



Pearson
Edexcel

Mark Scheme (Results)

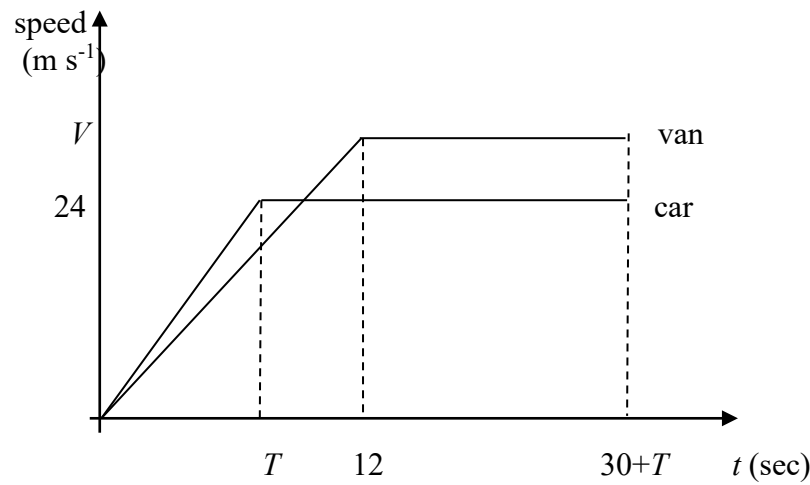
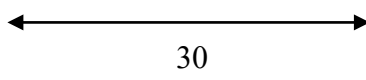
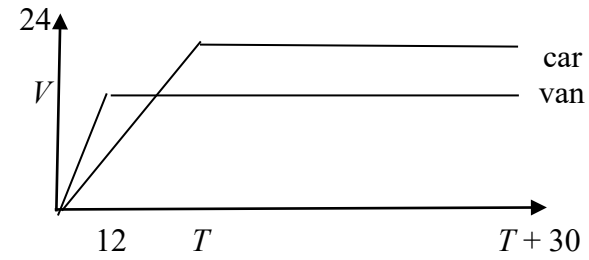
October 2018

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

Question Number	Scheme	Marks
<p>2(a)</p>	<p>N.B. Consistent use of extra g's in two equations can score the A marks for the equations and could score full marks for part (a). N.B. If they assume that the rod is uniform, can only score marks for a vertical resolution.</p> <p>$R(\uparrow): 0.5R_C + R_C = 60 + 12$ (N.B. $R_A = \frac{1}{2}R_C$)</p> <p>Possible moments equations: $M(A): 60x + (12 \times 5) = R_C \times 3$ $M(B): (2 \times R_C) + \left(\frac{1}{2}R_C \times 5\right) = 60(5 - x)$ $M(C): \left(\frac{1}{2}R_C \times 3\right) + (12 \times 2) = 60(3 - x)$ $M(G): 12(5 - x) + \frac{1}{2}R_C x = R_C(3 - x)$</p> <p>Eliminate R_C and solve for x (AG) $x = 1.4$ m</p>	<p>M1A1</p> <p>M1A1</p> <p>DM1</p> <p>A1 (6)</p> <p>B1</p> <p>B1 (2)</p> <p>[8]</p>
	Notes for qu 2	
	<p>N.B. If R and $\frac{1}{2}R$ are reversed, max score is M1A1 (resolution)</p> <p>M1A0 (moments)</p>	
<p>2a</p>	<p>First M1 for first equation, correct no. of terms, dim correct, condone sign errors and allow R and S at this stage and for moments equations allow a different length variable</p>	
	<p>First A1 for a correct resolution in one unknown or moments equation in two unknowns</p>	
	<p>Second M1 for second equation, correct no. of terms, dim correct, condone sign errors and allow R and S at this stage and for moments equations allow a different length variable</p>	
	<p>Second A1 for a correct resolution in one unknown or moments equation in two unknowns</p>	
	<p>Third DM1, dependent on both previous M marks, for eliminating and solving for AG</p>	
	<p>Third A1 for 1.4 (m) oe</p>	
<p>2b (i)</p>	<p>First B1 e.g. mass is concentrated at B B0 if incorrect extras</p>	
<p>(ii)</p>	<p>Second B1 e.g. the plank doesn't buckle or bend B0 if incorrect extras</p>	

