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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6360

MM2B Mechanics 2B

Mark Scheme

2008 examination - January series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Key to mark scheme and abbreviations used in marking

M	mark is for method		
m or dM	mark is dependent on one or more M marks and is for method		
A	mark is dependent on M or m marks and is for accuracy		
B	mark is independent of M or m marks and is for method and accuracy		
E	mark is for explanation		
√or ft or F	follow through from previous incorrect result	MC	mis-copy
CAO	correct answer only	MR	mis-read
CSO	correct solution only	RA	required accuracy
AWFW	anything which falls within	FW	further work
AWRT	anything which rounds to	ISW	ignore subsequent work
ACF	any correct form	FIW	from incorrect work
AG	answer given	BOD	given benefit of doubt
SC	special case	WR	work replaced by candidate
OE	or equivalent	FB	formulae book
A2,1	2 or 1 (or 0) accuracy marks	NOS	not on scheme
–*x* EE	deduct *x* marks for each error	G	graph
NMS	no method shown	c	candidate
PI	possibly implied	sf	significant figure(s)
SCA	substantially correct approach	dp	decimal place(s)

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

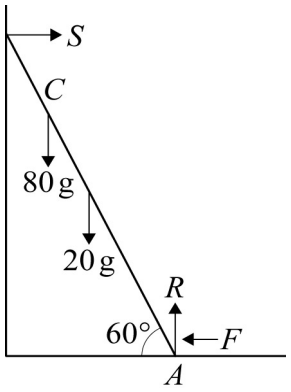
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

MM2B

Q	Solution	Marks	Total	Comments
1(a)	Kinetic energy = $\frac{1}{2} \times 0.6 \times 15^2$	M1		
	= 67.5 J	A1	2	
(b)	Using $mgh = \frac{1}{2}mv^2$:	M1		
	$67.5 = 0.6 \times g \times h$	A1		
	$\Rightarrow h = \frac{67.5}{0.6g}$			
	= 11.5 m	A1	3	
(c)	When 3 m above ground level: Change in PE is $0.6 \times g \times 3$ = 17.64 J			
	$\therefore$ KE of ball is 67.5 – 17.64	M1		
	= 49.86 J	A1		
	Speed of ball is $\sqrt{\frac{49.86}{\frac{1}{2} \times 0.6}}$	m1		Dep on M1
	= 12.9 m s^{-1}	A1	4	No KE given: speed = 12.9 SC3
(d)	eg ball is a particle, no air resistance, weight is the only force acting etc	E1	1	Accept no spin, no wind
	Total		**10**	
2(a)(i)	$a = \frac{dv}{dt} = 6t - 6\cos 3t$	M1A1	2	M1 for at least one term correct
(ii)	When $t = \frac{\pi}{3}$, $a = 6 \times \frac{\pi}{3} - 6\cos(3.\frac{\pi}{3})$	M1		
	$= 2\pi + 6$	A1	2	AG
(b)	$r = t^3 + \frac{2}{3}\cos 3t + 6t + c$	M1A1		M1 for 3 terms including $\cos 3t$ term Condone no '+ c'
	When $t = 0$, $r = 0$ $\therefore c = -\frac{2}{3}$	M1		
	$\therefore r = t^3 + \frac{2}{3}\cos 3t + 6t - \frac{2}{3}$	A1	4	
	Total		**8**	

MM2B (cont)

Q	Solution	Marks	Total	Comments
3(a)		B2	2	B1 for any 4 correct
(b)	Resolve vertically:			
	$R = 20g + 80g$			Must see $20g + 80g$ or $100g$ to obtain any marks in (b)
	$= 100g$	B1		
	Using $F = \mu R$:	m1		Dep on B1
	$F = 0.4 \times 100g$			
	$= 40g$ or 392 N	A1	3	AG
(c)	Resolve horizontally:			
	$S = 40g$	B1		
	Moments about A:			
	$80gx\cos 60 + 20g.2\cos 60$	M1A1		M1 for 3 terms, all moments
	$= S.4\cos 30$	A1		
	$40gx + 20g = 138.56g$			
	$x = \dfrac{118.56}{40}$	m1		Dep on M1
	$= 2.96$ m	A1	6	Accept $2\sqrt{3} - \dfrac{1}{2}$
	Total		**11**	
4(a)	$\mathbf{v} = \dfrac{\mathrm{d}r}{\mathrm{d}t}$			
	$\mathbf{v} = (3t^2 - 6t)\mathbf{i} + (4 + 2t)\mathbf{j}$	M1A1	2	
(b)(i)	$\mathbf{a} = (6t - 6)\mathbf{i} + 2\mathbf{j}$	M1 A1ft		
	Using $\mathbf{F} = m\mathbf{a}$:			
	$\mathbf{F} = (18t - 18)\mathbf{i} + 6\mathbf{j}$	A1ft	3	
(ii)	When $t = 3$, $\mathbf{F} = 36\mathbf{i} + 6\mathbf{j}$			
	Magnitude is $\sqrt{36^2 + 6^2}$	M1		
	$= 36.5$	A1ft	2	Accept $6\sqrt{37}$; ft from (b)(i)
(c)	When **F** acts due north:			
	Component of **F** in the **i** direction is 0	M1		
	$18t - 18 = 0$			
	$t = 1$	A1ft	2	ft from (b)(i)
	Total		**9**	

