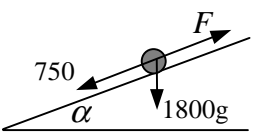
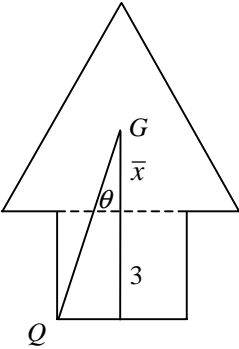



Question Number	Scheme	Marks
<p>1. (a)</p> <p>(b)</p>	$F = \frac{36\,000}{20} \quad (=1800)$ <p>N2L <math>\frac{3600}{20} - 750 = 1500a</math> <span style="float:right">ft their <math>F</math></span></p> $a = 0.7 \quad (\text{ms}^{-2})$  $\nearrow F = 750 + 1500g \times \frac{1}{10} \quad (=2220)$ $P = 2220 \times 20 = 44\,400$ <p>Accept also 44000, 44 kW, 44.4 kW</p>	<p>B1</p> <p>M1 A1ft</p> <p>A1      4</p> <p>M1 A1</p> <p>A1      3    7</p>
<p>2.</p> <p>(a)</p> <p>(b)</p> <p>(c)</p>	$\mathbf{I} = m\mathbf{v} - m\mathbf{u}$ $-4\mathbf{i} + 4\mathbf{j} = 0.2\mathbf{v} - 0.2 \times 30\mathbf{i}$ $\mathbf{v} = 10\mathbf{i} + 20\mathbf{j} \quad (\text{ms}^{-1})$ $\tan \theta = \frac{20}{10}$ $\theta = 63.4^\circ \quad \text{accept awrt } 63^\circ \text{ or } 1.1^\circ$ $\text{Final K.E.} = \frac{1}{2} \times 0.2 \times (10^2 + 20^2) \quad (=50) \quad \text{ft their } \mathbf{v}$ $\text{K.E. lost} = \frac{1}{2} \times 0.2 \times 30^2 - \frac{1}{2} \times 0.2 \times (10^2 + 20^2)$ $= 40 \quad (\text{J}) \quad \text{cao}$	<p>M1 A1</p> <p>A1      <u>3</u></p> <p>M1</p> <p>A1      <u>2</u></p> <p>M1 A1ft</p> <p>M1</p> <p>A1      <u>4</u>    9</p>

Question Number	Scheme	Marks
<p>3. (a)</p>	<p style="text-align: center;">Rectangle Triangle Decoration</p> <p>Mass Ratio      6            12            18                    Ratio 1:2:3</p> <p>CM from BG    <math>(-)\frac{1}{2}</math>            2            <math>\bar{x}</math></p> $18 \times \bar{x} = -6 \times \frac{1}{2} + 12 \times 2$ $\bar{x} = \frac{5}{6}$ <p style="text-align: right;">accept exact equivalents</p>	<p>B1</p> <p>B1</p> <p>M1 A1</p> <p>A1    <u>5</u></p>
<p>(b)</p>	<div style="text-align: center;">  <p>Identification and use of correct triangle</p> <math display="block">\tan \theta = \frac{1}{3 + \bar{x}}</math> <math display="block">\theta = 14.6^\circ</math> </div>	<p>M1</p> <p>M1 A1ft</p> <p>cao    A1    <u>4</u>    <b>9</b></p>

Question Number	Scheme	Marks
4.	<p>(a) <math>\mathbf{p} = (2t^2 - 7t)\mathbf{i} - 5t\mathbf{j} + 3\mathbf{i} + 5\mathbf{j}</math>  <math>= (2t^2 - 7t + 3)\mathbf{i} + (5 - 5t)\mathbf{j}</math></p> <p>(b) <math>\mathbf{q} = (2\mathbf{i} - 3\mathbf{j})t - 7\mathbf{i}</math></p> <p><math>\mathbf{j}</math>: <math>5 - 5t = -3t \Rightarrow t = 2.5</math> equating and solving</p> <p>At <math>t = 2.5</math> <math>\mathbf{i}</math>: <math>p_x = 2 \times 2.5^2 - 7 \times 2.5 + 3 = -2</math>  <math>q_x = 2 \times 2.5 - 7 = -2</math> both</p> <p><math>p_x = q_x \Rightarrow</math> collision cso</p>	<p>M1, M1  A1+A1 <u>4</u></p> <p>M1 A1</p> <p>M1 A1</p> <p>M1</p> <p>A1 <u>6</u> <b>10</b></p>
	<p><i>Alternative in (b)</i></p> <p><math>\mathbf{i}</math>: <math>2t^2 - 7t + 3 = 2t - 7 \Rightarrow 2t^2 - 9t + 10 = 0</math>  <math>t = 2, 2.5</math> equating and solving</p> <p>At <math>t = 2.5</math> <math>\mathbf{j}</math>: <math>p_y = 5 - 5 \times 2.5 = -7.5</math>  <math>q_y = -3 \times 2.5 = -7.5</math> both</p> <p><math>p_y = q_y \Rightarrow</math> collision cso</p> <p><i>In alternative, ignore any working associated with <math>t = 2</math></i></p>	<p>M1 A1</p> <p>M1</p> <p>A1</p>

