

Mark Scheme (Results)

January 2019

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

Question Number	Scheme	Marks
2(a)		
	$\tan \theta = \frac{6}{7}$	M1
	$\theta = 40.60^{\circ}$	A1
	Bearing is $360^{\circ} - 40.60^{\circ} = 319^{\circ}$ nearest degree	A1 (3)
(b)	$\mathbf{r}_{A} = (20\mathbf{i} - 17\mathbf{j}) + 4(-6\mathbf{i} + 7\mathbf{j}) = (-4\mathbf{i} + 11\mathbf{j})$	M1 A1
	$\mathbf{r}_{B} = (-8\mathbf{i}+9\mathbf{j}) + 4(p\mathbf{i}+2p\mathbf{j}) = (-8+4p)\mathbf{i} + (9+8p)\mathbf{j}$	A 1
	$\mathbf{r}_{A} - \mathbf{r}_{B} = (4 - 4p)\mathbf{i} + (2 - 8p)\mathbf{j}$	DM1
	-8+4p4=9+8p-11	M1 A1
	p = -0.5	A1
	$\mathbf{v}_{B} = (-0.5\mathbf{i} - \mathbf{j})$	M1
	$ \mathbf{v}_{B} = \sqrt{(-0.5)^{2} + (-1)^{2}}$	M1
	$\sqrt{5}$	A.1 (10)
	$=\frac{1}{2}=1.1 \text{ ms}^{-1}$ or better	AI (10) 13
	Notes	
2(a)	M1 for any trig ratio using 6 and 7: $\tan \theta = \pm \frac{6}{7} \text{ or } \pm \frac{7}{6} : \sin \theta \text{ or } \cos \theta = \pm \frac{6}{\sqrt{6^2 + 7^2}} \text{ or } \pm \frac{7}{\sqrt{6^2 + 7^2}}$	
	A1 for a correct angle from their <i>correct</i> 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 $(-4i + 11j)$ i's and j's must be collected at some stage	
	Second A1 for $(-8+4p)\mathbf{i} + (9+8p)\mathbf{j}$ is and j's must be collected at some stage	
	r vectors (must be an attempt to subtract both i and i components)	
	Third M1 for equating the i cpt and i cpt of their difference (M0 if no difference) to give	
	an equation in <i>p</i> only. oe	
	e.g. $\frac{(4-4p)}{(2-8p)} = \frac{(-)1}{(-)1}$	
	$\frac{(2-6p)}{(-)1}$ Third A1 for a correct equation in <i>p</i> only	
	Fourth A1 for a correct value of p	
	Fourth M1 for using their <i>p</i> value to obtain a velocity vector for <i>B</i>	
	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 $\frac{\sqrt{5}}{2}$ or 1.1 or better	

Question Number	Scheme	Marks			
3 (a)	560 - mg = 1.4m	M1 A1 (2)			
(b)	2800 - Mg - 560 = 1.4 M	M1 A1 (2)			
(c) (i)	560 = 11.2 m	DM 1			
	m = 50	A 1			
(ii)	2240 = 11.2 M	AI			
	M = 200	A1 (3) 7			
	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. <i>Credit given for this equation only if it appears in (a).</i>				
	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. <i>Credit given for this equation only if it appears in (b).</i>				
	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 <i>m</i> or <i>M</i> 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 <i>m</i> or <i>M</i> 				
	N.B. There are no marks available for the whole system equation First A1 for $m = 50$				
	First A1 for $M = 50$ Second A1 for $M = 200$				

Question Number	on Scheme		Marks	
4(a)	$M(R)$, $40g(x-3)+2.5g \times 2 = 30g \times 0.5$			
	x = 3.25 m from P		(4)	
(b)	Mass of the box is concentrated at the point Q oe	B1	(1)	
(c)	$M(R)$, $3Mg + 30g \times 0.5 = 2.5g \times 2 + 40g \times 2$	M1 A2		
	$M = \frac{70}{3}$, 23 or better	A1	(4) 9	
	Notes			
4(a)	M1 for moments about R to give an equation in x (or another unknown distance) <i>only</i> (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	ļ		
	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:			
	$(\uparrow)N_R = 40g + 30g + 2.5g$			
	$M(P), 40gx + 30g \times 2.5 + 2.5g \times 5 = 3N_R$			
	Possible equations: $M(Q), 40g(5-x) + 30g \times 2.5 = 2N_R$			
	$M(G), 40g(2.5-x) + 0.5N_{R} = 2.5g \times 2.5$			
	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 of Allow 3.3 m			
(b)	B1 for mass or weight 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. Mo 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 :			
	$(\uparrow)S_p = 40g + 30g + 2.5g + Mg$			
	M(P), 42.5g × 5 + 30g × 2.5 = 3S _p			
	Possible equations: $M(Q), Mg \times 5 + 30g \times 2.5 = 2S_p$			
	$M(G) M\sigma \times 25 + 0.5S_{-} = 42.5\sigma \times 25$			
	$\frac{1}{1} \frac{1}{1} \frac{1}$			
	at P is non-zero			
	Third A1 for $\frac{70}{3}$ oe or 23 or better Accept 24			

