



Mark Scheme (Results)

Summer 2021

Pearson Edexcel IAL In Mechanics 1

Paper WME01/01

Q	Solution	Mark	Notes
1.	either $\rightarrow u$ $\rightarrow 3u$ or $\leftarrow u$ $\rightarrow 3u$		
(a)	$\pm 5m(3u - (-2u))$	M1	Use of $I = m(v - u)$ 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 <i>suvat</i>	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 <i>suvat</i> 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 $\mathbf{F}_3$
	$\mathbf{F}_3 = -2\mathbf{i} - 3\mathbf{j} (\Rightarrow a = -2, b = -3)$	A1	Correct $\mathbf{F}_3$
	$\tan \theta = \frac{2}{3}$	M1	For an equation in a relevant angle using their a and b
	$\theta = 33.7^\circ$	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 $\mathbf{i}$'s and $\mathbf{j}$'s.
	$\mathbf{F} = 4\mathbf{a}$ oe, where $\mathbf{F}$ is their resultant, seen or implied (could be implied by $ \mathbf{F} = 13$)	M1	Must have attempted to add all 3 forces. N.B. $3.25 = \frac{1}{4}[(2 + \lambda)\mathbf{i} + (3 + 3\lambda)\mathbf{j}]$ oe Scores B1M1M0M0A0 but allow recovery.
	Finding magnitude of their $\mathbf{a}$ or $\mathbf{F}$ $\sqrt{\left(\frac{2 + \lambda}{4}\right)^2 + \left(\frac{3 + 3\lambda}{4}\right)^2}$ or $\sqrt{(2 + \lambda)^2 + (3 + 3\lambda)^2}$	M1	
	Use of $ \mathbf{a} = 3.25$ or $ \mathbf{F} = 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	$\uparrow T - (15g + 25g) = (15 + 25) \times 0.2$	M1	All terms required. Must be in T only. Condone sign errors
		A1	Correct unsimplified equation in T
	$T = 400 \text{ (N)}$	A1	Must be positive
		(3)	
4b	$\uparrow 12g - R = -0.1 \times 12$	M1	All terms required. Condone sign errors
		A1	Correct unsimplified equation in R only. Allow $+ R$ at this stage
	$R = 119 \text{ (N) } (120)$	A1	Must be positive
		(3)	
		[6]	

	Allow use of column vectors		
5a	$\mathbf{a} = \frac{(\mathbf{i} + 7\mathbf{j}) - (3\mathbf{i} + 5\mathbf{j})}{0.5}$ oe	M1	Use of $\mathbf{a} = \frac{\mathbf{v} - \mathbf{u}}{t}$ Allow $\mathbf{u}$ and $\mathbf{v}$ 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 $\mathbf{a}$
	$= (3 - 4t)\mathbf{i} + (5 + 4t)\mathbf{j}$	A1ft	Follow their $\mathbf{a}$. Must collect $\mathbf{i}$'s and $\mathbf{j}$'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)
	$T = \frac{11}{4}$ 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 $\mathbf{i}$ and $\mathbf{j}$ 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
	$F = \frac{1}{4} R = \frac{18g}{13} = 13.6(\text{N}) \text{ or } 14(\text{N})$	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 <i>suvat</i> 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 $(-s)$
	$s = 2.07(\text{m}) \text{ or } 2.1(\text{m})$	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 <i>suvat</i> , 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
	$8.29(\text{m}) \text{ or } 8.3(\text{m})$	A1	
		(5)	
		[13]	

7a	Possible equations: $\uparrow R + 3R (= 4R) = 60g$ 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
	$x = \frac{19a}{4}$ 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), $60g(x - a) + Mg a = S \times 5a$ 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 = $5 \times (6 \times 44 - 30) = 1170$ (m)	A1	Accept 1200 or better
		(5)	
		[13]	