Mark Scheme (Results)

January 2019

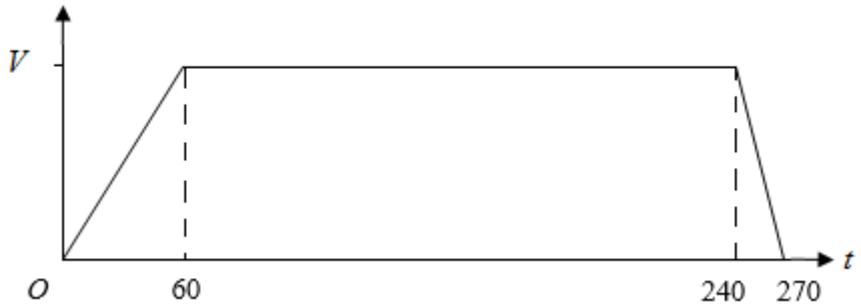
Pearson Edexcel International Advanced Level In Mechanics M1 (WME01/01)

Question Number	Scheme	Marks
2(a)	$\tan\theta = \frac{6}{7}$ $\theta = 40.60°...$ Bearing is $360° - 40.60° = 319°$ nearest degree	M1 A1 A1 (3)
(b)	$\mathbf{r}_A = (20\mathbf{i} - 17\mathbf{j}) + 4(-6\mathbf{i} + 7\mathbf{j}) = (-4\mathbf{i} + 11\mathbf{j})$ $\mathbf{r}_B = (-8\mathbf{i} + 9\mathbf{j}) + 4(p\mathbf{i} + 2p\mathbf{j}) = (-8 + 4p)\mathbf{i} + (9 + 8p)\mathbf{j}$ $\mathbf{r}_A - \mathbf{r}_B = (4 - 4p)\mathbf{i} + (2 - 8p)\mathbf{j}$ $-8 + 4p - -4 = 9 + 8p - 11$ $p = -0.5$ $\mathbf{v}_B = (-0.5\mathbf{i} - \mathbf{j})$ $\lvert\mathbf{v}_B\rvert = \sqrt{(-0.5)^2 + (-1)^2}$ $= \frac{\sqrt{5}}{2} = 1.1 \text{ ms}^{-1}$ or better	M1 A1 A1 **DM**1 M1 A1 A1 M1 M1 A1 (10) **13**
	Notes	
2(a)	M1 for any trig ratio using 6 and 7: $\tan\theta = \pm\frac{6}{7}$ or $\pm\frac{7}{6}$: $\sin\theta$ or $\cos\theta = \pm\frac{6}{\sqrt{6^2+7^2}}$ or $\pm\frac{7}{\sqrt{6^2+7^2}}$	
	A1 for a correct angle from their *correct* equation e.g. 49°, 41°, 139°, 131°,….	
	A1 for 319° cao	
2(b)	First M1 for attempt at use of $\mathbf{r}_4 = \mathbf{r}_0 + 4\mathbf{v}$ for either *A* or *B*	
	First A1 for $(-4\mathbf{i} + 11\mathbf{j})$ **i**'s and **j**'s must be collected at some stage	
	Second A1 for $(-8 + 4p)\mathbf{i} + (9 + 8p)\mathbf{j}$ **i**'s and **j**'s must be collected at some stage	
	Second **DM**1, dependent on first M1, for finding the difference between their two $\mathbf{r}_4$ vectors (must be an attempt to subtract both **i** and **j** components)	
	Third M1 for equating the **i** cpt and **j** cpt of their difference (M0 if no difference) to give an equation in *p only*. oe e.g. $\frac{(4-4p)}{(2-8p)} = \frac{(-)1}{(-)1}$	
	Third A1 for a correct equation in *p* only	
	Fourth A1 for a correct value of *p*	
	Fourth M1 for using their *p* value to obtain a velocity vector for *B*	
	Fifth M1 for finding the magnitude of their $\mathbf{v}_B$ (**N.B.** This M mark is available, even if their $\mathbf{v}_B$ does not have the correct form)	
	Fifth A1 for $\frac{\sqrt{5}}{2}$ oe or 1.1 or better	

