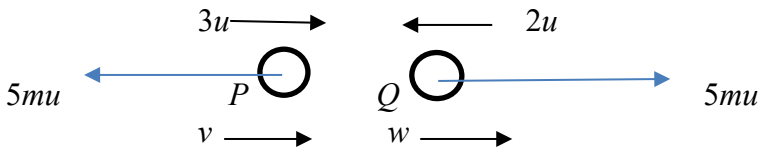
Mark Scheme (Results)

January 2021

Pearson Edexcel IAL In Mechanics 1
Paper WME01/01

Question Number	Scheme	Marks
1(a)	$v^2 = 20^2 - 2g \times (-3)$	M1
	$v = 21$ or 21.4 (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:** $0 = 20 - gt_1$ $(\Rightarrow t_1 = \frac{100}{49} = 2.040816..)$ $s_1 = (\frac{20+0}{2})t_1$ $(= \frac{1000}{49} = 20.40816...)$ (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	M1
	There are two A marks for all the equations they use, -1 each error **N.B.** The second M mark should be treated as an A mark	A1 M(A)1
	$t = 4.3$ or 4.32 (s)	A1
		(6)
	Notes for question 1	
1(a)	M1 **Complete** method to find the speed, must be using 3 or -3 (Allow 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.**	

Question Number	Scheme	Marks
2.		
2(a)	For P: $-5mu = 2m(v-3u)$	M1A1
	$v = \frac{1}{2}u$	A1 (3)
2(b)	For Q: $5mu = m(w-(-2u))$	M1A1
	$w = 3u$	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	
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	
	A1 cao (must be positive)	
2(b)	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 m to give an equation in w **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.	

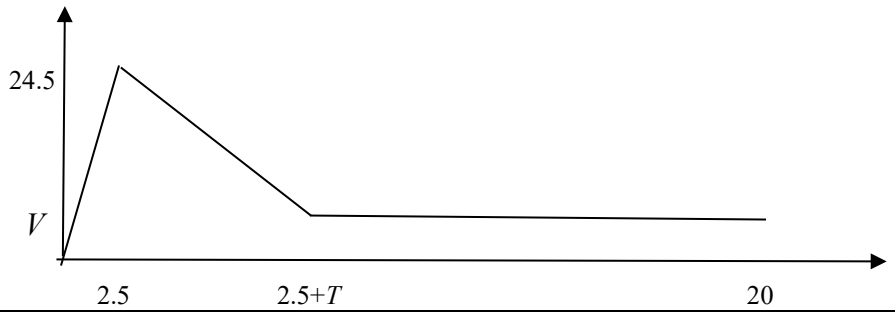
Question Number	Scheme	Marks
3.	$(\uparrow)\ R + 200\sin 15^o + T\sin 25^o = 20g$	M1A2
	$(\leftarrow)\ 200\cos 15^o - T\cos 25^o - F = 0$	M1A2
	$F = 0.3R$	B1
	Solving for T (192.31..)	**D**M1
	$T = 190$ or 192	A1
		(9)
	Notes for question 3	
	M1 Resolving vertically, correct no. of terms, condone sign 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	
	DM1 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.	$M(D), \quad 900\times 5 = W(5-x)$ Other possible equations: $(\uparrow), 900 + R_D = W$ $\text{M}(A), Wx = 5R_D$ $\text{M}(B), (900\times 6)+(R_D\times 1) = W(6-x)$ $\text{M}(C), (900\times 1)+W(x-1) = 4R_D$ $\text{M}(G), 900x = R_D(5-x)$ **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	M1A1
	$M(C), \quad 1500\times 5 = W(x-1)$ Other possible equations: $(\uparrow), 1500 + R_C = W$ $\text{M}(A), (1500\times 6)+(R_C\times 1) = Wx$ $\text{M}(B), W(6-x) = 5R_C$ $\text{M}(D), W(5-x)+(1500\times 1) = 4R_C$ $\text{M}(G), 1500(6-x) = R_C(x-1)$ **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	M1A1
	Solving for x	**DM**1
	$x = 3.5$	A1
		(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.	
	A1 cao with no wrong working seen.	