Question Number	Scheme	Marks
<p>5.</p>		
	<p>(a) LM <math>10mu = 2mx + 3my</math>          NEL <math>y - x = 5eu</math></p> <p>Solving to <math>y = 2(1 + e)u</math> *                      cso</p>	<p>M1 A1          B1          M1 A1 <u>5</u></p>
	<p>(b) <math>x = 2u - 3eu</math>                      finding <math>x</math>, with or without <math>e = 0.4</math>  <math>x = 0.8u</math></p> <p><math>x &gt; 0 \Rightarrow P</math> moves towards wall and <math>Q</math> rebounds from wall  <math>\Rightarrow</math> second collision                      ft any positive <math>x</math></p>	<p>M1          A1          A1 ft <u>3</u></p>
	<p>(c) <math>x = -0.4u</math></p> <p>Speed of <math>Q</math> on rebound is <math>3.6fu</math></p> <p>For second collision <math>3.6fu &gt; 0.4u</math></p>	<p>B1          M1</p>
	<p><math>f &gt; \frac{1}{9}</math>                      ignore <math>f</math>   1</p>	<p>A1 <u>3</u> <b>11</b></p>

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<p>6.</p>	<div style="text-align: center;"> </div> <p>(a) <math>M(A) \quad N \times 2a \sin \alpha = mg \times a \cos \alpha + 10mg \times 2a \cos \alpha</math>  <math>2N \tan \alpha = 21mg</math>  <math>N = 7mg \quad *</math> <span style="float: right;">cso</span></p> <p>(b) <math>\uparrow R = 11mg</math> <span style="float: right;">B1</span>  <math>F_r = 0.6 \times 11mg = 6.6mg</math> <span style="float: right;">B1</span></p> <p>For min <math>P \quad F_r \rightarrow \quad P_{\min} = 7mg - 6.6mg = 0.4mg</math> <span style="float: right;">M1 A1</span>          For max <math>P \quad F_r \leftarrow \quad P_{\max} = 7mg + 6.6mg = 13.6mg</math> <span style="float: right;">M1 A1</span></p> <p style="text-align: center;"><math>0.4mg \mid P \mid 13.6mg</math> <span style="float: right;">cso</span></p> <p><i>Note: In (a), if moments are taken about a point other than A, a complete set of equations for finding N is needed for the first M1. If this M1 is gained, the A2(1, 0) is awarded for the moments equation as it first appears.</i></p>	<p>M1 A2(1, 0)</p> <p>M1 A1 <u>5</u></p> <p>B1</p> <p>B1</p> <p>M1 A1</p> <p>M1 A1</p> <p>A1 <u>7</u> <b>12</b></p>

Question Number	Scheme	Marks
7.	<p>(a) Work-Energy <math>R \times 60 = 80 \times 9.8 \times 24.4 - \frac{1}{2} \times 80 \times 20^2</math>  <math>(= 19129.6 - 16000 = 3129.6)</math>  <math>R = 52 \text{ (N)}</math> accept 52.2</p> <p>(b) <math>-8.1 = 20 \sin \alpha \times t - \frac{1}{2} g t^2</math>  <math>4.9 t^2 - 12 t - 8.1 = 0</math>  <math>t = 3 \text{ (s)}</math></p> <p>(c) <math>20 \cos \alpha \times 3 = 16 \times 3 = 48 \text{ (m)}</math> ft their <math>t</math></p> <p>(d) Energy <math>\frac{1}{2} m v^2 - \frac{1}{2} m \times 20^2 = m \times 9.8 \times 8.1</math>  <math>v = \sqrt{(558.56)} \approx 24 \text{ (ms}^{-1}\text{)}</math> accept 23.6</p>	<p>M1 A2(1, 0)</p> <p>M1 A1 <u>5</u></p> <p>M1 A2(1, 0)</p> <p>M1 A1 <u>5</u></p> <p>M1 A1ft <u>2</u></p> <p>M1 A2(1, 0)</p> <p>M1 A1 <u>5</u> <b>17</b></p>
	<p><i>Alternative to (d)</i></p> <p><math>\uparrow v_y = 12 - 3g = -17.4</math>  <math>\rightarrow v_x = 16</math></p> <p><math>v = \sqrt{(17.4^2 + 16^2)} \approx 24 \text{ (ms}^{-1}\text{)}</math> accept 23.6</p>	<p>M1 A1</p> <p>A1</p> <p>M1 A1 <u>5</u></p>