



Pearson

# **Mark Scheme (Results)**

October 2017

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

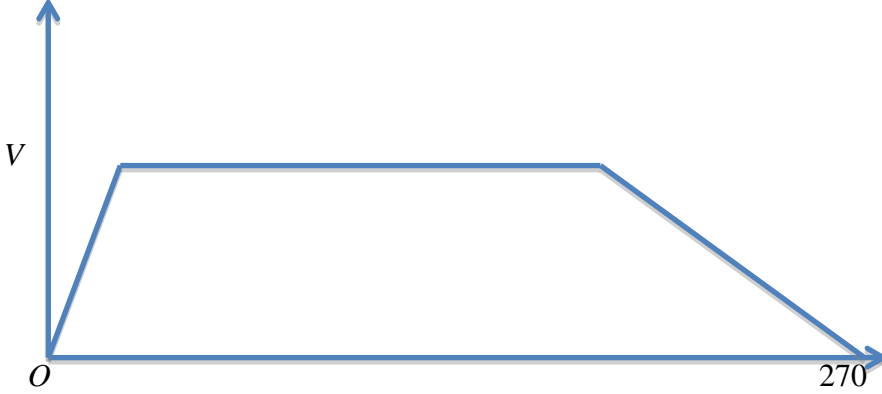
## General Principles for Mechanics Marking

Question Number	Scheme	Marks
<b>1</b>	$T \cos 70^\circ + R = 40g$	M1A1
	$T \cos 20^\circ = F$	M1A1
	$F = \frac{3}{4}R$	B1
	Eliminate $R$ and solve for $T$	<b>DM1</b>
	$T = 250 \text{ N}$ or $246 \text{ N}$	A1
		<b>7</b>
	<b>Notes</b>	
<b>1</b>	First M1 for resolving vertically with usual rules (must be using either $20^\circ$ or $70^\circ$ ) First A1 for a correct equation Second M1 for resolving horizontally with usual rules (must be using either $20^\circ$ or $70^\circ$ ) 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)	
<b>2a</b>	$M(D), (1080 \times 1) - (400 \times 2) = R_C \times 3.5$	M1 A1
	$R_C = 80 \text{ (N)}$	A1
	$M(C), (1080 \times 2.5) + (400 \times 5.5) = R_D \times 3.5$	M1A1
	$R_D = 1400 \text{ (N)}$	A1 (6)
	OR $(\uparrow) R_C + R_D = 1480$	M1A1
<b>2b</b>	$R_C + (R_C + 520) = 1480$ 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)
		<b>11</b>
	<b>Notes</b>	
<b>2a</b>	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 <b>N.B.</b> Equations may contain any or all of $R_C$ , $R_D$ or $x$ for M marks but must contain only <b>one</b> of $R_C$ or $R_D$ to earn the A mark. <b>N.B.</b> If they assume that $R_D = 520$ , they lose all the marks for part (b). <b>N.B.</b> If they start with $2R = 1480$ and then add or subtract (or both) 520 to their $R$ value, M0. <b>N.B.</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	$8mu - 4mu = 5mv$ $v = 0.8u$ For P: $-I = 4m(0.8u - 2u)$ $I = 4.8mu$ <b>OR</b> For Q: $I = m(0.8u + 4u)$ $I = 4.8mu$	M1A1 A1 M1 A1 A1  M1 A1 A1
		<b>6</b>
	<b>Notes</b>	
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 <i>clearly</i> 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 $-4m(0.8u - 2u)$ <b>OR</b> for $m(0.8u + 4u)$ or $-m(0.8u + 4u)$ Fourth A1 for $4.8mu$ (must be positive since magnitude)	
4(i)	$ \mathbf{F}_2 ^2 = 8^2 + 14^2 - 2 \times 8 \times 14 \cos 30$	M1 A1
	Solve for $ \mathbf{F}_2  = 8.1$ (N) or better	M1 A1 (4)
	<b>OR:</b> $ \mathbf{F}_2  \cos \alpha = 14 \cos 30 - 8$ $ \mathbf{F}_2  \sin \alpha = 14 \sin 30$	M1 A1
	Solve for $ \mathbf{F}_2  = 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: $\theta = 29.49^\circ$ or $\phi = 120.51^\circ$	M1 A1
	Bearing is $149^\circ$ (nearest degree)	A1 (5)
	<b>OR:</b> $ \mathbf{F}_2  \cos \alpha = 14 \cos 30 - 8 = 4.124(355.)$ $ \mathbf{F}_2  \sin \alpha = 14 \sin 30$	M1 A1
	Solve: $\alpha = 59.49^\circ$	M1 A1
	Bearing is $149^\circ$ (nearest degree)	A1 (5)
<b>Notes</b>		
4(i)	First M1 for use of cos rule with $30^\circ$ First A1 for a correct equation <b>OR:</b> First M1 for 'resolving' in 2 directions with $30^\circ / 60^\circ$ ( <b>N.B.</b> M0 here if cos/sin confused) First A1 for TWO correct equations Second M1 for solving for $ \mathbf{F}_2 $ , <u>independent</u> <i>but</i> must be solving a 'correct cosine formula but with wrong angle' if using method 1 <b>OR</b> for eliminating $\alpha$ from two equations, <u>independent</u> <i>but</i> 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 $30^\circ$ First A1 for a correct equation ( <u>allow 8.12 or better</u> ) <b>OR:</b> First M1 for 'resolving' in 2 directions with $30^\circ / 60^\circ$	

