edexcel
advancing learning, changing lives

Mark Scheme (Results)
Summer 2010

GCE

GCE Mechanics M4 (6680/01)

Edexcel Limited. Registered in England and Wales No. 4496750
Registered Office: One90 High Holborn, London WC1V 7BH

A PEARSON COMPANY

Edexcel is one of the leading examining and awarding bodies in the UK and throughout the world. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers.

Through a network of UK and overseas offices, Edexcel's centres receive the support they need to help them deliver their education and training programmes to learners.

For further information, please call our GCE line on 0844 576 0025, our GCSE team on 0844 576 0027, or visit our website at www.edexcel.com.

If you have any subject specific questions about the content of this Mark Scheme that require the help of a subject specialist, you may find our Ask The Expert email service helpful.

Ask The Expert can be accessed online at the following link:

http://www.edexcel.com/Aboutus/contact-us/

Summer 2010

Publications Code UA024478

All the material in this publication is copyright
© Edexcel Ltd 2010

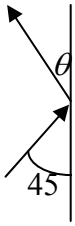
Mechanic guidance:

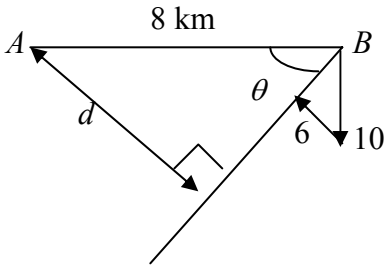
- For M marks, correct number of terms, dimensionally correct, all terms that need resolving are resolved.
- Omission of *g* from a resolution is an accuracy error, not a method error.
- Omission of mass from a resolution is a method error.
- Omission of a length from a moments equation is a method error.
- Where there is only one method mark for a question or part of a question, this is for a *complete* method.
- Omission of units is not (usually) counted as an error.
- Use of 9.81 for g is a rubric error. Deduct the final A1 from the first part of any question affected.
- More than 3 sf in an answer using an approximation for g is an accuracy error. Deduct the final A1 from the first part of any question affected.
- A dimensionally incorrect equation is a method error unless a correct equation was quoted and the error arises from a slip in substitution of values.
- For a misread which does not alter the character of a question or materially simplify it, all marks in that part of the question affected become ft. Deduct the first 2 A or B marks gained as a result and give the rest.

edexcel

Summer 2010
Mechanics M4 6680
Mark Scheme

Question Number	Scheme	Marks
Q1	$v(3\mathbf{i}-4\mathbf{j}) = \mathbf{v}_W - u\mathbf{j}$	M1A1
	$\mathbf{v}_W = 3v\mathbf{i} + (u-4v)\mathbf{j}$	
	$w\mathbf{i} = \mathbf{v}_W - \frac{u}{5}(-3\mathbf{i}+4\mathbf{j})$	M1A1
	$\mathbf{v}_W = (w-\frac{3u}{5})\mathbf{i} + \frac{4u}{5}\mathbf{j}$	
	$(u-4v) = \frac{4u}{5}$	M1
	$v = \frac{u}{20}$	A1
	$\mathbf{v}_W = \frac{3u}{20}\mathbf{i} + \frac{4u}{5}\mathbf{j}$	A1
		7

Question Number	Scheme	Marks
Q2 (a)	$\uparrow 2$ $\quad$ $\uparrow 1$ $1 \leftarrow$ $\quad$ $\rightarrow 1$ S 0.3kg $\quad$ T 0.6 kg $2 \uparrow$ $\quad$ $\uparrow 1$ $\rightarrow v$ $\quad$ $w \leftarrow$	
	$0.3v - 0.6w = 0.3$	M1 A1
	$v - 2w = 1$	
	$\frac{1}{2}(v+w) = 2$	M1 A1
	$v + w = 4$	
	$w = 1, v = 3$	
	(i) $\mathbf{u}_1 = 3\mathbf{i} + 2\mathbf{j}$ (ii) $\mathbf{u}_2 = -\mathbf{i} + \mathbf{j}$	A1 A1
		(6)
(b)	$\uparrow 1$ $v \leftarrow$	
	$v = 0.5$	B1
	$1 \uparrow$ $\rightarrow 1$	
		
	$\tan\theta = 0.5$ $\quad$ $\tan\theta =$ their v	M1
	$\theta = 26.6$	A1
	their $\theta + 45°$	M1
	Defln angle $= 45 + 26.6 = 71.6°$	A1
		(5)
(c)	KE Loss $= \frac{1}{2} \times 0.6 \times \{(1^2 + 1^2) - (1^2 + v^2)\}$	M1 A1
	$= 0.225$ J	A1
		(3)
		14

Question Number	Scheme	Marks
Q3 (a)		M1
	$\cos\theta = \frac{6}{10} \Rightarrow \theta = 53.1^{\circ}$	M1 A1
	Bearing is 307°	A1 (4)
(b)	$d = 8\sin\theta$ (=8×0.8) $= 6.4$ km	M1 A1 A1 (3)
(c)	$T = \frac{8\cos\theta}{\sqrt{10^2 - 6^2}}$ $= 0.6$ hrs i.e. the time is 12:36 pm	M1 A1 A1 (3)
		10

