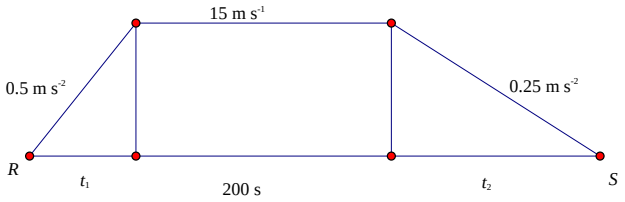
Pearson

Mark Scheme (Results)

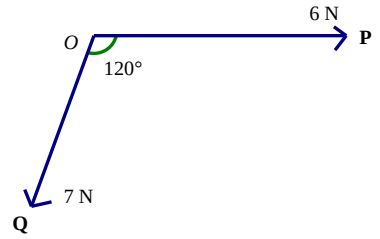
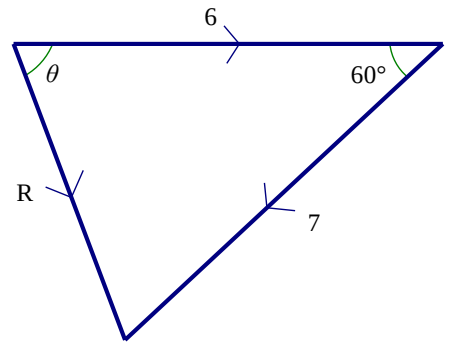
January 2017

Pearson Edexcel International A Levels in Mechanics 1(WME01/01)

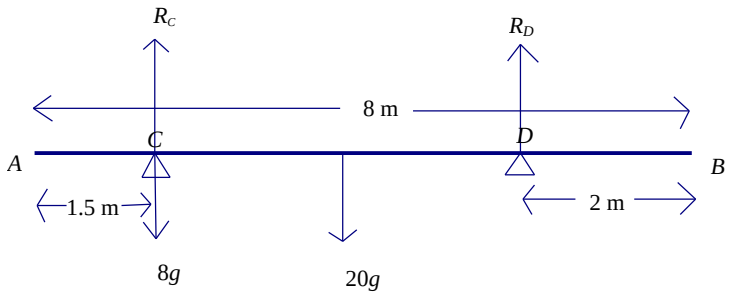
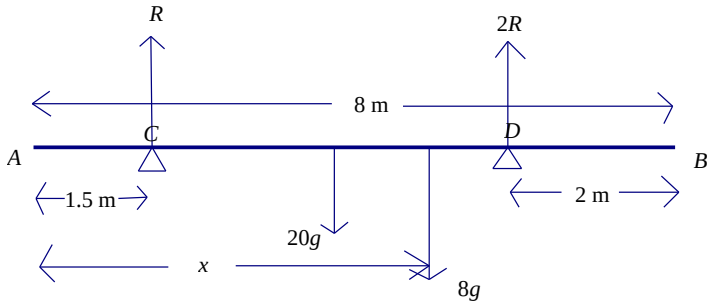
edexcel

Question Number	Scheme	Marks
1a		
	Use of $v = u + at$ to find t_1 or t_2	M1
	$t_1 = 15 \div 0.5 = 30\,(\text{s})$ **OR** $t_2 = 15 \div 0.25 = 60$	A1
	Total time $= 30 + 200 + 60 = 290\,(\text{s})$	A1 **cso**
		(3)
1b	Use area/ *suvat* to find distance: $\text{distance} = \frac{1}{2} \times 30 \times 15 + 200 \times 15 + \frac{1}{2} \times 60 \times 15$ Follow their t_1 & t_2	M1A2 **ft**
	$= 3675\,(\text{m})$ (3.675 km)	A1
		(4)
1c	Ave. speed $= \frac{\text{their(b)}}{\text{their(a)}}$	M1
	$= \frac{3675}{290}$ oe (m s^{-1}) (12.6724..)	A1
		(2)
		[9]
	Notes	
1a	M1 for use of $v = u + at$ or gradient or any other complete method to find a value for t_1 or t_2 (condone sign errors)	
	First A1 for either 30 or 60 (A0 if negative)	
	Second A1 for 290 with no errors seen	
1b	M1 for a complete method to find distance (must have a ½) either by using trapezium rule or by using 2 triangles and a rectangle	
	A2 **ft** on their t_1 & t_2 (-1 each error)	
	A1 for 3675 (m) or 3.675 km	
1c	M1 for $= \frac{\text{their(b)}}{\text{their(a)}}$	
	A1 for 13 or better	

