

Mark Scheme (Results)

January 2021

Pearson Edexcel IAL In Mechanics 1 Paper WME01/01

Question Number	Scheme	Marks	3
1(a)	$v^2 = 20^2 - 2g \times (-3)$	M1	
	$v = 21 \text{ or } 21.4 \text{ (m s}^{-1})$	A1	(2)
1(b)	Complete method to find the total time:		
	e.g. either: $-5 = 20t - \frac{1}{2}gt^2$ using one equation		
	or:		
	$0 = 20 - gt_1 \ (\Rightarrow t_1 = \frac{100}{49} = 2.040816)$		
	$s_1 = (\frac{20+0}{2})t_1 \ (=\frac{1000}{49} = 20.40816)$	M1	
	(or $s_1 = 20t_1 - \frac{1}{2}gt_1^2$) using four equations		
	$25.408 = \frac{1}{2}gt_2^2 \ (\Rightarrow t_2 = 2.2771)$		
	$t = t_1 + t_2 = 4.31795$		
	and many other methods		
	There are two A marks for all the equations they use, -1 each error	A1 M(A)1	
	N.B. The second M mark should be treated as an A mark	M(A)1	
	t = 4.3 or 4.32 (s)	A1	
	Notes for question 1		(6)
	Notes for question 1 M1 Complete method to find the speed, must be using 3 or -3 (Allow		
1(a)	9.81 for g or just g), condone sign errors		
	A1 Correct answer (Must have used 9.8 and be positive)		
1(b)	M1 Complete method to find the total time, condone sign errors		
	A1		
	M(A)1 There are now two A marks for the equation(s) that they use,		
	-1 for each error. (Allow 9.81 for g or just g)		
	A1 Correct answer (Must have used 9.8)		
	N.B. No isw for this question e.g. If they had the correct quadratic but went on to add the roots,		
	this would lose the M mark.		
	this would lose the 11 marks		

Question Number	Scheme	Mark	S
2.	$5mu \xrightarrow{\qquad P \qquad Q \qquad \qquad } 2u$ $v \longrightarrow \qquad w \longrightarrow \qquad 5mu$		
2(a)	For P : $-5mu = 2m(v-3u)$ $v = \frac{1}{2}u$	M1A1 A1	(3)
2(b)	For Q : $5mu = m(w - (-2u))$ $w = 3u$	M1A1 A1	(3)
	OR: CLM: $2m \times 3u - m \times 2u = 2m \times \frac{1}{2}u + mw$ M1A1 $w = 3u$ A1		(6)
	Notes for question 2		(0)
2(a)	M1 Dimensionally correct imp-momentum equation (M0 if g is included), with correct terms, condone sign errors, but must be a difference of momenta and must be using 2m to give an equation in v only.		
	A1 Correct equation		
2(b)	A1 cao (must be positive) M1 Dimensionally correct imp-momentum equation (M0 if <i>g</i> is included), with correct terms, condone sign errors, but must be a difference of momenta and must be using <i>m</i> to give an equation in <i>w</i> only . A1 Correct equation		
	A1 cao (must be positive) OR: M1 Dimensionally correct CLM equation (Allow consistent extra g's or cancelled m's), with correct terms, condone sign errors, to give an equation in w only. N.B. They may find w first and use CLM to find v. N.B. Mark parts (a) and (b) together if necessary.		

Question Number	Scheme	Marks
3.	$(\uparrow) R + 200\sin 15^o + T\sin 25^o = 20g$	M1A2
	$(\leftarrow) 200 \cos 15^{\circ} - T \cos 25^{\circ} - F = 0$	M1A2
	F = 0.3R	B1
	Solving for <i>T</i> (192.31)	D M1
	T = 190 or 192	A1
		(9)
	Notes for question 3	
	M1 Resolving vertically, correct no. of terms, condone sign errors and sin/cos confusion.	
	A2 Correct equation, -1 each error.	
	M1 Resolving horizontally, correct no. of terms, condone sign errors and sin/cos confusion.	
	A2 Correct equation, -1 each error.	
	B1 $F = 0.3R$ seen anywhere, e.g. on a diagram	
	D M1 Dependent on previous two M marks for solving for T	
	A1 cao (allow units)	
	N.B. For the first two M marks, forces and angles must be paired up correctly but allow slips.	

