Pearson

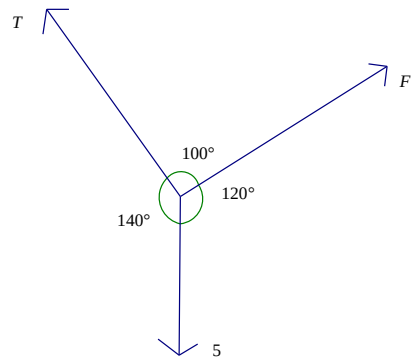
Mark Scheme (Results)

Summer 2017

Pearson Edexcel International A Level
In Mechanics (WME01) Paper 1

edexcel

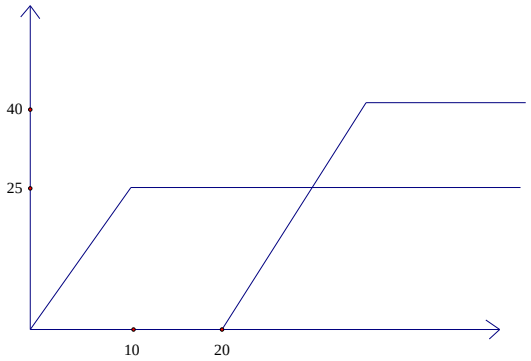
June 2017 Standardisation
WME01 Mechanics M1
Mark Scheme

Question	Scheme	Marks	Notes
1.	Vertically: $T\cos 40 + F\cos 60 = 5$	M1	First equation seen for resolution of forces. No missing/additional terms Condone sin/cos confusion and sign error(s) 5*g* in place of 5 is an accuracy error *T* must link with 40 or 50 and *F* with 60 or 30
		A1	Correct equation
	Horizontally: $T\cos 50 = F\cos 30$	M1	Second equation seen for resolution of forces No missing/additional terms Condone sin/cos confusion and sign error(s) 5*g* in place of 5 is an accuracy error *T* must link with 40 or 50 and *F* with 60 or 30
		A1	Correct equation
	Perpendicular to line of *F*: $T\cos 10 = 5\cos 30$		
	Perpendicular to line of *T*: $F\cos 10 = 5\cos 50$		
	Solve for T or F	dM1	Dependent on using equation(s) that scored M mark(s)
	$T = 4.3969..$ N = 4.4 N (or better)	A1	One correct
	$F = 3.263....$ = 3.3 N(or better)	A1	Both correct
		[7]	
1 alt			Solution using Lami's theorem Or a triangle of forces
	$\frac{5}{\sin 100} = \frac{F}{\sin 140} = \frac{T}{\sin 120}$	M1	One pair including $\frac{5}{\sin 100}$ or $\frac{5}{\sin 80}$ Incorrect pairing of forces and angles is M0
		A1	Two fractions correct
		M1	Second pair of fractions
		A1	All correct
	Solve for T or F	dM1	Dependent on using equation(s) that scored M mark(s)
	$T = 4.3969..$ N = 4.4 N (or better)	A1	One correct
	$F = 3.263....$ = 3.3 N(or better)	A1	Both correct

Question	Scheme	Marks	Notes
2.(a)	M(C) $140(a-2)+30(2a-2)=120$ x 4 M(G) $50(a-2)+30a=120(6-a)$ M(D) $4\times50+30(2a-6)=140(6-a)$ M(B) $140a=120(a-6)+50(2a-2)$ M(A) $50\times2+120\times6=140a+30\times2a$	M1	Moments or alternative complete method to form an equation in a only. Dimensionally correct. Condone sign error(s) No missing/additional terms Condone a common factor of g
		A1	At most one error
	$(200a=820)$	A1	Correct unsimplified equation in a
	$a=4.1$	A1	
		(4)	
(b)	$(\uparrow),\ (2R=170 \Rightarrow) R=85$	B1	Or a correct second moments equation in their a to achieve 2 equations in 2 unknowns
	M(A) $85\times2+85\times x = 140\times a+30\times2a$ M(C) $85(x-2)=140\times(a-2)+(2a-2)\times30$ M(G) $85\times(a-2)+30\times a=85(x-a)$ M(E) $30(2a-x)+85(x-2)=140(x-a)$ M(B) $85\times(2a-2)+85(2a-x)=140\times a$	M1	Moments equation with equal reactions in a or their a. Dimensionally correct. No missing/additional terms. Condone sign error(s) Accept alternative complete method to form an equation in a different horizontal distance to E Condone incorrect R, $R\neq120, R\neq50$ Condone a common factor of g
		A1ft	At most one error Follow their a and their $R\neq120, R\neq50$
		A1ft	Correct unsimplified equation in AE Follow their a and their $R\neq120, R\neq50$
	$AE=\frac{130}{17}$ m (7.6 m or better)	A1	
			If they find a different x, e.g. $CE=5.6$ and go no further, they score 4/5.
		(5)	
		[9]	
			A candidate who has a common factor of g throughout can score 8/9

