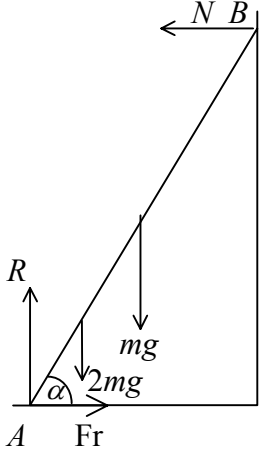











Question number	Scheme	Marks
<p>1. (a)</p>	<p>Use of <math>(8 + \lambda)m</math></p> <p>i: <math>3m \times 4 + \lambda m \times 4 = (8 + \lambda)m \times 2</math></p> <p>Solving to <math>\lambda = 2</math> (*)</p> <p>j: <math>5m \times (-3) + 2m \times 2 = 10m \times k</math></p> <p><math>k = -1.1</math></p>	<p>B1</p> <p>M1</p> <p>M1 A1 (4)</p> <p>M1 A1</p> <p>A1 (3)</p> <p><b>(7 marks)</b></p>
<p>2. (a)</p> <p>(b)</p> <p>(c)</p>	<p><math>T_r = \frac{24000}{12}</math> (= 2000)</p> <p>N2L: <math>T_r - 1200 = 1000 \times f</math></p> <p><math>f = 0.08</math></p> <p>Work Energy <math>\frac{1}{2} \times 1000 \times 14^2 = 1200d</math></p> <p><math>d = 81 \frac{2}{3}</math></p> <p>Resistances may vary with speed</p>	<p>M1</p> <p>M1 A1ft</p> <p>A1 (4)</p> <p>M1 A1</p> <p>awrt 81.7 A1 (3)</p> <p>B1 (1)</p> <p><b>(8 marks)</b></p>

Question number	Scheme	Marks															
3.	 <p> <math>(\uparrow) \quad R = 3mg</math>  <math>M(B)</math>  <math>mg a \cos \alpha + 2mg \times \frac{3}{2} a \cos \alpha + Fr \times 2a \sin \alpha = R \times 2a \cos \alpha</math>                      Solving to <math>Fr = \frac{3}{4} mg</math> </p> <p> <math>Fr \leq \mu R \Rightarrow \frac{3}{4} mg \leq \mu 3mg</math>  <math>\mu \geq \frac{1}{4}</math> (least value is <math>\frac{1}{4}</math>)                 </p>	B1 M1 A2 1,0 M1 A1 M1 M1 A1 (9) <b>(9 marks)</b>															
4. (a)	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;"></td> <td style="width: 20%; text-align: center;"></td> <td style="width: 20%; text-align: center;"></td> <td style="width: 20%; text-align: center;"></td> <td></td> </tr> <tr> <td>MR</td> <td style="text-align: center;"><math>48a^2</math></td> <td style="text-align: center;"><math>12a^2</math></td> <td style="text-align: center;"><math>60a^2</math></td> <td>B1, B1ft</td> </tr> <tr> <td>CM</td> <td style="text-align: center;"><math>4a</math></td> <td style="text-align: center;"><math>(-)\frac{1}{3} \times 4a</math></td> <td style="text-align: center;"><math>\bar{x}</math></td> <td>B1</td> </tr> </table> <p> <math>48a^2 \times 4a - 12a^2 \times \frac{4}{3} a = 60\bar{x}</math>                      Solving to <math>\bar{x} = \frac{44}{15} a</math> (*)                 </p>						MR	$48a^2$	$12a^2$	$60a^2$	B1, B1ft	CM	$4a$	$(-)\frac{1}{3} \times 4a$	$\bar{x}$	B1	M1 A1 A1 (6) M1 A1 A1 (3) <b>(9 marks)</b>
																	
MR	$48a^2$	$12a^2$	$60a^2$	B1, B1ft													
CM	$4a$	$(-)\frac{1}{3} \times 4a$	$\bar{x}$	B1													
(b)	<p> <math>\lambda M \times 4a = M \times \frac{44}{15} a</math>  <math>\lambda = \frac{11}{15}</math> </p>	A1 (3) <b>(9 marks)</b>															

