Mark Scheme (Results)

October 2017

Pearson Edexcel International A Level
in Mechanics M1 (WME01/01)

General Principles for Mechanics Marking

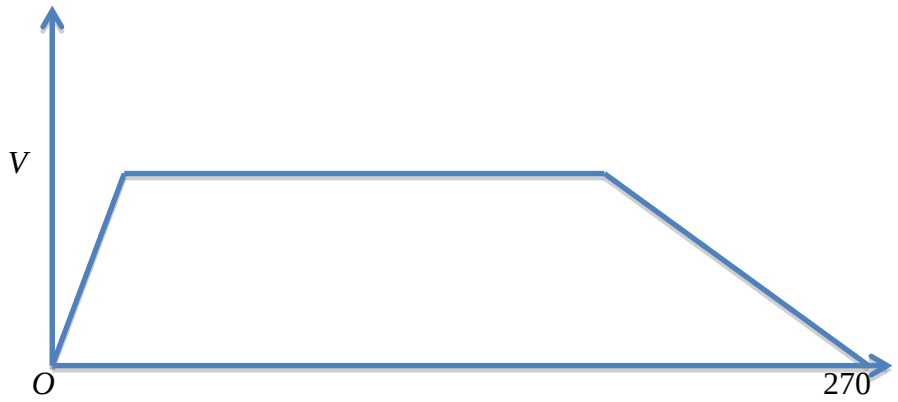
Question Number	Scheme	Marks
1	$T\cos 70^\circ + R = 40g$	M1A1
	$T\cos 20^\circ = F$	M1A1
	$F = \frac{3}{4}R$	B1
	Eliminate R and solve for T	**DM**1
	T = 250 N or 246 N	A1
		7
	Notes	
1	First M1 for resolving vertically with usual rules (must be using either 20^o or 70^o) First A1 for a correct equation Second M1 for resolving horizontally with usual rules (must be using either 20^o or 70^o) Second A1 for a correct equation B1 for $F = \frac{3}{4}R$ seen (could be on a diagram) Third DM1 dependent on previous two M marks Third A1 for either 250 (N) or 246 (N)	
2a	$M(D),\ (1080\times 1)-(400\times 2) = R_C \times 3.5$	M1 A1
	$R_C = 80$ (N)	A1
	$M(C),\ (1080\times 2.5)+(400\times 5.5) = R_D \times 3.5$	M1A1
	$R_D = 1400$ (N)	A1 (6)
	OR $(\uparrow)\ R_C + R_D = 1480$	M1A1
2b	$R_C + (R_C + 520) = 1480$ OR $R_D + (R_D - 520) = 1480$	M1 A1
	$M(D),\ (1080\times 1) - 400(x-4) = R_C \times 3.5$	M1 A1
	$x = 2.5$	A1 (5)
		11
	Notes	
2a	First M1 for a moments equation or a vertical resolution First A1 for a correct equation (R_C and/or R_D do NOT need to be substituted but if one is, it can be their value found from a previous equation)	

Question Number	Scheme	Marks
	Second A1 for $R_C = 80$ (N) Second M1 for a moments equation or a vertical resolution Third A1 for a correct equation (R_C and/or R_D do NOT need to be substituted but if one is, it can be their value found from a previous equation) Fourth A1 for $R_D = 1400$ (N) Enter marks for equations on ePEN, in the order they appear	
2b	First M1 for a moments equation or a vertical resolution First A1 for a correct equation (R_C and/or R_D do NOT need to be substituted but if one is, it can be their value found from a previous equation) Second M1 for a moments equation or a vertical resolution Second A1 for a correct equation (R_C and/or R_D do NOT need to be substituted but if one is, it can be their value found from a previous equation) Third A1 for $x = 2.5$ Enter marks for equations on ePEN, in the order they appear **N.B.** Equations may contain any or all of R_C , R_D or x for M marks but must contain only **one** of R_C or R_D to earn the A mark. **N.B.** If they assume that R_D = 520, they lose all the marks for part (b). **N.B** If they start with $2R$ = 1480 and then add or subtract (or both) 520 to their R value, M0**.** **N.B.** If brackets are omitted in a moments equation e.g. (520 + R_C).4 is written as 520 + R_C.4, the M mark can be scored	
3	$8mu - 4mu = 5mv$	M1A1
	$v = 0.8u$	A1
	For P: $-I = 4m(0.8u - 2u)$	M1 A1
	$I = 4.8mu$	A1
	OR For Q: $I = m(0.8u + 4u)$	M1 A1
	$I = 4.8mu$	A1
		6
	Notes	
3	First M1 for CLM with correct no. of terms, all dimensionally correct, to give an equation in m, u and their v only. Condone consistent g's or cancelled m's and sign errors. (N.B. The CLM equation could be obtained by equating the magnitudes of the impulses on each particle) First A1 for a correct equation (they may have - 5mv) Second A1 for 0.8u or – 0.8u (as appropriate) Second M1 for using Impulse = Change in Momentum for either P or Q (M0 if *clearly* adding momenta or if g is included or if different mass in the two momentum terms) but condone sign errors.	