MM2B (cont)

Q	Solution	Marks	Total	Comments
5(a)	Acceleration is $\frac{v^2}{r}$			
	$= \frac{2^2}{0.2}$	M1		
	$= 20$ m s^{-2}	A1	2	
(b)	$\theta = 30°$	B1		
	Resolve vertically:			
	$T_1 \cos\theta = mg$	M1		
	$T_1 \cos\theta = 4g$	A1		
	$T_1 = 45.3$ N	A1	4	AG
(c)	Resolve horizontally:			
	$T_1 \sin\theta + T_2 = \frac{mv^2}{r}$	M1A1		M1 for 3 terms, 2 correct
	$45.3\sin\theta + T_2 = 4 \times 20$			
	$T_2 = 57.4$ N	A1	3	Condone 57.3 N
	Total		**9**	
6(a)	EPE $= \frac{\lambda x^2}{2l}$			
	$= \frac{300 \times (1.5)^2}{2 \times 4}$	M1		
	$= 84.375$			
	$= 84.4$ J	A1	2	
(b)	When string is slack, gain in PE is mgh			
	$= 6 \times g \times 1.5\sin 30$	M1		
	$= 44.1$ J	A1		
	KE = EPE – gain in PE	m1		
	$= 84.375 - 44.1$			
	$= 40.275$	A1		
	$\frac{1}{2}.6.v^2 = 40.275$			
	$v = 3.66$	A1	5	AG
(c)	At A, PE gained above initial position is			
	$6 \times g \times 5.5 \sin 30$			Or PE above position string slack is 117.6
	$= 161.7$J	B1		KE at A is –77.3
	This is more than initial elastic potential energy	B1		
	$\therefore$ particle will not reach A	E1	3	**Or**
				Using $v^2 = u^2 + 2as$
				$a = 0.5g$ B1
				$s = 1.37$ or 1.366 B1 [or 2.87 above starting point]
				Hence stops before A E1
				Vertical height above sling slack is 0.683
				Vertical height above starting point is 1.435
	Total		**10**	

MM2B (cont)

Q	Solution	Marks	Total	Comments
7(a)	Conservation of energy:			
	$\frac{1}{2}m\left(3\sqrt{ag}\right)^2 + mg2a = \frac{1}{2}mv^2$	M1A1		M1 for 3 terms: 2 KE and PE
	$\frac{9}{2}mga + 2mga = \frac{1}{2}mv^2$	A1		
	$v = \sqrt{13ag}$	A1	4	
(b)	At A, consider vertical forces:			
	$T - mg = \frac{mv^2}{a}$	M1A1		M1 for 3 terms, 2 correct
	$T = mg + 13mg$	m1		
	$T = 14mg$	A1ft	4	ft from (a)
	Total		**8**	
8(a)	Power of engine is 8kW			
	$\therefore$ Force exerted by engine $= \frac{8000}{v}$	M1A1		M1 for Power = Fv
	Using $F = ma$:	m1		
	$\frac{8000}{v} - kv^2 = 600\frac{\mathrm{d}v}{\mathrm{d}t}$			
	$600\frac{\mathrm{d}v}{\mathrm{d}t} - \frac{8000}{v} + kv^2 = 0$	A1	4	AG
(b)(i)	When engine is turned off, power is zero:			
	$-kv^2 = 600\frac{\mathrm{d}v}{\mathrm{d}t}$	B1	1	AG
(ii)	$\int 600\frac{\mathrm{d}v}{v^2} = -\int k\,\mathrm{d}t$	M1		
	$-\frac{600}{v} = -kt + c$	A1		Need '+ c'
	When $t = 0$, $v = 20$:			
	$\therefore c = -\frac{600}{20} = -30$	A1		
	$\therefore \frac{600}{v} = kt + 30$			
	When $v = 10$, $kt = 30$:	M1		
	$\therefore t = \frac{30}{k}$	A1	5	$-\frac{30}{k}$ SC3
	Total		**10**	
	TOTAL		**75**	