Question	Scheme	Marks	Notes
3.(a)	$4.2 = 0.5(v - -4)$	M1	Impulse/ momentum equation Must be using $I = \pm(mv - mu)$ Inclusion of g is M0
		A1	Correct unsimplified equation
	$v = 4.4 \text{ ms}^{-1}$	A1	Must be positive - the question asks for the speed.
		(3)	
(b)	$2 - 2m = -\frac{1}{2}v \pm m$	M1	Conservation of momentum. No missing/additional terms. Condone sign errors. Dimensionally correct. Follow their v Condone a common factor of g throughout
		A1ft	Correct equation for one solution. Follow their v
		A1ft	Correct unsimplified equation(s) for both possible solutions. Follow their v
	$m = 1.4$ or 4.2	A1	Need both
		OR	
	$4.2 = m(\pm 1 - -2)$	M1	Impulse on Q. Dimensionally correct. Condone sign errors
		A1	Correct equation for one solution
		A1	Correct unsimplified equation for both possible solutions
	$m = 1.4$ or 4.2	A1	Need both
		(4)	
		[7]	

Question	Scheme	Marks	Notes
4(a)	$I = 0.2(7--10)$	M1	Impulse momentum equation. Dimensionally correct. Must be using $\pm(mv-mu)$
	$= 3.4$ N s	A1	
		(2)	
(b)	$0 = 7^2 - 2gH$	M1	Complete method to find max ht Must be using 7 ($u = 10$ is M0)
	$H = 2.5$ m	A1	Must be positive
		(2)	
(c)	$1 = 7t - 4.9t^2$	M1	Complete method to form an equation in t (using 7)
	$4.9t^2 - 7t + 1 = 0$	A1	Or equivalent
	$t = \dfrac{7 \pm \sqrt{49 - 19.6}}{9.8}$	dM1	Solve for t (sight of either root $\Rightarrow$ M1) Dependent on previous M1
	$= 0.16$ s or 0.161 s	A1	Final answer (do not ISW) Max 3 s.f.
		(4)	
(c) alt	$v^2 = 49 - 2g$	M1	Find speed when 1 m up and use of *suvat* to find t
	$v = \sqrt{\dfrac{147}{5}} = 7 - gt$	A1	or equivalent
		dM1	Solve for t Dependent on previous M1
	$t = 0.16$ s or 0.161 s	A1	Final answer (do not ISW) Max 3 s.f.
		(4)	
		[8]	

Question	Scheme	Marks	Notes
5. (a)		B1 B1 B1	One graph correct shape Both graphs correct shape, on same sketch and intersecting (with different start times) Figs 10,20,25,40 shown (with 20 as the second start time) Ignore all vertical lines
		(3)	
(b)	20 + 10	M1	Complete method
	= 30	A1	
		(2)	
(c)	$\frac{40}{t_1 - 20} = \frac{25}{10}$	M1	Complete method to find time when Q reaches 40 m s^{-1}
		A1	Correct unsimplified equation
	$\Rightarrow t_1 = 36$	A1	
Or:	Time to reach 40 m s^{-1} is $\frac{40}{2.5}(=16)$ (M1A1)		
	Time from start $= \frac{40}{2.5} + 20 = 36$ (A1)		(seen or implied)
		M1	Find distance travelled by either train at $t = T$
	$\frac{(T + T - 10)}{2} \times 25$	A1	One correct
	$\frac{(T - 20 + T - 36)}{2} \times 40$	A1ft	Both correct. Follow their 36
	Equate and solve for T	dM1	
	$T = 66\frac{1}{3}$	A1	Accept 66 or better
		(8)	
		13	

Question	Scheme	Marks	Notes
6. (a)	$\mathbf{v} = (10\mathbf{i} + 4\mathbf{j}) + 6(-2\mathbf{i} + 3\mathbf{j})$	M1	Use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$ with $t = 6$
	$= -2\mathbf{i} + 22\mathbf{j}$	A1	
	$\tan\theta = \pm\frac{22}{2}$ or $\tan\theta = \pm\frac{2}{22}$	M1	Correct use of trig to find a relevant angle for their **v**
	$\theta = 85^\circ$ or $5°$	A1	Seen or implied
	bearing is 355°	A1	
		(5)	
(b)	$\mathbf{v} = (10\mathbf{i} + 4\mathbf{j}) + t(-2\mathbf{i} + 3\mathbf{j})$	M1	Use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$
	$\left(= (10 - 2t)\mathbf{i} + (4 + 3t)\mathbf{j}\right)$	A1	Correct unsimplified
	$(10 - 2t) = (4 + 3t)$	DM1	Equate coefficients to give equation in t only
	$t = 1.2$	A1	
		(4)	
		[9]	