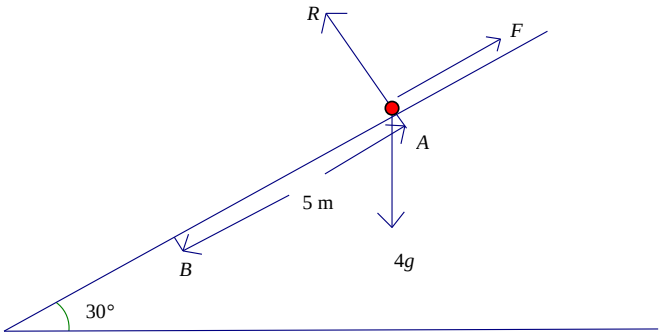
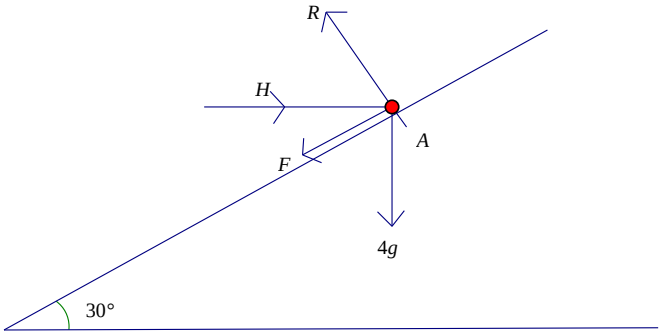
Question Number	Scheme	Marks
	Accept column vectors throughout	
2a	Use of $\mathbf{F} = m\mathbf{a}$: $2\mathbf{i} + 3\mathbf{j} = 0.5\mathbf{a}$	M1
	$\mathbf{a} = 4\mathbf{i} + 6\mathbf{j}$ (m s^{-2})	A1
		(2)
2b	Use of $\mathbf{v} = \mathbf{u} + 3\mathbf{a}$ with their $\mathbf{a}$	M1
	$= 16\mathbf{i} + 18\mathbf{j}$	A1
	Use of Pythagoras: speed $= \sqrt{16^2 + 18^2}$	M1
	$= \sqrt{580}$ or 24 (m s^{-1}) or better	A1
		(4)
2c	In component form: $\mathbf{v} = 4\mathbf{i} + t(4\mathbf{i} + 6\mathbf{j})$	M1
	$4 + 4T = 2 \times 6T$	M1
	$T = \frac{1}{2}$	A1
		(3)
		[9]
	Notes	
2a	M1 for use for $\mathbf{F} = m\mathbf{a}$:	
	A1 for $4\mathbf{i} + 6\mathbf{j}$ (m s^{-2}) isw if magnitude found.	
2b	First M1 for $\mathbf{v} = 4\mathbf{i} + 3(4\mathbf{i} + 6\mathbf{j})$ with their $\mathbf{a}$ (but M0 if they use 2**i** + 3**j** (the force) instead of **a**)	
	First A1 for $16\mathbf{i} + 18\mathbf{j}$ seen or implied	
	Second M1 for finding magnitude of their **v**	
	Second A1 for 24 or better (24.0831…) or $\sqrt{580}$	
2c	First M1 for $\mathbf{v} = 4\mathbf{i} + t(4\mathbf{i} + 6\mathbf{j})$ with their $\mathbf{a}$ (but M0 if they use 2**i** + 3**j** (the force) instead of **a**)	
	Second independent M1 for a correct method to give an equation in T *(t) only* using their **v**	
	A1 for (T) = ½	

