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Surname	Other names
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Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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Mechanics M1

Advanced/Advanced Subsidiary

Friday 6 June 2014 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
WME01/01

You must have:
Mathematical Formulae and Statistical Tables (Blue)

Total Marks

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Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Whenever a numerical value of g is required, take $g = 9.8 \text{ m s}^{-2}$, and give your answer to either two significant figures or three significant figures.
- When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information

- The total mark for this paper is 75.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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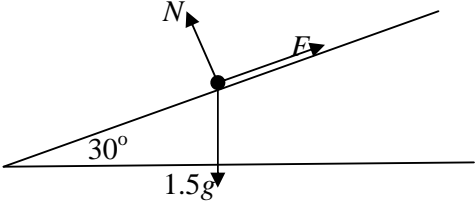
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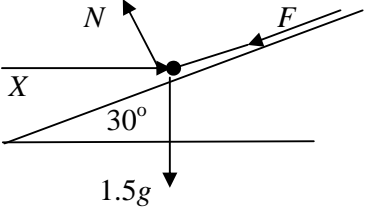


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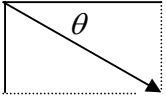
Question Number	Scheme	Marks	Notes
1.			
(a)	$0.9 \times 2 - 0.6v = 0 + 0.6 \times 2$	M1	Equation with all the terms – condone “0” missing. Terms must be of the form mv , but condone sign errors. Condone g present as a common factor. Correct unsimplified equation
	$v = 1$	A1	
		A1 (3)	
(b)	$I = 0.6(v + 2) = 1.8 \text{ N s}$ or $I = 0.9 \times 2 = 1.8 \text{ N s}$	M1	Change in momentum of A or of B . Condone sign slips and negative answer. No g . 1.8 only (or exact equivalent) From correct work only.
		A1	
		(2)	
	Watch out for fortuitous answers in (b); $v = 5$ from (a) used in (b) will score at most M1A0 in (b)	[5]	

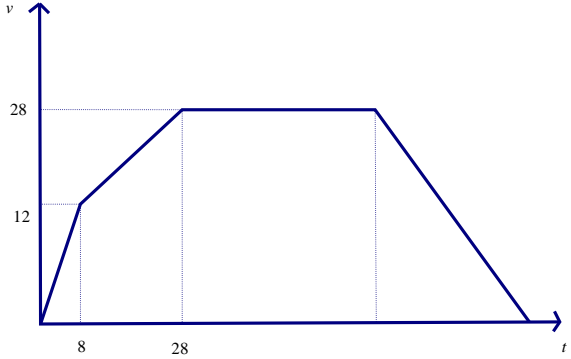
Question Number	Scheme	Marks	Notes
2 (a)	$h = -20 \times 5 + \frac{1}{2} \times 9.8 \times 25$	M1	Use of $s = ut + \frac{1}{2}at^2$ to find h . Must quote the correct formula and be using 20 & 5, but condone slips in substitution. Accept complete alternative solutions working via the maximum height. (max ht 20.4..., time to top 2.04...)
	$h = 22.5$ <p>NB Do not ignore subsequent working if they reach 22.5 and then move on to do further work.</p>	A1	Accept complete alternative methods using other <i>suvat</i> equations.
(b)	$V^2 = 20^2 + 2 \times 9.8 \times 22.5 \quad \text{OR} \quad V = -20 + (5 \times 9.8)$ $(V^2 = 841) \quad \quad \quad = 29$	M1	Correctly substituted equation(s) Condone use of a premature approximation. Final answer. Accept 22.5 or 23. Maximum 3sf. -22.5 is A0.
		A1	First ball - use of <i>suvat</i> to find V or V^2 Follow their h . Correct only (condone -29)
	$\left(\frac{3}{4}V\right)^2 = w^2 + 2 \times 9.8 \times 22.5$	M1	Second ball - <i>suvat</i> equation in V (or their V) to find w . Must be using the $\frac{3}{4}$.
	$w^2 = \frac{9}{16} \times 841 - 2 \times 9.8 \times 22.5$ $w = 5.66$	A1ft	Correctly substituted equation with their V and their h .
		A1	or 5.7. Answer correct to 2 s.f. or to 3 s.f.
		(5)	
		[8]	

