a$	DM1
	Equation in g and a: $7g - 2g\times\frac{12}{13} - 3g\frac{5}{13} = 7g - \frac{39}{13}g = 4g = 10a$	DM1
	$a = \frac{2g}{5}$ *oe* or 3.9 or 3.92	A1
		(10)
(b)	After 1 m,	
	$v^2 = u^2 + 2as$, $v^2 = 0 + 2\times\frac{2g}{5}\times 1$	M1
	$v = 2.8$	A1
		(2)
(c)	$-(F + 3g\ \sin\theta) = 3a$	M1
	$\frac{2}{3}\times 3g\times\frac{12}{13} + 3g\times\frac{5}{13} = 3g = -3a,\ a = -g$	A1
	$v = u + at,\ 0 = 2.8 - 9.8t,$	DM1
	$t = \frac{2}{7}$ oe, 0.29. 0.286	A1
		(4) **[16]**

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GCE Mechanics M1 (6677) Paper 1

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   - awrt – answers which round to
   - SC: special case
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   - dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - * The answer is printed on the paper
   - ⌊ The second mark is dependent on gaining the first mark

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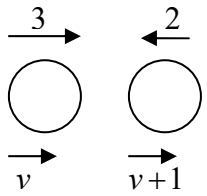
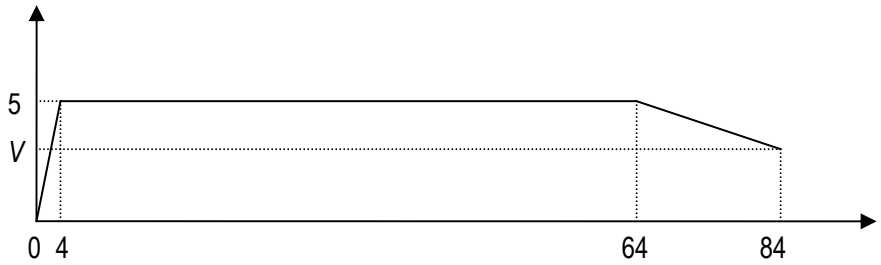
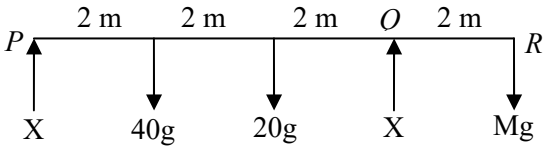
Mechanics M1 6677
Mark Scheme

Question Number	Scheme	Marks
1. **(a)**	$0^2 = u^2 - 2\text{x}9.8\text{x}40$ $u = 28$ m s^{-1} ** GIVEN ANSWER	M1 A1 A1 (3)
(b)	$33.6 = 28t - \frac{1}{2}9.8t^2$ $4.9t^2 - 28t + 33.6 = 0$ $t = \dfrac{28 \pm \sqrt{28^2 - 4\text{x}4.9\text{x}33.6}}{9.8}$ = 4 s or (1.7 s or 1.71 s)	M1 A1 M1 A1 A1 (5) **8**
2. **(a)**	 CLM: 3x3 - 2x2 = 3v + 2(v+1) v_P= 0.6 m s^{-1}; v_Q= 1.6 m s^{-1}	M1 A1 M1A1 (A1 **ft**) (5)
(b)	3(v – 3) OR 2(v + 1 – –2) = 7.2 Ns = 7.2 Ns	M1 A1 **ft** A1 (3) **8**

Question Number	Scheme	Marks
3.	↗ $4\cos\alpha + F = W\sin\alpha$ ↖ $R = 4\sin\alpha + W\cos\alpha$ $F = 0.5R$ $\cos\alpha = 0.8$ or $\sin\alpha = 0.6$ $R = 20N$ ** GIVEN ANSWER $W = 22N$	M1 A1 M1 A1 B1 B1 M1 A1 A1 (9)
OR	→ $R\sin\alpha = 4 + F\cos\alpha$ ↑ $R\cos\alpha + F\sin\alpha = W$ $F = 0.5R$ $\cos\alpha = 0.8$ or $\sin\alpha = 0.6$ $R = 20N$ ** GIVEN ANSWER $W = 22N$	M1 A1 M1 A1 B1 B1 M1 A1 A1 (9) **9**
4. **(a)**		B1 shape B1 figs (2)
(b)	$(\frac{1}{2}$x4x5) + 60 x 5 = 310	M1 A1 A1 (3)
(c)	$\frac{(5+V)}{2}$ x 20 = (400-310) $V = 4$	M1 A2 **ft** **DM**1 A1 (5)
(d)	$\frac{5-4}{20} = 0.05$ ms^{-2}	M1 A1 (2) **12**

Question Number	Scheme	Marks
5. **(a)**		
(i)	**EITHER** M(R), $8X + 2X = 40\text{g} \times 6 + 20\text{g} \times 4$	M1 A2
	solving for X, $X = 32\text{g} = 314$ or 310 N	M1 A1
(ii)	($\uparrow$) $X + X = 40\text{g} + 20\text{g} + Mg$ (or another moments equation)	M1 A2
	solving for M, $M = 4$	M1 A1
(i)	**OR** M(P), $6X = 40\text{g} \times 2 + 20\text{g} \times 4 + Mg \times 8$	M1 A2
	solving for X, $X = 32\text{g} = 314$ or 310 N	M1 A1
(ii)	($\uparrow$) $X + X = 40\text{g} + 20\text{g} + Mg$ (or another moments equation)	M1 A2
	solving for M, $M = 4$	M1 A1 (10)
(b)	Masses concentrated at a point or weights act at a point	B1 (1)
		11
6. **(a)**	$R = 0.3g\cos\alpha$	M1
	$= 0.24g = 2.35$ (3sf)=2.4 (2sf)	A1 (2)
(b)	$mg - T = 1.4m$	M1 A1
	$T - 0.3g\sin\alpha - F = 0.3 \times 1.4$	M1 A2
	$F = 0.5R$	M1
	Eliminating R and T	**DM**1
	$m = 0.4$	A1 (8)
(c)	$v = 1.4 \times 0.5$	B1
	$-0.3g\sin\alpha - F = 0.3a$	M1 A1
	$a = -9.8$	A1
	$0 = 0.7 - 9.8t$	M1
	$t = 0.071$ s or 0.0714 s (1/14 A0)	A1 (6)
		16

Question Number	Scheme	Marks
7. **(a)**	$\tan\theta = \frac{3}{4}$; bearing is 37° **(nearest degree)**	M1; A1 (2)
(b)		
(i)	$\mathbf{p} = (\mathbf{i} + \mathbf{j}) + t(2\mathbf{i} - 3\mathbf{j})$	M1 A1
(ii)	$\mathbf{q} = (-2\mathbf{j}) + t(3\mathbf{i} + 4\mathbf{j})$	A1
(iii)	$\mathbf{PQ} = \mathbf{q} - \mathbf{p} = (-\mathbf{i} - 3\mathbf{j}) + t(\mathbf{i} + 7\mathbf{j})$	M1 A1 (5)
(c)		
(i)	$-1 + t = 0$ $t = 1$ or 3pm	M1 A1
(ii)	$-1 + t = -(-3 + 7t)$ $t = \frac{1}{2}$ or 2.30 pm	M1 A1 (4)
		11

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- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used if you are using the annotation facility on ePEN.

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

General Principals for Core Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q),$ where $|pq| = |c|$, leading to x = ...

$(ax^2 + bx + c) = (mx + p)(nx + q),$ where $|pq| = |c|$ and $|mn| = |a|$, leading to x = …

2. Formula

Attempt to use correct formula (with values for *a*, *b* and *c*), leading to x = …

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c, \quad q \neq 0$, leading to x = …

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)

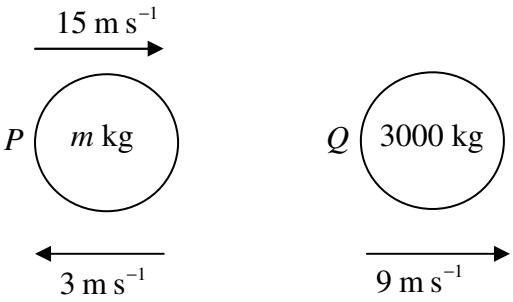
2. Integration

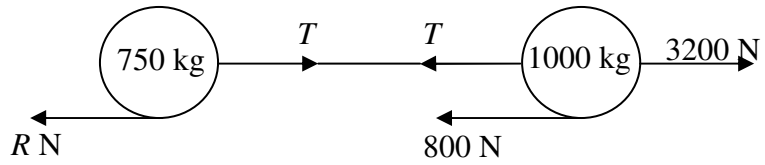
Power of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)

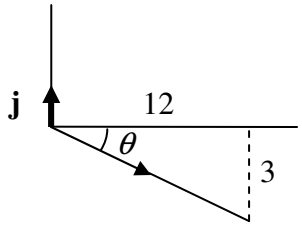
Use of a formula

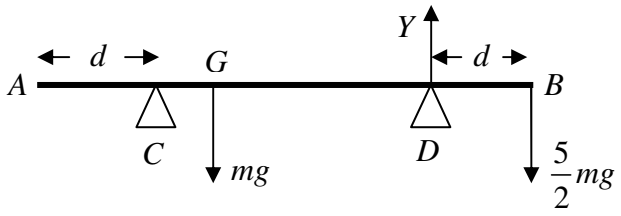
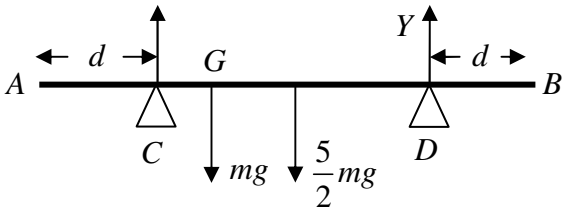
Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.
Normal marking procedure is as follows:
Method mark for quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values.
Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

