Mark Scheme (Results)

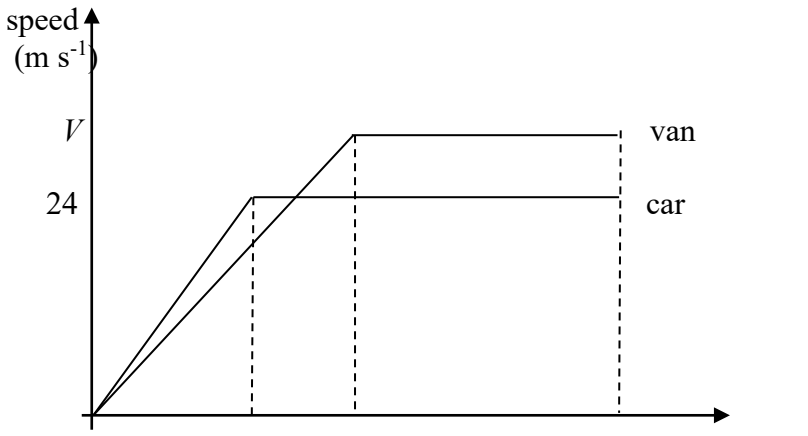
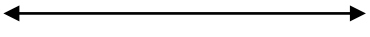
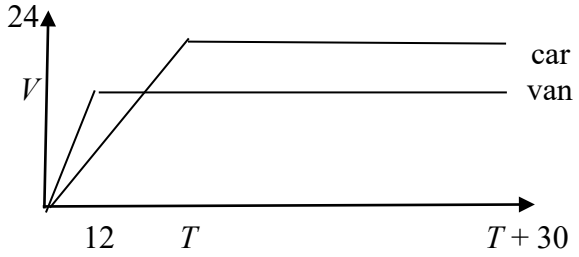
October 2018

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

Question Number	Scheme	Marks
2(a)	**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. $\mathrm{R}(\uparrow)$: $0.5R_C + R_C = 60 + 12$ (N.B. $R_A = \frac{1}{2}R_C$)	M1A1
	Possible moments equations: $\mathrm{M}(A)$: $60x + (12\times 5) = R_C \times 3$	M1A1
	$\mathrm{M}(B)$: $(2\times R_C) + \left(\frac{1}{2}R_C \times 5\right) = 60(5-x)$	
	$\mathrm{M}(C)$: $(\frac{1}{2}R_C \times 3) + (12\times 2) = 60(3-x)$	
	$\mathrm{M}(G)$: $12(5-x) + \frac{1}{2}R_C x = R_C(3-x)$	
	Eliminate R_C and solve for x (AG)	**DM1**
	$x = 1.4$ m	A1 (6)
(b)	(i) the weight of the parcel acts at B	B1
	(ii) the plank remains straight	B1 (2)
	(or equivalent statements)	**[8]**
	Notes for qu 2	
	N.B. If R and $\frac{1}{2}R$ are reversed, max score is M1A1 (resolution) M1A0 (moments)	
2a	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	
	First A1 for a correct resolution in one unknown or moments equation in two unknowns	
	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	
	Second A1 for a correct resolution in one unknown or moments equation in two unknowns	
	Third DM1, dependent on both previous M marks, for eliminating and solving for AG	
	Third A1 for 1.4 (m) oe	
2b (i)	First B1 e.g. mass is concentrated **at *B*** B0 if incorrect extras	
(ii)	Second B1 e.g. the plank doesn't buckle or bend B0 if incorrect extras	