Question Number	Scheme	Marks
3		
Method 1	Horizontal component $= 6 - 7\cos 60$ (N)	M1A1
	Vertical component (N) $= 7\cos 30$	M1A1
	Use Pythagoras: $\sqrt{2.5^2 + 6.06^2} = \sqrt{43} = 6.6$(N) or better	M1A1
	Use trig: angle = $\tan^{-1}(\frac{7\cos 30}{2.5}) = 68^o$(below **P**) or better Also allow 112^0, 292^0 or 248^0	M1A1
		(8)
Alt		
	Cosine rule to find $\lvert\mathbf{R}\rvert$: $R^2 = 36 + 49 - 2\times 6\times 7\times\cos 60 (= 43)$	M2 A2
	R = 6.6 (N) or better	M1 A1
	Solve Sine rule for θ: $\sin^{-1}(\frac{7\sin 60}{R})$	M1
	= 68^o or better Also allow 112^0 or 292^0 or 248^0	A1
		[8]
	Notes	
Method 1	First M1 for attempt, allow sin/cos confusion, to find component parallel to **P**	
	First A1 for a correct expression	
	Second M1 for attempt, allow sin/cos confusion to find component perp to **P**	
	First A1 for a correct expression	
	Third M1 for using Pythag to find magnitude of **R**	
	Third A1 for $\sqrt{43}$, 6.6 (N) or better	
	Fourth M1 for complete method to find angle (M0 if 6 used for 'horiz' cpt) Fourth A1 for 68^o or better (67.589089…) 112^0 or 292^0 or 248^0	

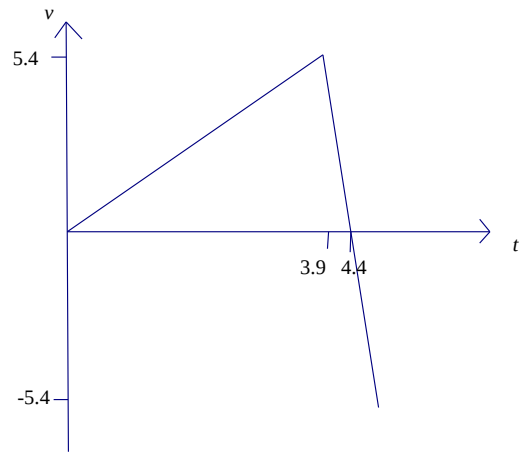
Question Number	Scheme	Marks
Alt	**Notes** First M2 for use of cosine rule with correct structure but allow $\cos 120^o$ and allow R^2 First A2 for a correct equation. (<u>A0 if 120^o used</u>) Third M1 for solving for R Third A1 for $\sqrt{43}$, 6.6 (N) or better Fourth M1 for complete method (e.g. sine rule) to find angle between their **R** and **P** Fourth A1 for 68^o or better	

Question Number	Scheme	Marks
4a		
	Moments about D: $20g\times 2+8g\times 4.5=R_C\times 4.5$ **OR** Resolve: $R_C+R_D=28g$	M1A1
(i)	$R_C=\frac{152}{9}g\,(=166 \text{ or } 170)$	A1
	Moments about C: $20g\times 2.5=R_D\times 4.5$ **OR** Resolve: $R_C+R_D=28g$	M1A1
(ii)	$R_D=\frac{100}{9}g\,(=109 \text{ or } 110)$	A1
		(6)
4b		
	Moments about A: $R\times 1.5+2R\times 6=20g\times 4+8g\times x$	M1A1
	Resolve: $3R=28g$, $\left(R=\frac{28}{3}g\,(=91.5)\right)$	M1A1
	Substitute for R and solve for x: $\frac{27}{2}\times\frac{28}{3}g=80g+8g\times x$	M1
	$126=80+8x$, $8x=46$, $x=5.75\,(\text{m})$	A1
		(6)
4c	The weight of the package acts at point C (or E)	B1 (1)
		[13]
	Notes **N.B.** In both parts, enter marks on ePen for the *equations* as they appear **BUT** in part (a) second A1 is for R_C and fourth A1 is for R_D Remember to only penalise overaccuracy, after use of g, ONCE per whole question	