January 2012
6677 Mechanics M1
Mark Scheme

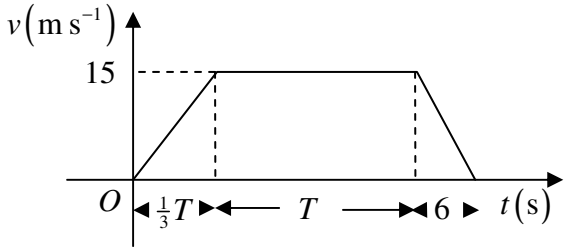
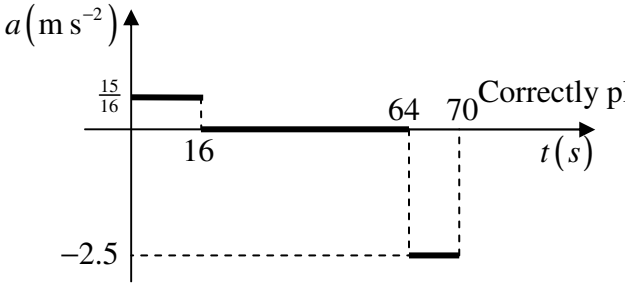
Question Number	Scheme	Marks
1 (a)	 For Q $\quad I = 3000\times 9 = 27\,000 \quad (\text{N s})$	M1 A1 (2)
(b)	Conservation of linear momentum $15m = -3m + 3000\times 9$ Leading to $\quad m = 1500$	M1 A1 A1 (3) **5**
	Alternative to (b) For P $\quad 27\,000 = m\left(15-\left(-3\right)\right)$ Leading to $\quad m = 1500$	M1 A1 A1 (3)

Question Number	Scheme	Marks
2 (a)	 For the whole system R $(\rightarrow)$ $3200-800-R=1750\times0.88$ Leading to $R=860$ ✱	M1 A1 A1 (3)
(b)	For the caravan R $(\rightarrow)$ $T-860=750\times0.88$ Leading to $T=1520$ (N)	M1 A1 A1 (3) **6**
	Alternative for (b) For the car R $(\rightarrow)$ $3200-800-T=1000\times0.88$ Leading to $T=1520$ (N)	M1 A1 A1 (3)

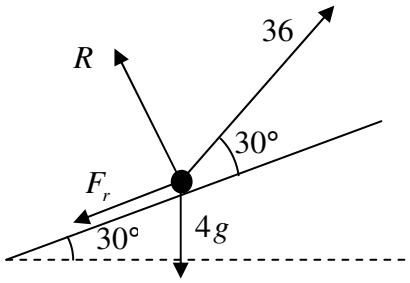
Question Number	Scheme	Marks
3 (a)	$7 + 5 + p = 0$ or $-9 + 6 + q = 0$ $p = -12$ $q = 3$	M1 A1 A1 (3)
(b)	$\mathbf{R} = 12\mathbf{i} - 3\mathbf{j}$ $\lvert\mathbf{R}\rvert = \sqrt{\left(12^2 + (-3)^2\right)} = \sqrt{153}$ or $3\sqrt{17}$ or 12.4 or better (N)	M1 A1 (2)
(c)	$\tan\theta = \frac{3}{12}$ $\theta = 14.03^0...$ Angle with **j** is 104°, to the nearest degree cao 	M1 A1 A1 (3) **8**

Question Number	Scheme	Marks
4 (a)		
	M(D) $\quad mg \times GD = \frac{5}{2}mg \times d$	M1 A1
	$GD = \frac{5}{2}d$ ✱	DM1 A1
		(4)
(b)		
	M(C) $\quad mg \times \frac{d}{2} + \frac{5}{2}mg \times \frac{3}{2}d = Y \times 3d$	M1 A2(1, 0)
	Leading to $\quad Y = \frac{17}{12}mg$	DM1 A1
		(5)
		9

Question Number	Scheme	Marks
5 (a)	$v = u + at(\uparrow) \Rightarrow 0 = u - g(\frac{25}{14})$	M1 M(A)1
	$u = 17\frac{1}{2}$ *	A1
		(3)
(b)	$v^2 = u^2 + 2as(\uparrow) \Rightarrow 0^2 = 17.5^2 - 2gs$	M1
	$s = 15.6 \quad (\text{m}) \quad$ or 16 (m)	A1
		(2)
(c)	$s = ut + \frac{1}{2}at^2(\uparrow) \Rightarrow 6.6 = 17.5t - \frac{1}{2}gt^2$	M1
	$4.9t^2 - 17.5t + 6.6 = 0$	A1
	$t = \frac{17.5 \pm \sqrt{(17.5^2 - 129.36)}}{9.8} = \frac{17.5 \pm 13.3}{9.8}$	DM1
	$t = 3.142..$ (22/7) or $0.428\ldots$(3/7)	A1
	$T = t_2 - t_1 = 2.71 \quad (2.7)$	DM1 A1 (6)
	OR	
	$v^2 = u^2 + 2as(\uparrow) \Rightarrow v^2 = 17.5^2 - 2g\text{x}6.6$	
	$v = \pm 13.3$	
	$v = u + at(\uparrow) \Rightarrow \pm 13.3 = 17.5 - gt$	M1A1
	$t = \frac{17.5 \pm 13.3}{9.8}$	DM1
	= 3.14.. (22/7) or 0.428..(3/7)	A1
	T = 3.14.. – 0.428.. = 2.71 or 2.7	DM1 A1 (6)
	OR	
	$v^2 = u^2 + 2as(\uparrow) \Rightarrow v^2 = 17.5^2 - 2g\text{x}6.6$ or $0^2 = u^2 - 2g\text{x}(15.625 - 6.6)$	
	$v = 13.3$ $\qquad$ u = 13.3	
	$v = u + at(\uparrow) \Rightarrow 0 = 13.3 - gt$	M1 A1
	$t = \frac{13.3}{g}$	DM1 A1
	$T = 2 \text{ x } \frac{13.3}{g} = 2.7$ or 2.71	DM1 A1 (6)
		11

Question Number	Scheme	Marks
6 (a)	$v = u + at \Rightarrow 0 = 15 - 2.5t$ $t = 6 \quad (\text{s})$	M1 A1 (2)
(b)	 Shape 15, T	B1 B1 (2)
(c)	$\frac{1}{2}15\left(\frac{4}{3}T + 6 + T\right) = 885$ ft their 6 $\frac{7}{3}T = 118 - 6$ $T = 112 \times \frac{3}{7} = 48$	M1 A1ft M1 A1 (4)
(d)	$a = \frac{15}{\frac{1}{3}T} = \frac{15}{16}$, 0.9375, 0.938, 0.94	M1 A1 (2)
(e)	 3 horizontal lines Correctly placed;no cts vert line −2.5 , ft their $\frac{15}{16}$	B1 B1 B1 (3)
		13

Question Number	Scheme	Marks
7 (a)	$\sqrt{\left((-4)^2+8^2\right)}=\sqrt{80}\quad\left(\text{km h}^{-1}\right)$ accept exact equivalents or 8.9 or better	M1 A1 (2)
(b)	$\mathbf{p}=\left(2\mathbf{i}-8\mathbf{j}\right)+t\left(-4\mathbf{i}+8\mathbf{j}\right)$	B1 (1)
(c)	Equating **j** components $-8+8t=12-8t$ $t=\frac{5}{4}$ oe	M1 A1 A1 (3)
(d)	Using their t from (c) to find the **i**-cpts of **p** and **q and subtract them** $10\frac{1}{2}-(-3)=13\frac{1}{2}\quad(\text{km})$	M1 A1 ft A1 (3) **9**

Question Number	Scheme	Marks
8 (a)		
	$R + 36\sin 30° = 4g\cos 30°$	M1 A1
	$R \approx 15.9,\ 16$	M1 A1
		(4)
(b)	Use of $F_r = \mu R$	B1
	$36\cos 30° = F + 4g\sin 30°$	M1 A1
	$\mu = \dfrac{36\cos 30° - 4g\sin 30°}{R} \approx 0.726$	M1 A1
	0.73	
		(5)
(c)	After force is removed	
	$R = 4g\cos 30°$	B1
	$-\mu 4g\cos 30° - 4g\sin 30° = 4a$	M1 A1
	$a = (-)11.06\ ...$	
	$v^2 = u^2 + 2as \Rightarrow 0^2 = 16^2 - 2\times 11.06\ ... \times s$	M1
	$s = \dfrac{16^2}{2\times 11.06\ ...} \approx 11.6 \quad (\text{m})$	A1
	12	
		(5)
		14

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Mark Scheme (Results)

Summer 2012

GCE Mechanics M1
(6677) Paper 1

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Summer 2012
Publications Code UA032675

Summer 2012
6677 Mechanics 1
Mark Scheme

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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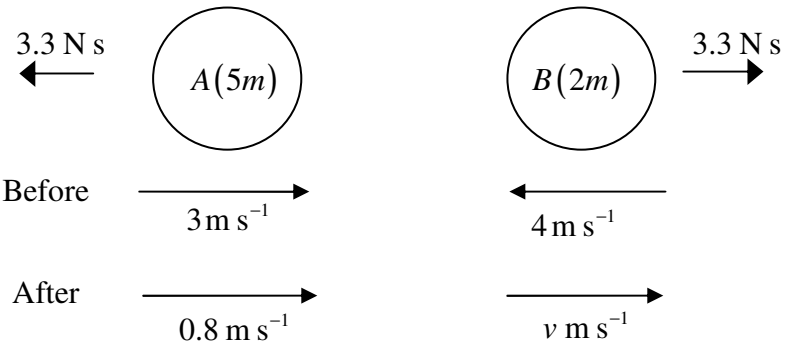
General Principles for Mechanics Marking

Usual rules for M marks: correct no. of terms; dim correct; all terms that need resolving (i.e. multiplied by cos or sin) are resolved.
Omission or extra g in a resolution is accuracy error not method error.
Omission of mass from a resolution is method error.
Omission of a length from a moments equation is a method error.
Omission of units or incorrect units is not (usually) counted as an accuracy error.
DM indicates a dependent method mark i.e. one that can only be awarded if a previous specified method mark has been awarded.
Any numerical answer which comes from use of g = 9.8 should be given to 2 or 3 SF.
Use of g = 9.81 should be penalised once per (complete) question.
N.B. Over-accuracy or under-accuracy of correct answers should only be penalised *ONCE* per complete question.
However, premature approximation should be penalised every time it occurs.
MARKS MUST BE ENTERED IN THE SAME ORDER AS THEY APPEAR ON THE MARK SCHEME.

