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General Certificate of Education (A-level)
June 2012

Mathematics MM1A

(Specification 6360)

Mechanics 1A

Mark Scheme

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 events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised 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 students' 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 abbreviations

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
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
–*x* EE	deduct *x* marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
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.

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.

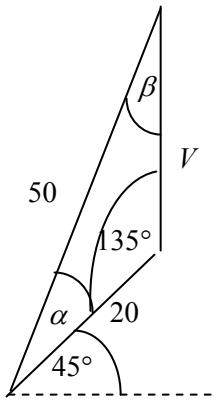
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

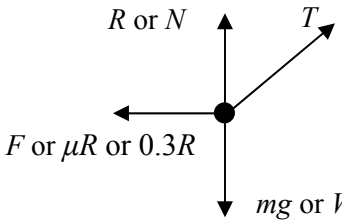
Otherwise we require evidence of a correct method for any marks to be awarded.

MM1A/W

Q	Solution	Marks	Total	Comments
1	$2\times 4+3m=3.8(2+m)$ $8+3m=7.6+3.8m$ $0.4=0.8m$ $m=\dfrac{0.4}{0.8}=0.5\text{ kg}$	M1A1 A1	 3	M1: Three term equation for conservation of momentum with correct RHS. Allow $2\times 4-3m$ on the LHS A1: Correct equation. A1: Correct answer. