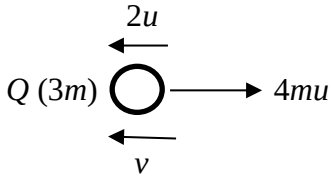
Mark Scheme (Results)

Summer 2022

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

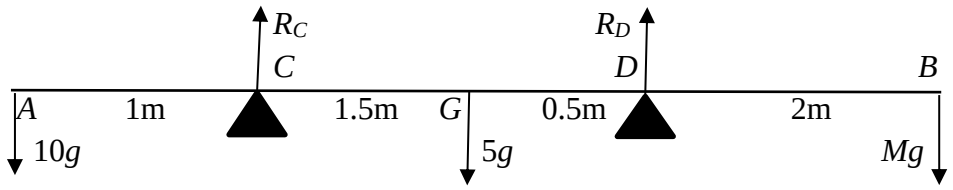
Question Number	Scheme	Marks
1.		
1(a)	$-4mu = 3m(v-2u)$ **or** $4mu = 3m(-v+2u)$ **or** $-4mu = 3m(-v-2u)$ **or** $4mu = 3m(v+2u)$	M1A1
	speed is $\frac{2}{3}u$, $0.67u$ or better	A1
		(3)
1(b)	Same as its original direction or direction is unchanged or just 'unchanged' or 'same direction' or 'it is the same'.Allow 'opposite to *P*'s original direction' or 'towards *P*' Apply isw if they add 'east' or 'to the left' etc ('motion of *Q* is unchanged'is B0)	DB1
		(1)
		(4)
	Notes for question 1	
1(a)	M1 impulse-momentum equation, dimensionally correct, correct no. of terms, condone sign errors but must be attempting a difference of momenta. Allow if they use *m* instead of 3*m*.	
	A1 Correct equation (v may be replaced by $-v$)	
	A1 cao (must be positive)	
1(b)	DB1 Dependent on obtaining either $\frac{2}{3}u$ or $-\frac{2}{3}u$ for v in (a).	

Question Number	Scheme	Marks
2(a)	$220 = (28\times 10) - \frac{1}{2}a\times 10^2$	M1 A1
	Other possible equations, any 2 of which could be used to obtain an equation in a **only**: $28 = u + 10a$ $220 = \frac{(u+28)}{2}\times 10$ $220 = 10u + \frac{1}{2}a\times 10^2$ $28^2 = u^2 + 2a\times 220$	
	a = 1.2 (m s^{-2})	A1
		(3)
2(b)	Any ONE of these: $28 = u_4 + 1.2\times 6 \Rightarrow u_4 = 20.8$ $28 = u_5 + 1.2\times 5 \Rightarrow u_5 = 22$ $s_4 = 16\times 4 + \frac{1}{2}\times 1.2\times 4^2 = 73.6$ $s_5 = 16\times 5 + \frac{1}{2}\times 1.2\times 5^2 = 95$ Allow distances from Q e.g. $s_6 = 28\times 6 - \frac{1}{2}\times 1.2\times 6^2 = 146.4$ $s_5 = 28\times 5 - \frac{1}{2}\times 1.2\times 5^2 = 125$	M1A1**ft**
	e.g. $s = 20.8\times 1 + \frac{1}{2}\times 1.2\times 1^2$ **OR** $s = 22\times 1 - \frac{1}{2}\times 1.2\times 1^2$ **OR** $s = 95 - 73.6$ **OR** $22^2 = 20.8^2 + 2\times 1.2s$ **OR** $s = 146.4 - 125$	M1
	21.4 (m) Allow 21 (m).	A1 (4)
		(7)
	Notes for question 2	
	N.B. Use of an incorrect *suvat* formula is M0.	
2(a)	M1 Complete method to find an equation in a **only** (note that u = 16) **N.B.** Allow $220 = (28\times 10) + \frac{1}{2}a\times 10^2$ ($s = ut + \frac{1}{2}at^2$ for 'reverse' motion) leading to a = -1.2 M1A0A0 but if they then change a to 1.2, then it becomes M1A1A1 retrospectively) M0 if they assume u = 0	
	A1 Correct equation	

	A1 cao	
2(b)	M1 Complete method to find the speed at $t = 4$ or 5 **OR** a distance at $t = 4$ or 5 M0 if they assume $u = 0$	
	A1**ft** A correct speed or distance, follow through on their a and u but only if u has been **used** to find a in part (a).	
	M1 Complete method to find the required distance	
	A1 cao	