Question Number	Scheme	Marks
	Third A1 for $4m(0.8u-2u)$ or $-4m(0.8u-2u)$ **OR** for $m(0.8u+4u)$ or $-m(0.8u+4u)$ Fourth A1 for 4.8*mu* (must be positive since magnitude)	
4(i)	$\lvert\mathbf{F}_2\rvert^2 = 8^2+14^2-2\times 8\times 14\cos 30$	M1 A1
	Solve for $\lvert\mathbf{F}_2\rvert$= 8.1 (N) or better	M1 A1 (4)
	OR: $\lvert\mathbf{F}_2\rvert\cos\alpha = 14\cos 30 - 8$ $\lvert\mathbf{F}_2\rvert\sin\alpha = 14\sin 30$	M1 A1
	Solve for $\lvert\mathbf{F}_2\rvert$= 8.1 (N) or better	M1 A1 (4)
4(ii)	$\frac{\sin\theta}{8} = \frac{\sin 30}{8.12467}$ or $\frac{\sin\phi}{14} = \frac{\sin 30}{8.12467}$	M1 A1
	Solve: $\theta = 29.49^o$ or $\phi = 120.51^o$	M1 A1
	Bearing is 149° (nearest degree)	A1 (5)
	OR: $\lvert\mathbf{F}_2\rvert\cos\alpha = 14\cos 30 - 8 = 4.124(355.)$ $\lvert\mathbf{F}_2\rvert\sin\alpha = 14\sin 30$	M1 A1
	Solve: $\alpha = 59.49^o$	M1 A1
	Bearing is 149° (nearest degree)	A1 (5)
	Notes	
4(i)	First M1 for use of cos rule with 30° First A1 for a correct equation **OR:** First M1 for 'resolving' in 2 directions with 30° / 60° (**N.B.** M0 here if cos/sin confused) First A1 for TWO correct equations Second M1 for solving for $\lvert\mathbf{F}_2\rvert$, independent *but* must be solving a 'correct cosine formula but with wrong angle' if using method 1 **OR** for eliminating α from two equations, independent *but* equations must have the correct structure if using method 2 Second A1 for 8.1 (N) or better	
4(ii)	First M1 for use of sin rule with 30° First A1 for a correct equation (allow 8.12 or better) **OR:** First M1 for 'resolving' in 2 directions with 30° / 60°	