Question Number	Scheme	Marks	Notes
<p>3</p> <p>(a)</p>	<div style="text-align: center;">  </div> <p>For equilibrium</p> <p>R(\perp plane) $N = 1.5g \cos 30$</p> <p>R(\parallel plane) $F = 1.5g \cos 60$</p> $\frac{F}{N} = \frac{\cos 60}{\cos 30} = 0.577... < 0.6$ <p>\therefore equilibrium</p> <p>ALT for first 3 marks: Resolve vertically $N \cos 30 + F \cos 60 = 1.5g$ Resolve horizontally $N \cos 60 = F \cos 30$</p> <p>ALT for last 2 marks: $F_{\max} = 0.6 \times 12.73 = 7.63 > 7.35$ $\therefore P$ is at rest</p> <p>Candidates who think that the diagram applies to (a) will score nothing in (a) but if they carry their results forward in to (b) then their work can score the marks available in (b).</p>	<p>M1</p> <p>A1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>(5)</p> <p>M1A1</p> <p>A1</p> <p>M1</p> <p>A1</p>	<p>For resolution of forces parallel or perpendicular to the plane. Weight must be resolved. Condone sin/cos confusion.</p> <p>Correct equation for N (12.7)</p> <p>Correct equation for F (7.35). Condone μR</p> <p>Use of $F_{\max} = \mu N$ and compare with F, or find the value of their $\frac{F}{N}$ and compare with μ</p> <p>Reach given conclusion correctly. They must make some comment, however brief.</p> <p>If the candidate has given the equation of motion for the particle moving down the plane then $A1$ for $1.5g \sin 30 - \mu R = \pm 1.5a$ To score more they need to comment correctly on their answer: $a = -0.19$ impossible M1 Conclude that the particle cannot be moving. A1</p>

Question Number	Scheme	Marks	Notes
(b)	 <p>R (\perp plane) $N = 1.5g \cos 30 + X \cos 60$</p> <p>R ($\parallel$ plane) $X \cos 30 = 1.5g \cos 60 + F$</p> $N = 1.5g \cos 30 + \frac{\cos 60}{\cos 30} (1.5g \cos 60 + 0.6N)$ $N \left(1 - \frac{\cos 60}{\cos 30} \times 0.6 \right) = 1.5g \cos 30 + \frac{\cos 60}{\cos 30} \times 1.5g \cos 60$ <p>(i) $N = 26$ or 26.0 (N)</p> <p>(ii) $X = (N - 1.5g \cos 30) \div \cos 60$ $X = 26$ or 26.5</p> <p>Alt:</p> $N \cos 30 - F \cos 60 = 1.5g, \quad N \cos 30 - 0.6N \cos 60 = 1.5g$ $N = \frac{1.5g}{\cos 30 - 0.6 \cos 60} = 26 \text{ or } 26.0$ $X = F \cos 30 + N \cos 60, = N(0.6 \cos 30 + \cos 60)$ $X = 26 \text{ or } 26.5$	<p>M1</p> <p>M1</p> <p>A1</p> <p>DM1</p> <p>A1</p> <p>DM1</p> <p>A1 (7)</p> <p>[12]</p> <p>M1,</p> <p>DM1</p> <p>A1</p> <p>A1</p> <p>M1,</p> <p>DM1</p> <p>A1</p>	<p>Requires all 3 terms. Condone sin/cos confusion and sign errors.</p> <p>Requires all 3 terms. Condone sin/cos confusion and sign errors.</p> <p>Both equations correct unsimplified. Use $F = 0.6N$ to form an equation in N or in X. Dependent on the two previous M marks</p> <p>OR: $0.6(X \cos 60 + 1.5g \cos 30) + 1.5g \sin 30 = X \cos 30$</p> <p>First value found correctly. (N or X)</p> <p>Substitute their N (or X) to find X (or N) Dependent on the previous M mark.</p> <p>Second value found correctly.</p> <p>Resolve vertically. Condone sin/cos confusion. Must have all terms.</p> <p>Use $F = 0.6N$</p> <p>Correct unsimplified equation</p> <p>Resolve horizontally. Follow their N. Must have all terms. Condone sin/cos confusion. Substitute for F and N</p>