Question number	Scheme	Marks
<p>5. (a)</p>	$v = \int a dt = 2t^2 - 8t (+c)$ <p>Using <math>v = 6, t = 0; v = 2t^2 - 8t + 6</math>  <math>v = 0 \Rightarrow 2t^2 - 8t + 6 = 0, \Rightarrow t = 1, 3</math></p> $S = \int (2t^2 - 8t + 6) dt = \left[ \frac{2}{3}t^3 - 4t^2 + 6t \right]$ $= 0 - 2\frac{2}{3}$ <p>Distance is <math>(\pm)2\frac{2}{3}</math> m</p>	<p>M1 A1  M1 A1 (4)  M1 A1  M1 A2, 1, 0  M1  A1 (7)  <b>(11 marks)</b></p>
<p>6. (a)</p> <p>(b)</p> <p>(c)</p>	<p>L.M. <math>2u = 2x + y</math>  NEL <math>y - x = \frac{1}{3}u</math></p> <p>Solving to <math>x = \frac{5}{9}u</math> (*)  <math>y = \frac{8}{9}u</math> (*)</p> <p><math>(\pm) \frac{8}{9}eu</math></p> <p>L.M <math>\frac{10}{9}u - \frac{8}{9}eu = w</math></p> <p>NEL <math>w = \frac{1}{3} \left( \frac{5}{9}u + \frac{8}{9}eu \right)</math></p> <p>Solving to <math>e = \frac{25}{32}</math> accept 0.7812s</p> <p><math>Q</math> still has velocity and will <i>bounce back</i> from wall colliding with <i>stationary P</i>.</p>	<p>M1 A1  M1 A1  M1 A1  A1 (7)  B1  M1 A1  M1 A1  M1 A1 (7)  B1 (1)  <b>(15 marks)</b></p>

Question number	Scheme	Marks
7.	<p>(a) <math>\mathbf{I} = 0.4(15\mathbf{i} + 16\mathbf{j} + 20\mathbf{i} - 4\mathbf{j}) \quad (= 0.4(35\mathbf{i} + 12\mathbf{j}) = 14\mathbf{i} + 4.8\mathbf{j})</math></p> <p><math> \mathbf{I}  = \sqrt{(14^2 + 4.8^2)} \text{ or } 0.4\sqrt{(35^2 + 12^2)}</math> <span style="float: right;">M1 for any magnitude</span></p> <p><math>= 14.8 \text{ (Ns)}</math></p> <p>(b) Initial K.E. <math>= \frac{1}{2} m(15^2 + 16^2) \quad (= 240.5m = 96.2 \text{ J})</math></p> <p><math>\frac{1}{2} mv^2 = \frac{1}{2} m(15^2 + 16^2) = m \times 9.8 \times 1.2</math> <span style="float: right;">-1 each incorrect term</span></p> <p><math>v^2 = 504.52</math></p> <p><math>v = 22 \text{ (m s}^{-1}\text{)}</math> <span style="float: right;">accept 22.5</span></p> <p>(c) <math>\arccos \frac{15}{22.5} = 48^\circ</math> <span style="float: right;">accept 48.1°</span></p> <p>(d) Air resistance Wind (problem not 2 dimensional) Rotation of ball (ball is not a particle) <span style="float: right;">any 2</span></p>	<p>M1</p> <p>M1 A1</p> <p>A1 (4)</p> <p>M1</p> <p>M1 A2, 1,0</p> <p>M1</p> <p>A1 (6)</p> <p>M1 A1 A1 A1 (4)</p> <p>B1, B1 (2)</p> <p><b>(16 marks)</b></p>
Alt (b)	<p>Resolve <math>\uparrow</math> with 16 and 9.8</p> <p><math>(\uparrow) \quad v_y^2 = 16^2 + 2 \times (-9.8) \times (-1.2)</math></p> <p><math>(v_y^2 = 279.52, v_y \approx 16.7 \dots)</math></p> <p><math>v^2 = 15^2 + 279.52</math></p> <p><math>v = 22 \text{ (m s}^{-1}\text{)}</math> <span style="float: right;">accept 22.5</span></p>	<p>M1</p> <p>M1 A1</p> <p>M1 A1</p> <p>A1 (6)</p>
Alt (c)	<p><math>\arctan \frac{16.7}{15} = 48^\circ</math></p>	<p>M1 A1 A1 A1 (4)</p>