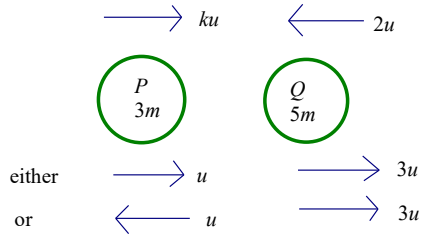
Mark Scheme (Results)

Summer 2021

Pearson Edexcel IAL In Mechanics 1

Paper WME01/01

Q	Solution	Mark	Notes
1.			
(a)	$\pm 5m\left(3u-\left(-2u\right)\right)$	M1	Use of $I=m\left(v-u\right)$ seen or implied, with correct terms. Condone sign errors. M0 if g included
	$25mu$	A1	Must be positive
		(2)	
(b)	Use of CLM	M1	Or equal and opposite impulses. Requires all terms dimensionally correct. Condone sign errors.
	$3mku-10mu=3mu+15mu$ or $3mku-10mu=-3mu+15mu$	A1	Correct unsimplified equation for either case.
	$\Rightarrow k=\frac{28}{3}$ or $k=\frac{22}{3}$	A1	One correct value. Any equivalent form. Accept decimal to 1dp or better.
	Equation for second value	M1	Their equation from M1 above with the final direction of P reversed.
	Second value correct.	A1	Any equivalent form. Accept decimal to 1dp or better.
		(5)	
		[7]	

2.	Use of $s = ut + \frac{1}{2}at^2$	M1	Form equation in u and a. **N.B.** Marks are available if they use two other unknowns, rather than u and a
	$20 = 3u + \frac{9a}{2}$	A1	Correct unsimplified equation
	Use of *suvat*	M1	Form second equation in u and a. **N.B.** Marks are available if they use the same two other unknowns, rather than u and a
	$10 = (u + 3a) + \frac{a}{2}$ or $30 = 4u + 8a$	A1	Correct unsimplified equation
	$30 = 3u + \frac{21a}{2} \Rightarrow 10 = 6a,\ a = \frac{5}{3}$	M1	Solve for u or a **Or** for one of their unknowns.
	$u = \frac{25}{6}$	A1	u and a both correct **or** both their unknowns correct. Accept equivalent forms. 1.7, 4.2 or better
	Use of $v = u + at$, $20 = \frac{25}{6} + \frac{5}{3}t$	M1	Complete method using *suvat* to find t. Correct unsimplified for their u, a.
	$t = 9.5$ (s)	A1	cao
		[8]	

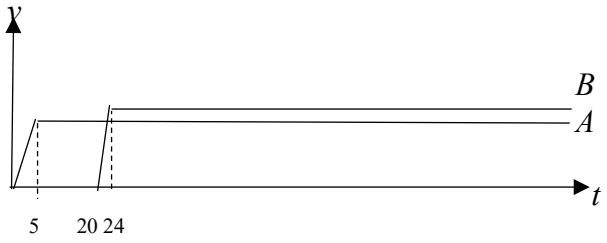
	Allow use of column vectors		
3a	$(5\mathbf{i}+2\mathbf{j})+(-3\mathbf{i}+\mathbf{j})+\mathbf{F}_3=\mathbf{0}$ oe	M1	Use equilibrium to find $\mathbf{F}_3$
	$\mathbf{F}_3=-2\mathbf{i}-3\mathbf{j}\,(\Rightarrow a=-2,\quad b=-3)$	A1	Correct $\mathbf{F}_3$
	$\tan\theta=\frac{2}{3}$	M1	For an equation in a relevant angle using their a and b
	$\theta=33.7°$	A1	$34°$ or better. 0.588 (0.59) rads
		(4)	
3b	Resultant force $=(2+\lambda)\mathbf{i}+(3+3\lambda)\mathbf{j}$	B1	Seen or implied. They must collect the **i**'s and **j**'s.
	$\mathbf{F}=4\mathbf{a}$ oe, where **F** is their resultant, seen or implied (could be implied by $\lvert\mathbf{F}\rvert=13$)	M1	Must have attempted to add all 3 forces. **N.B.** $3.25=\frac{1}{4}\left[(2+\lambda)\mathbf{i}+(3+3\lambda)\mathbf{j}\right]$ oe Scores B1M1M0M0A0 but allow recovery.
	Finding magnitude of their **a** or **F** $\sqrt{\left(\frac{2+\lambda}{4}\right)^2+\left(\frac{3+3\lambda}{4}\right)^2}$ or $\sqrt{(2+\lambda)^2+(3+3\lambda)^2}$	M1	
	Use of $\lvert\mathbf{a}\rvert=3.25$ or $\lvert\mathbf{F}\rvert=13$ to form (3 term quadratic in λ) $=0$ $(10\lambda^2+22\lambda-156=0)$	M1	
	$\lambda=3$	A1	A0 if they give 2 values.
		(5)	
		[9]	

