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General Certificate of Education

Mathematics 6360

MM1A/W Mechanics 1A

Mark Scheme

2009 examination - June 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.

MM1A/W

Q	Solution	Marks	Total	Comments
1(a)	$3\begin{bmatrix}6\\-2\end{bmatrix}+7\begin{bmatrix}-1\\4\end{bmatrix}=10\mathbf{v}$	M1		M1: Forming three term equation for conservation of momentum, but condone incorrect signs. Must see combined mass of 10.
		A1		A1: Correct equation with correct signs. Accept $3\begin{bmatrix}6\\-2\end{bmatrix}+7\begin{bmatrix}-1\\4\end{bmatrix}=3\mathbf{v}+7\mathbf{v}$ oe
	$\mathbf{v}=\frac{1}{10}\begin{bmatrix}11\\22\end{bmatrix}=\begin{bmatrix}1.1\\2.2\end{bmatrix}$	A1	3	A1: Correct velocity Consistent use of *mg* instead of *m* throughout deduct 1 mark
(b)	$v=\sqrt{1.1^2+2.2^2}$	M1		M1: Finding speed. Must be + inside square root.
	$v=2.46\text{ ms}^{-1}$	A1F	2	A1F: Correct speed for their velocity Accept $1.1\sqrt{5}$ or $\frac{11\sqrt{5}}{10}$ or 2.45 or AWRT 2.46
	Total		**5**	
2(a)	Resultant Force = 300 × 2.2 = 660 N AG	B1	1	B1: Correct value from correct multiplication.
(b)	$P-400=660$ $P=1060$	M1 A1	2	M1: Three term equation of motion A1: Correct value for P
(c)	$23=12+2.2t$	M1		M1: Use of a constant acceleration equation to find t.
		A1		A1: Correct equation
	$t=\frac{23-12}{2.2}=5\text{ s}$	A1	3	A1: Correct time
	Total		**6**	

MM1A/W (cont)

Q	Solution	Marks	Total	Comments
3(a)	$v=\frac{16}{10}=1.6\text{ ms}^{-1}$ AG	B1	1	B1: Printed result obtained from correct division. Must see 16 divided by 10.
(b)	$V^2=1.6^2+1.2^2$ $V=\sqrt{4}=2\text{ ms}^{-1}$	M1A1 A1	 3	M1: Equation to find V based on Pythagoras. Must involve addition of the squares of two components. A1: Correct equation A1: Correct V
(c)	$\sin\alpha=\frac{1.6}{2}$ or $\frac{1.2}{2}$ $\alpha=53.1°$ OR $\cos\alpha=\frac{1.2}{2}$ or $\frac{1.6}{2}$ $\alpha=53.1°$ OR $\tan\alpha=\frac{1.6}{1.2}$ or $\frac{1.2}{1.6}$ $\alpha=53.1°$	M1 A1F (M1) (A1F) (M1) (A1(F))	 2	M1: Trigonometric equation to find α. A1F: Correct α. Follow through incorrect answer to (b). Ignore diagrams
	Total		**6**	
4(a)	$13^2=0^2+2\times1.3s$ $s=\frac{13^2}{2.6}=65\text{ m}$	M1 A1 A1	 3	M1: Use of a constant acceleration equation to find distance. A1: Correct equation A1: Correct distance
(b)(i)	$3900-800-P=2000\times1.3$ $P=3900-800-2600=500\text{ N}$	M1 A1 A1	 3	M1: Four term equation of motion for car and trailer. A1: Correct equation A1: Correct value for P
(b)(ii)	$T-500=600\times1.3$ $T=500+780=1280\text{ N}$	M1 A1F A1F	 3	M1: Three term equation of motion for trailer. A1: Correct equation A1: Correct tension
	Total		**9**	

MM1A/W (cont)