Question Number	Scheme	Marks
4.	$M(D), 900 \times 5 = W(5 - x)$	M1A1
	Other possible equations:	
	(\uparrow) , $900 + R_D = W$	
	$M(A), Wx = 5R_D$	
	$M(B)$, $(900 \times 6) + (R_D \times 1) = W(6 - x)$	
	$M(C)$, $(900 \times 1) + W(x - 1) = 4R_D$	
	$M(G)$, $900x = R_D(5-x)$	
	BUT R_D then needs to be eliminated to produce an	
	equation in W and x only in order to earn the M mark.	
	N.B. M0 if they never put $R_C = 0$	
	Allow consistent use of Mg for W	
	$M(C)$, $1500 \times 5 = W(x-1)$	M1A1
	Other possible equations:	
	(\uparrow) , $1500 + R_C = W$	
	$M(A)$, $(1500 \times 6) + (R_C \times 1) = Wx$	
	$M(B), W(6-x) = 5R_C$	
	$M(D), W(5-x)+(1500\times1)=4R_C$	
	$M(G)$, 1500(6-x) = $R_C(x-1)$	
	BUT R_C then needs to be eliminated to produce an	
	equation in W and x only in order to earn the M mark.	
	N.B. M0 if they never put $R_D = 0$	
	Allow consistent use of Mg for W	
	Solving for <i>x</i>	DM 1
	x = 3.5	A1
	NI 4 C	(6)
	Notes for question 4 M1 For an equation in W and one unknown length. Correct no. of terms,	
	dim correct but condone sign errors.	
	An extra g on one side is an A error.	
	A1 Correct equation	
	M1 For an equation in W and the same unknown length. Correct no. of	
	terms, dim correct but condone sign errors.	
	An extra g on one side is an A error.	
	A1 Correct equation DM1 Solving for x, dependent on the two previous M marks	
	DM1 Solving for <i>x</i> , dependent on the two previous M marks. A1 cao with no wrong working seen.	
	111 cao with no wrong working seen.	

Question Number	Scheme	Marks
5(i)	$\mathbf{R} = \mathbf{F} + \mathbf{G}$	
	$R^{2} = 8^{2} + 10^{2} - 2 \times 8 \times 10 \cos 120^{\circ} \text{ oe } (244)$	
	OR: $R^2 = 8^2 + 10^2 + 2 \times 8 \times 10 \cos 60^\circ$	M1A1
	OR: $R^2 = (8\sin 60)^2 + (10 + 8\cos 60^\circ)^2$	
	OR: $R^2 = (10\sin 60)^2 + (8+10\cos 60^\circ)^2$	
	$R = \sqrt{244} = 15.620499 \text{ N}$	A1
5(ii)	$\frac{\sin \alpha}{8} = \frac{\sin 120^{\circ}}{\sqrt{244}} \text{ (allow sin60°) } \mathbf{OR} \frac{\sin \beta}{10} = \frac{\sin 120^{\circ}}{\sqrt{244}} \text{ (allow sin60°)}$	
	OR $8^2 = (\sqrt{244})^2 + 10^2 - 2 \times \sqrt{244} \times 10 \cos \alpha$	
	OR $10^2 = (\sqrt{244})^2 + 8^2 - 2 \times \sqrt{244} \times 8 \cos \beta$	
	OR $\tan \alpha = \frac{8\sin 60}{10 + 8\cos 60^{\circ}}$ or $\sin \alpha = \frac{8\sin 60}{\sqrt{244}}$ or $\cos \alpha = \frac{10 + 8\cos 60^{\circ}}{\sqrt{244}}$	M1A1
	(or reciprocal of tan)	
	OR $\tan \beta = \frac{10 \sin 60}{8 + 10 \cos 60^{\circ}}$ or $\sin \beta = \frac{10 \sin 60}{\sqrt{244}}$ or $\cos \beta = \frac{8 + 10 \cos 60^{\circ}}{\sqrt{244}}$	
	V211	
	(or reciprocal of tan)	
	$\alpha = 26.(3)^{\circ}$ OR $\beta = 33.67^{\circ}$ (accept 34)	A1
	Bearing is 206° (nearest degree)	Al
		(7)
	Notes for question 5	
5(i)	M1 for an equation in <i>R</i> only (M0 for $R^2 = 8^2 + 10^2 - 2 \times 8 \times 10 \cos 60^\circ$	
	or if they clearly misquote the cosine rule)	
	For the second alternative, condone sin/cos confusion and sign errors A1 for a correct equation	
	A1 for $\sqrt{244}$ or 16 or better (N) M1 for an equation in a relevant angle only , using their <i>R</i> value.	
5(ii)	For the SOHCAHTOA alternatives, allow sin/cos confusion and sign	
	errors	
	A1 for a correct equation	
	A1 for a relevant angle which is correct to the nearest degree	
	A1 cao	