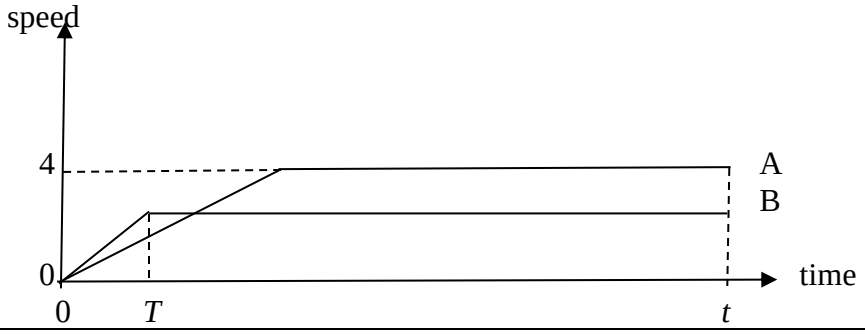
Question Number	Scheme	Marks
3(a)	$7400 - 200 - 6000 = 6000a$ $7400 - 200 - R = 8000a$ Any two of these three equations $6000 - R = 2000a$ **N.B.** 6000 (N) must be used as the tension to earn an M mark.	M1A1 M1A1
	$R = 5600$	DM1A1
	N.B. If they consistently use tonnes in their equations treat as a MR i.e. max M1A0M1A0M1A1 Wrong figs. for mass, e.g. 6000000 etc or just *m*, can score M mark in that equation.	
		(6)
3(b)	Same acceleration for the tractor and the block	B1
		(1)
		(7)
	Notes for question 3	
	N.B. Enter marks on ePen in the order in which the equations appear.	
3(a)	M1 Correct no. of terms, condone sign errors (use mass to determine which equation is being attempted)	
	A1 Correct equation	
	M1 Correct no. of terms, condone sign errors	
	A1 Correct equation	
	DM1 Solve for *R*, dependent on both M marks	
	A1 cao	
3(b)	B1 Any equivalent statement e.g 'both have the same acceleration' but not just 'same acceleration'. Need to say 'both' or mention the tractor and the block. Allow 'they have the same acceleration'. Allow 'same acceleration throughout the system' and 'both particles have the same acceleration'. **N.B.** B0 if extra wrong answers are included.	

Question Number	Scheme	Marks
4(a)	$(\uparrow)\ R = 5g - 14\sin 30^o$	M1 A1
	R = 42 (N)	A1
	(Max Friction =) $\frac{3}{7} \times 42 = 18$ (N) (18 only, with no working can score this M mark)	M1
	Horiz cpt of P = $14\cos 30^o = 12.124\ldots$ and 12 < 18 (their **max** friction) They must be comparing with a **maximum** friction i.e. the word '**maximum**' oe must have been clearly stated somewhere. **N.B.** M0 if they state or imply that the friction **acting** on the block is 18 N.	M1
	Friction = 12 or better (N) and block doesn't move	A1
		(6)
4(b)	$(\uparrow) P\sin 30^o + S = 5g$	M1A1
	$(\rightarrow) P\cos 30^o = \frac{3}{7}S$ (Allow M1A0 if they use the max friction from (a) or $\frac{3}{7} \times$ wrong value for S) (allow M1A0 for $P\cos 30^o = F$)	M1A1
	Solve for P	DM1
	P = 19 or 19.4 (N)	A1
		(6)
		(12)
	Notes for question 4	
4(a)	M1 Correct no. of terms, condone sin/cos confusion and sign errors	
	A1 Correct equation **in *R* only**.	
	A1 Correct value (seen or implied)	
	M1 Use of $F = \frac{3}{7}R$ with their R substituted.	
	M1 Condone sin/cos confusion	
	A1 cao and any equivalent correct statement and justification	
4(b)	M1 Correct no. of terms, condone sin/cos confusion and sign errors	
	A1 Correct equation	
	M1 Correct no. of terms, condone sin/cos confusion and sign errors	
	A1 Correct equation	
	DM1 Dependent on both M marks; must be solving two equations in P and one other unknown	
	A1 cao	