Question Number	Scheme	Marks
	First A1 for TWO correct equations ( <u>allow 4.12 or better</u> ) Second M1, <u>independent</u> , for solving a 'correct sine formula' for $\theta$ or $\phi$ <b>OR</b> <u>independent</u> for solving two equations, with correct structure, for $\alpha$ Second A1 for $\theta = \text{AWRT } 29^\circ$ or $\phi = \text{AWRT } 121^\circ$ <b>OR</b> $\alpha = \text{AWRT } 59^\circ$	
	Third A1 for Bearing is $149^\circ$ (nearest degree)	
	<b>N.B.</b> First M1A1 Could use cos rule to find an angle	
	<b>N.B.</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.	
<b>5a</b>	$0 = 14.7^2 - 2 \times 9.8h$	M1A1
	$h = 11.025$	A1
	$\text{max ht} = 13.5 \text{ or } 14 \text{ (m)}$	A1 (4)
<b>5b</b>	$-1.5 = 14.7t - 4.9t^2$	M1A1
	$4.9t^2 - 14.7t - 1.5 = 0$	
	$t = \frac{14.7 \pm \sqrt{14.7^2 + 6 \times 4.9}}{9.8}$	<b>DM1</b>
	$t = 3.1 \text{ or } 3.10 \text{ (s)}$	A1 (4)
<b>5c</b>	$v^2 = 14.7^2 + 2 \times (-9.8) \times (-2.5)$	M1 A1
	$v = 16.3 \text{ or } 16 \text{ (m s}^{-1}\text{)}$	A1 (3)
	<b>Notes</b>	<b>11</b>
<b>5a</b>	<b>N.B.</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 <i>suvat</i> 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)	
<b>5b</b>	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
<b>5c</b>	First M1 for a complete method to find the speed / velocity (Could involve two <i>suvat</i> 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 <sup>-1</sup> ) Must be <i>positive (speed)</i>	
<b>6a</b>		B1 shape B1 270, V  (2)
<b>6b</b>	$\frac{V}{0.6} = \frac{5V}{3}$ <b>Given answer</b>	M1A1 (2)
<b>6c</b>	Time decelerating is 5V	B1
	$\frac{1}{2}V\frac{5V}{3} + (270 - 5V - \frac{5V}{3})V + \frac{1}{2}V \cdot 5V = 1500$	M1 A2
	<b>OR:</b> $\frac{1}{2}(270 + 270 - 5V - \frac{5V}{3})V = 1500$	
	$V^2 - 81V + 450 = 0$ <b>Given answer</b>	<b>DM1A1</b> (6)
<b>6d</b>	$V^2 - 81V + 450 = 0$ or $V = \frac{81 \pm \sqrt{81^2 - 4 \times 450}}{2}$ $(V - 6)(V - 75) = 0$	M1 solving
	$V = 6$ or 75	A1 A1
	$V = 6$ since $(5 \times 75) > 270$ or $V = 75$ unrealistic	<b>B1</b> (4)
		<b>14</b>
	<b>Notes</b>	
<b>6a</b>	First B1 for a trapezium with line starting at the origin Second B1 for 270 and V correctly marked	
<b>6b</b>	M1 for $(t =) \frac{V}{0.6}$ ; <b>N.B.</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 $t = \frac{5V}{3}$ <b>Given answer</b>	