1

Question Number	Scheme	Marks
	First A1 for TWO correct equations (allow 4.12 or better) Second M1, independent, for solving a 'correct sine formula' for θ or ϕ **OR** independent for solving two equations, with correct structure, for α Second A1 for $\theta =$ AWRT 29^o or $\phi =$ AWRT 121^o **OR** $\alpha =$ AWRT 59^o	
	Third A1 for Bearing is 149^o (nearest degree)	
	N.B. First M1A1 Could use cos rule to find an angle	
	N.B. If the resolving method is used and there are no (i) or (ii) labels, only award M1A1 in both cases when an answer is reached.	
5a	$0 = 14.7^2 - 2 \times 9.8h$	M1A1
	$h = 11.025$	A1
	max ht $= 13.5$ or 14 (m)	A1 (4)
5b	$-1.5 = 14.7t - 4.9t^2$	M1A1
	$4.9t^2 - 14.7t - 1.5 = 0$	
	$t = \dfrac{14.7 \pm \sqrt{14.7^2 + 6 \times 4.9}}{9.8}$	**DM**1
	$t = 3.1$ or 3.10 (s)	A1 (4)
5c	$v^2 = 14.7^2 + 2 \times (-9.8) \times (-2.5)$	M1 A1
	$v = 16.3$ or 16 (m s^{-1})	A1 (3)
		11
	Notes	
5a	**N.B.** If they use g = 9.81, lose first A mark (once for whole question) but all other A marks can be scored. First M1 for a complete method to find the height (Could involve two *suvat* equations) condone sign errors. First A1 for a correct equation (or equations) Second A1 for h = 11 (may be unsimplified) or better (For other methods, give this A1 for any correct (may be unsimplified) intermediate answer) Third A1 for 13.5 or 14 (m)	
5b	First M1 for a complete method to find the required time (they may find the time up (1.5 s) and then add on the time down. Condone sign errors First A1 for a correct equation or equations Second DM1, dependent, for solving to find required time Second A1 for 3.1 or 3.10 (s)	

Question Number	Scheme	Marks
5c	First M1 for a complete method to find the speed / velocity(Could involve two *suvat* equations) Condone sign errors but must have correct numbers in their equation(s) First A1 for a correct equation (or equations) Second A1 for 16 or 16.3 (m s^{-1}) Must be *positive (speed)*	
6a		B1 shape B1 270, *V* (2)
6b	$\frac{V}{0.6}=\frac{5V}{3}$ **Given answer**	M1A1 (2)
6c	Time decelerating is $5V$	B1
	$\frac{1}{2}V\frac{5V}{3}+(270-5V-\frac{5V}{3})V+\frac{1}{2}V.5V=1500$ **OR:** $\frac{1}{2}(270+270-5V-\frac{5V}{3})V=1500$	M1 A2
	$V^2-81V+450=0$ **Given answer**	**DM1**A1 (6)
6d	$V^2-81V+450=0$ $(V-6)(V-75)=0$ or $V=\frac{81\pm\sqrt{81^2-4\times450}}{2}$	M1 solving
	$V=6$ or 75	A1 A1
	$V=6$ since $(5\times75)>270$ or $V=75$ unrealistic	**B**1 (4)
		14
	Notes	
6a	First B1 for a trapezium with line starting at the origin Second B1 for 270 and *V* correctly marked	
6b	M1 for $(t=)\frac{V}{0.6}$; **N.B.** M1A0 for $V=0.6t$ then answer Must see division or intermediate step from $V=0.6t$ e.g. Changing 0.6 into 3/5. A1 for $t=\frac{5V}{3}$ **Given answer**	

Question Number	Scheme	Marks
6c	B1 for $5V$ identified appropriately First M1 for clear attempt to equate the *total* area under graph to 1500. (Must include all 3 parts (if not using the trapezium rule) with $\frac{1}{2}$ seen at least once to give equation in V only; may use (1 triangle + 1 trapezium) or (rectangle - trapezium) (May use *suvat* for one or more parts of the area) A2 for a correct equation, -1 e.e.o.o. Second **DM**1 dependent on first M1 for multiplying out and collecting terms and putting into appropriate form Third A1 for correct equation. **Given answer**	
6d	First M1 for solving their 3 term quadratic equation for V N.B. This M1 can be implied by two correct roots but if either answer incorrect then an explicit method must be shown for this M mark. First A1 for $V = 6$ Second A1 for $V = 75$ B1 on ePEN but treat as **DM**1, dependent on both previous A marks, for either reason	
7a	$T - 3mg\sin\alpha - F = 3ma$	M1A1
	$4mg - T = 4ma$	M1A1 (4)
7b	$F = \frac{1}{4}R;\ R = 3mg\cos\alpha$	B1; M1A1
	$T - 2.4mg = 3ma$ $4mg - T = 4ma$	M1
	$a = \frac{8g}{35}$ **Given answer**	A1 (5)
7c	Particles have same acceleration	B1 (1)
7d	$v^2 = 2 \times \frac{8g}{35} \times 1.75$ (= $0.8g$)	M1 A1
	$-3mg\sin\alpha - F = 3ma'$	M1
	$a' = -0.8g$	A1
	$0 = 0.8g + 2 \times (-0.8g)s$	M1 A1
	Total distance = 0.5 + 1.75 = 2.25 (m) Accept 2.3 (m)	A1 (7)
		17
	Notes	
7a	First M1 for equation of motion for A with usual rules First A1 for a correct equation Second M1 for equation of motion for B with usual rules Second A1 for a correct equation **N.B.** If using different tension in second equation, M0 for that equation	