Question Number	Scheme	Marks	
5.	$PM = 3.5 - 2\tan 45^{\circ} = 1.5 \text{OR} PB = \sqrt{3.5^{2} + (\frac{2}{\sin 45})^{2} - 2 \times 3.5 \times (\frac{2}{\sin 45})\cos 45^{\circ}} = 2.5$ $\tan \alpha = \frac{1.5}{2}; \cos \alpha = \frac{4}{5}; \sin \alpha = \frac{3}{5}$ $\text{OR} \qquad \alpha = 37^{\circ} \text{or} (90^{\circ} - \alpha) = 53^{\circ} (\text{at least 2SF})$	M1 A1	
	$T_P \cos \alpha + T_O \cos 45^\circ = 6g$	M1 A2 -1 ee	
	$T_p \sin \alpha = T_o \cos 45^\circ$	M1 A1	
	$T_p = \frac{30g}{7} = 42 \text{ N}; T_Q = 36 \text{ or } 35.6 \text{ N}$	DM1 A1; A1	
		10	
	Notes		
	First M1 for finding the length of <i>PM</i> or <i>PB</i>		
	First A1 for a correct trig ratio for α or $(90^{\circ} - \alpha)$ or a correct value for α or $(90^{\circ} - \alpha)$		
	Do not penalise accuracy here if their final answers for the tensions are correct.		
	If they think $\alpha = 30$ or 60 or, they could get all 5 resolving marks as a value of α is not required but if $\alpha = 45$, 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/Inited AI'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.		
	$\frac{T_p}{\sin 45^\circ} = \frac{6g}{\sin(45^\circ + \alpha)} \qquad \text{OR} \qquad \frac{T_Q}{\sin(180^\circ - \alpha)} = \frac{6g}{\sin(45^\circ + \alpha)}$	M1 A2 -1 ee	
	$\frac{T_Q}{\sin(180^\circ - \alpha)} = \frac{6g}{\sin(45^\circ + \alpha)} \text{OR} \qquad \frac{T_P}{\sin 45^\circ} = \frac{6g}{\sin(45^\circ + \alpha)} \text{OR}$ $\frac{T_P}{\sin 45^\circ} = \frac{T_Q}{\sin(180^\circ - \alpha)}$	M1 A1	
	N.B. Treat omission of g as one error		

Question Number	n Scheme	
6(a)	*	B1 Shape
	V -	
		BI Figs. and V
		(2)
	O 60 240 270	
(b)	(270 ± 190) 1 1	
	$4500 = \frac{(270 + 180)}{2}V \qquad \text{OR} 4500 = \frac{1}{2}60V + 180V + \frac{1}{2}30V$	M1 A1
	V = 20	A1 (3)
(c)	(T+T-60) 20 2250 OP ¹ (0.20 (T (0.20 2250)	
	$\frac{2}{2} \times 20 = 2250 \text{OR} \frac{-60.20 + (T - 60).20}{2} = 2250$	M1 A2 ft
	T = 142.5 s	A1 (4)
(d)	$T = \frac{1}{2} \times 60$	M1
	$I_1 = \frac{1}{4} \times 60$	A1
	=15	
	(1) (2)	
	$T_2 = 270 - \left(\frac{1}{4} \times 30\right)$ OR $240 + \left(\frac{3}{4} \times 30\right)$	MIAI
	= 262.5	A1 (5)
	Notos	14
6(a)	First B1 for a trapezium (not to scale) starting and finishing on the <i>t</i> -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.	
	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 substantian 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 <i>ONE</i> variable e.g. t where $t = (T - 60)$, with the correct structure	
	i.e. one trapezium	
	or triangle + rectangle = 2250 (allow 2.25 for the M mark)	
	(M0 if a single <i>suvat</i> equation is used)	
	First and second A1's for a correct unsimplified equation ft on their 20 -1 each error	
	11111 A1 101 142.3 (s) cao <u>Accept 143</u> .	
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		(S
7(a)	For B , $S = 3mg \cos \alpha$	M1 A1 M1 A2	
	For <i>B</i> , $3mg\sin\alpha - T - F_1 = 3ma$	1,11 112	
	For A , $R = mg$	B1	
	For A , $T - F_2 = ma$	MI AI	
	$F_1 = \frac{1}{3}S; F_2 = \frac{1}{5}R$	M1	
	Solving for T	DM 1	
	$T = \frac{3mg}{5}$ or $5.88m$	A1	(11)
(b)	Constant tension throughout the string.	B1	(1)
(c)	$R = 2T \cos \frac{(180^\circ - \alpha)}{2}$ $(= 2T \sin \frac{1}{2} \alpha) (2T \cos 63.4^\circ)$	M1 A1	
	$= 2 \times \frac{3mg}{5} \times \frac{\sqrt{5}}{5}$	DM1	
	$=\frac{6mg\sqrt{5}}{25}$ (5.3 <i>m</i> or 5.26 <i>m</i>)	Al	(4) 16
	OR:		
	$R = \sqrt{(T - T\cos\alpha)^2 + (T\sin\alpha)^2}$ or $R = \sqrt{(T^2 + T^2 - 2T^2\cos\alpha)^2}$	M1A1	
	Substitute their expression for T (MUST be in terms of m) and a correct value of α	DM1	
	$=\frac{6mg\sqrt{5}}{25}$ (5.3 <i>m</i> or 5.26 <i>m</i>)	Al	
	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		
	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		
	3.6. Entire equation of motion can be replaced by the whole system equation: $3m\sigma \sin \alpha - F - F = 4ma$ (M142 or M141 as appropriate)		
(h)	$\begin{array}{c} \text{Sing Sin } & r_1 & r_2 - \pi m \\ \text{Penalise evtra wrong answers} \end{array}$		
(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 <i>m</i> is lost from their <i>T</i> but expression for <i>R</i>	
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 <i>m</i>	
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)