In all cases, if the candidate clearly labels their working under a particular part of a question i.e. (a) or (b) or (c),……then that working can only score marks for that part of the question.

Accept column vectors in all cases.

June 2012
6677 Mechanics M1
Mark Scheme

Question Number	Scheme	Marks
1.	 (a) CLM $5m\times3-2m\times4=5m\times0.8+2mv$ Leading to $v=1.5$ $\left(\text{Speed is } 1.5 \text{ m s}^{-1}\right)$	M1 A1 A1 **(3)**
	(b) Impulse for A $5m(0.8-3)=-3.3$ Leading to $m=0.3$	M1 A1 A1 **(3)** **[6]**
	Alternative for (b) Impulse for B $2m(1.5--4)=3.3$ Leading to $m=0.3$	M1 A1 A1 **(3)**

Question 1(a)

M1 for attempt at CLM equation, with correct no.of terms, correct masses and dimensionally consistent. Allow consistent extra g's , consistent missing *m*'s and sign errors. However, M0 if masses are not paired with the correct speeds.

First A1 for a correct equation.

Second A1 for $v = 1.5$. (-1.5 A0)

N.B. Allow M1 for an attempt to equate the impulses on the particles but must have $5m$ (0.8 – 3) or $5m$ (3 – 0.8) on one side of the equation and $2m$ ($\pm v \pm 4$) on the other.

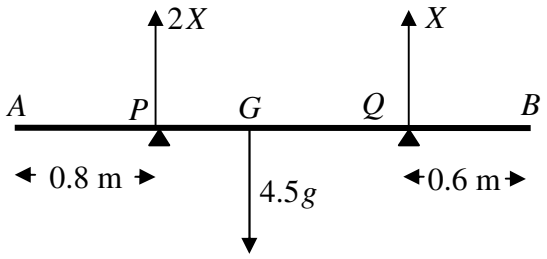
Question 1(b)

M1 for attempt at impulse = difference in momenta, for either particle, (must be considering one particle) (M0 if g's are included or if mass omitted or if just *m* used)

Allow Initial Momentum – Final Momentum.

A1 cao (i.e. no ft on their *v*) for a correct equation in *m* only.

A1 for $m = 0.3$

Question Number	Scheme	Marks
2.		
	(a) $\uparrow$ $2X + X = 4.5g$	M1 A1
	Leading to $X = \frac{3g}{2}$ or 14.7 or 15 (N)	A1 **(3)**
	(b) $\mathrm{M}(A)$ $4.5g \times AG = (2X) \times 0.8 + X \times 2.4$	M1 A2 **ft** (1,0)
	$AG = \frac{4}{3}$ (m), 1.3, 1.33,...	A1 **(4)**
		[7]

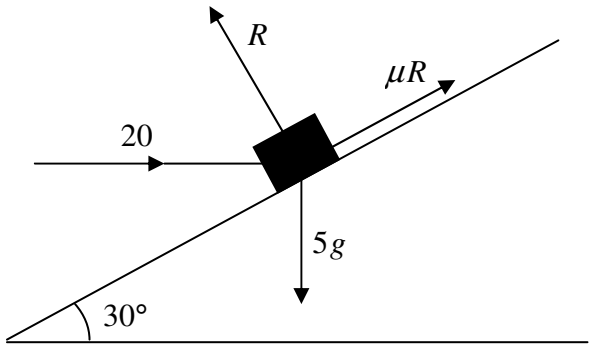
Question 2(a)

First M1 for a complete method for finding R_Q, either by resolving vertically, or taking moments twice, with usual criteria (allow M1 even if $R_P = 2R_Q$ not substituted)
First A1 for a correct equation in either R_Q or R_P ONLY.
Second A1 for 1.5g or 14.7 or 15 (A0 for a negative answer)

Question 2(b)

First M1 for taking moments about any point, with usual criteria.
A2 ft for a correct equation (A1A0 one error, A0A0 for two or more errors, ignoring consistent omission of g's) in terms of X and their x (which may not be AG at this stage)
Third A1 for AG = 4/3, 1.3, 1.33,….. (any number of decimal places, since g cancels) need 'AG =' or x marked on diagram

N.B. if $R_Q = 2R_P$ throughout, mark as a misread as follows:
(a) M1A1A0 (resolution method) (b) M1A0A1A1, assuming all work follows through correctly..

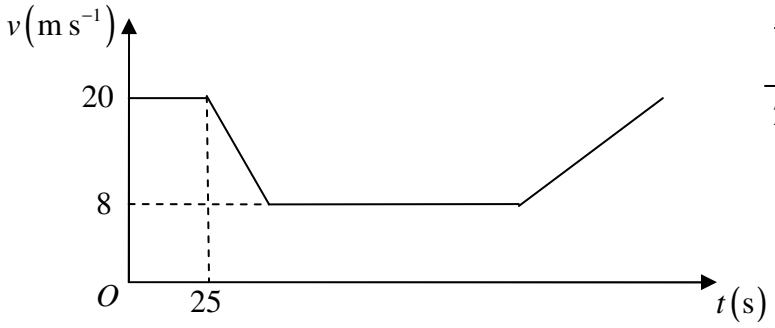
Question Number	Scheme	Marks
3.		
	(a) ⊥ plane $R = 20\cos 60° + 5g\cos 30°$ $= 52.4\ (\text{N})$ or 52	M1 A2(1,0) A1 **(4)**
	(b) $F_r = \mu R$ P plane $F + 20\cos 30^\circ = 5g\cos 60^\circ$ Leading to $\mu = 0.137$ or 0.14	B1 M1 A2(1, 0) A1 **(5)** **[9]**

Question 3(a)

First M1 for resolving perpendicular to plane with usual criteria
First A2 for a correct equation (A1A0 one error, A0A0 for two or more errors)
Second A1 for either 52 or 52.4
N.B. In part (a), the M1 is for a complete method, so they must have sufficient equations to be able to solve for R. The A2 marks are then for *all* the equations.

Question 3(b)

B1 for use of $F=\mu R$ (could just be on diagram)
First M1 (allow if F is used rather than μR) for resolving parallel to the plane with usual criteria
First A2 for a correct equation (A1A0 one error, A0A0 for two or more errors)
Second A1 for either 0.14 or 0.137
N.B. If they resolve vertically AND horizontally, there are max 6 marks available (M1A2, M1A2) for the TWO equations, but if they only have one equation, there are no marks available for that equation.
The marks for the horizontal resolution should be entered first on ePen.

Question Number	Scheme	Marks
4.	(a) 	B1 B1 B1 **(3)**
	(b) $v = u + at \Rightarrow 8 = 20 - 0.4t$ $t = 30 \ (\text{s})$	M1 A1 **(2)**
	(c) $1960 = (25 \text{ x } 20) + (30 \text{ x } 8) + (\tfrac{1}{2} \text{ x } 30 \text{ x } 12) + (60 \text{ x } 8) + 8 \text{ x } t + \tfrac{1}{2} \text{ x } t \text{ x } 12$	M1A3 **ft** (2 ,1, 0)
	$1960 = 500 + 240 + 180 + 480 + 14t$	DM1 A1
	$T = 115 + 40$ $= 155$	DM1 A1
	N.B. SEE ALTERNATIVES	**(8)** **[13]**

Question 4(a)
First B1 for 1st section of graph
Second B1 for 2nd section
Third B1 for the figures 20, 8 and 25

Question 4(b)
M1 for a complete method to produce an equation in t only; allow (20 – 8)/0.4
A1 for 30 N.B.
Give A0 for t = - 30, even if changed to 30, but then allow use of 30 in part (c), where full marks could then be scored.

Question 4(c)

First M1 (generous) for clear attempt to find whole area under *their* graph (must include at least one "1/2"), in terms of *a single unknown time (t say),* and equate it to 1960.
First A3, ft on their (b), for a correct equation.
Deduct 1 mark for each numerical error, or omission, in each of the 4 *sections of the area* corresponding to each stage of the motion. (they may 'slice' it, horizontally into 3 sections, or a combination of the two)
Second DM1, dependent on first M1, for simplifying to produce an equation with all their t terms collected.
Fourth A1 for a correct equation for t or T
Third DM1, dependent on second M1. for solving for T
Fifth A1 155

Please note that any incorrect answer to (b) will lead to an answer of 155 in (c) and can score max 6/8;

Solutions with the correct answer of 155 will need to be checked carefully.

