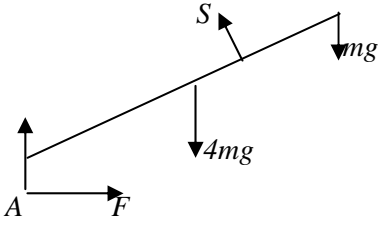
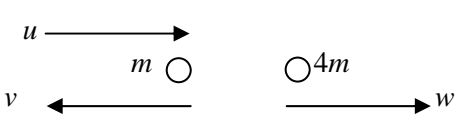


June 2006
6678 Mechanics M2
Mark Scheme

Question Number	Scheme	Mark
1.	$a = 5 - 2t \Rightarrow v = 5t - t^2 + 6$ $v = 0 \Rightarrow t^2 - 5t - 6 = 0$ $(t - 6)(t + 1) = 0$ $t = \underline{6\text{ s}}$	M1 A1, A indep M1 dep M1 A1
2. (a) (b)	$\frac{P}{24} = 600 \text{ or } \frac{1000P}{24} = 600 \Rightarrow P = 14.4\text{ kW}$ $\frac{30000}{20} - 1200 \times 9.8 \times \sin \alpha - 600 = 1200a$ $\Rightarrow a = \underline{0.4 \text{ m s}^{-2}}$	M1 A1 M1 A2,1,0 A1
3. (a) (b)	$I = \pm 0.5(16\mathbf{i} + 20\mathbf{j} - (-30\mathbf{i}))$ $= \pm(23\mathbf{i} + 10\mathbf{j})$ $\text{magn} = \sqrt{(23^2 + 10^2)} \approx \underline{25.1 \text{ N s}}$ $\mathbf{v} = 16\mathbf{i} + (20 - 10t)\mathbf{j}$ $t = 3 \Rightarrow \mathbf{v} = 16\mathbf{i} - 10\mathbf{j}$ $v = \sqrt{(16^2 + 10^2)} \approx \underline{18.9 \text{ m s}^{-1}}$	M1 Indep M1 Indep M1 M1 indep M1 indep M1

<p>4. (a)</p>	<p>Total mass = $12m$ (used)</p> <p>(i) M(AB): $m.3a/2 + m.3a/2 + m.3a + 6m.3a + 2m.3a = 12m.x$</p> $\Rightarrow x = \frac{5}{2}a$ <p>(ii) M(AD): $m.a + m.a + m.2a + 6m.2a = 12m.y$</p> $\Rightarrow y = \frac{4}{3}a$	<p>M1 indep M1</p> <p>indep M1 A1</p>
<p>(b)</p>	$\tan \alpha = \frac{2a - 4a/3}{5a/2}$ $\Rightarrow \alpha \approx \underline{14.9^\circ}$	<p>M1 A1 f.t.</p> <p>A1 cao</p>
<p>5. (a)</p>	$x_A = 28t \quad x_B = 35 \cos \alpha t$ <p>Meet $\Rightarrow 28t = 35 \cos \alpha t \Rightarrow \cos \alpha = 28/35 = 4/5$ *</p>	<p>B1 B1 M1 A1</p>
<p>(b)</p>	$y_A = 73.5 - \frac{1}{2}gt^2 \quad y_B = 21t - \frac{1}{2}gt^2$ <p>Meet $\Rightarrow 73.5 = 21t \Rightarrow t = \underline{3.5 \text{ s}}$</p>	<p>B1 B1 M1 A1</p>
<p>6. (a)</p>	 <p>M(A):</p> $S.3a = 4mg.2a \cos \alpha + mg.4a \cos \alpha$ $= \frac{48}{5}mga \Rightarrow S = \frac{16}{5}mg$ *	<p>M1 A1 A1</p>
<p>(b)</p>	<p>R(\uparrow): $R + S \cos \alpha = 5mg$</p> <p>R(\rightarrow): $F = S \sin \alpha$</p> $F \leq \mu R \Rightarrow \mu \geq \frac{48}{61}$ *	<p>M1 A1 M1 A1 dep on bot previous M M1 A1</p>
<p>(c)</p>	<p>Direction of S is perpendicular to plank or No friction at the peg</p>	<p>B1</p>

<p>7. (a)</p> <p>(b)</p> <p>(c)</p>	$R = 4g \cos \alpha = 16g/5 \Rightarrow F = 2/7 \times 16g/5$ $\text{Work done} = F \times 2.5 = \underline{22.4 \text{ J}} \text{ or } 22 \text{ J}$ $\frac{1}{2} \times 4 \times u^2 = 22.4 + 4g \times 2.5 \times 3/5$ $\Rightarrow u \approx \underline{6.37 \text{ m s}^{-1}} \quad \text{or } 6.4 \text{ ms}^{-1}$ $\frac{1}{2} \times 4 \times v^2 = \frac{1}{2} \times 4 \times u^2 - 44.8$ <p>[OR $\frac{1}{2} \times 4 \times v^2 = 0 + 4g \times 2.5 \times 3/5 - 22.4]$</p> $\Rightarrow v \approx \underline{4.27 \text{ m s}^{-1}} \quad \text{or } 4.3 \text{ ms}^{-1}$	<p>M1</p> <p>Indep M1</p> <p>M1 A2,1,0</p> <p>A1cao</p> <p>M1 A2,1,0</p> <p>A1</p>
<p>8. (a)</p> <p>(b)</p>	 $mu = 4mw - mv$ $eu = w + v$ $\Rightarrow w = \left(\frac{1+e}{5}\right)u, \quad v = \left(\frac{4e-1}{5}\right)u$ $w' = \left(\frac{4+4e}{25}\right)u$ <p>Second collision $\Rightarrow w' > v$</p> $\Rightarrow \frac{4+4e}{25} > \frac{4e-1}{5}$ $\Rightarrow e < 9/16$ <p>Also $v > 0 \Rightarrow e > 1/4$ Hence result (*)</p>	<p>M1 A1</p> <p>M1 A1</p> <p>Indep M1</p> <p>B1 f.t.</p> <p>M1</p> <p>dep M1 A</p> <p>B</p>

(c)	$\text{KE lost} = \frac{1}{2} mu^2 - [\frac{1}{2} \cdot 4m \{ \frac{u}{5}(1+e) \}^2 + \frac{1}{2} m \{ \frac{u}{5}(4e-1) \}^2] \quad \text{M1 A1 f.t.}$ $= \frac{3}{10} mu^2$	M1 A1 f.t. A1 cao
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