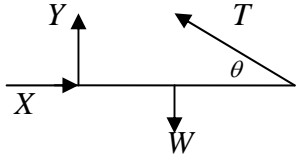
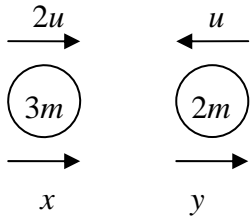


January 2005

6678 Mechanics M2  
Mark Scheme

Question Number	Scheme	Marks												
1.	 <p>(a) <math>M(A)</math> <math>W \times 4a = T \times 8a \sin \theta</math> Using a value of <math>\sin \theta</math> and solving <math>T = \frac{5}{6}W</math> * cso</p> <p>(b) <math>\rightarrow</math> <math>X = T \cos \theta</math> <math>= \frac{2}{3}W</math></p>	<p>M1 A1 M1 A1 <u>4</u></p> <p>M1 A1 A1 <u>3</u> <b>7</b></p>												
2.	<p>(a)</p> <table border="0" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"></td> <td style="width: 20%; text-align: center;">circle</td> <td style="width: 20%; text-align: center;">rectangle</td> <td style="width: 30%; text-align: center;">plate</td> </tr> <tr> <td>Mass ratios</td> <td style="text-align: center;"><math>9\pi</math></td> <td style="text-align: center;">200;</td> <td style="text-align: center;"><math>200 - 9\pi</math></td> </tr> <tr> <td>Centres of mass</td> <td style="text-align: center;">6</td> <td style="text-align: center;">10</td> <td style="text-align: center;"><math>\bar{x}</math></td> </tr> </table> <p style="text-align: center;"><math>9\pi \times 6 + (200 - 9\pi)\bar{x} = 200 \times 10</math></p> <p style="text-align: center;"><math>\bar{x} \approx 10.7</math> (cm) cao</p> <p>(b)</p> <p style="text-align: center;"><math>\tan \theta = \frac{5}{10.7}</math> ft their <math>\bar{x}</math></p> <p style="text-align: center;"><math>\theta \approx 25^\circ</math> cao</p>		circle	rectangle	plate	Mass ratios	$9\pi$	200;	$200 - 9\pi$	Centres of mass	6	10	$\bar{x}$	<p>B1; B1ft B1</p> <p>M1 A1 <u>5</u></p> <p>M1 A1ft A1 <u>3</u> <b>8</b></p>
	circle	rectangle	plate											
Mass ratios	$9\pi$	200;	$200 - 9\pi$											
Centres of mass	6	10	$\bar{x}$											

Question Number	Scheme	Marks
3.	<p>(a) KE lost is <math>\frac{1}{2} \times 0.6 \times (10^2 - 9^2)</math> (= 5.7 J)  PE lost is <math>0.6 \times 9.8 \times 12 \sin 30^\circ</math> (= 35.28 J)  Total loss in energy is 41.0 (J) accept 41</p> <p>(b) <math>R = 0.6 \times 9.8 \times \cos 30^\circ</math> (<math>\approx 5.09</math>)  WE <math>40.98 = \mu \times 0.6 \times 9.8 \times \cos 30^\circ \times 12</math> ft their (a)  <math>\mu \approx 0.67</math> or 0.671</p> <p><i>Alternative for (b)</i>  <math>a = \frac{9^2 - 10^2}{2 \times 12} \left( = (-) \frac{19}{24} \right)</math> awrt 0.79  N2L <math>mg \sin 30^\circ - \mu mg \cos 30^\circ = m \left( -\frac{19}{24} \right)</math> ft their a  <math>\mu \approx 0.67</math> or 0.671</p>	<p>B1  B1  M1 A1 <u>4</u></p> <p>B1  M1 A1ft  M1 A1 <u>5</u> <b>9</b></p> <p>B1  M1 A1ft  M1 A1 <u>5</u></p>
4.	<p>(a) <math>\ddot{\mathbf{r}} = 6\mathbf{i} + (2t + 3)\mathbf{j}</math>  <math>\mathbf{F} = 0.4(6\mathbf{i} + 11\mathbf{j})</math> 0.4×something obtained by differentiation, with <math>t = 4</math>  <math> \mathbf{F}  = \sqrt{(2.4^2 + 4.4^2)}</math> modulus of a vector  <math>\approx 5.0</math> accept more accurate answers</p> <p>(b) <math>\mathbf{r} = (3t^2 + 4t)\mathbf{i} + \left(\frac{1}{3}t^3 + \frac{3}{2}t^2\right)\mathbf{j} (+ \mathbf{C})</math>  Using boundary values, <math>\mathbf{r} = (3t^2 + 4t - 3)\mathbf{i} + \left(\frac{1}{3}t^3 + \frac{3}{2}t^2 + 4\right)\mathbf{j}</math>  <math>t = 4, \mathbf{r} = 61\mathbf{i} + 49\frac{1}{3}\mathbf{j}</math>  OS = <math>\sqrt{(61^2 + 49\frac{1}{3}^2)} \approx 78</math> (m) accept more accurate answers</p>	<p>B1  M1  M1  A1 <u>4</u></p> <p>M1  A1  A1  M1 A1 <u>5</u> <b>9</b></p>