Question Number	Scheme	Mark	s
6(a)	$(11\mathbf{i} + 11\mathbf{j}) + t(3\mathbf{i} - \mathbf{j})$	M1A1	(2)
6(b)	When $t = 6$, $\mathbf{r}_A = (29\mathbf{i} + 5\mathbf{j})$	M1	
	$\mathbf{r}_B = (7\mathbf{i} + 16\mathbf{j}) + t(4\mathbf{i} - 2\mathbf{j}) = (29\mathbf{i} + 5\mathbf{j})$	M1	
	Solve both $4t + 7 = 29$ and $16 - 2t = 5$ explicitly to give $t = 5.5$ for	DM1	
	both equations (Division by vectors is DM0)	A1*	(4)
6(c)	$\overrightarrow{AB} = (7\mathbf{i} + 16\mathbf{j}) + t(4\mathbf{i} - 2\mathbf{j}) - \{(11\mathbf{i} + 11\mathbf{j}) + t(3\mathbf{i} - \mathbf{j})\}$	M1	
	$\overrightarrow{AB} = [(t-4)\mathbf{i} + (5-t)\mathbf{j}] \text{ m} \qquad \text{GIVEN ANSWER}$	A1*	(2)
6(d)	$AB^2 = (t-4)^2 + (5-t)^2$ oe seen or implied by a numerical calculation	M1	
	$=2(t-4.5)^2+0.5$	A1	
	Complete method using the above to find the minimum	M1	
	Minimum $AB = \sqrt{0.5} = 0.71$ m (or better)	A1	
	OR $AB^2 = (t-4)^2 + (5-t)^2$ oe seen or implied by a numerical calculation M1		
	4t-18 or $2(t-4)-2(5-t)$ A1		
	N.B. Either of these could be implied by seeing $t = 4.5$		
	Complete method using the above to find the minimum M1		
	Minimum $AB = \sqrt{0.5} = 0.71$ m (or better)		(4)
	OR $AB^2 = (t-4)^2 + (5-t)^2$ oe seen or implied by a numerical		
	calculation M1		
	$2t^{2}-18t+(41-d^{2})=0 (d=AB) A1$ Complete method using $b^{2}-4ac=0$: $(-18)^{2}-4\times 2(41-d^{2})=0$ to		
	find minimum M1		
	Minimum $AB = \sqrt{0.5} = 0.71$ m (or better)		
	Accept column vectors throughout except in (c)		(12)
6(a)	Notes for question 6 M1 for an attempt at \mathbf{r}_A with a correct structure		
6(a)	A1 cao		
6(b)	M1 for putting $t = 6$ into their \mathbf{r}_A to find \mathbf{r}_P		
J(N)	M1 for equating their \mathbf{r}_{B} at time t (with correct structure) to their \mathbf{r}_{P}		
	DM1 Solve their vector equation for both components, dependent on both previous M marks. Need to see 5.5 occurring twice . N.B. One ratio equation is not sufficient for this mark		

uestion Number	Scheme	Marks
	A1* cao	
6(c)	M1 for finding their \mathbf{r}_B – their \mathbf{r}_A or their \mathbf{r}_A – their \mathbf{r}_B	
	M0 if they start with $\mathbf{r}_A = \mathbf{r}_B$	
	A1* for correctly establishing <i>exactly</i> (i.e. not a column vector) the	
	given expression (allow omission of m), writing out in full the	
	difference between the vectors before simplifying correctly to the given	
	answer.	
6(d)	M1 for a correct expression for either AB or AB^2 seen or implied.	
	A1 for a correct quadratic in completed square form	
	M1 for a complete method using the completed square form to find the	
	minimum value of AB.	
	A1 cao	
	OR:	
	M1 for a correct expression for either AB or AB^2 seen or implied	
	A1 for a correct derivative (N.B. can be implied by $t = 4.5$)	
	M1 for a complete method using the derivative to find the minimum	
	value of AB.	
	A1 cao	
	OR:	
	M1 for a correct expression for either AB or AB^2 seen or implied	
	A1 for a correct equation	
	M1 for a complete method using the discriminant = 0 to find the minimum value of AB .	
	A1 cao	
	Al Cao	