Question	Scheme	Marks	Notes
7(a)	$\lvert\mathbf{R}\rvert^2 = 8^2 + 5^2 - 2 \times 8 \times 5\cos 130^o$	M1	Use of cosine rule
		A1	At most one error e.g. 50 in place of 130
		A1	Correct unsimplified.
	$\lvert\mathbf{R}\rvert = 11.9$ N (3 SF)	A1	12 or better
		(4)	
7a alt	$\lvert\mathbf{R}\rvert^2 = (5+8\cos 50°)^2 + (8\sin 50°)^2$	M1	Use of Pythagoras (with usual rules for resolved components)
	$(= 10.14^2 + 6.13^2)$	A1	At most one error
		A1	Correct unsimplified.
	$\lvert\mathbf{R}\rvert = 11.9$ N (3 SF)	A1	
		(4)	
(b)	$\frac{\sin\theta}{5} = \frac{\sin 130}{11.85}$	M1	Independent M1. Use of sine rule or cosine rule with their $\lvert\mathbf{R}\rvert$
		A1ft	Follow their $\lvert\mathbf{R}\rvert$
	$\sin\theta = \frac{\sin 130}{11.85}$	DM1	Solve for θ
	$\theta = 19^o$	A1	
		(4)	
7balt	$\tan\alpha = \frac{8\sin 50°}{5+8\cos 50°}$	M1	Independent M1 Correct use of trig to find direction of **R** Or use cosine rule to find α
	$(\alpha = 31.1...°)$	A1ft	Correct unsimplified. Follow their components
	$\theta = 50° - \alpha$	DM1	Use their α to solve for θ
	$\theta = 19^o$	A1	
			Alternatively, find $\beta = 58.8....$ and use $\theta = \beta - 40$
		(4)	
		[8]	

Question	Scheme	Marks	Notes
8. (a)			
	$R = mg$	B1	Resolve vertically at Q
	$F = \frac{1}{2}R$	B1	Use of $F = \mu R$
	$T - F = ma$	M1	Equation of motion for Q No missing/additional terms Condone sign error(s)
		A1	
	$2mg\sin\alpha - T = 2ma$	M1	Equation of motion for P No missing/additional terms Condone sign error(s) and sin/cos confusion
		A1	
(i)		dM1	Solve for a or T Dependent on 2 correct equations (one of which could be for the whole system)
	$a = \frac{7g}{30} = 2.3$ or $2.29\ \text{ms}^{-2}$	A1	a or T correct
(ii)	$T = \frac{7mg}{30} + \frac{mg}{2}$	dM1	Solve for second unknown Dependent on 2 correct equations (one of which could be for the whole system)
	$= \frac{11mg}{15}$	A1 (10)	Both correct Accept $T = 7.2m$ or better
(b)	$a = 0 \Rightarrow 2mg\sin\alpha - T = 0$	M1	Use equation of motion of P to find T.
	$\Rightarrow T = \frac{6mg}{5}$	A1	$(11.76m)$
	$\mu mg \geq \frac{6mg}{5}$	dM1	For Q, $T \leq \mu R$. Dependent on preceding M Condone use of $T = \mu R$
	Least value is 1.2	A1 (4)	
(b) alt	$2mg\sin\alpha - \mu R = 0$	M1A1	Using the combined equation
	$\frac{6}{5}mg = \mu mg$	M1	Substitute for trig and R and solve
	Least value is 1.2	A1 (4)	
		[14]	

Mark Scheme (Results)

Summer 2017

Pearson Edexcel International A Level
In Mechanics M2 (WME02) Paper 1

Question Number	Scheme	Marks
1	Impulse-momentum principle: $(7\mathbf{i}-5\mathbf{j})=4\mathbf{v}-4(2\mathbf{i}+3\mathbf{j})$	M1A1
	$\left(\mathbf{v}=\frac{15}{4}\mathbf{i}+\frac{7}{4}\mathbf{j}\right)$	A1
	$\lvert\mathbf{v}\rvert=\frac{1}{4}\sqrt{15^2+7^2}$	M1
	$=\frac{1}{4}\sqrt{274}=4.1\,(\text{m s}^{-1})$ (or better)	A1 cso
		(5)
		[5]
	Notes	
	First M1 for use of Impulse-Momentum principle, dim correct, correct no. of terms and must be a *difference* of momenta. First A1 for a correct equation Second A1 for correct velocity vector Second M1 for attempt to find magnitude of their **v** Third A1 cso for an exact answer or 4.1 or better	
2a	Use of $P = Fv$: $280 = F \times 2$ oe	M1
	Equation of motion: $F-75g\sin\theta=R$	M1 A1
	$140-75\times9.8\times\frac{1}{21}=R$	
	$R=105$ (or 110)	A1
		(4)
	Notes	
	First M1 for $280 = F \times 2$ oe Second M1 for resolving parallel to the plane with $a = 0$ with usual rules	
	First A1 for a correct equation as shown	
	Second A1 for 105 or 110	
2b	Equation of motion: $75g\sin\theta+\frac{280}{3.5}-60=75a$ or $-75a$	M1A2
	$a=0.73$ (m s^{-2}) (0.733) or – 0.73 (- 0.733)	A1
		(4)
		[8]
	Notes	
	First M1 for resolving parallel to the plane with $a \neq 0$ with usual rules First A1and Second A1 for a correct equation. Deduct 1 mark for each incorrect term. (A1A0 or A0A0) (Use of 280/2 is an A error) Third A1 for 0.73 or 0.733 (allow negative answers)	
3a	Integrate: $v=\int(4t-8)\,\mathrm{d}t=2t^2-8t\,(+C)$	M1