Question Number	Scheme	Marks
5(i)	**R = F + G**	
	$R^2 = 8^2 + 10^2 - 2\times 8\times 10\cos 120^o$ oe (244) **OR:** $R^2 = 8^2 + 10^2 + 2\times 8\times 10\cos 60^o$ **OR**: $R^2 = (8\sin 60)^2 + (10 + 8\cos 60^o)^2$ **OR**: $R^2 = (10\sin 60)^2 + (8 + 10\cos 60^o)^2$	M1A1
	$R = \sqrt{244}$=15.620499... N	A1
5(ii)	$\frac{\sin\alpha}{8} = \frac{\sin 120^o}{\sqrt{244}}$ (allow sin60º) **OR** $\frac{\sin\beta}{10} = \frac{\sin 120^o}{\sqrt{244}}$ (allow sin60º) **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** $\tan\alpha = \frac{8\sin 60}{10 + 8\cos 60^o}$ or $\sin\alpha = \frac{8\sin 60}{\sqrt{244}}$ or $\cos\alpha = \frac{10 + 8\cos 60^o}{\sqrt{244}}$ (or reciprocal of tan) **OR** $\tan\beta = \frac{10\sin 60}{8 + 10\cos 60^o}$ or $\sin\beta = \frac{10\sin 60}{\sqrt{244}}$ or $\cos\beta = \frac{8 + 10\cos 60^o}{\sqrt{244}}$ (or reciprocal of tan)	M1A1
	$\alpha = 26.(3..)^o$ **OR** $\beta = 33.67\ldots^o$ (accept 34)	A1
	Bearing is 206º (nearest degree)	A1
		(7)
	Notes for question 5	
5(i)	M1 for an equation in R **only** (M0 for $R^2 = 8^2 + 10^2 - 2\times 8\times 10\cos 60^o$ 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)	
5(ii)	M1 for an equation in a relevant angle **only**, using their R value. 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	Marks
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 **both equations** (Division by vectors is DM0)	**D**M1 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
	$\overrightarrow{AB} = [(t-4)\mathbf{i}+(5-t)\mathbf{j}]$ m 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) A1	(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 $b^2-4ac=0$: $(-18)^2-4\times2(41-d^2)=0$ to find minimum M1	
	Minimum $AB = \sqrt{0.5} = 0.71$ m (or better) A1	
	Accept column vectors throughout except in (c)	**(12)**
	Notes for question 6	
6(a)	M1 for an attempt at $\mathbf{r}_A$ with a correct structure	
	A1 cao	
6(b)	M1 for putting $t = 6$ into their $\mathbf{r}_A$ to find $\mathbf{r}_P$	
	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	

Question 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 *exactly* (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	

Question Number	Scheme	Marks
7(a)	$v = 2.5\times 9.8 = 24.5\ (\text{m s}^{-1})$ Allow $2.5g$	B1 (1)
7(b)		B1 shape B1 figures (2)
7(c)	$73.75 = \dfrac{(24.5+(24.5-3.9T))T}{2}$ **OR** $73.75 = 24.5T - \dfrac{1}{2}\times 3.9T^2$ **OR** $73.75 = (24.5-3.9T))T + \dfrac{1}{2}\times 3.9T\times T$ **OR** $V^2 = 24.5^2 + 2\times(-3.9)\times 73.75$ and then $5 = 24.5 - 3.9T$ $T = 5$ **N.B.** The second M mark should be treated as an A mark	M1 A1A1M1 A1 (5)
7(d)	Height = Total area under graph	
	$= \left(\dfrac{1}{2}\times 24.5\times 2.5\right) + 73.75 + (20-2.5-5)\times(24.5-3.9\times 5)$	M1A2
	=167 (m) nearest metre.	A1 (4)
		(12)
	Notes for question 7	
7(a)	B1 cao	
7(b)	B1 Correct shape of graph with the second line less steep than the first 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 T 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 H above the ground.	
	A2 For a correct equation, -1 each error.	
	A1 cao	

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
	$T = 2.4g = \frac{12g}{5} = 24$ or 23.5 (N)	A1 (9)
8(b)	$2.4g - 2g\sin a - 0.4g = 2a$ OR $4g - 2.4g = 4a$	M1
	$a = 0.4g$	A1
	$v^2 = \frac{4gh}{5}$	M1
	$-\frac{6g}{5} - \frac{2g}{5} = 2a'$ (a' is new acceleration of A up the slope) Allow +ve terms on LHS	B1
	$0 = \frac{4gh}{5} - \frac{8g}{5}s$	M1
	$s = \frac{1}{2}h$	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 *two* equations of *motion* with a 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.	