Question Number	Scheme	Marks
<p>3</p> <p>EITHER: $h = -19.6(t+3) + \frac{1}{2}g(t+3)^2$ and $h = \frac{1}{2}gt^2$</p> <p>OR : $h = -19.6T + \frac{1}{2}gT^2$ and $h = \frac{1}{2}g(T-3)^2$</p> <p>$-19.6T + \frac{1}{2}gT^2 = \frac{1}{2}g(T-3)^2$ OR $-19.6(t+3) + \frac{1}{2}g(t+3)^2 = \frac{1}{2}gt^2$</p> <p>(i) $T = 4.5$</p> <p>(ii) $h = \frac{1}{2} \times 9.8 \times (T-3)^2$ oe</p> <p>$= 11$ or 11.0</p>		M1A1A1
		M1A1A1
		M1
		A1
		M1
		A1
[7]		
Notes for qu 3		
<p>3</p>	<p>First M1 for use of $s = ut + \frac{1}{2}at^2$ (or any other complete method) to produce an equation in h and T only or h and t only for stone 1 or 2, correct no. of terms but condone sign errors</p>	
	<p>First A1 for a correct equation for stone 1 (g does not need to be substituted but if it is, it must be 9.8)</p>	
	<p>Second A1 for a correct equation for stone 2</p> <p>N.B. Both A marks can be earned if they use s (instead of h or $-h$) in one of the two equations and then use s consistently in the other equation.</p> <p>N.B. When h and T are used in any equation, they must be used correctly (including sign of h) to obtain A marks</p>	
<p>(i)</p>	<p>Second M1 for eliminating h</p>	
	<p>Third A1 for $T = 4.5$</p>	
<p>(ii)</p>	<p>Third M1 for using their T or t value in one of their equations to obtain an h value</p>	
	<p>Fourth A1 for $h = 11$ or 11.0</p>	

Question Number	Scheme	Marks
<p>4.</p> <p>(i)</p> <p>(ii)</p>	<p>$\sin \theta = \frac{3}{5}$ or $\cos \theta = \frac{4}{5}$ or $\tan \theta = \frac{3}{4}$ oe (may use the angle the string makes with the horizontal, the complementary angle) seen or implied by use of a <u>trig function</u> of e.g. 37° or 53° anywhere. N.B. If they assume angles are 45° can score max B0M1A0A1M0A0A0</p> <p>Any <i>two</i> of the following equations: R(\rightarrow): $F \cos \theta = 16 \sin \theta$ oe e.g. $F = 16 \tan \theta$ (from triangle of forces) R(\nearrow): $F = mg \sin \theta$ R(\uparrow): $mg = 16 \cos \theta + F \sin \theta$ R(\nwarrow): $16 = mg \cos \theta$ $(mg)^2 = F^2 + 16^2$ (Pythagoras from triangle of forces) N.B. In all of these equations, θ is what they <i>think</i> the angle that the string makes with the vertical is. $F = 12$ (A0 if 12 obtained from rounding an inaccurate answer and A0 for 12.0) N.B. If $F = 12$ is given as answer, without any evidence of rounding, give BOD and award A1.</p> <p>$m = 2.04$ or 2.0 (A0 for 2)</p>	<p>B1</p> <p>M1A1 (1st equation)</p> <p>M1A1 (2nd equation)</p> <p>A1</p> <p>A1</p> <p>[7]</p>
Notes for qu 4		
B1 for any correct trig ratio seen		
First M1 for 1 st equation seen with usual rules		
First A1 for a correct equation		
Second A1 is now M1 for 2nd equation seen with usual rules		
Second M1 is now A1 for a correct equation		
Third A1 for 12		
Fourth A1 for 2.04 or 2.0 (A0 for 2)		

Question Number	Scheme	Marks
5(a)	<div style="text-align: center;">  <p>OR</p>  </div> <p>N.B.</p> <div style="text-align: center;">  </div> <p>(b) $\frac{1}{2}(T+30+30) \times 24 = 816$ OR $\frac{1}{2} \times T \times 24 + 30 \times 24 = 816$</p> <p style="text-align: center;">$T = 8$ (s)</p> <p>(c) $\frac{1}{2}((T+30)+(T+18))V = 816$ OR $\frac{1}{2} \times 12V + V(18+T) = 816$</p> <p style="text-align: center;">$V = 25.5$</p> <p>ALT (b) Dist travelled while accelerating = $816 - 720 = 96$ m</p> $s = \frac{u+v}{2}t \Rightarrow \left(\frac{0+24}{2}\right)T = 96$ <p style="text-align: center;">$T = 8$ (s)</p>	<p>B1 shape of either B1 shape of second (must cross first and end at the same t value) B1 $V, 24, 12,$ $T, T+30$ oe with delineator B0 if vertical solid lines (3)</p> <p>This graph can score all 3 marks.</p> <p>M1A1</p> <p>A1 (3)</p> <p>M1A1 ft</p> <p>A1 (3)</p> <p>[9]</p> <p>M1A1</p> <p>A1</p>