Question Number	Scheme	Marks	Notes
<p>4 (a)</p> <p>Alt</p> <p>(b)</p>	<p>(i) $M(D) \quad 3R_C + 1 \times 3g = 2 \times 4g + 5 \times 2g$</p> <p>$R_C = 5g$ or $49N$</p> <p>(ii) $R(\uparrow) \quad R_C + R_D = 4g + 2g + 3g$</p> <p>$R_D = 4g$ or 39 or $39.2N$</p> <p>$M(A) \quad 3 \times 4g + 6 \times 3g = 2R_C + 5R_D (= 30g)$</p> <p>$M(B) \quad 3 \times 4g + 6 \times 2g = R_D + 4R_C (= 24g)$</p> <p>$M(C) \quad 3R_D + 2 \times 2g = 1 \times 4g + 4 \times 3g$</p> <p>$M(\text{centre}) \quad 3g \times 3 + R_C = 2R_D + 2g \times 3$</p> <p>$R_C = 5g$ or $49N$, $R_D = 4g$ or 39 or $39.2N$</p> <p>$M(D) \quad 3R_C + xg = 8g + 10g \quad (3R_C = (18 - x)g)$</p> <p>$R(\uparrow) \quad R_C + R_D = 4g + 2g + xg$</p> <p>Alternatives: $M(B) \quad 4R_C + R_D = 12g + 12g$</p> <p>$M(A): 2R_C + 5R_D = 6xg + 3 \times 4g$</p> <p>$M(C): 2 \times 2g + 3R_D = 4xg + 1 \times 4g$</p> <p>$2(18 - x)g = 3(6 + x)g$</p> <p>$x = 3.6$</p>	<p>M1</p> <p>A1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>A1 (6)</p> <p>M1A1</p> <p>M1A1</p> <p>A1,A1</p> <p>M1</p> <p>M1</p> <p>DM1</p> <p>A1 (4)</p> <p>[10]</p>	<p>e.g. Take moments about D – requires all 4 terms of the correct form, but condone sign errors. 1x need not be seen Correct unsimplified equation</p> <p>e.g. Resolve vertically to form an equation in R_C and R_D, requires all 5 terms Correct unsimplified equation</p> <p>Two equations – M1A1 for each</p> <p>Solve simultaneously for R_C and R_D</p> <p>First equation in x and R (or R_C and R_D) – correct terms required but condone sign slips. A second equation, correct terms required but condone sign slips.</p> <p>Use $R_C = R_D$ and solve for x. (as far as $x = \dots$) Dependent on the two previous M marks.</p>