	1	1	
Q	Scheme	Marks	Notes
5	Differentiate to find <i>a</i> :	M1	Powers going down
	$a = \frac{\mathrm{d}v}{\mathrm{d}t} = 3t^{\frac{1}{2}} - 6$	Al	
	Solve for $a = 0$:	M1	
	$t^{\frac{1}{2}} = 2 \Longrightarrow t = 4$	A1	
	Integrate to find s: $s = \int v dt$	M1	Powers going up
	$=\frac{4}{5}t^{\frac{5}{2}}-3t^{2}+2t(+C)$	Al	
	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]	
		1	

Q	Scheme	Marks	Notes
6a	R C D		
	Moments about A:	M1	Dimensionally correct. Condone sin/cos confusion
	$2.5N = 2\cos\theta \times 20$	A1	Correct unsimplified equation
	$N = \frac{2 \times \frac{4}{5} \times 20}{2.5} = 12.8 $ (N)	A1	Accept $\frac{64}{5}$
		(3)	
6b	Resolve \uparrow : $R + N\cos\theta + P\sin\theta = 20$	M1	1st equation. Dimensionally correct. Condone sin/cos confusion and sign errors
	(R = 9.76 - 0.6P)	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: $7.68 - 0.8P = \frac{1}{4}(9.76 - 0.6P)$ (P = 8.06)	DM1	(or eliminate <i>P</i>) 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
		1	
		<u> </u>	

Q	Scheme	Marks	Notes
6b alt	Moments about C: $20 \times 0.5 \cos \theta + F \times 2.5 \sin \theta = R \times 2.5 \cos \theta$	M1	1 st equation. Dimensionally correct. Condone sin/cos confusion and sign errors
	(40+7.5F=10R)	A1	Correct unsimplified equation
	Resolve parallel rod:	M1	2 nd 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 $F = \frac{1}{4}R$: (8.125 R = 40, R = 4.92)	B1	
	Solve for <i>P</i> : $P = 12 - \frac{R}{4} \times \frac{4}{5} - R \times \frac{3}{5} = 12 - \frac{4}{5}R = 8.06$	DM1	Dependent on the preceding 2 M marks
	Solve for μ : $P = \mu N$,	DM1	Dependent on the preceding M mark
	$\mu = 0.630 (0.63)$	A1	
		(8)	
6alt	If the use of moments about <i>C</i> is part of the solution to (a)		
	Moments about C and use : $20 \times 0.5 \cos \theta + F \times 2.5 \sin \theta = R \times 2.5 \cos \theta$	M1	From (b) Dimensionally correct. Condone sin/cos confusion and sign errors
	Use of $F = \frac{1}{4}R$	B1	From (b)
	$R = \frac{64}{13}, (R = 4.92)$	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 (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 <i>P</i> : $P = 12 - \frac{R}{4} \times \frac{4}{5} - R \times \frac{3}{5} = 12 - \frac{4}{5}R = 8.06$	DM1	
	Solve for μ : $P = \mu N$,	DM1	
	$\mu = 0.630 (0.63)$	A1	
			* could use an alternative pair of
		[11]	resolutions