Q	Solution	Marks	Total	Comments
5(a)	$\mathbf{v}=(-2\mathbf{i}+2\mathbf{j})+(0.25\mathbf{i}+0.3\mathbf{j})\times 20$	M1 A1		M1: Finding velocity using $\mathbf{v}=\mathbf{u}+\mathbf{a}t$ A1: Correct expression
	$\mathbf{v}=3\mathbf{i}+8\mathbf{j}$	A1	3	A1: Correct velocity in simplest form
(b)	$-2+0.25t=0$ $t=8$ s	M1A1 A1		M1: One component equal to zero (either **i** or **j** component). A1: Correct equation A1: Correct time
	$\mathbf{v}=(2+0.3\times 8)\mathbf{j}=4.4\mathbf{j}$	A1	4	A1: Correct velocity
(c)	$\mathbf{r}=(-2\mathbf{i}+2\mathbf{j})\times 20+\frac{1}{2}(0.25\mathbf{i}+0.3\mathbf{j})\times 20^2+(9\mathbf{i}+7\mathbf{j})$ OR $\mathbf{r}=\frac{1}{2}\big((-2\mathbf{i}+2\mathbf{j})+(3\mathbf{i}+8\mathbf{j})\big)\times 20+(9\mathbf{i}+7\mathbf{j})$	M1 A1		M1: Finding position vector using a constant acceleration equation with or without the initial position with $t=20$. A1: Correct expression for position vector including initial position.
	$\mathbf{r}=19\mathbf{i}+107\mathbf{j}$	A1	3	A1: Correct position vector in simplest form.
(d)	$\mathbf{v}_{AVERAGE}=\frac{(19\mathbf{i}+107\mathbf{j})-(9\mathbf{i}+7\mathbf{j})}{20}$ $=\frac{10\mathbf{i}+100\mathbf{j}}{20}$	M1		M1: Finding average velocity based on change of position. Subtraction of initial position must be seen or implied. Division by 8 scores M0
	$=0.5\mathbf{i}+5\mathbf{j}$	A1F	2	A1F: Correct average velocity. Follow through incorrect answers from part (c). Allow $\frac{\mathbf{u}+\mathbf{v}}{2}$
	Total		**12**	
6(a)	$h=\frac{1}{2}\times 9.8\times 0.6^2=1.76$ m AG	M1 A1	2	M1: Equation to find h A1: Correct value from correct working
(b)	$x=18\times 0.6=10.8$ m	M1 A1	2	M1: Calculating range A1: Correct value
(c)	$v_y=9.8\times 0.6=5.88$ ms^{-1}	B1		B1: Correct vertical
	$v=\sqrt{5.88^2+18^2}=18.9$ ms^{-1}	M1 A1		M1: Calculating speed A1: Correct speed
	$\theta=\tan^{-1}\left(\frac{5.88}{18}\right)=18.1°$	M1 A1		M1: Calculating angle using tan A1: Correct angle
	18.9 ms^{-1} at 18.1° below the horizontal.	B1	6	B1: States below horizontal
	Total		**10**	

MM1A/W (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	$20\times 9.8 = R + 60\sin 30°$ $(R =)20\times 9.8 - 60\sin 30° = 166$ N AG	M1 A1 A1	3	M1: Equation or expression for normal reaction with *mg* or 20*g* or 196 and 60sin30° or 60cos30°. A1: Correct equation or expression with correct signs. A1: Correct value from correct working. Must be positive. Don't penalise use of g = 9.81 if already done earlier on script. Should still get 166, but from 166.2.
(ii)	$166\mu = 60\cos 30°$ $\mu = \frac{60\cos 30°}{166}$ $= 0.313$	M1 M1A1 A1	4	M1: Use of $F = \mu R$, with R = 166 or 166.2. Do not allow inequalities here. M1: Resolving horizontally with cos30° or sin30° oe A1: Correct equation Examples: $166\mu = 60$ M1M0A0 $166\mu = -60\cos 30°$ M1M1A0 A1: Correct coefficient of friction.
(b)	$20\times 0.8 = T\cos 30° - 0.313(20\times 9.8 - T\sin 30°)$ $T = \frac{20\times 0.8 + 0.313\times 20\times 9.8}{\cos 30° + 0.313\sin 30°} = 75.6$ N	B1 M1 A1F dM1 A1F	5	B1: $20g - T\sin 30°$ oe seen. M1: Three term equation of motion, where normal reaction is dependent on T. A1F: Correct equation dM1: Solving for T including factorisation. A1F: Correct tension AWRT 75.6 Follow through incorrect values of μ from part (a). Don't penalise use of g = 9.81 if already done earlier on script. Should get 75.7. Allow 75.8 if intermediate values rounded.
	Total		**12**	
	TOTAL		**60**	