Question Number	Scheme	Marks
5.		
5(a)	M(D), $2\times R_C + 2Mg = 0.5\times 5g + 3\times 10g$	M1 A1
	$R_C = 16.25g - Mg$ oe or $R_C = 159 - 9.8M$ or $160 - 9.8M$	A1
		(3)
	Other possible equations that could be used in (a), to obtain an equation in R_C and M **only,** or in (b), to obtain an equation in R_D and M **only** ($\uparrow$), $R_C + R_D = 10g + 5g + Mg$ M(A), $R_C + 3R_D = 5g\times 2.5 + 5Mg$ M(B), $4R_C + 2R_D = 5g\times 2.5 + 5\times 10g$ M(G), $1.5R_C + 2.5Mg = 0.5R_D + 2.5\times 10g$	
5(b)	M(C), $2\times R_D + 1\times 10g = 1.5\times 5g + 4\times Mg$	M1A1
	$R_D = 2Mg - 1.25g$ oe or $R_D = 19.6M - 12.3$ or $20M - 12$	A1
		(3)
5(c)	Use of when $R_C \geq 0$ or $R_D \geq 0$ Allow equality or > 0 **N.B**. They may take moments about D or C again, with respectively $R_C = 0$ or $R_D = 0$	M1
	$M \leq 16.25$ **OR** $M \geq 0.625$ Allow equality **N.B.** Allow 2SF or better.	A1ft
	$0.625 \leq M \leq 16.25$ **N.B.** Allow 2SF or better. If either critical value appears, without working or from working done in parts (a) and/or (b), they can score M1A1ft and also potentially, the final A1.	A1
		(3)
		(9)
	Notes for question 5	
	N.B. Only penalise over accuracy, after use of g = 9.8, ONCE in this question.	
5(a)	M1 Complete method to give an equation in R_C and M **only**, correct number of terms, condone sign errors, dim correct M0 if they assume that the reactions are equal.	
	A1 Correct equation(s)	
	A1 Correct expression (g's must be collected)	
5(b)	M1 Complete method to give an equation in R_D and M **only**, correct number of terms, condone sign errors, dim correct	

	M0 if they assume that the reactions are equal.	
	A1 Correct equation(s)	
	A1 Correct expression (g's must be collected)	
5(c)	M1 Use of either of their reactions to find one critical value	
	A1ft Critical value of R_C **OR** Critical value of R_D but must be POSITIVE.	
	A1 cao Allow $0.625\text{kg} \leq M\text{kg} \leq 16.25\text{kg}$	

Question Number	Scheme	Marks
6.	$(5\mathbf{i}-8\mathbf{j})=(-\mathbf{i}+4\mathbf{j})+3\mathbf{a}$	M1A1
	$\mathbf{v}=(-\mathbf{i}+4\mathbf{j})+2.5(2\mathbf{i}-4\mathbf{j})$	M1
	$\mathbf{v}=(4\mathbf{i}-6\mathbf{j})$	A1
	Speed = $\sqrt{4^2+(-6)^2}=\sqrt{52}=7.2$ (m s^{-1}) or better	M1A1
		(6)
	OR: $(4-3.5)\left[\mathbf{v}-(-\mathbf{i}+4\mathbf{j})\right]=(3.5-1)\left[(5\mathbf{i}-8\mathbf{j})-\mathbf{v}\right]$ oe	M2A1
	$\mathbf{v}=(4\mathbf{i}-6\mathbf{j})$	A1
	Speed = $\sqrt{4^2+(-6)^2}=\sqrt{52}=7.2$ (m s^{-1}) or better	M1A1
		(6)
	Notes for question 6	
	M1 For use of $\mathbf{v}=\mathbf{u}+\mathbf{a}t$, with t = 3 oe, to give an *equation* in **a** only Allow **u** and **v** reversed	
	A1 Correct unsimplified equation in **a** only	
	M1 For an equation in **v** only using their **a** and t = 2.5 oe (e.g. they may find **u** (= $(-3\mathbf{i}+8\mathbf{j})$), the velocity at t = 0, then use t = 3.5) M0 if they assume **u** = **0**	
	A1 $(4\mathbf{i}-6\mathbf{j})$	
	M1 Use of Pythagoras, including square root, to find magnitude of their **v**	
	A1 cao	
	OR: Ratio method	
	M2 for an equation in **v** only, with the correct structure	
	A1 Correct unsimplified ratio equation A1 $(4\mathbf{i}-6\mathbf{j})$	
	M1 Use of Pythagoras, including square root, to find magnitude of their **v**	
	A1 cao	

