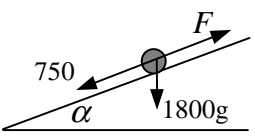
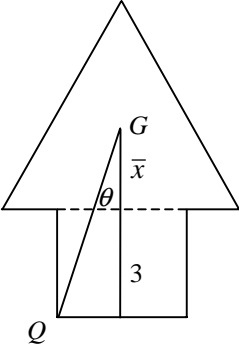

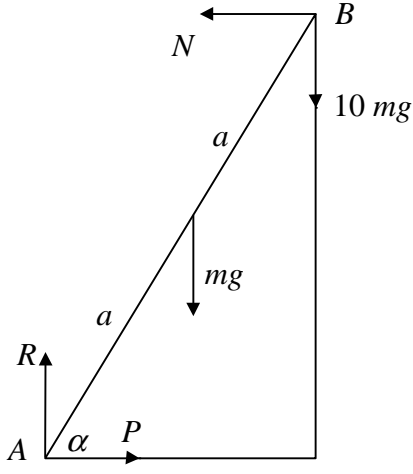


Question Number	Scheme	Marks
<p>1. (a)</p> <p>(b)</p>	$F = \frac{36\,000}{20} \quad (=1800)$ <p>N2L $\frac{3600}{20} - 750 = 1500a$ ft their F</p> $a = 0.7 \quad (\text{ms}^{-2})$  $\nearrow F = 750 + 1500g \times \frac{1}{10} \quad (=2220)$ $P = 2220 \times 20 = 44\,400$ <p>Accept also 44000, 44 kW, 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 $(-)\frac{1}{2}$ 2 \bar{x}</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> $\tan \theta = \frac{1}{3 + \bar{x}}$ $\theta = 14.6^\circ$ </div>	<p>M1</p> <p>M1 A1ft</p> <p>cao A1 <u>4</u> 9</p>

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

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

Question Number	Scheme	Marks
6.	<div style="text-align: center;">  </div> <p>(a) $M(A) \quad N \times 2a \sin \alpha = mg \times a \cos \alpha + 10mg \times 2a \cos \alpha$ $2N \tan \alpha = 21mg$ $N = 7mg \quad *$ cso</p> <p>(b) $\uparrow R = 11mg$ B1 $F_r = 0.6 \times 11mg = 6.6mg$ B1 For min $P \quad F_r \rightarrow \quad P_{\min} = 7mg - 6.6mg = 0.4mg$ M1 A1 For max $P \quad F_r \leftarrow \quad P_{\max} = 7mg + 6.6mg = 13.6mg$ M1 A1 $0.4mg \mid P \mid 13.6mg$ cso</p> <p style="text-align: right;"><u>7</u> 12</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> 12</p>

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