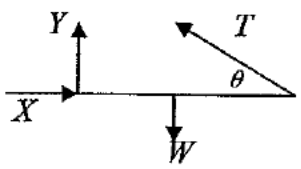
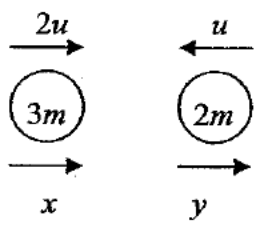


January 2005

6678 Mechanics M2
Mark Scheme

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

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

Question Number	Scheme	Marks
5.	<p>(a) $50000 = F \times 25$ ($F = 2000$) or equivalent $\rightarrow F = R + 750$ $R = 1250$ * cs0</p> <p>(b) N2L $1500 + 2000 = 2500a$ ignore sign of a $a = 1.4$ (ms^{-2}) cao</p> <p>(c) Trailer: $T + R = 1500 \times 1.4$ or Car: $T - 1500 - 750 = 1000 \times -1.4$ $T = 850$ (N)</p> <p>(d) $25^2 = 2 \times 1.4 \times s$ ($s = 223.2\dots$) $W = 1500 \times s$ ft their s $= 335$ (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> 13</p>
6.	 <p>(a) LM $6mu - 2mu = 3mx + 2my$ NEL $y - x = 3eu$ Solving to $y = \frac{1}{5}u(9e + 4)$ * cs0</p> <p>(b) Solving to $x = \frac{2}{5}u(2 - 3e)$ oe $x < 0 \Rightarrow e > \frac{2}{3}$ $\frac{2}{3} < e < 1$ ft their e for glb</p> <p>(c) $2m[\frac{1}{5}u(9e + 4) + u] = \frac{32}{5}mu$ Solving to $e = \frac{7}{9}$ 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> 14</p>

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