Question Number	Scheme	Marks
4a	**Omission of g is an A error in this part.** If answers are given as decimal multiples of g, penalise once If answers given as (fraction x g), fraction must be ratio of two integers First M1 for any moments equation (even if it contains both reactions) or vertical resolution First A1 for a correct equation Second A1 for $R_C = \frac{152}{9}g \left(= 166 \text{ or } 170\right)$ Second M1 for another moments equation (even if it contains both reactions) or vert resolution Third A1 for a correct equation Fourth A1 for $R_D = \frac{100}{9}g \left(= 109 \text{ or } 110\right)$	
4b **4c**	**Notes** **N.B. Consistent omission of g can score full marks in this part.** **If they use the values of the reactions from part(a), no marks for part b.** If *R* and 2*R* reversed, can score max M1A1 (vert res) M1A0 (mom about C or D) M1A0 First M1 for a moments equation in *R* and *x* only (*x* may not be *AE*) First A1 for a correct equation e.g. M(A) $R \times 1.5 + 2R \times 6 = 20g \times 4 + 8g \times x$ Second M1 for another moments equation in *R* and *x* only or vert resolution in *R* only Second A1 for a correct equation Third M1 for solving for *AE* Third A1 for 5.75 (m) (Must be EXACT) Mass or wt of package is or acts at (point) *C* (or *E*)	

Question Number	Scheme	Marks
6a		
	Resolve perpendicular to plane: $R = 4g\cos 30$	B1
	$F = 0.3R$ seen	B1
	Use of $F = ma$ parallel to plane: $4a = 4g\sin 30 - F$	M1A1
	$4a = 4g\sin 30 - 0.3\times 4g\cos 30$	A1
	Use of $v^2 = (u^2 +)2as$: $v = \sqrt{(10a)}$	M1
	v = 4.9 or 4.85(m s^{-1})	A1
		(7)
6b		
	Resolve perpendicular to the plane: $R = 4g\cos 30 + H\cos 60$	M1A1
	Resolve parallel to the plane: $H\cos 30 = F + 4g\sin 30$	M1A1
	Use of $F = 0.3R$	M1
	Solve for H: $H = \dfrac{g(1.2\cos 30 + 4\sin 30)}{\cos 30 - 0.3\cos 60}$	**DM**1
	= 42 or 41.6	A1
		(7)
6b alt	Resolve vertically: $R\cos 30 = 4g + F\cos 60$	M1A1
	Resolve horizontally: $H = R\cos 60 + F\cos 30$	M1A1
	Use of $F = 0.3R$	M1
	Solve for H:	**DM**1
	H = 42 or 41.6	A1 (7)
	N.B. Enter marks on ePen for equations as they appear.	[14]

Question Number	Scheme	Marks
6a	**Notes** First B1 for $R = 4g\cos 30$ Second B1 for $F = 0.3R$ seen (could just be on diagram) First M1 for equation of motion, with usual rules, condone sign errors First A1 for a correct equation (F not substituted) Second A1 for a correct equation in a only, without trig ratios substituted Second M1 for a complete method for finding v (must have found an a value) Third A1 for 4.9 or 4.85	
6b	First M1 for a resolution, with usual rules, condone sign errors First A1 for a correct equation Second M1 for another resolution, with usual rules, condone sign errors Second A1 for a correct equation Third M1 for use of (i.e. it must appear in an equation) $F = 0.3R$ (**N.B.** M0 if using R from part **a**) Fourth M1 **dependent** on first, second and third M's, for eliminating F and R and solving for H Third A1 for 42 or 41.6	

Question Number	Scheme	Marks
7a	Motion of P: $T - 3g = 3a$	M1
	$33.6 - 3g = 3a$	A1
	$a = 1.4\ (\text{m s}^{-2})$ ***Given Answer***	A1
		(3)
7b	Motion of Q: $mg - T = ma$	M1
	$mg - 33.6 = 1.4m$	A1
	$m = 4$	A1
		(3)
7c	Use of $s = (ut +)\frac{1}{2}at^2$: $10.5 = \frac{1}{2} \times 1.4 \times t^2$	M1A1
	$T_1 = \sqrt{15} = 3.9$ or better	A1
		(3)
7d	Use $v^2 = (u^2 +)2as$ to find speed of particles when Q hits ground: $v = \sqrt{2 \times 1.4 \times 10.5}\ (= \sqrt{29.4})$	M1
	Use $v = u + at$ to find additional time for P to come to rest: $0 = \sqrt{29.4} - gt$	**DM**1
	Total time : $T_2 = \sqrt{15} + \frac{\sqrt{29.4}}{9.8} = 4.4$ or 4.43	A1
		(3)
7e		B1 Shape **DB**1 **ft** their values for 5.4, -5.4, 3.9, 4.4 (or T_1 T_2) (2)
		[14]