Question Number	Scheme	Marks
3	**EITHER:** $h=-19.6(t+3)+\frac{1}{2}g(t+3)^2$ and $h=\frac{1}{2}gt^2$	M1A1A1
	OR : $h=-19.6T+\frac{1}{2}gT^2$ and $h=\frac{1}{2}g\left(T-3\right)^2$	M1A1A1
	$-19.6T+\frac{1}{2}gT^2=\frac{1}{2}g\left(T-3\right)^2$ **OR** $-19.6(t+3)+\frac{1}{2}g(t+3)^2=\frac{1}{2}gt^2$	M1
(i)	$T=4.5$	A1
(ii)	$h=\frac{1}{2}\times 9.8\times\left(T-3\right)^2$ oe	M1
	$=11$ or 11.0	A1 **[7]**
	Notes for qu 3	
3	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	
	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)	
	Second A1 for a correct equation for **stone 2** **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. **N.B.** When *h* and *T* are used in any equation, they must be used correctly (including sign of *h*) to obtain A marks	
(i)	Second M1 for eliminating *h*	
	Third A1 for *T* = 4.5	
(ii)	Third M1 for using their *T* or *t* value in one of their equations to obtain an *h* value	
	Fourth A1 for *h* = 11 or 11.0	

Question Number	Scheme	Marks
4.	$\sin\theta = \frac{3}{5}$ 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 trig function of e.g. 37° or 53° anywhere. **N.B.** If they assume angles are 45° can score max B0M1A0A1M0A0A0	B1
	Any *two* 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)	M1A1 (1^{st} equation) M1A1 (2^{nd} equation)
(i)	**N.B**. In all of these equations, θ is what they *think* 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.**	A1
(ii)	$m = 2.04$ or 2.0 (A0 for 2)	A1 **[7]**
	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 2^{nd} 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)	 **OR** 	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)
	N.B. 	**This graph can score all 3 marks.**
(b)	$\frac{1}{2}(T+30+30)\times 24=816$ **OR** $\frac{1}{2}\times T\times 24+30\times 24=816$ $T=8$ (s)	M1A1 A1 (3)
(c)	$\frac{1}{2}\big((T+30)+(T+18)\big)V=816$ **OR** $\frac{1}{2}\times 12V+V(18+T)=816$ $V=25.5$	M1A1 **ft** A1 (3) **[9]**
ALT	(b) Dist travelled while accelerating $=816-720=96$ m $s=\frac{u+v}{2}t \Rightarrow \left(\frac{0+24}{2}\right)T=96$ M1A1 $T=8$ (s) A1	

Question Number	Scheme	Marks
	(c) Dist travelled by the van $= \frac{1}{2} \times 12V + (18+T) \times V = 816$ M1A1**ft** $V = 25.5$ 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) *only* , using 816 distance travelled by CAR, *with correct structure* i.e. a trapezium or (triangle + rectangle)	
	First A1 for a correct equation	
	Second A1 for 8 (s)	
5c	M1 for equation in V *only* , using 816 distance travelled by VAN , *with correct structure* 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)	$(\mathbf{r} =)\left(3\mathbf{i}-2\mathbf{j}\right)+t\left(\mathbf{4i}+5\mathbf{j}\right)$.	M1A1 (2)
(c)	$\mathbf{j}$ comp $= 6$	
	$5T-2=6$	M1
	$T=\frac{8}{5}\ \left(=1.6\right)$	A1 (2)
(d)	$t=1.6\ \Rightarrow\ (\mathbf{r} =)(3+(4\times1.6))\mathbf{i}\ \ \left(+6\mathbf{j}\right)$	M1A1**ft**
	boy travels $9.4-1=8.4$ m (allow 8.4**i)**	A1
	$\frac{8.4}{1.6}$ or $\frac{8.4\mathbf{i}}{1.6}$	**DM**1
	$v = 5.25$	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 **j** cpt of their **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 **i** cpt of their answer for (b) oe	
	First A1 **ft ,** with or without **i**	
	Second A1 for 8.4 or 8.4**i** cao	
	Second DM1, dependent on first M1, for dividing their distance or vector (c**i)** 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)	$2560\times0.4=2100-640-R$	M1A1
	$R=436$ * GIVEN ANSWER	A1 * (3)
(b)	Truck: $1600\times0.4=2100-640-T$ **OR** car: $960\times0.4=T-436$	M1A1
	$T=820$ N	A1 (3)
(c)	$2560a'=2100-640-436+1600g\sin\alpha+960g\sin\alpha$ (omission of g is one error)	M1A1A1
	$a'=1.05$ or 1.1 m s^{-2}	A1 (4) **[10]**
	Notes for qu 7	
	Use the *mass* 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, *in R only*	
	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 *in a' only*, 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$(\perp$ plane$)$: $R = 0.5g\cos 30^\circ + 5\sin 30°$	M1A1A1
	$R = 6.743... = 6.7$ or 6.74 N	A1 (4)
(b)	R$(\|\|$ plane$)$: $F = 5\cos 30° - 0.5g\sin 30°$ $(= 1.880...)$	M1A1A1
	$\mu = \frac{F}{R} = \frac{1.880}{6.743}$, $= 0.27880... = 0.28$ or 0.279	M1A1 (5)
(c)	NL2: $0.5g\sin 30° - F' = 0.5a$	M1A1
	R$(\perp$ plane$)$: $R' = 0.5g\cos 30^\circ$ $(= 4.2435...)$	M1A1
	Use of $F' = \mu R' = 0.2787... \times R'$ $(= 1.18345...)$ and solve for a	**DM**1
	$a = 2.53...$ m s^{-2}	A1
	$v^2 = 2as = 2 \times 2.533 \times 3$	M1
	$v = 3.9$ or 3.90 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 (independent but must have used an equation of motion to find a) for complete method to find v using their a M0 if particle is decelerating i.e if their a is negative down the plane.	
	Fourth A1 for $v = 3.9$ or $3.90\ \text{ms}^{-1}$	