Solutions to 4 (c) **N.B.** $t = T - 115$

A. $1960 = (25 \times 20) + (30 \times 8) + (\frac{1}{2} \times 30 \times 12) + (60 \times 8) + 8 \times t + \frac{1}{2} \times t \times 12$ M1 A3 **ft**
$1960 = 500 + 240 + 180 + 480 + 14t$ M1 A1
$T = 115 + 40$ M1
$= 155$ A1

B. $1960 = (25 \times 20) + \frac{1}{2} \times 30 \times (20 + 8) + (60 \times 8) + \frac{1}{2} \times t \times (20 + 8)$ M1 A3 **ft**
$1960 = 500 + 420 + 480 + 14t$ M1 A1
$T = 115 + 40$ M1
$= 155$ A1

C. $1960 = 8T + \frac{1}{2} \times 12 \times (55 + 25) + \frac{1}{2} \times 12 \times (T - 115)$ M1 A3 **ft**
$1960 = 8T + 480 + 6T - 690$
$1960 = 14T - 210$ M1 A1
$155 = T$ M1 A1

D. $1960 = 20T - \frac{1}{2} \times 12 \times (60 + T - 25)$ M1 A3 **ft**
$1960 = 20T - 6T - 210$
$1960 = 14T - 210$ M1 A1
$155 = T$ M1 A1

E. $1960 = (55 \times 20) - \frac{1}{2} \times 30 \times 12 + (60 \times 8) + \frac{1}{2} \times t \times (20 + 8)$ M1 A3 **ft**
$1960 = 1100 - 180 + 480 + 14t$ M1 A1
$T = 115 + 40$ M1
$= 155$ A1

F. $1960 = (8 \times 115) + \frac{1}{2} \times 12 \times (55 + 25) + \frac{1}{2} \times 28 \times (T - 115)$ M1 A3 **ft**
$1960 = 920 + 480 + 14T - 1610$
$1960 = 14T - 210$ M1 A1
$155 = T$ M1 A1

Question Number	Scheme	Marks
5.	(a) $v^2 = u^2 + 2as \Rightarrow 28^2 = u^2 + 2\times 9.8\times 17.5$	M1 A1
	Leading to $u = 21$ ✱ cso	A1 **(3)**
	(b) $s = ut + \frac{1}{2}at^2 \Rightarrow 19 = 21t - 4.9t^2$	M1 A1
	$4.9t^2 - 21t + 19 = 0$	
	$t = \frac{21 \pm \sqrt{21^2 - 4\text{x}4.9.\text{x}19}}{9.8}$	
	$t = 2.99$ or 3.0	DM1 A1 A1
	$t = 1.30$ or 1.3	**(5)**
	(c) N2L $4g - 5000 = 4a$	M1 A1
	$(a = -1240.2)$	
	$v^2 = u^2 + 2as \Rightarrow 0^2 = 28^2 - 2\times 1240.2\times s$	
	Leading to $s = 0.316$ (m) or 0.32	M1 A1 **(4)**
		[12]
	OR	
	$\frac{1}{2}$ x 4 x $28^2 + 4gs = 5000s$	M1 A1
	Work-Energy: $s = 0.316$ or 0.32	M1 A1

Question 5(a)

First M1 for a complete method for finding u e.g.

$28^2 = u^2 + 2g\text{x}17.5$

or $28^2 = u^2 + 2(-g)\text{x}(-17.5)$

or $28^2 = 2gs \Rightarrow s = 40$ then $0^2 = u^2 + 2(-g)\text{x}(22.5)$

condone sign errors

First A1 for a correct equation(s) with g = 9.8

Second A1 for "$u = 21$" PRINTED ANSWER

N.B. Allow a verification method, but they must state, as a conclusion, that "$u = 21$" , to score the final A1.

Question 5(b)

First M1 for a complete method for finding at least one t value i.e. for producing an equation in t only.
(condone sign errors but not missing terms)

First A1 for a correct quadratic equation in t only or TWO correct linear equations in t only.

Second DM1, dependent on first M1, for attempt to solve the quadratic or one of the linear equations.

Second A1 for 3.0 or 3 or 2.99

Third A1 for 1.3 or 1.30

Question 5(c)

First M1 for resolving vertically with usual rules.

First A1 for a correct equation

Second M1 for use of $v^2 = u^2 + 2as$, with $v = 0$, $u = 28$ or $u = 0$ and $v = 28$ and their a, (or any other complete method which produces an equation in s, which could be negative)

M0 if they haven't *calculated* a value of a.

Second A1 for 0.32 or 0.316. (must be positive since it's a distance)

Question Number	Scheme	Marks
6.	(a) $\arctan\frac{7.5}{12} = 32°$	M1 A1
	Bearing is 302 (allow more accuracy)	A1 **(3)**
	(b) $\mathbf{s} = 40\mathbf{i} - 6\mathbf{j} + t\left(-12\mathbf{i} + 7.5\mathbf{j}\right)$	M1 A1 **(2)**
	(c) $t = 3$, $\mathbf{s} = 4\mathbf{i} + 16.5\mathbf{j}$	M1
	$\mathbf{s} - \mathbf{b} = -3\mathbf{i} + 4\mathbf{j}$	M1
	$SB = \sqrt{\left((-3)^2 + 4^2\right)} = 5 \ (\text{km})$	DM1 A1 **(4)**
	(d) Equating **i** components	
	$40 - 12t = 7$ **or** $-33 + 12t = 0$	M1
	$t = 2\frac{3}{4}$	A1
	When $t = 2\frac{3}{4}$, $\mathbf{s} = \left(7\mathbf{i}\right) + 14\frac{5}{8}\mathbf{j}$	M1
	$SB = 2\frac{1}{8}$ (km) 2.125, 2.13	A1 **(4)**
		[13]
	OR When $t = 2\frac{3}{4}$, $7.5t - 18.5 = 2.125, 2.13$	M1 A1

Question 6(a)

First M1 for $\arctan\left(\frac{\pm 7.5}{\pm 12}\right)$ either way up
First A1 for a correct value from their expression, usually 32^o or 58^o
Second A1 for 302 (allow more accurate answers)

Question 6(b)

M1 for a clear attempt at $(40\mathbf{i} - 6\mathbf{j}) + t(-12\mathbf{i} + 7.5\mathbf{j})$
A1 for any correct expression

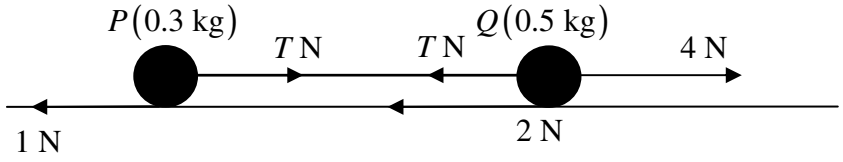
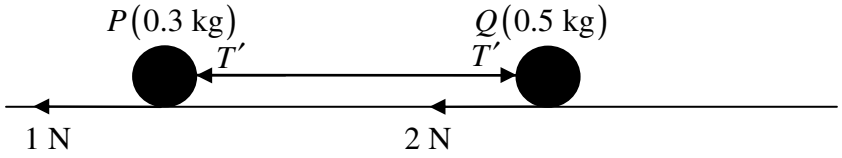
Question 6(c)

First M1 is really B1 for $4\mathbf{i} + 16.5\mathbf{j}$ (seen or implied but can be in unsimplified form)
Second M1 is for a subtraction, $\mathbf{s} - \mathbf{b}$ or $\mathbf{b} - \mathbf{s}$.
Third DM1, dependent on second M1, for finding magnitude of their $\mathbf{s} - \mathbf{b}$ or $\mathbf{b} - \mathbf{s}$
A1 for 5

Question 6(d)

First M1 for equating **i**-component of their answer in part (b) to 7 or
the **i**-component of their $\mathbf{s} - \mathbf{b}$ or $\mathbf{b} - \mathbf{s}$ to zero

First A1 for 2.75 cao
Second M1 (independent) for attempt to find **j**-component of their **s** at their
$t = 2.75$
Second A1 2.125 or 2.13 cao

Question Number	Scheme	Marks
7.		
	(a) For system N2L $4-3=0.8a$ $a=1.25\ \left(\text{m s}^{-2}\right)$, 1.3	M1 A1 A1 **(3)**
	(b) $v=u+at \Rightarrow v=0+1.25\times 6=7.5\ \left(\text{m s}^{-1}\right)$	M1 A1 **(2)**
	(c) For P N2L $T-1=0.3\times 1.25$ ft their a $T=1.375\ (\text{N})$ 1.38, 1.4	M1 A1ft A1 **(3)**
	OR For Q N2L 4 - 2 – T = 0.5 x 1.25	
		
	(d) For system N2L $-3=0.8a \Rightarrow a=-3.75$ $v^2=u^2+2as \Rightarrow 0^2=7.5^2-2\times 3.75s$ $s=7.5\ (\text{m})$	M1 A1 M1 A1 **(4)**
	(e) For P N2L $T'+1=0.3\times 3.75$ $T'=0.125\ (\text{N})$, 0.13	M1 A1 A1 **(3)** **[15]**
	Alternative for (e) For Q N2L $2-T'=0.5\times 3.75$ $T'=0.125\ (\text{N})$, 0.13	M1 A1 A1 **(3)**

Question 7(a) ***(In parts (a), (c), (d) and (e) use the value of the mass being used to guide you as to which part of the system is being considered, and mark equation(s) accordingly)***

M1 for resolving horizontally to produce an equation in a ONLY.
First A1 for a correct equation
Second A1 for 1.25

Question 7(b)

M1 for a complete method to find the speed
A1 cao 7.5

Question 7(c)

M1 for resolving horizontally, for either P or Q, to produce an equation in T only.
First A1ft for a correct equation,ft on their a
Second A1 cao for 1.38 (N) or 1.375 (N)

Question 7(d)

First M1 for resolving horizontally to produce an equation in a ONLY.
First A1cao for -3.75 (or 3.75)
Second M1 for use of $v^2 = u^2 + 2as$, with $v = 0$, u= their (b) and their a, (or any other complete method which produces an equation in s only)
M0 if they haven't *calculated* a value of a.
Second A1 for 7.5 m

Question 7(e)

M1 for resolving horizontally, for either P or Q, to produce an equation in T only.
M0 if they haven't *calculated* a value of a
First A1cao for a correct equation
Second A1 cao for 0.125 or 0.13 (N) (must be positive)

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Mark Scheme (Results)

January 2013

GCE Mechanics M1 (6677/01)

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January 2013
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- $*$ The answer is printed on the paper
- $\underline{}$ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but incorrect answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
    - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.