Question Number	Scheme	Marks
3(a)	$560 - mg = 1.4m$	M1 A1 (2)
(b)	$2800 - Mg - 560 = 1.4M$	M1 A1 (2)
(c) (i)	$560 = 11.2m$	**DM**1
	$m = 50$	A1
(ii)	$2240 = 11.2M$	A1 (3) **7**
	$M = 200$	
	Notes	
(a)	M1 for equation of motion for the person only, with usual rules, condone sign errors, and with at least one value (560 or 1.4) substituted. *Credit given for this equation only if it appears in (a).*	
	A1 for a correct equation	
(b)	M1 for equation of motion for the lift only, with usual rules, condone sign errors, and with at least one value (2800, 560 or 1.4) substituted. *Credit given for this equation only if it appears in (b).*	
	A1 for a correct equation	
(c)	**Hence**: DM1, dependent on appropriate previous M mark, for solving one of their equations, wherever it appears, for either *m* or *M* **Otherwise**: DM1, dependent on appropriate previous M mark, for solving one of their equations and/or the whole system equation, wherever they appear, for either *m* or *M* **N.B.** There are no marks available for the whole system equation	
	First A1 for $m = 50$	
	Second A1 for $M = 200$	

Question Number	Scheme	Marks
4(a)	$M(R),\ 40g(x-3)+2.5g\times 2=30g\times 0.5$ $x=3.25$ m from P	M1 A2 A1 (4)
(b)	Mass of the box is concentrated at the point Q oe	B1 (1)
(c)	$M(R),\ 3Mg\ +\ 30g\times 0.5=2.5g\times 2+40g\times 2$ $M=\frac{70}{3}$, 23 or better	M1 A2 A1 (4) **9**
	Notes	
4(a)	M1 for moments about *R* to give an equation in *x* (or another unknown distance) *only* (i.e. M0 if reaction at *P* is non-zero) Correct no. of terms, dimensionally correct	
	A2 for a correct equation in *x only* (allow consistent omission of *g*) -1 each error	
	Alternative: Instead of $M(R)$, they may write down 2 equations and eliminate the normal reaction at *R*, N_R, to obtain an equation in a distance *only* : Possible equations: $(\uparrow)N_R=40g+30g+2.5g$ $M(P),40gx+30g\times 2.5+2.5g\times 5=3N_R$ $M(Q),40g(5-x)+30g\times 2.5=2N_R$ $M(G),40g(2.5-x)+0.5N_R=2.5g\times 2.5$ Equations must have correct no. of terms and be dimensionally correct but M0 if reaction at *P* is non-zero	
	Third A1 for $\frac{13}{4}$ m oe Allow 3.3 m	
(b)	B1 for *mass* or *weigh*t of box acts at Q but B0 if extra wrong answers	
(c)	M1 for moments about *R* to give an equation in *M only* (i.e. M0 if reaction at *P* is non-zero) Correct no. of terms, dimensionally correct	
	A2 for a correct equation in *M only* (allow consistent omission of *g*) -1 each error	
	Alternative: Instead of $M(R)$, they may write down 2 equations and eliminate the normal reaction at *R*, S_R , to obtain an equation in *M only* : Possible equations: $(\uparrow)S_R=40g+30g+2.5g+Mg$ $M(P),42.5g\times 5+30g\times 2.5=3S_R$ $M(Q),Mg\times 5+30g\times 2.5=2S_R$ $M(G),Mg\times 2.5+0.5S_R=42.5g\times 2.5$ Equations must have correct no. of terms and be dimensionally correct but M0 if reaction at *P* is non-zero	
	Third A1 for $\frac{70}{3}$ oe or 23 or better Accept 24	

