Mark Scheme (Results)
Summer 2008

GCE

GCE Mathematics (6680/01)

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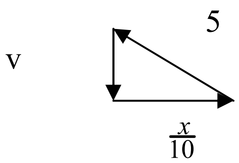
General Marking Guidance

- 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.

June 2008
6680 Mechanics M4
Mark Scheme

Question Number	Scheme	Marks
1.	${}_Q\mathbf{V}_P = \mathbf{V}_Q - \mathbf{V}_P = (3\mathbf{i}+7\mathbf{j})-(5\mathbf{i}-4\mathbf{j})$	M1
	$= (-2\mathbf{i}+11\mathbf{j})$	A1
	$\tan\theta = \frac{11}{2} \Rightarrow \theta = 79.69^0...$	M1 A1
	Bearing is 350^0	A1 **5**
2.	$2m(2\mathbf{i}-2\mathbf{j})+m(-3\mathbf{i}-\mathbf{j}) = 2m(\mathbf{i}-3\mathbf{j})+m\mathbf{v}$	M1 A1
	$(\mathbf{i}-5\mathbf{j}) = (2\mathbf{i}-6\mathbf{j})+\mathbf{v}$	
	$(-\mathbf{i}+\mathbf{j}) = \mathbf{v}$	A1
	$\lvert\mathbf{v}\rvert = \sqrt{(-1)^2+1^2} = \sqrt{2}$ m s^{-1} cwo	DM1 A1 **5**
3.	$mg - mkv = m\frac{\mathrm{d}v}{\mathrm{d}t}$	M1* A1 A1
	$\int \mathrm{d}t = \int \frac{\mathrm{d}v}{g-kv}$	DM1*
	$t = -\frac{1}{k}\ln(g-kv)+c$	A1cao
	$t=0, v=u \Rightarrow c = \frac{1}{k}\ln(g-ku)$	M1†
	$T = \frac{1}{k}\ln(g-ku) - \frac{1}{k}\ln(g-2ku)$	DM1†
	$= \frac{1}{k}\ln\left(\frac{g-ku}{g-2ku}\right)$	A1 **8**

Question Number	Scheme	Marks
4.	$u\cos 2\theta = v\cos\theta$	M1 A1
	$\frac{3}{8}u\sin 2\theta = v\sin\theta$	M1 A1
	$3\tan 2\theta = 8\tan\theta$	M1
	$\dfrac{6\tan\theta}{1-\tan^2\theta} = 8\tan\theta$	M1
	$\tan^2\theta = \frac{1}{4} \quad (\tan\theta \neq 0)$	
	$\tan\theta = \frac{1}{2}$	M1 A1 **8**
5.(a)	$-T - \frac{1}{2}mg - 2mv\sqrt{\frac{g}{l}} = m\ddot{x}$	M1 A3,2,1,0
	$\frac{-mgx}{l} - \frac{1}{2}mg - 2m\dot{x}\sqrt{\frac{g}{l}} = m\ddot{x}$	M1
	$\frac{\mathrm{d}^2x}{\mathrm{d}t^2} + 2\omega\frac{\mathrm{d}x}{\mathrm{d}t} + \omega^2 x = -0.5g \quad \text{(AG)}$	A1 (6)
(b)	$u^2 + 2\omega u + \omega^2 = 0 \Rightarrow u = \omega$ (twice)	
	CF is $x = e^{-\omega t}(At + B)$	B1
	PI is $x = -\frac{1}{2}l \quad (-\frac{g}{2\omega^2})$	
	GS is $x = e^{-\omega t}(At + B) - \frac{1}{2}l$	M1
	$t = 0, x = 0 \Rightarrow B = \frac{1}{2}l \quad (\frac{g}{2\omega^2})$	M1
	$\frac{\mathrm{d}x}{\mathrm{d}t} = -\omega e^{-\omega t}(At + B) + Ae^{-\omega t}$	M1
	$t = 0, \frac{\mathrm{d}x}{\mathrm{d}t} = \sqrt{gl} = \omega l \Rightarrow A = \frac{3}{2}\omega l (= \frac{3\sqrt{gl}}{2})(= \sqrt{gl} + \frac{0.5g}{\omega})$	M1
	so $x = e^{-\omega t}(\frac{3}{2}\omega l t + \frac{1}{2}l) - \frac{1}{2}l = \frac{1}{2}le^{-\omega t}(3\omega t + 1) - \frac{1}{2}l$	A1 (6)
(c)	$\frac{\mathrm{d}x}{\mathrm{d}t} = 0 \Rightarrow -\omega e^{-\omega t}(At + B) + Ae^{-\omega t} = 0$	M1
	$\Rightarrow t = \frac{2}{3\omega}$	M1 A1 (3)
		15