Question Number	Scheme	Marks
Q4		
(a)	$-mg(1+\frac{v^2}{k^2}) = m\frac{\mathrm{d}v}{\mathrm{d}t}$	M1 A1
	$g\int_0^T \mathrm{d}t = \int_U^0 \frac{-k^2\mathrm{d}v}{(k^2+v^2)}$	DM1
	$T = \frac{k}{g}\left[\tan^{-1}\frac{v}{k}\right]_0^U$	A1
	$= \frac{k}{g}\tan^{-1}\frac{U}{k}$	DM1A1
		(6)
(b)	$-mg(1+\frac{v^2}{k^2}) = mv\frac{\mathrm{d}v}{\mathrm{d}x}$	M1 A1
	$g\int_0^H \mathrm{d}x = \int_U^0 \frac{-k^2 v\mathrm{d}v}{(k^2+v^2)}$	DM1
	$H = \frac{k^2}{2g}\left[\ln(k^2+v^2)\right]_0^U$	A1
	$H = \frac{k^2}{2g}\ln\frac{(k^2+U^2)}{k^2}$	DM1A1
		(6)
		12

Question Number	Scheme	Marks
Q5 (a)	$\sqrt{4a^2+16a^2-16a^2\sin\theta}$	M1 A1
	Let length of string be L.	
	$V=-4mga\cos\theta-mg(L-\sqrt{4a^2+16a^2-16a^2\sin\theta}$	M1 A1
	$=-4mga\cos\theta-mgL+2mga\sqrt{5-4\sin\theta}$	
	$=2mga\left\{\sqrt{5-4\sin\theta}-2\cos\theta\right\}+\text{constant}$ **	A1
		(5)
(b)	$V'(\theta)=2mga\left\{\frac{-2\cos\theta}{\sqrt{5-4\sin\theta}}+2\sin\theta\right\}$	M1 A1
	For equilibrium, $V'(\theta)=0$	
	$\left\{\frac{-2\cos\theta}{\sqrt{5-4\sin\theta}}+2\sin\theta\right\}=0$	M1
	$\frac{\cos^2\theta}{5-4\sin\theta}=\sin^2\theta$	
	$1-\sin^2\theta=\sin^2\theta(5-4\sin\theta)$	DM1
	$4\sin^3\theta-6\sin^2\theta+1=0$ **	A1
		(5)
(c)	$V''(\theta)=2mga\left(\frac{\left\{\sqrt{5-4\sin\theta}.2\sin\theta-\frac{-2\cos\theta.(-4\cos\theta)}{2\sqrt{5-4\sin\theta}}\right\}}{(5-4\sin\theta)}+2\cos\theta\right)$	M1 A1 A1
	$V''(\frac{\pi}{6})=2mga\left\{\frac{\sqrt{3}-\frac{8x^{\frac{3}{4}}}{2\sqrt{3}}}{3}+\sqrt{3}\right\}=2mga\sqrt{3}>0$ so stable	DM1 A1
		(5)
		15

Question Number	Scheme	Marks
Q6		
(a)	$T_1 = \dfrac{2mge}{a}\ ;\ T_2 = \dfrac{mg(2a-e)}{a}$	B1 (either)
	$T_1 = T_2$	
	$2e = (2a-e)$	M1 A1
	$e = \dfrac{2a}{3}$	
	$AP = a + \dfrac{2a}{3} = \dfrac{5a}{3}$ **	A1
		(4)
(b)	$T_2 - T_1 - 4m\omega\dot{x} = m\ddot{x}$	
	$\dfrac{mg}{a}\left(\dfrac{4a}{3} - x\right) - \dfrac{2mg}{a}\left(\dfrac{2a}{3} + x\right) - 4m\omega\dot{x} = m\ddot{x}$	M1 A3
	$\ddot{x} + 4\omega\dot{x} + \dfrac{3g}{a}x = 0$	
	$\ddot{x} + 4\omega\dot{x} + 3\omega^2 x = 0$ **	A1
		(5)
(c)	$\lambda^2 + 4\omega\lambda + 3\omega^2 = 0$	
	$(\lambda + 3\omega)(\lambda + \omega) = 0$	M1
	$\lambda = -3\omega$ or $\lambda = -\omega$	
	$x = Ae^{-\omega t} + Be^{-3\omega t}$	A1
	$\dot{x} = -\omega Ae^{-\omega t} - 3\omega Be^{-3\omega t}$	M1 A1
	$t = 0,\ x = \frac{1}{2}a,\ \dot{x} = 0$	M1
	$\frac{1}{2}a = A + B$	
	$0 = -\omega A - 3\omega B$	A1
	$A = \frac{3}{4}a,\ B = -\frac{1}{4}a$	A1
	$\dot{x} = v = \frac{3}{4}a\omega\left(\mathrm{e}^{-3\omega t} - \mathrm{e}^{-\omega t}\right)$	A1
		(8)
		17

Further copies of this publication are available from
Edexcel Publications, Adamsway, Mansfield, Notts, NG18 4FN

Telephone 01623 467467
Fax 01623 450481

Email publications@linneydirect.com

Order Code UA024478 Summer 2010

For more information on Edexcel qualifications, please visit www.edexcel.com/quals

Edexcel Limited. Registered in England and Wales no.4496750
Registered Office: One90 High Holborn, London, WC1V 7BH