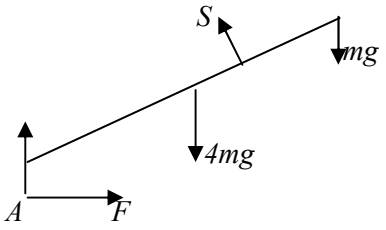
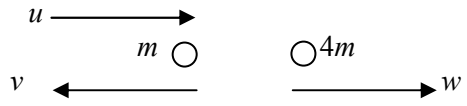
June 2006
6678 Mechanics M2
Mark Scheme

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

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

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

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