Question Number	Scheme	Marks
	(c) Dist travelled by the van $= \frac{1}{2} \times 12V + (18 + T) \times V = 816$ $V = 25.5$	M1A1ft A1
	Notes for qu 5	
5a	First B1 for shape of graph	
	Second B1 for shape of graph, crossing first graph	
	Third B1 for V , 12, 24, T and $T+30$ placed correctly oe e.g. with delineators. Allow their T and (their $T + 30$) where they find T in (b) first.	
5b	M1 for equation in T or $t (= T + 30)$ <i>only</i> , using 816 distance travelled by CAR, <i>with correct structure</i> i.e. a trapezium or (triangle + rectangle)	
	First A1 for a correct equation	
	Second A1 for 8 (s)	
	M1 for equation in V <i>only</i> , using 816 distance travelled by VAN , <i>with correct structure</i> i.e. a trapezium or (triangle + rectangle) N.B. M0 if they assume the TOTAL time is 30 (or 42) when setting up the equation.	
	First A1 ft on their T value , for a correct equation	
	Second A1 for $V = 25.5$	

Question Number	Scheme	Marks
6(a)	Speed = $\sqrt{4^2 + 5^2} = \sqrt{41}$ or 6.4031...m s ⁻¹ (Accept 6.4 or better)	M1A1 (2)
(b)	$(\mathbf{r} =)(3\mathbf{i} - 2\mathbf{j}) + t(4\mathbf{i} + 5\mathbf{j})$.	M1A1 (2)
(c)	\mathbf{j} comp = 6 $5T - 2 = 6$	M1
	$T = \frac{8}{5}$ (=1.6)	A1 (2)
(d)	$t = 1.6 \Rightarrow (\mathbf{r} =)(3 + (4 \times 1.6))\mathbf{i} (+6\mathbf{j})$ boy travels $9.4 - 1 = 8.4$ m (allow 8.4i)	M1A1ft A1
	$\frac{8.4}{1.6}$ or $\frac{8.4\mathbf{i}}{1.6}$ $v = 5.25$	DM1 A1 (5) [11]
Notes for qu 6		
6a	M1 for attempt to find magnitude of velocity A1 6.4 or better	
6b	M1 for attempt at pv with correct structure i.e. $\mathbf{r}_0 + t\mathbf{v}$ A1 for a correct expression seen (ie use isw)	
6c	M1 for equating \mathbf{j} cpt of their \mathbf{r} to 6 (Must be of form: $a + bT = 6$ oe) A1 for 1.6 oe	
6d	First M1 for substituting their answer for (c), their T , into \mathbf{i} cpt of their answer for (b) oe First A1 ft , with or without \mathbf{i} Second A1 for 8.4 or 8.4i cao Second DM1, dependent on first M1, for dividing their distance or vector (\mathbf{ci}) by their T (> 0) value to find the value of v . ($9.4/T$ oe is DM0) Third A1 for 5.25 cao	

Question Number	Scheme	Marks
7(a)	$2560 \times 0.4 = 2100 - 640 - R$ $R = 436$ * GIVEN ANSWER	M1A1 A1 * (3)
(b)	Truck: $1600 \times 0.4 = 2100 - 640 - T$ OR car: $960 \times 0.4 = T - 436$ $T = 820$ N	M1A1 A1 (3)
(c)	$2560a' = 2100 - 640 - 436 + 1600g \sin \alpha + 960g \sin \alpha$ (omission of g is one error) $a' = 1.05$ or 1.1 m s^{-2}	M1A1A1 A1 (4) [10]
Notes for qu 7		
Use the <i>mass</i> which is being used, in $F=ma$, to decide which part of the system an equation applies to.		
7a	M1 for an equation of motion, dim correct with correct no.of terms, condone sign errors, <i>in R only</i> First A1 for a correct equation Second A1 for $R = 436$ GIVEN ANSWER N.B. They may do (b) first, using the Truck equation to find $T = 820$, and then use Car equation here to show that $R = 436$	
7b	M1 for an equation of motion, dim correct with correct no.of terms, condone sign errors, for either truck or car, in T only. (Equation could appear in (a) but must be being used in (b)) First A1 for a correct equation Second A1 for $T = 820$ (N)	
7c	M1 for an equation of motion <i>in a' only</i> , dim correct with correct no.of terms, condone sign errors and missing g 's, First and second A1 for a correct equation, -1 each error (Omission of g is one error) If both weight cpts are negative, treat as one error. Third A1 for 1.05 or 1.1 (m s^{-2}) N.B. Note that $T = 820$ again but if they just assume that $T = 820$, M0	