Question Number	Scheme	Marks
7(a)		B1 for A B1 for B B1 4 & *T* Allow their numerical value of *T* (3)
7(b)	$\frac{4}{0.8} = 5$ (s)	B1
	$100 = \frac{(t + t - 5)}{2} \times 4$ **OR** $100 = \frac{1}{2} \times 5 \times 4 + 4(t - 5)$	M1A1ft
	$t = 27.5$ (s)	A1
		(4)
7(c)	$100 = \frac{(27.5 + 27.5 - T)}{2} \times T$ **OR** $100 = \frac{1}{2} \times T \times T + T(27.5 - T)$	M1A1ft
	$T^2 - 55T + 200 = 0$ oe	A1
	$T = 3.915047\ldots$ accept 3.9 or better	A1
		(4)
7(d)	$4 - 3.915..$	M1
	0.085 or better $(\mathrm{m\,s^{-1}})$	A1**ft**
		(2)
		(13)
	Notes for question 7	
7(a)	B1 Correct shape for A's graph.	
	B1 Correct shape for B's graph with steeper gradient initially and must cross A's graph. <u>Both graphs must end at the same time</u>. B0 once if solid vertical line at the end	
	B1 4 and *T* correctly marked. Allow appropriate delineators. **N.B.** If graphs are on separate axes can score max B1B0B1 If no labels, give BOD. If incorrect labels, max B1B0B1	
7(b)	B1 5 (s) seen – could be on graph	
	M1 Attempt at equation in *t only*, with correct structure i.e. trapezium or (rectangle + triangle) or (rectangle – triangle) oe including $\frac{1}{2}$ where appropriate, based on total area (OR distance using 2 or more *suvat* formulae) being 100 M0 for a *single suvat* equation for the *whole* motion. **N.B.** If they clearly use *T* (for *t*) in their equation and **in their answer**, it's M0 but give BOD where possible.	
	A1ft Correct equation in *t* only, ft on their 5	
	A1 cao	
7(c)	M1 Attempt at equation in *T only*, with correct structure, i.e. trapezium or (rectangle + triangle) or (rectangle – triangle) oe based on total area (OR distance using 2 or more *suvat* formulae) being 100 M0 for a *single suvat* equation for the *whole* motion.	

	A1ft Correct equation in T only, ft on their 27.5	
	A1 Correct 3 term quadratic	
	A1 cao	
7(d)	M1 for $4-T$. (Allow $T-4$)	
	A1 **ft** follow through on their T value provided it's < 4. Must be correct to at least **2 SF**.	

Question Number	Scheme	Marks
	Allow column vectors throughout except for the answer to (b).	
8(a)	Use trig to get an equation in a relevant angle e.g tan α = 1 or uses isosceles triangle. M0 if not using the velocity of Q	M1
	135^o	A1
		(2)
8(b)	$\mathbf{p} = t(15\mathbf{i})$	M1 A1
	$\mathbf{q} = 200\mathbf{j} + t(20\mathbf{i} - 20\mathbf{j})$ oe	A1
	$\overrightarrow{PQ} = \mathbf{q} - \mathbf{p} = 200\mathbf{j} + t(20\mathbf{i} - 20\mathbf{j}) - t(15\mathbf{i})$ (M0 if they put **p** = **q**) Need to see at least this line of working.	M1
	$\overrightarrow{PQ} = 5t\mathbf{i} + (200 - 20t)\mathbf{j}$ (m) *	A1*
		(5)
8(c)	$\overrightarrow{PQ} = 50\mathbf{i}$ at t = 10 (Allow M1 if they find **p** = 150**i** and **q** = 200**i** at t = 10) **N.B.** This mark could be implied by a correct diagram	M1
	270^o	A1
		(2)
8(d)	$5t = 200 - 20t$	M1
	$t = 8$	A1
	$\overrightarrow{PQ} = (5\times 8)\mathbf{i} + (200 - 20\times 8)\mathbf{j}$	M1
	$PQ = \sqrt{40^2 + 40^2} = 40\sqrt{2}$ (m) , 57 or better	M1A1
		(5)
8(e)	$(5t)^2 + (200 - 20t)^2 = 200^2$	M1
	$425t^2 - 8000t = 0$	A1
	t = 0 or $\frac{320}{17}$=18.82… Accept 19 or better Apply isw	A1
		(3)
		(17)
	Notes for question 8	
8(a)	M1 e.g. use of cos or sin or the cosine rule	
	A1 cao	
8(b)	M1 Correct structure for either	
	A1 oe	
	A1 oe	
	M1 Allow **p** – **q**	
	A1* Correct given answer correctly obtained, allow omission of m.	
8(c)	M1 Clear attempt to find $\overrightarrow{PQ}$ at t = 10 or **p** and **q** at t = 10	
	A1 cao	
8(d)	M1 Equating components to give an equation in t only, with no vectors	
	A1 cao	
	M1 Substituting their t value into their $\overrightarrow{PQ}$	
	M1 Finding the magnitude, with square root	

	A1 cao	
8(e)	M1 Use of Pythagoras – allow with square root – to obtain an equation in *t*.	
	A1 Correct unsimplified 2 term quadratic in *t*.	
	A1 For both answers	