Question Number	Scheme	Marks
5.	$PM = 3.5 - 2\tan 45^o = 1.5$ OR $PB = \sqrt{3.5^2 + (\frac{2}{\sin 45})^2 - 2\times 3.5\times(\frac{2}{\sin 45})\cos 45^o} = 2.5$	M1
	$\tan\alpha = \frac{1.5}{2}; \cos\alpha = \frac{4}{5}; \sin\alpha = \frac{3}{5}$	A1
	OR $\alpha = 37^o$ *or* $(90^o - \alpha) = 53^o$ (at least 2SF)	
	$T_P\cos\alpha + T_Q\cos 45^o = 6g$	M1 A2 -1 ee
	$T_P\sin\alpha = T_Q\cos 45^o$	M1 A1
	$T_P = \frac{30g}{7} = 42$ N; $T_Q = 36$ or 35.6 N	**DM1** A1; A1
		10
	Notes	
	First M1 for finding the length of *PM* or *PB*	
	First A1 for a correct trig ratio for α or $(90^o - \alpha)$ or a correct value for α or $(90^o - \alpha)$ Do not penalise accuracy here if their final answers for the tensions are correct.	
	N.B. If they assume the tensions are the same , no further marks available If they think α = 30 or 60 or....., they could get all 5 resolving marks as a value of α is not required **but if α = 45, only M marks available.** However, if α and 45 are interchanged in the resolving equations - no marks available for resolving	
	Second M1 for resolving vertically with usual rules	
	Second/Third A1's for a correct equation, (α does not need to be substituted) -1 each error	
	Third M1 for resolving horizontally with usual rules	
	Fourth A1 for a correct equation (α does not need to be substituted but if it is , follow through on their value)	
	Fourth DM1, dependent on all **THREE** previous M marks, for solving for either tension	
	Fifth A1 for T_P Allow 42.0 Units not needed	
	Sixth A1 for T_Q Units not needed	
	Alternative, using Triangle of Forces/Lami's Theorem, for middle 5 marks.	
	$\frac{T_P}{\sin 45^o} = \frac{6g}{\sin(45^o + \alpha)}$ OR $\frac{T_Q}{\sin(180^o - \alpha)} = \frac{6g}{\sin(45^o + \alpha)}$	M1 A2 -1 ee
	$\frac{T_Q}{\sin(180^o - \alpha)} = \frac{6g}{\sin(45^o + \alpha)}$ OR $\frac{T_P}{\sin 45^o} = \frac{6g}{\sin(45^o + \alpha)}$ OR $\frac{T_P}{\sin 45^o} = \frac{T_Q}{\sin(180^o - \alpha)}$	M1 A1
	N.B. Treat omission of *g* as one error	

Question Number	Scheme	Marks
6(a)		B1 Shape B1 Figs. and V (2)
(b)	$4500 = \frac{(270+180)}{2}V$ OR $4500 = \frac{1}{2}60V + 180V + \frac{1}{2}30V$ $V = 20$	M1 A1 A1 (3)
(c)	$\frac{(T+T-60)}{2}\times 20 = 2250$ OR $\frac{1}{2}60.20 + (T-60).20 = 2250$ $T = 142.5$ s	M1 A2 **ft** A1 (4)
(d)	$T_1 = \frac{1}{4}\times 60$ $= 15$ $T_2 = 270 - \left(\frac{1}{4}\times 30\right)$ OR $240 + \left(\frac{3}{4}\times 30\right)$ $= 262.5$	M1 A1 M1 A1 A1 (5) **14**
	Notes	
6(a)	First B1 for a trapezium (not to scale) starting and finishing on the t-axis but B0 if solid vertical lines included	
	Second B1 for 3 figs. (60, 270 and use of 30 with a delineator or 240) and V. 270 can be implied by 3 correct delineators	
6(b)	M1 for a complete method to produce an equation, in V only, with the correct structure i.e. one trapezium or two triangles + rectangle or triangle + trapezium or trapezium + triangle or rectangle – two triangles = 4500 (allow 4.5 for the M mark) (M0 if a single *suvat* equation is used)	
	First A1 for a correct unsimplified equation	
	Second A1 for $V = 20$	
6(c)	M1 for a complete method to produce an equation, in *ONE* variable e.g. t where $t = (T - 60)$, with the correct structure i.e. one trapezium or triangle + rectangle or rectangle – triangle = 2250 (allow 2.25 for the M mark) (M0 if a single *suvat* equation is used)	
	First and second A1's for a correct unsimplified equation **ft on their 20** -1 each error	
	Third A1 for 142.5 (s) cao Accept 143.	
6(d)	First M1 for a complete method to give an equation in T_1 *only*	