- If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

8. The maximum mark allocation for each question/part question(item) is set out in the marking grid and you should allocate a score of '0' or '1' for each mark, or "trait", as shown:

	0	1
aM		●
aA	●	
bM1		●
bA1	●	
bB	●	
bM2		●
bA2		●

Jan 2013
6677 Mechanics M1
Mark Scheme

Question Number	Scheme	Marks
1. (a)	$4m.2u - m.5u = -4m.\frac{1}{2}u + mv$ $3mu = -2mu + mv$ $v = 5u$, opposite direction	M1 A1 A1, A1 **cso** (4)
(b)	$I = 4m(\frac{1}{2}u - -2u)$ = $10mu$ OR $I = m(5u - -5u)$ = $10mu$	M1 A1 A1 (3) **7**
2.(a)	$M(D)$, $8R = (80g \text{ x } 6) + (200g \text{ x } 4)$ $R = 160g$, 1600, 1570	M1 A1 A1 (3)
(b)	$(\uparrow)$, $2S = 80g + 200g$ $S = 140g$, 1400, 1370	M1 A1 (2)
(c)	$M(B)$, $Sx + (S \text{ x } 10) = (80g \text{ x } 8) + (200g \text{ x } 6)$ $140x + 1400 = 640 + 1200$ $140x = 440$ $x = \frac{22}{7}$	M1 A2 A1 (4) **9**
3.	$(\uparrow)$, $T\cos 30 + F\cos 60 = 2g$ $(\rightarrow)$, $T\cos 60 - F\cos 30 = 0$ $F = g = 9.8$ $T = \sqrt{3}g = 17$ or 17.0	M1 A1 M1 A1 M1 A1 M1 A1 **8**
	OR: ( ), $F = 2g\cos 60$ ( ), $T = 2g\cos 30$ $F = g = 9.8$ $T = \sqrt{3}g = 17$ or 17.0	M1 A1 M1 A1 M1 A1 M1 A1 **8**

4.	$12.6^2 = 2a.50 \qquad (\Rightarrow a = 1.5876)$ $800g\sin 15 - F = 800a$ $R = 800g\cos 15$ $F = \mu R$ $800g\sin 15 - \mu 800g\cos 15 = 800 \text{ x } 1.5876$ μ= 0.1, 0.10, 0.100	M1 A1 M1 A1 M1 A1 B1 M1 A1 **9**
5. (a)	$30^2 = 2a.300$ $a = 1.5$	M1 A1 (2)
(b)	$0^2 = 30^2 - 2 \text{ x } 1.25s$ OR $0 = 30 - 1.25t_2$ $s = 360$ $t_2 = 24$ $300 + 30T + 360 = 1500$ $\frac{(20 + T + 24 + T)}{2} \text{ x } 30 = 1500$ $T = 28$ $T = 28$	M1 A1 M1 A1 A1 (5)
(c)	triangle, *drawn on the diagram*, with base coinciding with base of trapezium, top vertex above line $v = 30$ and meeting trapezium at least once V marked correctly	B1 DB1 (2)
(d)	$30 = 1.5t_1 \Rightarrow \quad t_1 = 20$ $30 = 1.25t_2 \Rightarrow t_2 = 24$ $\frac{1}{2}(20 + 28 + 24)V = 1500$ $V = \frac{750}{18} = 41.67$ $= \frac{125}{3}$ (oe) 0r 42 (or better)	M1 A1 A1 M1 A1 A1 (6) **15**

6.(a)	$\frac{(\mathbf{i}-4\mathbf{j})-(4\mathbf{i}-8\mathbf{j})}{0.5};(\pm 6\mathbf{i}\ \pm\ 8\mathbf{j})$ $\sqrt{(\pm 6)^2+(\pm 8)^2}=10$	M1 A1 M1 A1 (4)
(b)	$\mathbf{r}=(4\mathbf{i}-8\mathbf{j})+t(-6\mathbf{i}+8\mathbf{j})$ $=(4\mathbf{i}-8\mathbf{j})-6t\mathbf{i}+8t\mathbf{j}$ $=(4-6t)\mathbf{i}+(8t-8)\mathbf{j}$ *	M1 A1 (2)
(c)	At 10 am, $\mathbf{r}=-2\mathbf{i}$ At 10.30 am, $\mathbf{r}=-5\mathbf{i}+4\mathbf{j}$ $\mathbf{l}=k\mathbf{i},\ k<-2$ $k=-5-4=-9$ $\mathbf{l}=-9\mathbf{i}$	M1 A1 A1 DM1 A1 (5) **11**
7.(a)	Inextensible string	B1 (1)
(b)	$4mg-T=4ma$ $T-2mg\sin\alpha-F=2ma$	M1A1 M1A1 (4)
(c)	$F=0.25R$ $R=2mg\cos\alpha$ $\cos\alpha=0.8$ or $\sin\alpha=0.6$ Eliminating R, F and T $a=0.4g=3.92$	B1 B1 B1 M1 A1 (5)
(d)	$v^2=2$ x $0.4gh$ $-2mg\sin\alpha-F=2ma'$ $a'=-0.8g$ $0^2=0.8gh-2$x $0.8g$ x s $s=0.5h$ $XY=0.5h+h=1.5h$	M1 M1 A1 M1 A1 A1 (6) **16**

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Summer 2013
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
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- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
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- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
   - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

8. In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme

General Rules for Marking Mechanics

- Usual rules for M marks: correct no. of terms; dim correct; all terms that need resolving (i.e. multiplied by cos or sin) are resolved.

- Omission or extra g in a resolution is accuracy error not method error.

- Omission of mass from a resolution is method error.

- Omission of a length from a moments equation is a method error.

- Omission of units or incorrect units is not (usually) counted as an accuracy error.

- DM indicates a dependent method mark i.e. one that can only be awarded if a previous specified method mark has been awarded.

- Any numerical answer which comes from use of g = 9.8 should be given to 2 or 3 SF.

- Use of g = 9.81 should be penalised once per (complete) question.

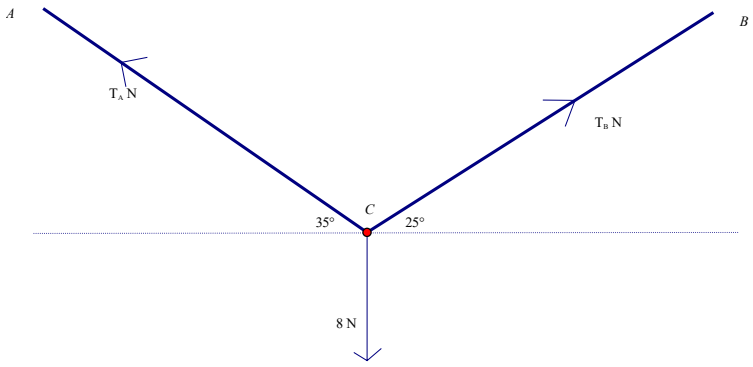
  N.B. Over-accuracy or under-accuracy of correct answers should only be penalised *ONCE* per complete question.

- In all cases, if the candidate clearly labels their working under a particular part of a question i.e. (a) or (b) or (c),……then that working can only score marks for that part of the question.

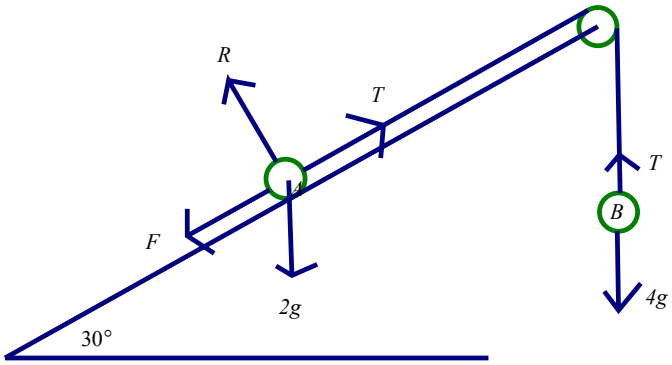
- Accept column vectors in all cases.

- Misreads – if a misread does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, bearing in mind that after a misread, the subsequent A marks affected are treated as A ft.

Question Number	Scheme	Marks
1(a)	 $2v+10=14$ $v=2$ m s^{-1}	M1A1 A1 **(3)**
(b)	$3w+18=14$ $w=\frac{4}{3}$ m s^{-1}	M1A1 A1 **(3)** **[6]**
Notes for Question 1		
Q1(a)	M1 for attempt at Impulse = difference in momenta <u>for particle *A*</u>, (must be considering *one* particle) (M0 if g is included or if mass omitted). First A1 for $-14=2(\pm v-5)$ Second A1 for 2 (Must be positive). Allow change of sign at end to obtain speed.	
Q1(b)	**EITHER** M1 for attempt at Impulse = difference in momenta <u>for particle *B*</u>, (must be considering *one* particle) (M0 if g is included or if mass omitted). First A1 $14=3(\pm w--6)$ Second A1 for 4/3, 1.3 or better (Must be positive). Allow change of sign at end to obtain speed. **OR** M1 for attempt at CLM equation, with correct no. of terms, dimensionally correct. Allow consistent extra g's and sign errors. First A1 (**Not f.t.**) for a correct equation e.g. 2 x 5 - 3 x 6 = -2 x 2 + 3*w* Second A1 for speed is 4/3; 1.3 or better N.B. They may find the speed of *B* first and then use CLM to find the speed of *A*. It must be clear which speed is which, in order to gain the A marks for the answers	

