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Mathematics

Mechanics 2 M2 (6678)

June 2008

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Final Mark Scheme

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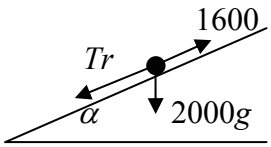
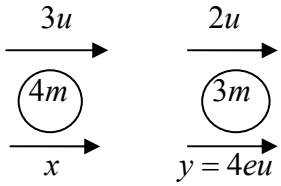
Mathematics

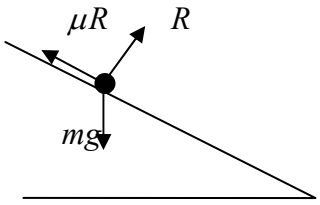
General Marking Guidance

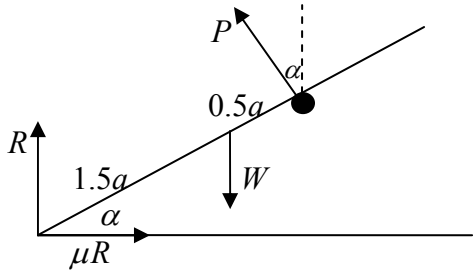
- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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June 2008
6678 Mechanics M2
Mark Scheme

Question Number	Scheme	Marks
1.	 Resolve ↗ : $T_r + 2000g \times \sin\alpha = 1600$ $(T_r = 816)$ $P = 816 \times 14\,(\text{W})$ ft their T_r $\approx 11\,(\text{kW})$ accept 11.4	M1 A1 A1 M1 A1ft A1 cso **(6)** **[6]**
2.	(a)  LM $12mu + 6mu = 4mx + 12meu$ NEL $4eu - x = eu$ Eliminating x to obtain equation in e Leading to $e = \frac{3}{4}$ ∗ cso (b) $x = 3eu$ or $\frac{9}{4}u$ or 4.5u – 3eu seen or implied in (b) Loss in KE $= \frac{1}{2}4m(3u)^2 + \frac{1}{2}3m(2u)^2 - \frac{1}{2}4m\left(\frac{9}{4}u\right)^2 - \frac{1}{2}3m(3u)^2$ ft their x $= 24mu^2 - 23\frac{5}{8}mu^2 = \frac{3}{8}mu^2 = 0.375mu^2$	B1 M1 A1 DM1 A1 **(5)** B1 M1 A1ft A1 **(4)** **[9]**

Question Number	Scheme	Marks
3.	(a $\Delta\text{KE} = \frac{1}{2}\times 3.5\left(12^2 - 8^2\right)$ $(=140)$ or KE at A, B correct separately	B1
	$\Delta\text{PE} = 3.5\times 9.8\times 14\sin 20°$ (≈ 164.238) or PE at A, B correct separately	M1 A1
	$\Delta\text{E} = \Delta\text{KE} + \Delta\text{PE} \approx 304$, 300	DM1 A1 **(5)**
	(b) Using Work-Energy	
	$F_r = \mu \times 3.5g\cos 20°$	M1 A1
	$304.238... = F_r \times 14$ ft their (a), F_r	M1 A1 ft
	$304.238... = \mu 3.5g\cos 20°\times 14$	
	$\mu \approx 0.674$, 0.67	A1 **(5)**
		[10]
	Alternative using N2L	
	 $F_r = \mu \times 3.5g\cos 20°$	M1 A1
	$v^2 = u^2 + 2as \Rightarrow 8^2 = 12^2 - 2a\times 14$	
	$\left(a = \frac{20}{7}\right)(2.857\ldots.)$	
	N2L R ↖ : {their F_r}- $mg\sin 20° = ma$ ft their F_r.	M1 A1ft
	Leading to $\mu \approx 0.674$ or 0.67	A1 **(5)**
4.	(a) N2L $(6t-5)\mathbf{i} + (t^2 - 2t)\mathbf{j} = 0.5\mathbf{a}$	M1
	$\mathbf{a} = (12t-10)\mathbf{i} + (2t^2 - 4t)\mathbf{j}$	A1
	$\mathbf{v} = (6t^2 - 10t)\mathbf{i} + \left(\frac{2}{3}t^3 - 2t^2\right)\mathbf{j}$ $(+\mathbf{C})$ ft their **a**	M1 A1ft+A1ft
	$\mathbf{v} = (6t^2 - 10t + 1)\mathbf{i} + \left(\frac{2}{3}t^3 - 2t^2 - 4\right)\mathbf{j}$	A1 **(6)**
	(b) When $t = 3$, $\mathbf{v}_3 = 25\mathbf{i} - 4\mathbf{j}$	M1
	$-5\mathbf{i} + 12\mathbf{j} = 0.5(\mathbf{v} - (25\mathbf{i} - 4\mathbf{j}))$ ft their $\mathbf{v}_3$	M1 A1ft
	$\mathbf{v} = 15\mathbf{i} + 20\mathbf{j}$	A1
	$\lvert\mathbf{v}\rvert = \sqrt{(15^2 + 20^2)} = 25$ (ms^{-1}) cso	M1 A1 **(6)**
		[12]