Question Number	Scheme	Marks
	Use $t=0, v=6$: $v=2t^2-8t+6$	M1A1
	Use factor theorem or factorise: $v=2(t-1)(t-3)$ $\Rightarrow$ at rest for $t=1$	M1
	Second value $t=3$	A1
	Alternative: verify that $v=0$ when $t=1$ then find second solution.	(5)
	Notes	
	First M1 for attempt to integrate, at least one power increasing Second M1 for using initial conditions to find an expression for *v* First A1 for a correct expression for *v* Third M1 for showing that *v* = 0 when *t* = 1 Second A1 for *t* =3 **(N.B. this is actually B1 mark)** *but must come from a correct v.*	
3b	Integrate to find distance: $s=\int v\mathrm{d}t=\frac{2}{3}t^3-4t^2+Ct$ Follow their $C\neq 0$	M1**A1 ft**
	Correct strategy: $\left\lvert\left[\frac{2}{3}t^3-4t^2+Ct\right]_1^3\right\rvert+\left[\frac{2}{3}t^3-4t^2+Ct\right]_3^4$	M1
	$-\left(0-\frac{8}{3}\right)+\left(\frac{8}{3}-0\right)=\frac{16}{3}$ (m) (5.33)	A1 (4)
	Notes	
	First M1 for attempt to integrate their *v* (M0 if they integrate a multiple of their *v*), at least one power increasing First A1 ft on their *v* (but must include a non-zero *C*) Second M1 (independent) for a complete method to find the total distance Second A1 for 16/3 or 5.3 or better **N.B.** If they consider $0 < t < 4$ instead of $1 < t < 4$, then treat as a MR and they can score the second M1, if they use a correct strategy for (0,4).	

Question Number	Scheme	Marks
4a	Moments about A: $0.5\times 2g + 2\times 5g\,(=11g) = T\cos\theta \times 4 = T\times\frac{3}{5}\times 4$	M1A2
	$T = 11g\times\frac{5}{12} = \frac{55}{12}g = 44.9$ (45) (N)	A1 (4)
	Notes	
	N.B. If all g's are missing, mark as a MR. M1 for M(A), with usual rules First A1 and second A1 for a correct equation in T only i.e. must be using a correct angle (but value of trig ratio not needed at this stage) Deduct 1 mark for each incorrect term. (A1A0 or A0A0) Third A1 for 45 or 44.9 (N) (A0 for 45.0)	
4b	Resolving: $\leftrightarrow H = T\sin\theta$ **OR** M(D), $H\times 3 = 2g\times 0.5 + 5g\times 2$	M1
	$\updownarrow T\cos\theta + V = 7g$ **OR** M(B), $V\times 4 = 2g\times 3.5 + 5g\times 2$	M1A1
	Pythagoras: $\lvert R\rvert = \sqrt{41.65^2 + 35.93^2} = 55.0$ (55) (N)	M1A1 (5)
	Notes	
	First M1 for resolving horizontally or M(D) with usual rules to give equation in T only. (T does not need to be substituted) Second M1 for resolving vertically or M(B) with usual rules First A1 for a correct equation in T only. (T does not need to be substituted) Third M1 (independent but must have found 2 components) for squaring, adding and rooting their 2 components Second A1 for 55 or 55.0	
4c	Use of $F \le F_{\max} = \mu R$: $V \le \mu H$ (Must have found H and V)	M1
	μ $\frac{V}{H} = \frac{41.65}{35.93..} = \frac{51}{44}$, 1.2 or better.	A1 (2)
	Notes	
	M1 for use of $V \le \mu H$ M0 for use of $V = H$ or $V < H$ μ $\frac{V}{H} = \frac{51}{44}$ Allow fraction (since g cancels) or 1.2 or better	