Question Number	Scheme	Marks
8(a)	$R(\perp \text{ plane}): R = 0.5g \cos 30^\circ + 5 \sin 30^\circ$	M1A1A1
	$R = 6.743\dots = 6.7 \text{ or } 6.74 \text{ N}$	A1 (4)
(b)	$R(\parallel \text{ plane}): F = 5 \cos 30^\circ - 0.5g \sin 30^\circ (=1.880\dots)$	M1A1A1
	$\mu = \frac{F}{R} = \frac{1.880}{6.743}, = 0.27880\dots = 0.28 \text{ or } 0.279$	M1A1 (5)
(c)	NL2: $0.5g \sin 30^\circ - F' = 0.5a$	M1A1
	$R(\perp \text{ plane}): R' = 0.5g \cos 30^\circ (=4.2435\dots)$	M1A1
	Use of $F' = \mu R' = 0.2787\dots \times R' (=1.18345\dots)$ and solve for a	DM1
	$a = 2.53\dots \text{ m s}^{-2}$	A1
	$v^2 = 2as = 2 \times 2.533 \times 3$	M1
	$v = 3.9 \text{ or } 3.90 \text{ ms}^{-1}$	A1 (8) [17]
Notes for qu 8		
8a	M1 for resolution perp to the plane, with usual rules	
	First and second A1 for a correct equation, -1 each error	
	Third A1 for 6.7 or 6.74 (N) must be positive	
8b	First M1 for resolution parallel to the plane, with usual rules	
	First and second A1 for a correct equation, -1 each error	
	Second M1 for use of $\mu = \frac{F}{R}$	
	Third A1 for 0.28 or 0.279	
8c	SC: If 5N force is not removed, can score max: M1A0M1A0DM1A0M0A0 with usual rules applying for M marks assuming that 5N force still acting.	
	First M1 for equation of motion parallel to plane, with usual rules	
	First A1 for a correct equation (F' does not need to be substituted and allow if they use the value of F from part (b))	
	Second M1 for resolution perp to the plane, with usual rules	
	Second A1 for a correct equation	
	Third DM1, dependent on both previous M marks, for use of $F' = \mu R'$ and	

Question Number	Scheme	Marks
	solving for a	
	Third A1 for $a = 2.53$ or better, if they get v wrong, but if they get $v = 3.9$ then allow $a = 2.5$ or 2.54	
	Fourth M1 (<u>independent but must have used an equation of motion to find a</u>) for complete method to find v using their a <u>M0 if particle is decelerating i.e if their a is negative down the plane.</u>	
	Fourth A1 for $v = 3.9$ or 3.90 ms^{-1}	



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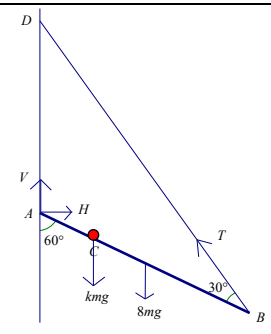
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Pearson Edexcel International Advanced Level
in Mechanics M2 (WME02/01)

Q	Scheme	Marks	Notes
3a	Use of $\mathbf{v} = \frac{d\mathbf{r}}{dt}$:	M1	Differentiate – powers going down
	$\mathbf{v} = (16 - 9t^2)\mathbf{i} + (3t^2 - 2t)\mathbf{j}$	A1	
	i component of velocity = 0:	M1	
	$16 - 9t^2 = 0 \Rightarrow t = \frac{4}{3},$	DM1	Solve for t and find \mathbf{v} or $ \mathbf{v} $ Dependent on previous M1
	$\mathbf{v} = \left(3 \times \frac{16}{9} - 2 \times \frac{4}{3}\right)\mathbf{j} = \frac{8}{3}\mathbf{j} \quad (2.67\mathbf{j})$	A1	Answer must be a vector. ISW
		(5)	
3b	Use of $\mathbf{a} = \frac{d\mathbf{v}}{dt}$:	M1	Differentiate – powers going down
	$\mathbf{a} = (-18t)\mathbf{i} + (6t - 2)\mathbf{j} (= -72\mathbf{i} + 22\mathbf{j})$	A1ft	Follow their \mathbf{v}
	Use of Pythagoras' theorem: $ \mathbf{a} = \sqrt{72^2 + 22^2}$	M1	
	$ \mathbf{a} = \sqrt{5668} = 75.3(\text{m s}^{-2}) (75)$	A1	Or better. From correct work
		(4)	
		[9]	