Question Number	Scheme	Marks
7b	B1 for $F = \frac{1}{4}R$ seen e.g. on diagram First M1 for resolving for *A* perp to the plane First A1 for correct equation N.B. These first 3 marks can be earned in (a). Second M1 (Hence) for substituting for *R* and *F* and trig. and solving for *a* (must be some evidence of this) <u>their equations of motion from part (a)</u> Second A1 for **given answer (Not available if not using exact values for trig ratios)**	
7c	B1 for particles have same acceleration (B0 for same velocity or if incorrect extras given)	
7d	First M1 for attempt to find speed (or speed^2) when *B* hits the ground (M0 if uses *g*) First A1 for a correct expression Second M1 for attempt to find deceleration of *A* Second A1 for correct deceleration Third M1 for using deceleration (must have found a deceleration) with $v = 0$ to find distance (M0 if uses *g*) Third A1 for a correct equation Fourth A1 for 2.25 (m)	

Pearson

Mark Scheme (Results)

Oct 2017

Pearson Edexcel IAL in Mechanics 2 (WME02/01)

edexcel

Question Number	Scheme	Marks	Notes
4(a)	M(A) or alternative complete method to an equation in T only	M1	Must have all terms. Terms must be dimensionally correct. Condone sign errors and sin/cos confusion.
	$T \times 2a = mg \times 3a \sin 60° + mg \times 6a \sin 60°$	A1	Unsimplified equation with at most one error
		A1	Correct unsimplified equation
	$T = 9mg\dfrac{\sqrt{3}}{4}$	A1 (4)	With trig. substituted. $3.90mg$ or better
(b)	$\mathrm{R}(\rightarrow) \quad R = T\cos 60°$	M1	Resolve horizontally. Condone sin/cos confusion
	$\left(= 9mg\dfrac{\sqrt{3}}{4} \times \dfrac{1}{2}\right)$	A1ft	Follow their T. Allow with $\cos 60°$
	$R = \dfrac{9\sqrt{3}}{8}mg$	A1ft (3)	$1.95mg$ or better. Follow their (a).
Alt 4(b)	$2mg\cos 60° = R\cos 30° - F\cos 60°$ $T - F\cos 30 = 2mg\cos 30° + R\cos 60°$	(M1)	Resolve parallel and perpendicular to the rod and eliminate F
	$\dfrac{5mg\sqrt{3}}{4} - \dfrac{R}{2} = -\sqrt{3}mg + \dfrac{3R}{2}$	(A1ft)	Equation in R only. Follow their T
	$R = \dfrac{9\sqrt{3}}{8}mg$	(A1ft)	With trig. substituted. Follow their (a)
(c)	$\mathrm{R}(\uparrow) \quad T\cos 30° - F = mg + mg$	M1	Resolve vertically. Need all terms. Condone sign errors and sin/cos confusion. Allow for $\pm F$
		A1	Unsimplified equation with at most one error. Allow for $\pm F$
	$F = 9mg\dfrac{\sqrt{3}}{4} \times \dfrac{\sqrt{3}}{2} - 2mg\left(= \dfrac{11}{8}mg\right)$	A1	Correct unsimplified expression for F, with trig. substituted. Allow for $\pm F$. Seen or implied.
	$\mu = \dfrac{F}{R} = \dfrac{\frac{11}{8}mg}{\frac{9\sqrt{3}}{8}mg}$	dM1	Use of $F = \mu R$ Dependent on the two previous M marks
	$= \dfrac{11}{9\sqrt{3}} \quad (= 0.71 \text{ or } 0.706 \text{ or better})$	A1 (5)	(g cancels)
(c) alt 1st 3 marks	$2mg\cos 60° = R\cos 30° - F\cos 60°$	(M1)	Resolve parallel to the rod. Need all terms. Condone sign errors and sin/cos confusion. Allow for $\pm F$
	$mg = \dfrac{27}{16}mg - \dfrac{1}{2}F$	(A1)	Unsimplified equation with at most one error. Allow for $\pm F$. sin/cos confusion is one error
	$F = \dfrac{11}{8}mg$	(A1)	Correct unsimplified expression for F. Allow for $\pm F$. Seen or implied.
		[12]	