Question Number	Scheme	Marks
5.	<p>(a) <math>50000 = F \times 25</math> (<math>F = 2000</math>) or equivalent  <math>\rightarrow F = R + 750</math>  <math>R = 1250</math> * cso</p> <p>(b) N2L <math>1500 + 2000 = 2500a</math> ignore sign of <math>a</math>  <math>a = 1.4</math> (<math>\text{ms}^{-2}</math>) cao</p> <p>(c) Trailer: <math>T + R = 1500 \times 1.4</math> or Car: <math>T - 1500 - 750 = 1000 \times -1.4</math>  <math>T = 850</math> (N)</p> <p>(d) <math>25^2 = 2 \times 1.4 \times s</math> (<math>s = 223.2\dots</math>)  <math>W = 1500 \times s</math> ft their <math>s</math>  <math>= 335</math> (kJ) accept 330</p> <p>(e) Resistances <u>vary with speeds</u></p>	<p>M1 M1 A1 <u>3</u></p> <p>M1 A1 A1 <u>3</u></p> <p>M1 A1 <u>2</u></p> <p>M1 M1 A1ft A1 <u>4</u></p> <p>B1 <u>1</u> <b>13</b></p>
6.	 <p>(a) LM <math>6mu - 2mu = 3mx + 2my</math>  NEL <math>y - x = 3eu</math>  Solving to <math>y = \frac{1}{5}u(9e + 4)</math> * cso</p> <p>(b) Solving to <math>x = \frac{2}{5}u(2 - 3e)</math> oe  <math>x &lt; 0 \Rightarrow e &gt; \frac{2}{3}</math>  <math>\frac{2}{3} &lt; e \leq 1</math> ft their <math>e</math> for glb</p> <p>(c) <math>2m[\frac{1}{5}u(9e + 4) + u] = \frac{32}{5}mu</math>  Solving to <math>e = \frac{7}{9}</math> awrt 0.78</p>	<p>M1 A1 B1 M1 A1 <u>5</u></p> <p>M1 A1 M1 A1 A1ft <u>5</u></p> <p>M1 A1 M1 A1 <u>4</u> <b>14</b></p>

Question Number	Scheme	Marks
7.	(a) $\uparrow u_y = 32 \times \frac{3}{5} (=19.2)$ $-20 = 19.2t - 4.9t^2$ $t \approx 4.8$ or $4.77$ (s)	B1 M1 A2(1, 0) A1 <u>5</u>
	(b) $\rightarrow u_x = 32 \times \frac{4}{5} (=25.6)$ $d = 25.6 \times 4.77\dots$ $\approx 120$ or $122$ (m)	B1 M1 A1 <u>3</u>
	(c) $\uparrow v_y^2 = 19.2^2 + 2 \times 9.8 \times 4$ [ $v_y^2 = 447.04, v_y \approx 21.14$ ] $V^2 = 447.04 + 25.6^2$ $V = 33$ or $33.2$ ( $\text{ms}^{-1}$ )	M1 M1 A1 A1 <u>4</u>
	(d) $\tan \theta = \frac{21.14}{25.6}$ (or $\cos \theta = \frac{25.6}{33.2}, \dots$ ) ft their components  $\theta \approx 40^\circ$ or $39.6^\circ$ or resultant	M1 A1ft  A1 <u>3</u> <b>15</b>
	<i>Alternative for (c)</i> $\frac{1}{2}m(V^2 - 32^2) = mg \times 4$ $V^2 = 1102.4$ $V = 33$ or $33.2$ ( $\text{ms}^{-1}$ )	M1 A1 M1 A1 <u>4</u>

*There is a maximum penalty of one mark per question for not rounding to appropriate accuracy.*