Question Number	Scheme	Marks
2.		
	Resolve horizontally: $T_A \cos 35° = T_B \cos 25°$	M1A1
	Resolve vertically: $T_A \sin 35° + T_B \sin 25° = 8$	M1A1
	Equation in one unknown: $T_B \dfrac{\cos 25°}{\cos 35°} \sin 35° + T_B \sin 25° = 8$	**DM1**A1
	or $T_A \sin 35° + T_A \dfrac{\cos 35°}{\cos 25°} \sin 25° = 8$	
	T_A = 8.4, 8.37, 8.372 (N) or better	A1
	T_B = 7.6, 7.57, 7.567 (N) or better	A1 **(8)**
2alt	**OR**	
	Using Sine Rule on triangle of forces: $\dfrac{8}{\sin 60°} = \dfrac{T_A}{\sin 65°} = \dfrac{T_B}{\sin 55°}$	M1A1
	$\dfrac{8 \times \sin 65°}{\sin 60°} = T_A$, = 8.4, 8.37, 8.372 (N) or better	M1A1, A1
	$\dfrac{8 \times \sin 55°}{\sin 60°} = T_B$, = 7.6, 7.57, 7.567 (N) or better	M1A1, A1

Notes for Question 2		
2	First M1 for resolving horizontally with correct no. of terms and both T_A and T_B terms resolved. First A1 for a correct equation. Second M1 for resolving vertically with correct no. of terms and both T_A and T_B terms resolved. Second A1 for a correct equation. Third M1, dependent on first two M marks, for eliminating T_A or T_B Third A1 for a correct equation in one unknown Fourth A1 for T_A = 8.4 (N) or better. Fifth A1 for T_B = 7.6 (N) or better. N.B. The first two M marks can be for two resolutions in any two directions. N.B. If the two tensions are taken to be equal, can score max M1A0 for vertical resolution.	
2 alt 1	See **Alternative 1** using a Triangle of Forces and the Sine Rule.	
2 alt 2	**Alternative 2** is to resolve perpendicular to each string: The scheme is similar to Alt 1 and gives the same expressions for T_A and T_B M1A1 resolving perp to *both* strings as a complete method. M1A1A1 for finding T_A M1A1A1 for finding T_B	

Question Number	Scheme	Marks
3.	 Equation of motion of B: $4g - T = 4a$ Equation of motion of A: $T - F - 2g\sin 30 = 2a$ OR: $4g - F - 2g\sin 30 = 6a$ Resolve perpendicular to the plane at A: $R = 2g\cos 30$ Use of $F = \mu R$: $F = \frac{1}{\sqrt{3}} \times 2g\cos 30 (= g)$ $T - g - g = T - 2g = 2a$ $2T - 4g = 4g - T$, $3T = 8g$, $T = \frac{8g}{3} (\approx 26)$ 26.1(N)	 M1A1 M1A2 B1 M1 **DM1**A1 **(9)** **[9]**
Notes for Question 3		
3	First M1 for resolving vertically (up or down) for *B,* with correct no. of terms. First A1 for a correct equation. Second M1 for resolving parallel to the plane (up or down) for *A,* with correct no. of terms. A2 for a correct equation (-1 each error) **OR**: M2 A3 for the whole system equation - any method error loses all the marks. B1 for perpendicular resolution Third M1 for sub for R in $F = \mu R$ Fourth DM1, dependent on first and second M marks, for eliminating a. Fourth A1 for 8g/3, 26.1 or 26 (N). (392/15 oe is A0)	

Question Number	Scheme	Marks
4. **(a)**	Use of $s = ut + \frac{1}{2}at^2$	M1
	$-2t + \frac{1}{2}gt^2$ (+ or – 50)	A1
	$20t - \frac{1}{2}gt^2$ (+ or – 50)	A1
	$50 = -2T + \frac{1}{2}gT^2 + 20T - \frac{1}{2}gT^2 = 18T$	M1
	$T = \frac{50}{18} = 2.777.... = 2.8$ or better	A1 **(5)**
(b)	$h = 20 \times T - 4.9 \times T^2 = 17.74.... \approx 17.7$ (18 to 2 s.f.) (use of 2.8 gives 17.584)	M1A1 **(2)** **[7]**
	Notes on Question 4	
Q4(a)	First M1 for use of $s = ut + 1/2at^2$ (or use of 2 *suvat* formulae AND eliminating v, to give an equation in s and t). N.B. M0 if they use $s = 50$ or $u = 0$ or $v = 0$) First A1 with $u = 2$ and $a = -g$ or -9.8 to obtain a distance, possibly with 50 added or subtracted. (2 and 4.9 must have *opposite* signs) Second A1 with $u = 20$ and $a = -g$ or -9.8 to obtain a distance, possibly with 50 added or subtracted. (2 and 4.9 must have *opposite* signs) Second M1 dependent on first M1 for a *correct* equation obtained correctly in T only. Third A1 for 25/9 oe, 2.8 or better	
Q4(b)	First M1 for substituting their T value (allow –ve changed to +ve but A mark is then unavailable) into an appropriate equation First A1 for 17.7 or 18 (m). (A0 if they then add 50)	

Question Number	Scheme	Marks
5. **(a)**	$s = \frac{u+v}{2}t \qquad 10 = \frac{2+v}{2} \times 3.5$ $v = \frac{20}{3.5} - 2 = \frac{26}{7} = 3.71 \ \ (\text{m s}^{-1})$	M1A1 A1 **(3)**
(b)	$a = \frac{v-u}{t} = \frac{\frac{26}{7} - 2}{3.5} = \frac{24}{49} = 0.490 \ \ (\text{m s}^{-2})$	M1A1 **(2)**
(c)	Normal reaction : $R = 0.6g\cos 25°$ Resolve parallel to the slope : $0.6g\sin 25° - \mu \times R = 0.6 \times a$ $\mu = 0.41$ or 0.411	B1 M1A2 A1 **(5)** **[10]**

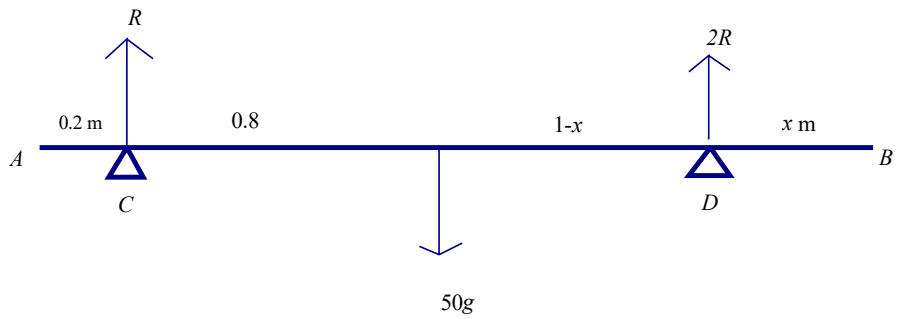
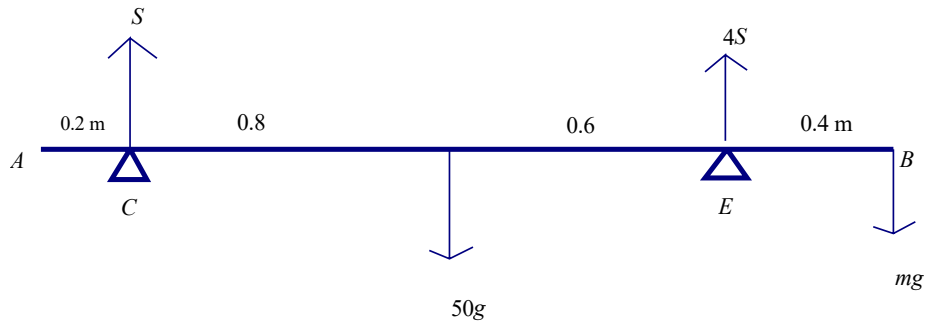
Notes for Question 5

Q5(a)	First M1 for producing an equation in *v only.* First A1 for a correct equation Second A1 for 26/7 oe, 3.7 or better (ms^{-1})
Q5(b)	M1 for producing an equation in *a only.* A1 for 24/49, 0.49 or better (ms^{-2})
Q5(c)	B1 for $R = 0.6g\cos 25^{\circ}$ M1 for resolving along the plane, correct no. of terms etc. A2 (-1 each error) *R* and *a* do not need to be substituted Third A1 for 0.41 or 0.411

Question Number	Scheme	Marks
6. **(a)**	Use of $\mathrm{r} = \mathrm{r}_0 + \mathrm{v}t$ $(-4\mathrm{i}+2\mathrm{j})+(3\mathrm{i}+3\mathrm{j})t = (-4+3t)\mathrm{i}+(2+3t)\mathrm{j}$	M1 A1 **(2)**
(b)	$(6\mathrm{i}+\mathrm{j})+(-2\mathrm{i}+n\mathrm{j})t = (6-2t)\mathrm{i}+(1+nt)\mathrm{j}$ Position vectors identical $\Rightarrow -4+3t = 6-2t$ **AND** $5t = 10$, Either equation $2+3\times 2 = 1+2n$, $n = 3.5$	B1 M1 A1 **DM1** A1 **(5)**
(c)	Position vector of P is $(-4+6)\mathrm{i}+(2+6)\,\mathrm{j} = 2\mathrm{i}+8\mathrm{j}$ Distance OP $= \sqrt{2^2+8^2} = \sqrt{68} = 8.25\,(\mathrm{km})$	M1A1 M1A1 **(4)** **[11]**

Notes for Question 6		
Q6(a)	M1 for clear attempt to use $\mathbf{r}_0 + t\mathbf{v}$ (M0 if $\mathbf{r}_0$ and $\mathbf{v}$ reversed) A1 for answer in any form.	
Q6(b)	B1 for $(6\mathbf{i} + \mathbf{j}) + (-2\mathbf{i} + n\mathbf{j})t$ seen or implied First M1 for equating their **i**- cpts *and* their **j**- cpts. (must have *both* equations in terms of *same t*) First A1 for a correct equation (either) Second M1 dependent on first M1 for producing an equation in n only. Second A1 for $n = 3.5$ oe	
Q6(c)	First M1 for clear attempt to find pv of P, using their t and/or n value(s) First A1 for $2\mathbf{i} + 8\mathbf{j}$ Second M1 for attempt to find magnitude of their **p** Second A1 for $\sqrt{68}$, $2\sqrt{17}$, 8.2 or better (km)	