Question Number	Scheme	Marks	Notes
6(a)		M1	Integrate a to obtain v
	$v = t^2 - 3t \ \ (+c)$	A1	Condone missing C
	$t = 3,\ v = 2 \ \Rightarrow c = 2$	M1	Substitute to find C
	$v = t^2 - 3t + 2$	A1	
		(4)	
(b)	$0 = (t-2)(t-1)$	M1	Set their $v = 0$ and solve for t
	$t = 1,\ 2$	A1	
	$s = \int_1^2 (t^2 - 3t + 2)\,\mathrm{d}t$	M1	Integrate v to obtain s
	$= \left[\frac{1}{3}t^3 - \frac{3}{2}t^2 + 2t\right]_1^2$	A1ft	Condone if limits not seen. Follow their v.
	$= -\frac{1}{6}$ m	dM1	Use their t values as limits. Dependent on the preceding M1.
	Dist $= \frac{1}{6}$ (m)	A1	0.17, 0.167 or better
		(6)	
		[10]	

Question Number	Scheme	Marks	Notes
7(a)	$\frac{1}{2}m\times v^2-\frac{1}{2}m\times 15^2=47.5mg$	M1	The Q tells them to use energy. Need all 3 terms. Condone sign errors Must be dimensionally correct.
		A1	Unsimplified equation with at most one error
		A1	Correct unsimplified equation
	$v=34$ m s^{-1}	A1	
		(4)	
(b)	$u=15\times\frac{3}{5}$ m s^{-1}, $a=-9.8$ m s^{-1}, $v=0$		
	$0=9^2-2\times 9.8s$	M1	Complete method using *suvat* to reach an equation in s.
	$s=4.1326...$	A1	
	ht above beach $=51.63...=52$ (m)	A1ft	Or 51.6(m). Their s + 47.5. Max 3 s.f.
		(3)	
(c)	least speed $=15\times\frac{4}{5}=12$ m s^{-1}	B1	
		(1)	
(d)	$u=-15\times\frac{3}{5}$ m s^{-1}, $a=9.8$ m s^{-1}, $s=47.5$		
	$47.5=-9t+\frac{1}{2}\times 9.8t^2$	M1	Complete method using *suvat* to reach an equation in t.
	$\left(4.9t^2-9t-47.5=0\right)$	A1	Correct equation (any form)
	$t=\frac{9\pm\sqrt{9^2+4\times 4.9\times 47.5}}{9.8}$	dM1	Solve for t. Dependent on preceding M
	$t=4.16448...$	A1	Only. –ve value must be rejected if seen.
	Horiz dist $=15\times\frac{4}{5}\times 4.16448...\left(=49.9738...\text{m}\right)$	M1	Complete method using *suvat* and their t to find distance. Independent
	$=50$ or 50.0 (m)	A1	Max 3 s.f.
		(6)	
		[14]	
	Alternative for first 4 marks in **(d)**		
	Complete method to find vertical component of the speed on impact with the ground	M1	Or use their $\sqrt{(a)^2-(c)^2}$ provided $(c)\neq 0$
	$v=\sqrt{1012}\left(=31.8....\right)$	A1	
	$\sqrt{1012}=-9+gt$	M1	Use *suvat* to find t. Condone sign error(s)
	$t=4.16448...$	A1	