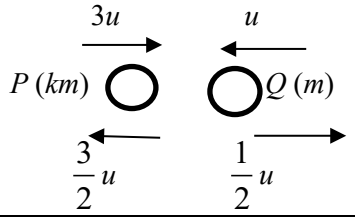
Pearson Edexcel

Mark Scheme (Results)

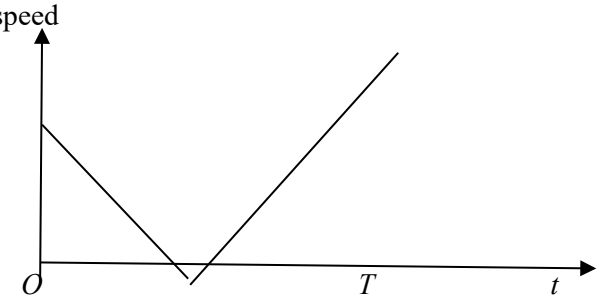
January 2022

Pearson Edexcel International A Level
In Mechanics 1 (WME01) Paper 01

Question Number	Scheme	Marks
1(a)	$F = 5\cos 30^\circ$ oe (Resolving perp to string or from triangle of forces or Lami's Theorem: $\frac{F}{\sin 120^\circ} = \frac{5}{\sin 90^\circ}$) **OR** $\frac{F\sin 30^\circ}{\sin 60^\circ}\cos 60^\circ + F\cos 30^\circ = 5$	M1 A1
	$F = \frac{5\sqrt{3}}{2}$ 4.3 or better	A1
	N.B. $F\sin 30^\circ = T\sin 60^\circ$	(3)
1(b)	$T = 5\sin 30^\circ$ oe (Resolving along string or from triangle of forces or Lami's Theorem: $\frac{T}{\sin 150^\circ} = \frac{5}{\sin 90^\circ}$) **OR** $T\cos 60^\circ + \frac{T\sin 60^\circ}{\sin 30^\circ}\cos 30^\circ = 5$	M1 A1
	$T = \frac{5}{2}$ (N)	A1
	N.B. $F\sin 30^\circ = T\sin 60^\circ$	(3)
		(6)
	Notes for question 1	
1(a)	M1 Complete method to obtain equation in F only - correct no. of terms, condone sign errors and sin/cos confusion (If they resolve horizontally and vertically, they will need to eliminate T to obtain this M mark, with the usual rules applying to each equation they use) **N.B.** If they do (b) first and find an incorrect value for T and then use that value in (a), using an equation that would earn M1, with usual rules, to find F, give M1A0A0 in (a). M0 if using wrong angles e.g. 45°	
	A1 Correct equation	
	A1 cao (4.3301..)	
1(b)	M1 Complete method to obtain equation in T only - correct no. of terms, condone sign errors and sin/cos confusion (If they resolve horizontally and vertically, they will need to eliminate F to obtain this M mark, with the usual rules applying to each equation they use) **N.B.** If they find an incorrect value for F in (a) and then use that value in (b), using an equation that would earn M1, with usual rules, to find T, give M1A0A0 in (b). M0 if using wrong angles e.g. 45°	
	A1 Correct equation	
	A1 cao	

Question Number	Scheme	Marks
2(a)		
	CLM: $km\times 3u - mu = -km\times\frac{3}{2}u + m\times\frac{1}{2}u$	M1 A1 A1
	$k = \frac{1}{3}$	A1
		(4)
2(b)	$I = m\left(\frac{1}{2}u - -u\right)$ **OR** $I = \frac{1}{3}m\left(\frac{3}{2}u - -3u\right)$	M1 A1
	$I = \frac{3}{2}mu$ must be positive	A1
		(3)
		(7)
	Notes for question 2	
2(a)	M1 Correct no. of terms, dim correct, condone sign errors but structure must be correct – allow consistently cancelled *m*'s or extra *g*'s	
	A1 Correct equation with one error	
	A1 Correct equation	
	A1 Allow 0.33 or better	
2(b)	M1 Condone sign errors but must have masses and speeds paired correctly and must be attempting a difference of momenta. Allow M1 if *k* is not substituted. M0 if *g* included	
	A1 Allow $\pm m\left(\frac{1}{2}u - -u\right)$ **OR** $\pm\frac{1}{3}m\left(\frac{3}{2}u - -3u\right)$ (no ft on *k*)	
	A1 cao Allow them to change a negative expression into a positve one	
	N.B. If they do (b) first, and obtain an impulse of magnitude *I*, then they do (a) : $I = km(\frac{3u}{2} - -3u)$, apply CLM scheme to their equation.	