	First A1 for 15 (independent of V so allow even if their V is wrong)	
	Second M1 for a complete method to give an equation in T_2 *only*	
	Second A1 for a correct equation	
	Third A1 for 262.5 (independent of V so allow even if their V is wrong) **Accept 263**	
	N.B. Accept $T_1 = 262.5$ and $T_2 = 15$	

Question Number	Scheme	Marks
7(a)	For B, $S = 3mg\cos\alpha$ For B, $3mg\sin\alpha - T - F_1 = 3ma$ For A, $R = mg$ For A, $T - F_2 = ma$ $F_1 = \frac{1}{3}S$; $F_2 = \frac{1}{5}R$ Solving for T $T = \frac{3mg}{5}$ or $5.88m$	M1 A1 M1 A2 B1 M1 A1 M1 **DM**1 A1 (11)
(b)	Constant tension throughout the string.	B1 (1)
(c)	$R = 2T\cos\frac{(180^o - \alpha)}{2}$ $(= 2T\sin\frac{1}{2}\alpha)$ $(2T\cos 63.4^o)$ $= 2\times\frac{3mg}{5}\times\frac{\sqrt{5}}{5}$ $= \frac{6mg\sqrt{5}}{25}$ $(5.3m$ or $5.26m)$ **OR:** $R = \sqrt{(T - T\cos\alpha)^2 + (T\sin\alpha)^2}$ or $R = \sqrt{(T^2 + T^2 - 2T^2\cos\alpha}$ Substitute their expression for T (MUST be in terms of m) and a correct value of α $= \frac{6mg\sqrt{5}}{25}$ $(5.3m$ or $5.26m)$	M1 A1 DM1 A1 (4) **16** M1A1 DM1 A1
	Notes	
	N.B. Use of sin(4/5) or similar, treat as an A error but allow recovery	
7(a)	First M1 for resolving perp to the plane , with usual rules	
	First A1 for a correct equation	
	Second M1 for equation of motion parallel to the inclined plane, with usual rules	
	Second and Third A1's for a correct equation -1 each error	
	B1 cao	
	Third M1 for equation of motion horizontally, with usual rules	
	Fourth A1 for a correct equation	
	Fourth M1 for using '$F = \mu R$' correctly twice	
	Fifth DM1, dependent on all M marks, for solving for T in terms of *m only*	
	Fifth A1 cao	
	N.B. Either equation of motion can be replaced by the whole system equation: $3mg\sin\alpha - F_1 - F_2 = 4ma$ (M1A2 or M1A1 as appropriate)	
(b)	Penalise extra wrong answers	
(c)	First M1 for attempt at correct expression for R in terms of T and α with usual rules i.e. condone cos/sin confusion but must be using the correct angle (can be in terms of α)	

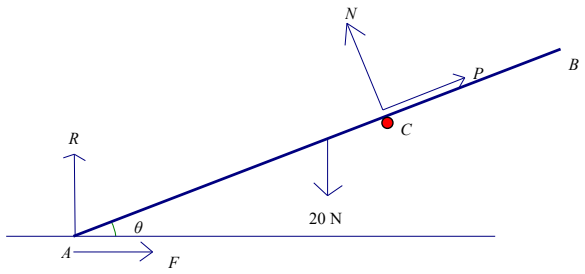
	Special Case: Allow max M1A1DM0A0 if *m* is lost from their *T* but expression for *R* is otherwise correct.	
	First A1 for a correct expression for R in terms of T and α	
	Second DM1 for substituting in their expression for T and a correct value for α but must be in terms of m	
	Second A1 for a correct answer (any equivalent surd form)	

Mark Scheme (Results)

January 2019

Pearson Edexcel International Advanced Level In Mechanics M2 (WME02/01)

Q	Scheme	Marks	Notes
5	Differentiate to find a:	M1	Powers going down
	$a = \frac{\mathrm{d}v}{\mathrm{d}t} = 3t^{\frac{1}{2}} - 6$	A1	
	Solve for $a = 0$:	M1	
	$t^{\frac{1}{2}} = 2 \Rightarrow t = 4$	A1	
	Integrate to find s: $s = \int v\mathrm{d}t$	M1	Powers going up
	$= \frac{4}{5}t^{\frac{5}{2}} - 3t^2 + 2t\,(+C)$	A1	
	Use limits 0 and their 4: $s = \frac{4}{5} \times 32 - 48 + 8 (= -14.4)$	DM1	Limits used correctly Use of 0 can be implied Dependent on the preceding M1
	Distance $= 14.4$ (m) (14 (m))	A1	Or equivalent. Positive answer required
		(8)	
		[8]	