Question Number	Scheme	Marks	Notes
5 (a)	Speed = $\sqrt{3^2 + (-2)^2}$ or $\sqrt{3^2 + 2^2} = \sqrt{13} \text{ m s}^{-1}$	M1 A1(2)	Use Pythagoras Accept 3.6 or better Ignore their diagram if it does not support their working
(b)	 <p>$\tan \theta = \frac{2}{3}, \theta = 33.7$ OR $\tan \theta = \frac{3}{2}, \theta = 56.3$ OR find another useful angle Bearing = 124</p>	M1 A1 A1 (3)	Find a relevant angle Their angle correct (seen or implied) Correct bearing. Accept 124° or awrt $124/124^\circ$ Accept N 124 E or S 56 E
(c)	$\mathbf{r}_B = 10\mathbf{j} + t(3\mathbf{i} - 2\mathbf{j})$ $\mathbf{r}_G = 4\mathbf{i} - 2\mathbf{j} + t\left(\frac{5}{3}\mathbf{i} + 2\mathbf{j}\right)$ $3t = 4 + \frac{5}{3}t$ OR $10 - 2t = -2 + 2t$ (i) $t = 3 \text{ s}$ (ii) $\mathbf{r} = 10\mathbf{j} + 3(3\mathbf{i} - 2\mathbf{j}) = (9\mathbf{i} + 4\mathbf{j}) \text{ m}$ OR $\mathbf{r} = 4\mathbf{i} - 2\mathbf{j} + 3\left(\frac{5}{3}\mathbf{i} + 2\mathbf{j}\right) = (9\mathbf{i} + 4\mathbf{j}) \text{ m}$	M1 A1 A1 DM1 A1 A1 (6)	Find the position vector of B or G at time t Correct for B Correct for G Compare coefficients of \mathbf{i} or of \mathbf{j} to form an equation in t . Correct unambiguous conclusion. Final answer. Accept with no units. Do not ignore subsequent working.
		[11]	

Question Number	Scheme	Marks	Notes
<p>6(a)</p> <p>$v_1 = 8 \times 1.5 (=12)$ $v_2 = 12 + 0.8 \times 20$ $v_2 = 28 \text{ m s}^{-1}$</p> <p>(b)</p>  <p>(c)</p> <p>first 8 s: $\text{dist} = \frac{1}{2} \times 8 \times 12 (= 48)$</p> <p>next 20 s: $\text{dist} = \frac{1}{2} \times (12 + 28) \times 20 (= 400)$</p> <p>Total dist = 448 m</p> <p>(d)</p> <p>$0 = 28^2 - 2 \times 2.8s$</p> <p>$s = \frac{28^2}{2 \times 2.8} (=140)$</p> <p>$448 + 140 + 28T = 2000$</p> <p>$T = \frac{2000 - 448 - 140}{28} = 50.4$</p>	<p>M1</p> <p>M1</p> <p>A1 (3)</p> <p>B1</p> <p>B1ft</p> <p>(2)</p> <p>M1</p> <p>A1ft</p> <p>A1ft</p> <p>A1 (4)</p> <p>M1</p> <p>A1ft</p> <p>DM1</p> <p>A1 (4)</p> <p>[13]</p>	<p>Use of $v = u + at$ or equivalent for $t = 8$</p> <p>Follow their 12</p> <p>shape</p> <p>nos: 8,28; 12,28 indicated. Follow their 12, 28</p> <p>Correct method for distance for the triangle (0-8) or the trapezium (8-28)</p> <p>Follow their 12</p> <p>Follow their 12, 28</p> <p>Correct answer only (cao)</p> <p>Find area of right hand triangle or an expression in T for the trapezium (rectangle + triangle).</p> <p>Follow their 28</p> <p>Form an equation in T for their 16, 448 and 140</p> <p>Or better (50.42857...) Accept 50.</p>	

7.