Question Number	Scheme	Marks
3(a)	M(D), $mg \times 1.2 = 30g \times 0.8$	M1 A1
	Other possible equations: $(\uparrow)\ R = mg + 30g$ M(A) $2.5mg + 30g \times 4.5 = 3.7R$ M(G) $30g \times 2 = 1.2R$ M(C) $mg \times 2 = 0.8R$ M(B) $2.5mg + 30g \times 0.5 = 1.3R$	
	m = 20 (kg)	A1
	N.B. Allow an inequality if they state m = 20 (kg) at the end	(3)
3(b)	M(D), $Xg \times 3.7 + 20g \times 1.2 = 30g \times 1.3$ **N.B.** Allow inequality $\geq$…the correct way round for M1A1ft	M1A1**ft**
	Other possible equations: $(\uparrow)\ S = mg + 30g + Xg$ M(A) $2.5mg + 30g \times 5 = 3.7S$ M(G) $30g \times 2.5 = 1.2S + Xg \times 2.5$ M(B) $2.5mg + Xg \times 5 = 1.3S$ where m is their answer from (a).	
	$X = \frac{150}{37}$, 4.1 or better (4.05405…)	A1
		(3)
3(c)	The mass of the block is concentrated at a point. oe	B1
	N.B. Must mention either mass or weight and 'acting at a point' or 'concentrated at a point'.	(1)
		(7)
	Notes for question 3	
3(a)	M1 Complete method to give an equation in m only. Allow M1 if they use weight instead of mg **N.B.** If they don't use M(D), e.g. ($\uparrow$) and M(A), they will need to eliminate the reaction at D to obtain the M mark. Each equation used must have the correct no. of terms and be dimensionally correct. M0 if they don't have the reaction acting at D.	
	A1 Correct equation	
	A1 cao	
3(b)	M1 Complete method to give an equation in X only. Allow M1 if they use weight instead of Xg **N.B.** If they don't use M(D), e.g. ($\uparrow$) and M(A), they will need to eliminate the reaction at D to obtain the M mark. Each equation used must have the correct no. of terms and be dimensionally correct. M0 if they don't have the reaction acting at D.	
	A1**ft** Correct equation. Follow through on their 20	
	A1 cao	
3(c)	B1 Any equivalent statement.	

Question Number	Scheme	Marks
4(a)	$0^2 = u^2 - 2\times g\times 19.6$	M1 A1
	$-24.5 = uT - \frac{1}{2}gT^2$	M1 A1
	Produce an equation in *T only* and solve for *T*	DM1
	$T = 5$	A1
		(6)
4(b)	speed  	B1 Shape DB1 Second line longer than the first, approx. equal angles and *T* or their answer for *T* marked
		(2)
		(8)
	Notes for question 4	
4(a)	M1 Attempt at a relevant *suvat* equation which uses $s = 19.6$ (or -19.6), with correct no. of terms but condone sign errors.	
	A1 A correct equation (*g* does not need to be substituted)	
	M1 Attempt at another relevant *suvat* equation which uses 24.5 or 44.1 e.g. finding time from *B* to the ground, with correct no. of terms but condone sign errors,	
	A1 A correct equation (neither *u* nor *g* need to be substituted)	
	DM1 dependent on both M marks , for finding an equation in *T* only and solving for *T* i.e. for a complete method to find *T* **N.B**. This mark cannot be awarded if their equation has NO solutions.	
	A1 $T = 5$ **N.B.** If $g = 9.8$ has not been used, A0	
4(b)	B1 A V-shape (*and nothing else*) starting on the speed axis, with point on the *t*-axis	
	DB1 Dependent on the first B1, for approximately equal angles between the 2 lines and the *t*-axis, second line longer than the first, *T* or their *T* marked correctly. B0 if clearly unequal angles. **N.B**. If graph reflected, B0 DB0.	