Q	Scheme	Marks	Notes
4a	Velocity at T : $\rightarrow 12 \cos 30^\circ = u_h (= u \cos \theta^\circ)$	M1	
	$(u \cos \theta^\circ = 6\sqrt{3} = 10.39\dots)$	A1	Correct unsimplified equation for horizontal component of u
	$\uparrow -12 \sin 30^\circ = u_v - 2g (= u \sin \theta^\circ - 2 \times 9.8)$	M1	
	$(u \sin \theta^\circ = 13.6)$	A1	Correct unsimplified equation for vertical component of u
	$\tan \theta^\circ = \frac{13.6}{6\sqrt{3}}$	DM1	Solve equations for u or θ Dependant on both preceding M marks
	$\theta = 52.6$ (53)	A1	One correct (max 3 s.f.)
	$u = 17.1$ (17)	A1	Both correct (max 3 s.f.)
		(7)	
4b	Vertical distance : $h = -12 \sin 30^\circ \times 2 + \frac{1}{2} \times 9.8 \times 2^2$	M1	Complete method using <i>suvat</i> to find h .
	$\left(\text{or } h = 17.1 \sin 52.6^\circ \times 2 - \frac{1}{2} \times 9.8 \times 2^2 \right)$ $\left(\text{or } 6^2 = (u \sin \theta)^\circ - 2gh \right)$	A1	Or equivalent correct unsimplified equation in h
	$h = 7.6$ (7.60)	A1	
		(3)	
4b alt	Using energy: $\frac{1}{2} mu^2 - \frac{1}{2} m12^2 = mgh$	M1A1	
	$h = 7.6$ (7.60)	A1	
		(3)	

Q	Scheme	Marks	Notes
4c	Double the time from max ht to T : $-12 \sin 30^\circ = -gt$	M1	
	Time above T : $2t = 2 \times \frac{12 \sin 30^\circ}{g}$	A1	
	$= 1.22$ (1.2) (s)	A1	
		(3)	
4c alt	Vertical component of speed equal magnitude and opposite sign: $-12 \sin 30^\circ = 12 \sin 30^\circ - gT$	M1	
	$t = \frac{24 \sin 30^\circ}{g}$	A1	
	$t = 1.22$	A1	
		(3)	
4c alt	Equation for vertical distance and solve for values of t : $7.6 = u \sin \theta^\circ \times t - \frac{1}{2}gt^2$, $4.9t^2 - 13.6t + 7.6 = 0$	M1	
	$t_2 - t_1 = \frac{\sqrt{13.6^2 - 4 \times 4.9 \times 7.6}}{4.9}$	A1	$2 - \frac{38}{49}$ (2 - 0.7785)
	$t = 1.22$	A1	From correct work only
		(3)	
	For other alternatives: $\left\{ \begin{array}{ll} \text{complete strategy} & \text{M1} \\ \text{correct equation in } t & \text{A1} \\ t = 1.22 & \text{A1} \end{array} \right.$		
		[13]	

Q	Scheme	Marks	Notes
			
6a	Moments about A:	M1	Need all terms and dimensionally correct
	$kmg \times 0.5a \sin 60^\circ + 8mg \times a \sin 60^\circ = T \sin 30^\circ \times 2a$	A1 A1	Unsimplified equation. -1 each error $\cos 60^\circ$ for $\sin 60^\circ$ twice counts as one error
	$T = g \sin 60^\circ \left(\frac{km}{2} + 8m \right) = \frac{\sqrt{3}}{4} (16+k)mg$ Given Answer	A1	Obtain given answer from correct working
		(4)	
6b	Resolving: $\rightarrow T \cos 60^\circ = H$	M1	Condone sin/cos confusion
	$\uparrow V + T \cos 30^\circ = 8mg + kmg$	M1	Condone sin/cos confusion & sign errors
		A1	Both equations correct unsimplified
			Allow M1M1A1 for alternative equations that are sufficient to solve for k
	Use $F = \mu R$ with their V and H		
	$\left(V = \mu H \Rightarrow (8+k)mg - T \cos 30^\circ = \frac{2}{3} \sqrt{3} \times T \cos 60^\circ \right)$	M1	Dependent on having expressions for V and H
	Substitute for T and solve for k : $(8+k) - \frac{3}{8}(16+k) = \frac{\sqrt{3}}{3} \frac{\sqrt{3}}{4}(16+k)$	DM1	Dependent on 3 preceding M marks
	$2 + \frac{5}{8}k = 4 + \frac{1}{4}k$, $\frac{3}{8}k = 2$, $k = \frac{16}{3}$ (or 5.33)	A1	
		(6)	
		[10]	