Question Number	Scheme	Marks
6c	<p>B1 for 5V identified appropriately</p> <p>First M1 for clear attempt to equate the <i>total</i> area under graph to 1500.</p> <p>(Must include all 3 parts (if not using the trapezium rule) with <math>\frac{1}{2}</math> seen at least once to give equation in V only; may use (1 triangle + 1 trapezium) or (rectangle - trapezium)</p> <p>(May use <i>suvat</i> for one or more parts of the area)</p> <p>A2 for a correct equation, -1 e.e.o.o.</p> <p>Second <b>DM1</b> dependent on first M1 for multiplying out and collecting terms and putting into appropriate form</p> <p>Third A1 for correct equation. <b>Given answer</b></p>	
6d	<p>First M1 for solving their 3 term quadratic equation for V</p> <p>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.</p> <p>First A1 for V = 6</p> <p>Second A1 for V = 75</p> <p>B1 on ePEN but treat as <b>DM1</b>, dependent on both previous A marks, for either reason</p>	
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
	$a = \frac{8g}{35} \quad \text{Given answer}$	A1 (5)
7c	Particles have same acceleration	B1 (1)
7d	$v^2 = 2 \times \frac{8g}{35} \times 1.75 \quad (= 0.8g)$	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)
		<b>17</b>
	<b>Notes</b>	
7a	<p>First M1 for equation of motion for A with usual rules</p> <p>First A1 for a correct equation</p> <p>Second M1 for equation of motion for B with usual rules</p> <p>Second A1 for a correct equation</p> <p><b>N.B.</b> If using different tension in second equation, M0 for that equation</p>	

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 <b>given answer (Not available if not using exact values for trig ratios)</b>	
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 <sup>2</sup> ) 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)

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

Question Number	Scheme	Marks	Notes
<b>6(a)</b>		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>(b)</b>	$0 = (t-2)(t-1)$	M1	Set their $v = 0$ and solve for $t$
	$t = 1, 2$	A1	
	$s = \int_1^2 (t^2 - 3t + 2) dt$	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 $v$ .
	$= -\frac{1}{6} \text{ m}$	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
<b>7(a)</b>	$\frac{1}{2}m \times v^2 - \frac{1}{2}m \times 15^2 = 47.5mg$	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
	$v = 34 \text{ m s}^{-1}$	A1	
		<b>(4)</b>	
<b>(b)</b>	$u = 15 \times \frac{3}{5} \text{ m s}^{-1}, a = -9.8 \text{ m s}^{-2}, v = 0$		
	$0 = 9^2 - 2 \times 9.8s$	M1	Complete method using <i>suvat</i> to reach an equation in <i>s</i> .
	$s = 4.1326\dots$	A1	
	ht above beach = $51.63\dots = 52 \text{ (m)}$	A1ft	Or 51.6(m). Their <i>s</i> + 47.5. Max 3 s.f.
		<b>(3)</b>	
<b>(c)</b>	least speed = $15 \times \frac{4}{5} = 12 \text{ m s}^{-1}$	B1	
		<b>(1)</b>	
<b>(d)</b>	$u = -15 \times \frac{3}{5} \text{ m s}^{-1}, a = 9.8 \text{ m s}^{-2}, s = 47.5$		
	$47.5 = -9t + \frac{1}{2} \times 9.8t^2$	M1	Complete method using <i>suvat</i> to reach an equation in <i>t</i> .
	$(4.9t^2 - 9t - 47.5 = 0)$	A1	Correct equation (any form)
	$t = \frac{9 \pm \sqrt{9^2 + 4 \times 4.9 \times 47.5}}{9.8}$	dM1	Solve for <i>t</i> . Dependent on preceding M
	$t = 4.16448\dots$	A1	Only. -ve value must be rejected if seen.
	Horiz dist $= 15 \times \frac{4}{5} \times 4.16448\dots (= 49.9738\dots \text{m})$	M1	Complete method using <i>suvat</i> and their <i>t</i> to find distance. Independent
	$= 50 \text{ or } 50.0 \text{ (m)}$	A1	Max 3 s.f.
		<b>(6)</b>	
		<b>[14]</b>	
	Alternative for first 4 marks in <b>(d)</b>		
	Complete method to find vertical component of the speed on impact with the ground	M1	Or use their $\sqrt{(a)^2 - (c)^2}$ provided $(c) \neq 0$
	$v = \sqrt{1012} (= 31.8\dots)$	A1	
	$\sqrt{1012} = -9 + gt$	M1	Use <i>suvat</i> to find <i>t</i> . Condone sign error(s)
	$t = 4.16448\dots$	A1	