Question Number	Scheme	Marks
5.	Resolve perp to the plane: $R = mg\cos\alpha$	M1A1
	Resolve parallel to the plane:	M1
	$mg\sin\alpha + F = 2P$	A1
	$mg\sin\alpha - F = P$	A1
	Use of $F = \mu R$	M1
	Substitute correctly for trig, eliminate P and F and solve for μ	M1
	$\mu = 0.25$	A1
	N.B. If they consistently omit g and obtain the correct answer, max marks are: M1A0M1A0A0M1M1A1	(8)
		(8)
	Notes for question 5	
	M1 First resolution, correct no. of terms, condone sign errors and sin/cos confusion **N.B.** If they use cos (4/5) etc, treat as an A error but allow recovery.	
	A1 Correct equation	
	M1 Second (or third) resolution, correct no. of terms, condone sign errors and sin/cos confusion **N.B.** M0 if they don't substitute for X, but full marks is possible if they use X and $2X$ oe. If they use sin (3/5) etc, treat as an A error but allow recovery.	
	A1 Correct equation (A0 if they use different R's or F's)	
	A1 Correct equation (A0 if they use different R's or F's)	
	M1 Use of $F = \mu R$	
	M1 Substitute for trig, eliminate P and F and solve for μ	
	A1 cao	
	Other possible equations:	
	$(\rightarrow) 2P\cos\alpha = R\sin\alpha + F\cos\alpha \quad (1)$	
	$(\rightarrow) \quad P\cos\alpha = R\sin\alpha - F\cos\alpha \quad (2)$	
	$(\uparrow) mg - 2P\sin\alpha = R\cos\alpha - F\sin\alpha \quad (3)$	
	$(\uparrow) mg - P\sin\alpha = R\cos\alpha + F\sin\alpha \quad (4)$	
	SC: (Only needs 2 equations)	
	Equation (1): M1A1	
	Equation (2): M1A1	
	(1) + (2): $3P\cos\alpha = 2R\sin\alpha$	
	$(1)-(2)$: $P\cos\alpha = 2F\cos\alpha$	
	Divide $\frac{1}{3} = \frac{F}{R}\cot\alpha$. A1	
	Use of $F = \mu R$ M1	
	Substitute for trig and solve for μ M1	
	$\mu = 0.25$ A1	

Question Number	Scheme	Marks
6(a)	$(p\mathbf{i} + q\mathbf{j}) + (2q\mathbf{i} + p\mathbf{j}) = 2(\mathbf{i} - \mathbf{j})$ (allow 2g)	M1
	Equating coefficients of **i** or **j**	M1
	$p + 2q = 2$	A1
	$q + p = -2$	A1
	$p = -6$; $q = 4$	A1
		(5)
6(b)	$\tan\alpha = \pm 1$; e.g. 45° or $\frac{\pi}{4}$	M1
	Angle is $135°$ or $225°$ or $\frac{3\pi}{4}$ or $\frac{5\pi}{4}$	A1
		(2)
6(c)	$\mathbf{v} = (3\mathbf{i} - 4\mathbf{j}) + T(\mathbf{i} - \mathbf{j})$	M1
	$\frac{3+T}{-4-T} = \frac{11}{-13}$	M1A1
	Solve for T	**DM**1
	$T = 2.5$	A1
		(5)
		(12)
	Notes for question 6	
6(a)	M1 Use of $\mathbf{F} = m\mathbf{a}$ with $m = 2$. Correct no. of terms and must be attempting to add the two forces.	
	M1 Must have an equation in p and q *only* (no vectors) This mark is available if m has been omitted. M0 if they use a ratio i.e. $\frac{p+2q}{2} = \frac{q+p}{-2}$ but never equate coefficients.	
	A1 A correct equation in any form	
	A1 Two correct equations in any form	
	A1 cao	
6(b)	M1 (Use of trig.) to find a relevant angle	
	A1 cao accept radians or degrees	
6(c)	M1 Use of $\mathbf{v} = \mathbf{u} + \mathbf{a}T$ to obtain a velocity vector.	
	M1 Use of ratios using *their* **v (**must be a **velocity)** to produce an equation in T (allow t) only Condone sign error but must be the correct way up.	
	A1 Correct equation	
	DM1 Dependent on previous M mark for solving for T	
	A1 cao	