Question Number	Scheme	Mar	ks
7()	2509 245(-1) 411 25	D1	(1)
7(a)	$v = 2.5 \times 9.8 = 24.5 \text{ (m s}^{-1}\text{)}$ Allow 2.5g	B1	(1)
7(b)	24.5	B1 sh B1 fig	- 1
	2.5 2.5+T 20		(2)
7(c)	$73.75 = \frac{(24.5 + (24.5 - 3.9T))T}{2}$		
	OR $73.75 = 24.5T - \frac{1}{2} \times 3.9T^2$	M1	N / 1
	OR $73.75 = (24.5 - 3.9T)T + \frac{1}{2} \times 3.9T \times T$	A1A1	MI
	OR $V^2 = 24.5^2 + 2 \times (-3.9) \times 73.75$ and then $5 = 24.5 - 3.9T$		
	T=5	A1	(5)
	N.B. The second M mark should be treated as an A mark		
7(d)	Height = Total area under graph		
	$= \left(\frac{1}{2} \times 24.5 \times 2.5\right) + 73.75 + (20 - 2.5 - 5) \times (24.5 - 3.9 \times 5)$	M1A2	
	=167 (m) nearest metre.	A1	(4)
			(12)
= ()	Notes for question 7		
7(a)	B1 cao B1 Correct shape of graph with the second line less steep than the first		
7(b)	Graph may be reflected in the t -axis. B0 if solid vertical line at $t = 20$		
	B1 All five values correctly placed (allow omission of 0 and appropriate delineators)		
7(c)	M1 for a complete method to obtain an equation, with a correct structure, in <i>T</i> only.		
	A1A1M1(A1) For a correct equation or equations, -1 each error.		
	A1 cao (must be a single answer i.e the other root (7.56) must be clearly rejected.		
7(d)	M1 for a complete method, using the total area under the graph oe, with a correct structure (i.e. triangle + trapezium + rectangle oe), to obtain an expression for the height of <i>H</i> above the ground.		
	A1 cas		
	A1 cao		
	1	l	

Question Number	Scheme	Marks
8(a)	$R = 2g \cos \alpha$ (Could be earned in (b) if used there)	M1A1
()	$T - 2g\sin a - F = 2a$	M1A1
	4g-T=4a	M1A1
	OR $4g - 2g \sin a - F = 6a$ (whole system) M1A1	
	F = 0.25R seen anywhere e.g on a diagram or in (b)	B1
	Solve for T	M1
	$T = 2.4g = \frac{12g}{5} = 24 \text{ or } 23.5 \text{ (N)}$	A1 (9)
8(b)	$2.4g - 2g\sin a - 0.4g = 2a \text{OR} 4g - 2.4g = 4a$	M1
8(b)	a = 0.4g	Al
	$v^2 = \frac{-8^{3}}{5}$	M1
	$v^{2} = \frac{4gh}{5}$ $-\frac{6g}{5} - \frac{2g}{5} = 2a' \qquad (a' \text{ is new acceleration of } A \text{ up the slope})$	B1
	Allow +ve terms on LHS	
	$0 = \frac{4gn}{5} - \frac{8g}{5}s$	M1
	$0 = \frac{4gh}{5} - \frac{8g}{5}s$ $s = \frac{1}{2}h$	A1
	d > 1.5h	A1 (7)
8(c)	Weight of string; extensibility of the string; friction at pulley	B1 (1)
	N.B. Simply restating what's in the question is B0.	(17)
	Notes for question 8	
8(a)	M1 Resolving perpendicular to the plane, correct no. of terms, condone sign errors and sin/cos confusion	
	A1 Correct equation	
	M1 Equation of motion parallel to the plane, correct no. of terms,	
	condone sign errors and sin/cos confusion	
	A1 Correct equation M1 Equation of motion vertically, correct no. of terms, condone sign	
	errors.	
	A1 Correct equation	
	N.B.	
	Either equation of motion may be replaced by a whole system equation with usual rules.	
	B1 $F = 0.25R$ seen anywhere e.g. on diagram	
	M1 Solve for T (Must have two equations of motion with a in each)	
	A1 cao	
8 (b)	M1 Eliminate T from their equations of motion to give an equation in a only . (N.B . May be done in (a) but must be used in (b))	

Question Number	Scheme	Marks
	(Must have <i>two</i> equations of <i>motion</i> with <i>a</i> in each)	
	A1 $a = 0.4g$ oe (N.B. May be found in (a) but must be used in (b))	
	M1 Complete method to give an equation in v and h only using their a , which must have been found. (M0 if $0.4g$ or g used)	
	B1 Correct equation of motion, with forces in numerical form or in	
	terms of g , for A after B hits the ground in a' only	
	M1 for an equation in s and h only, using their a' (M0 if no a' found)	
	A1 For a correct expression for s in terms of h.	
	A1 cao	
8(c)	B1 Any correct answer. B0 if any incorrect extras included.	