6.(a)	 vector triangle	M1
	$v^2 + (\frac{x}{10})^2 = 5^2$	M1
	$\Rightarrow 100v^2 = 2500 - x^2$	A1 (3)
(b)	$200v\frac{\mathrm{d}v}{\mathrm{d}x} = -2x$	M1 A1
	$200\frac{\mathrm{d}^2x}{\mathrm{d}t^2} + 2x = 0$	D M1
	$\frac{\mathrm{d}^2x}{\mathrm{d}t^2} + \frac{x}{100} = 0$ *	A1 (4)
(c)	Aux equn: $m^2 + \frac{1}{100} = 0$	M1
	$\Rightarrow m = \pm\frac{i}{10}$	A1
	$x = A\sin\frac{t}{10} + B\cos\frac{t}{10}$	A1
	$t = 0, x = 0 \Rightarrow B = 0$	B1
	$\frac{\mathrm{d}x}{\mathrm{d}t} = \frac{A}{10}\cos\frac{t}{10}$	M1
	$t = 0, x = 0 \Rightarrow v = \frac{\mathrm{d}x}{\mathrm{d}t} = 5$	
	$\Rightarrow 5 = \frac{A}{10} \Rightarrow A = 50$	M1
	$\Rightarrow x = 50\sin\frac{t}{10}$	A1
	$x = 30$: $30 = 50\sin\frac{t}{10}$	
	$\Rightarrow t = 10\sin^{-1}(\frac{3}{5}) = 6.44$ s	M1A1 (9)
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7.(a)	PE of rod $= -kMga\sin 2\theta$ $BP = 2\text{x}2a\sin\theta = 4a\sin\theta$ PE of mass $= -Mg(6a - 4a\sin\theta)$ $V = -Mg(6a - 4a\sin\theta) - kMga\sin 2\theta$ $= Mga(4\sin\theta - k\sin 2\theta) +$ constant *	B1 M1 A1 M1 A1 (5)
(b)	$\frac{dV}{d\theta} = Mga(4\cos\theta - 2k\cos 2\theta)$ so, $4\text{x}\frac{3}{4} - 2k(2(\frac{3}{4})^2 - 1) = 0$ $\Rightarrow k = 12$	M1 A1 M1 M1 A1 (5)
(c)	$4\cos\theta - 24(2\cos^2\theta - 1) = 0$ $12\cos^2\theta - \cos\theta - 6 = 0$ $(4\cos\theta - 3)(3\cos\theta + 2) = 0$ $\cos\theta = -\frac{2}{3}$	M1 D M1 A1 (3)
(d)	$\frac{d^2V}{d\theta^2} = (Mga)(-4\sin\theta + 4k\sin 2\theta)$ when $\cos\theta = \frac{3}{4}, \frac{d^2V}{d\theta^2} = (Mga) \times 44.97.. \Rightarrow$ stable when $\cos\theta = \frac{-2}{3}, \frac{d^2V}{d\theta^2} = (Mga) \times -50.68.. \Rightarrow$ unstable	M1 A1 M1 A1 A1 (5) **18**