Question Number	Scheme	Marks
	Notes	
7a	M1 for equation of motion for P with T not substituted, condone sign errors First A1 for a correct equation in a only (allow $\pm a$) Second A1 for **given answer** (units not needed)	
7b	M1 for equation of motion for Q with neither T nor a substituted, condone sign errors First A1 for a correct equation in m only Second A1 for $m = 4$ **N.B.** Whole system equn: $mg - 3g = a(m + 3)$ may be used	
7c	M1 for a complete method to find T_1 (M0 if g used) First A1 for a correct equation (or equations) Second A1 for $\sqrt{15}$, 3.9 or better $v = \sqrt{29.4}$ (5.4) may be found in this part but only gets credit if it appears in part (d)	
7d	First M1 for a complete method to find the speed of particles when Q hits the ground (M0 if using g) Second M1 **dependent** on first M1for a complete method to find the additional time for P to come to rest (must be using g) A1 for 4.4 or 4.43	
7e	First B1 (generous) for shape. Graph does not need to go down as far as it goes up and ignore gradients. (B0 if it goes outside the range $0 \leq t \leq T_3$ or if a continuous vertical line is included) Second **B**1, **dependent** on first B1, **ft** on their $\sqrt{29.4}$, T_1 and T_2 Allow T_1 and T_2 entered on the graph (rather than their numerical values)	

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Mark Scheme (Results)

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Pearson Edexcel International A Level in Mechanics 2 (WME02/01)

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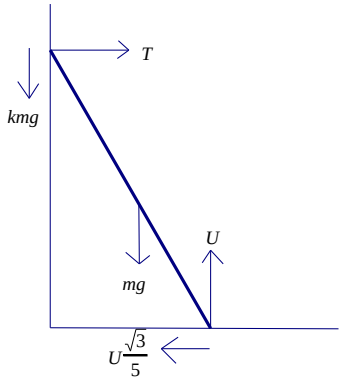
Question Number	Scheme	Marks	Notes
3.	$v=(2t-3)(t-2)=0$	M1	Solve for $v=0$
	$t=\frac{3}{2}$ or 2	A1	Both values
			The first two marks could be implied by the use of 2 and $\frac{3}{2}$ as limits in the integration
	$\int 2t^2-7t+6\mathrm{d}t$	M1	Use of $s=\int v\mathrm{d}t$
	$=\frac{2}{3}t^3-\frac{7}{2}t^2+6t\,(+C)$	A1	Correct integration
	$s=\int_0^{\frac{3}{2}} v\ \mathrm{d}t-\int_{\frac{3}{2}}^{2} v\ \mathrm{d}t+\int_2^3 v\ \mathrm{d}t$	M1	Correct strategy for distance. Accept equivalent e.g. $s=\int_0^3 v\ \mathrm{d}t+2\left\lvert\int_{\frac{3}{2}}^{2} v\ \mathrm{d}t\right\rvert$
	$=\left[\frac{2}{3}t^3-\frac{7}{2}t^2+6t\right]_0^{\frac{3}{2}}$ $-\left[\frac{2}{3}t^3-\frac{7}{2}t^2+6t\right]_{\frac{3}{2}}^{2}$ $+\left[\frac{2}{3}t^3-\frac{7}{2}t^2+6t\right]_2^3$		$=\frac{27}{8}+\frac{1}{24}+\frac{7}{6}$
	$=\frac{55}{12}$	A1	4.6 or better from correct working
		6	

NB Marks changed - 3rd M1 is shown as A1 on epen.