Question Number	Scheme	Marks
7(a)	$T = ma$ (allow -*a*)	B1
		(1)
7(b)	$4mg\sin\alpha - T - F = 4ma$ **OR** $4mg\sin\alpha - F = 5ma$ (allow -*a*) (allow -*a*)	M1A1
	$F = \frac{1}{4}R$	B1
	$R = 4mg\cos\alpha$	M1A1
	Solve for *T* in terms of *mg* only	**D**M1
	$T = \frac{8mg}{25}$ oe	A1
		(7)
7©	$2T\sin\frac{1}{2}\alpha$ oe e.g. $\sqrt{T^2 + T^2 - 2T^2\cos\alpha}$ using cos rule Or $\frac{T\sin\alpha}{\sin(90^o - \frac{1}{2}\alpha)}$ using sine rule Or $\sqrt{(T - T\cos\alpha)^2 + (T\sin\alpha)^2}$ using components and Pythag.	M1 A1
	Substitute for *T* and trig	M1
	$\frac{8mg\sqrt{10}}{125}$ oe, $2m$ or $2.0m$ or $1.98m$ or $0.2mg$ or better	A1
		(4)
7(d)	e.g. Tension will be the same *throughout a* ***section*** of the string.	B1 (1)
		(13)
	Notes for question 7	
7(a)	B1 cao The equation must appear in (a) to earn the B1.	
7(b)	M1 Equation of motion for *P* parallel to the plane, correct no. of terms, condone sign errors and sin/cos confusion	
	A1 Correct equation	
	B1 $F = \frac{1}{4}R$ seen – could just be on the diagram	
	M1 Resolve perpendicular to the plane for *P*, correct no. of terms, condone sign errors and sin/cos confusion	
	A1 Correct equation	
	DM1 Dependent on both M marks, for solving for *T* – must be in terms of *mg only* (must be of form *kmg*)	
	A1 cao	
7©	M1 If using resolving, condone cos/sin confusion and sign errors but must have correct angle	
	A1 Any correct unsimplified expression in terms of *T* and α	
	M1 For substituting in their *T* (must be of form *kmg*) and *correct* values for their trig	
	A1 cao	
7(d)	B1 B0 for 'tension is the same throughout the string' B0 if incorrect extras	

Question Number	Scheme	Marks
8(a)	$\mathbf{r} = (13\mathbf{i} + 5\mathbf{j}) + t(3\mathbf{i} - 10\mathbf{j})$	M1 A1
		(2)
8(b)	$\mathbf{s} = (3\mathbf{i} - 5\mathbf{j}) + t(15\mathbf{i} + 14\mathbf{j})$	M1 A1
	$\overrightarrow{AB} = \mathbf{s} - \mathbf{r}$	M1
	=	
	$\overrightarrow{AB} = (12t - 10)\mathbf{i} + (24t - 10)\mathbf{j}$ km *	A1 *
		(4)
8(c)	$AB^2 = (12t - 10)^2 + (24t - 10)^2$ ($720t^2 - 720t + 200$)	M1
	Differentiate and equate to 0 **OR** Complete square **OR** **use** $t = \dfrac{-b}{2a}$	M1
	$1440t - 720 = 0$ oe $\qquad 720(t - \frac{1}{2})^2 + 20$	A1
	Solve for t $\qquad$ Use $(t - \frac{1}{2})^2 \geq 0$ $\qquad t = \dfrac{720}{2 \times 720}$	DM1
	Substitute their value of t into their AB expression	M1
	$\sqrt{20}$ oe (km) 4.5 or better	A1
	OR for last 5 marks:	
	Complete method	M1
	$720t^2 - 720t + 200 = D^2$ i.e. $720t^2 - 720t + 200 - D^2 = 0$	A1
	(For real t, $720^2 \geq 4 \times 720(200 - D^2)$	DM1
	Solve for D, ($D \geq \sqrt{20}$)	M1
	$\sqrt{20}$ oe (km) 4.5 or better	A1
		(6)
8(d)	Use $\overrightarrow{AB} = -4\mathbf{i} + 2\mathbf{j}$ at $t = \frac{1}{2}$ to obtain a relevant angle e.g. 26.56°.. Allow e.g. $\tan\alpha$ = ½ or $\tan^{-1}\dfrac{1}{2}$	M1
	Bearing is 297° or better	A1
		(2)
		(14)
	Notes for question 8	
	Accept column vectors through out apart from the answer for (b)	
8(a)	M1 Expression with correct structure	
	A1 cao	
8(b)	M1 Expression with correct structure	
	A1 cao	
	M1 Allow difference in either order	
	A1* Correct given expression correctly obtained **N.B.** $\overrightarrow{AB} = (-10 + 12t)\mathbf{i} + (-10 + 24t)\mathbf{j}$ is A0	
8(c)	M1 Correct expression (with or without square root)	
	M1 Attempt to differentiate (at least one power decreasing by 1) or to complete the square	
	A1 Correct equation or expression	
	DM1 Dependent on previous M for finding the critical value for t **OR** For the completing the square method, for 'ignoring' the $(t - \frac{1}{2})^2$ term.	

Question Number	Scheme	Marks
	M1 Substitute their t (it may not be clear where it has come from but it *must be non-zero*) into their AB expression (must have square root)	
	A1 cao	
8(d)	M1 Using their t value to obtain $\overrightarrow{AB}$ and a relevant angle	
	A1 cao	