4a	$\updownarrow T-(15g+25g)=(15+25)\times 0.2$	M1	All terms required. Must be in T only. Condone sign errors
		A1	Correct unsimplified equation in T
	$T=400$ (N)	A1	Must be positive
		(3)	
4b	$\updownarrow 12g-R=-0.1\times 12$	M1	All terms required. Condone sign errors
		A1	Correct unsimplified equation in R only. Allow + R at this stage
	$R=119$ (N) (120)	A1	Must be positive
		(3)	
		[6]	

	Allow use of column vectors		
5a	$\mathbf{a} = \dfrac{(\mathbf{i}+7\mathbf{j})-(3\mathbf{i}+5\mathbf{j})}{0.5}$ oe	M1	Use of $\mathbf{a} = \dfrac{\mathbf{v}-\mathbf{u}}{t}$ Allow **u** and **v** reversed
	$\mathbf{a} = -4\mathbf{i}+4\mathbf{j}$	A1	Or equivalent
	$\Rightarrow \mathbf{v}_P = (3\mathbf{i}+5\mathbf{j})+(-4\mathbf{i}+4\mathbf{j})t$	M1	For their **a**
	$= (3-4t)\mathbf{i}+(5+4t)\mathbf{j}$	A1ft	Follow their **a.** Must collect **i**'s and **j**'s This could be implied in subsequent working
	$\Rightarrow 5+4T = -2(3-4T)$	M1	Use of correct ratio to form equation in T (allow t)
	$T = \dfrac{11}{4}$ oe	A1	cao
		(6)	
5b	$\mathbf{v}_P = \mathbf{v}_Q \Rightarrow \begin{pmatrix} 3-4t \\ 5+4t \end{pmatrix} = \begin{pmatrix} -4-2t \\ \mu+3t \end{pmatrix}$ $\Rightarrow 3-4t = -4-2t$ and $5+4t = \mu+3t$	M1	Equate velocities and form two equations in t and μ i.e. must equate coefficients of **i** and **j** oe Follow their $\mathbf{v}_P$
		M1	Solve for μ. Follow their $\mathbf{v}_P$
	$\mu = 8.5$ oe	A1	cao
		(3)	
		[9]	

6a	Resolve perpendicular to the plane	M1	Condone sin/cos confusion
	$R = 6g\cos\theta$	A1	Correct resolution
	$F = \frac{1}{4}R = \frac{18g}{13} = 13.6(\text{N})$ or $14(\text{N})$	A1	2 sf or 3 sf for decimal answer
		(3)	
6b	Equation of motion parallel to the plane	M1	Need all terms and dimensionally correct. Condone sign errors and sin/cos confusion.
	$-F - 6g\sin\theta = 6a$	A1	Correct unsimplified equation in F Allow $-6a$ on RHS
	$0 = 5^2 + 2\times as$	M1	Complete method using *suvat* and calculated a ($a \neq g$) to find s This is independent of previous M mark but they must have found a value for a.
	$0 = 5^2 - 2\times\frac{8g}{13}s$	A1	Correct unsimplified equation. Allow ($-s$)
	$s = 2.07(\text{m})$ or $2.1(\text{m})$	A1	Must be positive.
		(5)	
6c	Equation of motion parallel to the plane	M1	Need all terms and dimensionally correct. Condone sign errors and sin/cos confusion.
	$6g\sin\theta - F = 6a'$	A1	Correct unsimplified equation in F
	$5^2 = 0 + 2a's$	M1	Complete method using *suvat*, with $a' \neq a$ and $a' \neq g$ to find s
	$5^2 = 0 + 2\times\frac{2g}{13}\times s$	A1	Correct unsimplified equation
	$8.29(\text{m})$ or $8.3(\text{m})$	A1	
		(5)	
		[13]	