Mark Scheme (Results)

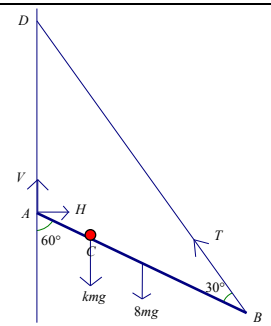
October 2018

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

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

Q	Scheme	Marks	Notes
4a	Velocity at T: $\rightarrow\ 12\cos 30° = u_h \left(= u\cos\theta°\right)$	M1	
	$\left(u\cos\theta° = 6\sqrt{3} = 10.39....\right)$	A1	Correct unsimplified equation for horizontal component of u
	$\uparrow\ -12\sin 30° = u_v - 2g\left(= u\sin\theta° - 2\times 9.8\right)$	M1	
	$\left(u\sin\theta° = 13.6\right)$	A1	Correct unsimplified equation for vertical component of u
	$\tan\theta° = \dfrac{13.6}{6\sqrt{3}}$	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 : $h = -12\sin 30°\times 2 + \dfrac{1}{2}\times 9.8\times 2^2$	M1	Complete method using *suvat* to find h.
	$\left(\text{or}\ \ h = 17.1\sin 52.6°\times 2 - \dfrac{1}{2}\times 9.8\times 2^2\right)$ $\left(\text{or}\ \ 6^2 = \left(u\sin\theta\right)^2 - 2gh\right)$	A1	Or equivalent correct unsimplified equation in h
	$h = 7.6\ (7.60)$	A1	
		(3)	
4b alt	Using energy: $\dfrac{1}{2}mu^2 - \dfrac{1}{2}m12^2 = mgh$	M1A1	
	$h = 7.6\ (7.60)$	A1	
		(3)	

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

Q	Scheme	Marks	Notes
			
6a	Moments about A:	M1	Need all terms and dimensionally correct
	$kmg \times 0.5a \sin 60° + 8mg \times a \sin 60° = T \sin 30° \times 2a$	A1 A1	Unsimplified equation. -1 each error $\cos 60°$ for $\sin 60°$ twice counts as one error
	$T = g \sin 60° \left(\frac{km}{2} + 8m \right) = \frac{\sqrt{3}}{4}(16+k)mg$ **Given Answer**	A1	Obtain **given answer** from correct working
		(4)	
6b	Resolving: $\rightarrow$ $T \cos 60° = H$	M1	Condone sin/cos confusion
	$\uparrow$ $V + T \cos 30° = 8mg + kmg$	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 $\left(V = \mu H \Rightarrow (8+k)mg - T \cos 30° = \frac{2}{3}\sqrt{3} \times T \cos 60° \right)$	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]	