Question Number	Scheme	Marks	Notes
7(a)	$M(A) \quad S.2a\cos 30^\circ = mga\sin 30^\circ$	M1	Correct number of terms. Terms must be dimensionally correct Condone trig confusion
		A1	At most one error Consistent trig confusion is one error
		A1	Correct unsimplified equation
	$S = \dfrac{mg\sqrt{3}}{6}$	A1 (4)	Accept exact equivalent Accept $0.289mg$ or better
(b)	$R = mg \ ; \quad F = S$	B1	Resolve vertically and horizontally - must be stated or shown on a diagram. (Used here if seen in (a))
	$\dfrac{mg\sqrt{3}}{6} \le \mu mg$	M1	Use of $F \le \mu R$ (not for $F = \mu R$ followed by a fudge of the inequality)
	$\dfrac{\sqrt{3}}{6} \le \mu$	A1 (3)	***Answer Given*** CSO
(c)			
	$\updownarrow : U = mg + kmg = mg(1+k)$	B1	Or equation in U and k from a second moments equation.
	M(A): $T \times 2a \times \dfrac{\sqrt{3}}{2} = mga \times \dfrac{1}{2} + kmg\,2a \times \dfrac{1}{2}$ M(B): $mg \times \dfrac{a}{2} + \dfrac{U\sqrt{3}}{5} \times \sqrt{3}a = Ua$ M(X): $kmga + mg \times \dfrac{a}{2} = \dfrac{U\sqrt{3}}{5} \times \sqrt{3}a$ M(corner): $aU = Ta\sqrt{3} + mg\dfrac{a}{2}$	M1	Need all three terms. Condone $\mu = \dfrac{\sqrt{3}}{6}$ Terms must be dimensionally correct. Condone trig confusion. Condone sign errors (X is point of intersection of lines of action of T and U)
	$\Rightarrow 2T\cos 30° = mg\sin 30° + 2kmg\sin 30°$	A1	Correct unsimplified moments equation
	$\Rightarrow \dfrac{3}{5}U = \dfrac{1}{2}mg + kmg$	A1	Correct equation in U (and k) μ correct if used
	$\Rightarrow \dfrac{3}{5}(1+k) = \dfrac{1}{2} + k$	DM1	Solve for k. Dependent on preceding M
	$k = \dfrac{1}{4}$	A1 (6)	
		13	

Question Number	Scheme	Marks	Notes
8(a)	Vertical motion : Use of $v = u + at$	M1	Correct equation in U, t
	$(\uparrow)$: $-U = U - gt$	A1	
	Horizontal motion: Use of $s = ut$	M1	Second equation in U and their t e.g. $\frac{U^2}{2g} = U \times \frac{20}{U} - \frac{g}{2}\left(\frac{20}{U}\right)^2$
	$(\rightarrow)$: $3Ut = 120$	A1ft	Follow their t provided it matches the value of s used.
	$\Rightarrow U = 14$	A1	***Answer Given*** Need to see supporting evidence e.g. correct linear equation or solution of quadratic in U^2 giving $U^2 = 20g$
		(5)	
(b)	$v = \sqrt{U^2 + (3U)^2}$	M1	Correct use of Pythagoras' theorem and $U = 14$
	$v = 14\sqrt{10} = 44$ or 44.3 m s^{-1}	A1	Max 3 s.f.
		(2)	
(c)	$\tan\alpha = \frac{1}{4} \Rightarrow \frac{V}{3U} = \frac{1}{4}$	M1	Use angle to find vertical component
	$\Rightarrow V = \frac{3}{4}U$	A1	$\left(10.5\ \left(\text{m s}^{-1}\right)\right)$
	Use of $v = u + at$ $(\uparrow)$: $\pm\frac{3}{4}U = U - gt$	M1	Condone without $\pm$ Accept complete alternative routes via suvat.
		A1	Correct unsimplified (including $\pm$)
	$t_1 = \frac{U}{4g} = 0.36\text{s}$, $t_2 = \frac{7U}{4g} = 2.5\text{s}$	A1	One value correct Accept $\frac{7}{2g}$ and $\frac{49}{2g}$, but not $\frac{5}{14}$ decimals to max 3 s.f.
		A1	Both values correct Apply accuracy penalty only once
		(6)	
		13	

NB a candidate who misreads horizontal and vertical components gets $t = 4.64\left(\frac{13u}{4g}\right)$ and $t = 3.93\left(\frac{11u}{4g}\right)$.

They can score 11/13. Deduct the first 2 A marks for the misread penalty.