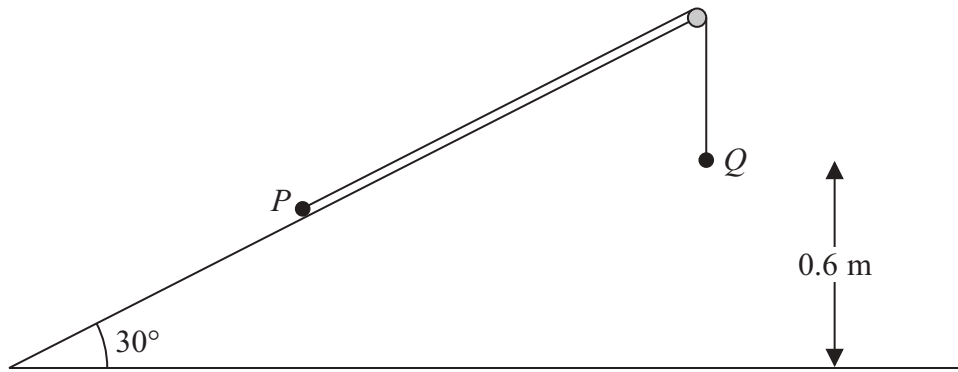


Figure 3

Two particles P and Q , of mass 2 kg and 3 kg respectively, are connected by a light inextensible string. Initially P is held at rest on a fixed smooth plane inclined at 30° to the horizontal. The string passes over a small smooth fixed pulley at the top of the plane. The particle Q hangs freely below the pulley and 0.6 m above the ground, as shown in Figure 3. The part of the string from P to the pulley is parallel to a line of greatest slope of the plane. The system is released from rest with the string taut.

For the motion before Q hits the ground,

- (a) (i) show that the acceleration of Q is $\frac{2g}{5}$,
- (ii) find the tension in the string. (8)

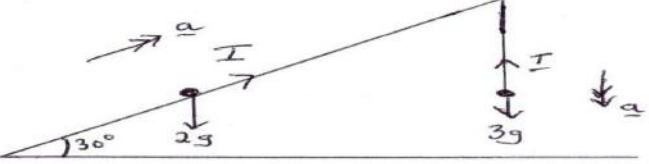
On hitting the ground Q is immediately brought to rest by the impact.

- (b) Find the speed of P at the instant when Q hits the ground. (2)

In its subsequent motion P does not reach the pulley.

- (c) Find the total distance moved up the plane by P before it comes to instantaneous rest. (4)
- (d) Find the length of time between Q hitting the ground and P first coming to instantaneous rest. (2)



Question Number	Scheme	Marks	Notes
7	 <p>(a)</p> $3g - T = 3a$ $T - 2g \cos 60 = 2a \quad (T - g = 2a)$ <p>Allow M1A1 for $3g - 2g \cos 60 = 5a$ in place of either of these two equations</p> $2g = 5a \quad a = \frac{2g}{5} \quad *$ $T = 2 \times \frac{2g}{5} + g = \frac{9g}{5}$ <p>(b)</p> $v^2 = 2 \times \frac{2g}{5} \times 0.6 = \frac{2.4g}{5}$ $v = \frac{2}{5} \sqrt{3g} \quad \text{oe involving } g$	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>DM1</p> <p>A1</p> <p>M1</p> <p>A1 (8)</p> <p>M1</p> <p>A1 (2)</p>	<p>Eqn of motion for Q: must have the correct terms but condone sign errors</p> <p>Correct equation</p> <p>Eqn of motion for P: must have the correct terms but condone sign errors. Weight must be resolved.</p> <p>Correct equation</p> <p>Use an exact method to solve for a (i.e. not the equation solver on their calculator). Dependent on the first 2 M marks or the M for the combined equation.</p> <p>Given answer derived correctly from exact working.</p> <p>Use given acceleration to solve for T.</p> <p>accept 18 or 17.6</p> <p>Use the given acceleration to find the speed</p> <p>Accept 2.2 or 2.17</p>

Question Number	Scheme	Marks	Notes
(c)	String slack: accel of P (up plane) = $-g \cos 60 = -\frac{1}{2}g$ $0 = \frac{2.4g}{5} - gs$ $s = \frac{2.4g}{5} \times \frac{1}{g} = \frac{2.4}{5} = 0.48$ Total dist = 1.08 m	B1 M1 A1 A1ft (4)	Use of $v^2 = u^2 + 2as$ or equivalent for their acceleration $\neq \frac{2g}{5}$ 0.6 + their 0.48
	(d) $0 = \frac{2}{5}\sqrt{3}g - \frac{g}{2}t \quad (0 = 2.17 - 4.9t)$ $t = \frac{4\sqrt{3}g}{5g} = 0.4426\dots$ $= 0.44 \quad \text{or} \quad 0.443$	M1 A1 (2)	Use of $v = u + at$ or equivalent with their acceleration $\neq \frac{2g}{5}$ to find t . only
		[16]	