Question Number	Scheme	Marks
7		
(a)	Use of $v^2 = u^2 + 2as$	M1
	$14^2 = 20^2 - 2a \times 100$	A1
	Deceleration is $1.02(\text{m s}^{-2})$	A1
		(3)
(b)	Horizontal forces on the car: $\pm T\cos\theta - 300 = 750 \times -1.02 = -765$	M1A2 **f.t.**
	$T = -1550/3$	
	The force in the tow-bar is 1550/3, 520 (N) or better (allow –ve answer)	A1
		(4)
(c)	Horizontal forces on the truck: $\pm T\cos\theta - 500 - R = 1750 \times -1.02$	M1A2 **f.t.**
	Braking force $R =$ 1750 (N)	A1
		(4)
		[11]
	ALT: Whole system: $800 + R = 2500 \times 1.02$	M1A2 **f.t.**
	$R = 1750$	A1
Notes for Question 7		
Q7(a)	M1 for a complete method to produce an equation in a only. First A1 for a correct equation. Second A1 for 1.02 (ms^{-2}) oe. must be POSITIVE.	
Q7(b)	M1 for considering *the car ONLY* horizontally to produce an equation in T only, with usual rules. i.e. correct no. of terms AND T resolved: $\pm T\cos\theta - 300 = 750$ x -1.02 A2 **ft** on their a for a correct equation (300 and a must have *same* sign); -1 each error (treat cos 0.9 as an A error) A1 for 1550/3 oe, 520 or better (N) N.B. Allow a negative answer.	
Q7(c)	M1 for considering *the truck ONLY* horizontally to produce an equation, with usual rules. i.e. correct no. of terms AND T resolved: $\pm T\cos\theta - 500 - R = 1750$ x -1.02 A2 **ft** on their T and a for a correct equation (500, a and R must have *same* sign); -1 each error (treat cos 0.9 as an A error) A1 for 1750 (N). **OR** M1 for considering *the whole system* to produce an equation in R only, with usual rules. i.e. correct no. of terms. A2 **ft** on their a for a correct equation (a and R must have *same* sign) -1 each error A1 for 1750 (N). N.B. If 300 and 500 are given separately, penalise any sign errors only ONCE.	

Question Number	Scheme	Marks
8. **(a)**		
	Vertical equilibrium: $R+2R=50g$,	M1A1
	Moments about C: $50g\times0.8=(1.8-x)\times2\times R$	M1A1
	$3\times0.8=3.6-2x$, $x=0.6$	**DM1**A1
		(6)
(b)		
	S, $4S$	B1
	Vertical equilibrium: $S+4S=(50+m)g=5S$	M1A1
	Moments about B: $50g\times1=4S\times0.4+S\times1.8=3.4S$	M1A1
	$50\times\frac{5}{3.4}=(50+m)$	**DM1**
	m = 400/17, 24, 23.5 or better	A1
		(7)
		[13]

Notes for Question 8		
Q8(a)	**In both parts consistent omission of g's can score all the marks.** First M1 for vertical resolution or a moments equation, with usual rules. (allow R and N at this stage) First A1 for a correct equation (with $N = 2R$ substituted) Second M1 for a moments equation in R and one unknown length with usual rules. Second A1 for a correct equation. Third M1, dependent on first and second M marks, for solving for x Third A1 for $x = 0.6$. S.C. Moments about centre of rod: R x $0.8 = 2R(1 - x)$ M2 A2	
Q8(b)	B1 for S and $4S$ placed correctly. First M1 for vertical resolution or a moments equation, with usual rules. (allow S and $4S$ reversed) First A1 for a correct equation. Second M1 for a moments equation in S (and m) with usual rules. Second A1 for a correct equation. Third M1, dependent on first and second M marks, for *eliminating* S to give an equation in *m only.* Third A1 for $m = 400/17$ oe or 24 or better. N.B. SC If they use the reaction(s) found in part (a) in their equations, can score max B1M1A0M1A0DM0A0.	

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Summer 2013

GCE Mechanics 1 (6677/01)

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Summer 2013
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- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes:

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
   - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

8. In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme

General Rules for Marking Mechanics

- Usual rules for M marks: correct no. of terms; dim correct; all terms that need resolving (i.e. multiplied by cos or sin) are resolved.

- Omission or extra g in a resolution is accuracy error not method error.

- Omission of mass from a resolution is method error.

- Omission of a length from a moments equation is a method error.

- Omission of units or incorrect units is not (usually) counted as an accuracy error.

- DM indicates a dependent method mark i.e. one that can only be awarded if a previous specified method mark has been awarded.

- Any numerical answer which comes from use of g = 9.8 should be given to 2 or 3 SF.

- Use of g = 9.81 should be penalised once per (complete) question.

- N.B. Over-accuracy or under-accuracy of correct answers should only be penalised *ONCE* per complete question.

- In all cases, if the candidate clearly labels their working under a particular part of a question i.e. (a) or (b) or (c),……then that working can only score marks for that part of the question.

- Accept column vectors in all cases.

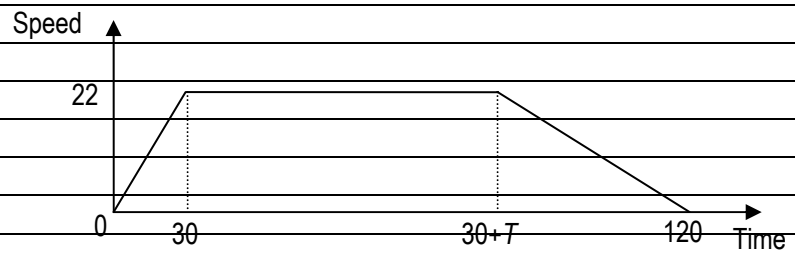
- Misreads – if a misread does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, bearing in mind that after a misread, the subsequent A marks affected are treated as A ft.

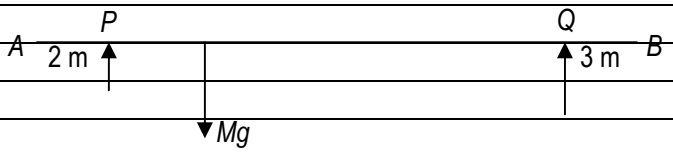
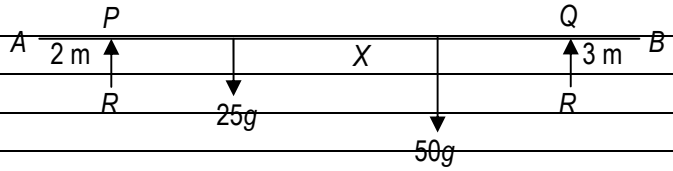
Question Number	Scheme	Marks
1.		
(a)	For P, $-I = 3(1-4)$	M1 A1
	$I = 9$ Ns	A1
		(3)
(b)	For Q, $9 = m(1.5--3)$	M1 A1
	$m = 2$	A1
	OR	
	$12-3m = 3+1.5m$	M1 A1
	$m = 2$	A1
		(3)
		[6]
Notes for Question 1		
Q1(a)	M1 for attempt at Impulse = difference in momenta <u>for particle *P*</u>, (must be considering *one* particle i.e. have *same mass* in both terms) (M0 if g is included or if mass omitted). First A1 for $\pm 3(1-4)$ Second A1 for 9 (Must be positive). Allow change of sign at end to obtain magnitude. **<u>N.B.</u>** For M1 they may use CLM to find a value for m first and then use it when considering the change in momentum of Q to find the impulse.	
Q1(b)	**EITHER** M1 for attempt at: their Impulse from (a) = difference in momenta <u>for particle *Q*</u>, (must be considering *one* particle) (M0 if g is included or if mass omitted). First A1 for $9 = m(1.5--3)$ oe. Second A1 for $m = 2$. **OR** M1 for attempt at CLM equation, with correct no. of terms, dimensionally correct. Allow consistent extra g's and sign errors. First A1 for a correct equation i.e. $12-3m = 3+1.5m$ oe. Second A1 for $m = 2$.	

Question Number	Scheme	Marks
2.		
(a)	For system, $(\uparrow),\ T-950g-50g=1000\ \times -2$	M1 A1
	$T = 7800$ N	A1
		(3)
(b)	For woman, $(\uparrow),\quad R-50g=50\times -2$	M1 A1
	$R = 390$ N	A1
		(3)
		[6]
Notes for Question 2		
Q2(a)	(In both parts, use the *mass* to decide which part of the system is being considered and M marks can only be scored if an equation contains only forces acting on that part of the system) M1 is for a complete method for finding T i.e. for an equation in T *only*, dimensionally correct, with the correct number of terms. First A1 for a correct equation. Second A1 for 7800 (N).	
Q2(b)	M1 is for a complete method for finding R i.e. for an equation in R *only*, dimensionally correct, with the correct number of terms. First A1 for a correct equation. Second A1 for 390 (N). N.B. Equation for lift *only* is: T – 950g – R = 950 x (-2)	

Question Number	Scheme	Marks
3.	$T\cos\alpha - F = 2g\cos 60^o$	M1 A1
	$T\sin\alpha + R = 2g\cos 30^o$	M1 A1
	$F = \frac{1}{3}R$	B1
	eliminating F and R	**DM**1
	$T = g(1+\frac{1}{\sqrt{3}})$, 1.6g (or better), 15.5, 15 (N)	**DM**1 A1
		(8)
		[8]
Notes for Question 3		
Q3	First M1 for resolving parallel to the plane with correct no. of terms and both T and $2g$ terms resolved. First A1 for a correct equation. (use of α instead of 30° or 60° or vice versa is an A error not M error; similarly if they use sin(3/5) or cos(4/5) when resolving, this can score M1A0) Second M1 for resolving perpendicular to the plane with correct no. of terms and both T and $2g$ terms resolved. Second A1 for a correct equation (use of α instead of 30° or 60° or vice versa is an A error not M error; similarly if they use sin(3/5) or cos(4/5) when resolving, this can score M1A0) B1 for $F = 1/3\ R$ seen or implied. Third M1, dependent on first two M marks and appropriate angles used when resolving in *both* equations, for eliminating *F and R.* Fourth M1 dependent on third M1, for solving for T Third A1 for 15(N) or 15.5 (N). N.B. The first two M marks can be for two resolutions in any directions. Use of tan α = 4/3 leads to an answer of 17.83…and can score max 7/8.	