7a	Possible equations: $\updownarrow R+3R\left(=4R\right)=60g$ M(A), $60gx=R\times a+3R\times 6a$ M(B), $60g(8a-x)=R\times 7a+3R\times 2a$ M(C), $60g(x-a)=3R\times 5a$ M(D), $60g(6a-x)=R\times 5a$	M1A1 M1A1	Two equations required. For each equation, M1 for correct no. of terms, dim correct but condone sign errors. A1 for a correct unsimplified equation. Consistent omission of g could score full marks. Inconsistent omission of g is an A error. All four of these marks could be scored for consistent use of another unknown length which is clearly defined e.g. on a diagram **N.B.** M marks only available if using R and $3R$ oe but allow if wrong way round. For vertical resolution, can score M1A1, even if wrong way round.
	S.C. M(G), $R(x-a)=3R(6a-x)$	M2A2	-1 each error
	$x=\dfrac{19a}{4}$ oe	A1	Or equivalent
		(5)	
7b			
	Possible equations: ($\uparrow$), $60g+Mg=S+S$ M(A), $60gx+Mg\times 2a=S\times a+S\times 6a$ M(B), $60g(8a-x)+Mg\times 6a=S\times 7a+S\times 2a$ M(C), $60g(x-a)+Mga=S\times 5a$ M(D), $60g(6a-x)+Mg\times 4a=S\times 5a$ M(G), $S(x-a)=S(6a-x)+Mg(x-2a)$	M1A1ft M1A1ft	Two equations in two unknowns (M and S) required. For each equation, M1 for correct no. of terms, dim correct but condone sign errors. A1ft for a correct unsimplified equation, follow their x. x must be substituted to earn the A marks. Consistent omission of g could score full marks. Inconsistent omission of g is an A error.
	$M=50$	A1	Exact answer only.
		(5)	
		[10]	

8a			
	Correct shape for sketch for A, starting at the origin.	B1	B0 if solid vertical line at the end of either.
	Correct shape for sketch for B, must be correct relative to A, crossing it and ending at same time. Must be done on the same axes.	B1	Tram B starts later and acceleration greater.
	5, 20, 24 shown	DB1	Dependent on previous two marks
		(3)	
8b	$t = 20 + \frac{10}{3}\left(= \frac{70}{3}\right)$	B1	
	Distance travelled for either vehicle	M1	
	$\frac{1}{2} \times \frac{10}{3} \times 10$ **OR** $\frac{1}{2} \times 5 \times 10 + \frac{55}{3} \times 10$; $\frac{1}{2}\left(\frac{70}{3} + \frac{70}{3} - 5\right) \times 10$	A1	
	Find second distance and subtract	M1	
	$d = \frac{625}{3} - \frac{50}{3} = \frac{575}{3} = 191\frac{2}{3}$	A1	Accept 192 or better.
		(5)	
8c	Equate distances from O	M1	Find both distances at time t seconds and equate, using correct structure – see examples.
	$\left(\frac{t + t - 5}{2}\right) \times 10 = \left(\frac{t - 20 + t - 24}{2}\right) \times 12$ **OR** $\left(\frac{1}{2} \times 5 \times 10\right) + 10(t - 5) = \left(\frac{1}{2} \times 4 \times 12\right) + 12(t - 24)$	A2	Correct unsimplified equation, -1 each error (up to a maximum of 2)
	$t = 119.5$	M1	Solve for t
	Distance $= 5 \times \left(6 \times 44 - 30\right) = 1170\,(\text{m})$	A1	Accept 1200 or better
		(5)	
		[13]	