Question Number	Scheme	Marks
5.	(a) 	
	$R(\uparrow)\quad R + P\cos\alpha = W$	M1 A1
	$M(A)\qquad P \times 2a = W \times 1.5a\cos\alpha$	M1 A1
	$\left(P = \frac{3}{4}W\cos\alpha\right)$	
	$R = W - P\cos\alpha = W - \frac{3}{4}W\cos^2\alpha$	DM1
	$= \frac{1}{4}\left(4 - 3\cos^2\alpha\right)W$ ✱ cso	A1 **(6)**
	(b) Using $\cos\alpha = \frac{2}{3}$, $\qquad R = \frac{2}{3}W$	B1
	$R(\rightarrow)\qquad \mu R = P\sin\alpha$	M1 A1
	Leading to $\mu = \frac{3}{4}\sin\alpha$	
	$\left(\sin\alpha = \sqrt{\left(1 - \frac{4}{9}\right)} = \frac{\sqrt{5}}{3}\right)$	
	$\mu = \frac{\sqrt{5}}{4}$ awrt 0.56	DM1 A1 **(5)**
		[11]

Question Number	Scheme		Marks
6.	(a) $M(Oy)$ $(8+k)m\times 6.4 = 5m\times 8 + km\times 8$		M1 A1
	$1.6k = 11.2 \Rightarrow k = 7$ ✱	cso	DM1 A1 **(4)**
	(b) $M(Oy)$ $27m\bar{x} = 12m\times 4 + 5m\times 8 + 7m\times 8$		M1 A1
	$\bar{x} = \frac{16}{3}$	5.3 or better	A1
	$M(Ox)$ $27m\bar{y} = 12m\times 2.5 + 8m\times 5$		M1 A1
	$\bar{y} = \frac{70}{27}$	2.6 or better	A1 **(6)**
	(c) $\tan\theta = \frac{\bar{y}}{\bar{x}} = \frac{35}{72}$		M1 A1ft
	$\theta \approx 26°$	awrt 25.9 °	A1 **(3)** **[13]**

Question Number	Scheme	Marks
7.	(a) $(\downarrow)$ $u_y = 25\sin 30° \ (=12.5)$	B1
	$12 = 12.5t + 4.9t^2$ -1 each error	M1 A2 (1, 0)
	Leading to $t = 0.743$, 0.74	A1 **(5)**
	(b) $(\rightarrow)$ $u_x = 25\cos 30° \left(= \frac{25\sqrt{3}}{2} \approx 21.65\right)$	B1
	$OB = 25\cos 30° \times t \ (\approx 16.094\,58)$ ft their (a)	M1 A1ft
	$TB \approx 1.1$ (m) awrt 1.09	A1 **(4)**
	(c) $(\rightarrow)$ $15 = u_x \times t \Rightarrow t = \frac{15}{u_x} (= \frac{2\sqrt{3}}{5} \approx 0.693$ or $0.69)$	M1 A1
	either $(\downarrow)$ $v_y = 12.5 + 9.8t \ (\approx 19.2896)$	M1
	$V^2 = u_x{}^2 + v_y{}^2 \ (\approx 840.840)$	
	$V \approx 29 \ (\text{ms}^{-1})$, 29.0	M1 A1 **(5)**
		[14]
	or $(\downarrow)$ $s_y = 12.5t + 4.9t^2 \ (\approx 11.0)$	M1
	$\frac{1}{2}m \times 25^2 + mg \times s_y = \frac{1}{2}mv^2$	
	$V \approx 29 \ (\text{ms}^{-1})$, 29.0	M1A1