Q	Scheme	Marks	Notes
6a			
	Moments about A:	M1	Dimensionally correct. Condone sin/cos confusion
	$2.5N = 2\cos\theta \times 20$	A1	Correct unsimplified equation
	$N = \dfrac{2\times\frac{4}{5}\times 20}{2.5} = 12.8$ (N)	A1	Accept $\frac{64}{5}$
		(3)	
6b	Resolve $\updownarrow$: $R + N\cos\theta + P\sin\theta = 20$	M1	1st equation. Dimensionally correct. Condone sin/cos confusion and sign errors
	$\left(R = 9.76 - 0.6P\right)$	A1ft	Correct unsimplified equation in N or their N
	Resolve $\leftrightarrow$: $F + P\cos\theta = N\sin\theta$	M1	2nd equation. Dimensionally correct. Condone sin/cos confusion and sign errors
	$\left(F = 7.68 - 0.8P\right)$	A1ft	Correct unsimplified equation in N or their N
	Use $F = \frac{1}{4}R$:	B1	
	Equation in P only: $7.68 - 0.8P = \frac{1}{4}(9.76 - 0.6P)$ $\left(P = 8.06....\right)$	DM1	(or eliminate P) Dependent on the preceding 2 M marks
	Solve for μ : $P = \mu N$	DM1	Dependent on the preceding M mark
	$\mu = 0.630$, (0.63)	A1	0.63 or better
		(8)	
			See over for alternatives

Q	Scheme	Marks	Notes
6b alt	Moments about C: $20\times0.5\cos\theta+F\times2.5\sin\theta=R\times2.5\cos\theta$	M1	1st equation. Dimensionally correct. Condone sin/cos confusion and sign errors
	$(40+7.5F=10R)$	A1	Correct unsimplified equation
	Resolve parallel rod:	M1	2nd equation. Dimensionally correct. Condone sin/cos confusion and sign errors
	$P+F\cos\theta+R\sin\theta=20\sin\theta(=12)$	A1	Correct unsimplified equation
	Use $F=\frac{1}{4}R$: $(8.125R=40,\quad R=4.92...)$	B1	
	Solve for P: $P=12-\frac{R}{4}\times\frac{4}{5}-R\times\frac{3}{5}=12-\frac{4}{5}R=8.06...$	DM1	Dependent on the preceding 2 M marks
	Solve for μ : $P=\mu N$,	DM1	Dependent on the preceding M mark
	$\mu=0.630\quad(0.63)$	A1	
		(8)	
6alt	If the use of moments about C is part of the solution to (a)		
	Moments about C and use : $20\times0.5\cos\theta+F\times2.5\sin\theta=R\times2.5\cos\theta$	M1	From (b) Dimensionally correct. Condone sin/cos confusion and sign errors
	Use of $F=\frac{1}{4}R$	B1	From (b)
	$R=\frac{64}{13},\quad(R=4.92...)$	A1	From (b)
	Resolve perpendicular to the rod:	M1	*From (a)
	$N+R\cos\theta=\mu R\sin\theta+W\cos\theta$	A1	From (a) Correct unsimplified equation
	$N=12.8\quad(\text{N})$	A1	From (a)
	Resolve parallel rod:	M1	*Dimensionally correct. Condone sin/cos confusion and sign errors
	$P+F\cos\theta+R\sin\theta=20\sin\theta(=12)$	A1	Correct unsimplified equation
	Solve for P: $P=12-\frac{R}{4}\times\frac{4}{5}-R\times\frac{3}{5}=12-\frac{4}{5}R=8.06...$	DM1	
	Solve for μ : $P=\mu N$,	DM1	
	$\mu=0.630\quad(0.63)$	A1	
			* could use an alternative pair of resolutions
		[11]	