Question Number	Scheme	Marks
4.		
(a)	$240 = \frac{1}{2}(u+34)10$	M1 A1
	$u = 14$	A1
		(3)
(b)	$34 = 14 + 10a \quad => \quad a = 2$	M1 A1
	$120 = 14t + \frac{1}{2} \times 2 \times t^2$	M1 A1
	$t^2 + 14t - 120 = 0$	
	Solving, $t = -20$ or 6	**DM**1
	$t = 6$	A1
	OR	
	$34 = 14 + 10a \quad => \quad a = 2$	M1 A1
	$v^2 = 14^2 + 2 \times 2 \times 120 \quad \Rightarrow v = 26$	
	AND $26 = 14 + 2t$	M1 A1
	$t = 6$	**DM**1 A1
		(6)
		[9]
Notes for Question 4		
Q4(a)	First M1 for a complete method to produce an equation in u only. First A1 for a correct equation. ($u^2 - 48u + 476 = 0$ oe is possible). Second A1 for $u = 14$.	
Q4(b)	**EITHER** First M1 for an equation in a only. (M0 if $v = 34$ when $s = 120$ is used) First A1 for $a = 2$. (This may have been found in part (a)) Second M1 for a 3-term quadratic equation in t only, allow sign errors (must have found a value of a. (M0 if $v = 34$ when $s = 120$ is used) Second A1 for a correct equaton. Third M1 dependent on previous M1 for solving for t. Third A1 for $t = 6$ **OR** First M1 for an equation in a only. First A1 for $a = 2$. (This may have been found in part (a)) Second M1 for a complete method to obtain an equation in t only, allow sign errors. (must have found a value of a) Second A1 for a correct equaton. Third M1 dependent on previous M1 for solving for t. Third A1 for $t = 6$	

Question Number	Scheme	Marks
5.		
(a)	 Shape	B1
	Figures	B1
		(2)
(b)	$\frac{(120+T)22}{2}=2145$	M1 A1
	$T=75$	A1
		(3)
(c)	$\frac{(t+t-30)22}{2}=990$	M1 A1
	$t=60$	A1
	Answer $=60-10=50$	A1
		(4)
(d)	$990=0.5a50^2$	M1
	$a=0.79$, 0.792, 99/125 oe	A1
		(2)
		[11]
Notes for Question 5		
Q5(a)	First B1 for a trapezium starting at the origin and ending on the *t*-axis. Second B1 for the figures marked (allow missing 0 and a delineator oe for *T*) (allow if they have used $T=75$ correctly on their graph)	
Q5(b)	First M1 for producing an equation in their *T only* by equating the area of the trapezium to 2145, with the correct no. of terms. If using a single trapezium, we need to see evidence of using ½ the sum of the two parallel sides or if using triangle(s), need to see ½ base x height. Second A1 cao for a correct equation in *T* (This is not f.t. on their *T*) Third A1 for $T=75$. N.B. Use of a single *suvat* equation for the whole motion of the car e.g. $s=t(u+v)/2$ is M0	
Q5(c)	First M1 for producing an equation in *t only* (they may use $(t-30)$ oe as their variable) by equating the area of the trapezium to 990, with the correct no. of terms. If using a trapezium, we need to see evidence of using ½ the sum of the two parallel sides or if using triangle(s), need to see ½ base x height. First A1 for a correct equation. Second A1 for $t=60$ (Allow 30 + 30). Third A1 for answer of 50. N.B. Use of a single *suvat* equation for the whole motion of the car e.g. $s=t(u+v)/2$ is M0. Use of the motion of the motorcycle is M0 (insufficient information). Use of $v=22$ for the motorcycle is M0.	
Q5(d)	First M1 for an equation in *a* only. First A1 for $a=0.79$, 0.792, 99/125 oe	

Question Number	Scheme	Marks
6.		
(a)		
	M(P), $50g \times 2 = Mg \times (x-2)$	M1 A1
	M(Q), $50g \times 3 = Mg \times (12-x)$	M1 A1
(i)	$M = 25$ (kg)	**DM**1 A1
(ii)	$x = 6$ (m)	**DM**1 A1
		(8)
(b)		
	$(\uparrow) R + R = 25g + 50g$	M1 A1 **ft**
	M(A), $2R + 12R = 25g \times 6 + 50g \times AX$	M1 A1 **ft**
	$AX = 7.5$ (m)	**DM**1 A1
		(6)
		[14]

Notes for Question 6		
Q6(a)	First M1 for moments about P equation with usual rules (or moments about a different point AND vertical resolution and R then eliminated) (M0 if non-zero reaction at Q) Second M1 for moments about Q equation with usual rules (or moments about a different point AND vertical resolution) (M0 if non-zero reaction at P) Second A1 for a correct equation in M and same unknown. Third M1, dependent on first and second M marks, for solving for M Third A1 for 25 (kg) Fourth M1, dependent on first and second M marks, for solving for x Fourth A1 for 6 (m) N.B. No marks available if rod is assumed to be uniform but can score max 5/6 in part (b), provided they have found values for M and x to f.t. on. If they have just invented values for M and x in part (a), they can score the M marks in part (b) but not the A marks.	
Q6(b)	First M1 for vertical resolution or a moments equation, with usual rules. First A1 **ft** on their M and x from part (a), for a correct equation. (must have *equal reactions* in vertical resolution to earn this mark) Second M1 for a moments equation with usual rules. Second A1 **ft** on their M and x from part (a), for a correct equation in R and same unknown length. Third M1, dependent on first and second M marks, for solving for AX *(not their unknown length)* with $AX \leq 15$ Third A1 for $AX = 7.5$ (m) N.B. If a single equation is used (see below), equating the sum of the moments of the child and the weight about P to the sum of the moments of the child and the weight about Q, this can score M2 A2 **ft** on their M and x from part (a), provided the equation is in one unknown. Any method error, loses both M marks. e.g. $25g.4 + 50g(x - 2) = 25g.6 + 50g(12 - x)$ oe.	

Question Number	Scheme	Marks
7.		
(a)	$t = 0$ gives $\mathbf{v} = \mathbf{i} - 3\mathbf{j}$	B1
	speed $= \sqrt{1^2 + (-3)^2}$	M1
	$= \sqrt{10} = 3.2$ or better	A1
		(3)
(b)	$t = 2$ gives $\mathbf{v} = (-3\mathbf{i} + 3\mathbf{j})$	M1
	Bearing is 315°	A1
		(2)
(c)(i)	$1 - 2t = 0 \Rightarrow t = 0.5$	M1 A1
(ii)	$-(3t - 3) = -3(1 - 2t)$	M1 A1
	Solving for t	**DM**1
	t = 2/3, 0.67 or better	A1
		(6)
		[11]
Notes for Question 7		
Q7(a)	B1 for **i** – 3**j.** M1 for √ (sum of squares of cpt.s) A1 for √10, 3.2 or better	
Q7(b)	M1 for clear attempt to sub $t = 2$ into given expression. A1 for 315.	
Q7(c)	**(i)** First M1 for $1 - 2t = 0$. First A1 for $t = 0.5$. N.B. If they offer two solutions, by equating both the **i** and **j** components to zero, give M0. **(ii)** First M1 for $\frac{1-2t}{3t-3} = \pm(\frac{-1}{-3})$ o.e. (Must be an equation in t *only*) First A1 for a correct equation (the + sign) Second M1, dependent on first M1, for solving for t. Second A1 for 2/3, 0.67 or better.	

Question Number	Scheme	Marks
8.		
(a)	For A, $T = 2ma$	B1
	For B, $3mg - T = 3ma$	M1 A1
	$3mg = 5ma$	**DM**1
	$\frac{3g}{5} = a$ (5.9 or 5.88 m s^{-2})	A1
		(5)
(b)	$T = 6mg/5$; $12m$; $11.8m$	B1
		(1)
(c)	$F = \sqrt{T^2 + T^2}$	M1 A1 **ft**
	$F = \frac{6mg\sqrt{2}}{5}$;$1.7mg$ (or better);$16.6m$;$17m$	A1
	Direction clearly marked on a diagram, with an arrow, and 45^o (oe) marked	B1
		(4)
		[10]
Notes for Question 8		
Q8(a)	B1 for $T = 2ma$ First M1 for resolving vertically (up or down) for B, with correct no. of terms. (allow omission of m, provided 3 is there) First A1 for a correct equation. Second M1, dependent on first M1, for eliminating T, to give an equation in a only. Second A1 for 0.6g, 5.88 or 5.9. N.B. 'Whole system' equation: $3mg = 5ma$ earns first 4 marks but any error loses all 4.	
Q8(b)	B1 for $\frac{6mg}{5}$, $11.8m$, $12m$	
Q8(c)	M1 $\sqrt{(T^2 + T^2)}$ or $\frac{T}{\sin 45^o}$ or $\frac{T}{\cos 45^o}$ or $2T\cos 45^o$ or $2T\sin 45^o$ (allow if m omitted) (M0 for $T \sin 45^o$) First A1 ft on their T. Second A1 cao for $\frac{6mg\sqrt{2}}{5}$ oe, $1.7mg$ (or better),$16.6m$,$17m$ B1 for the direction clearly shown on a diagram with an arrow and 45^o marked.	

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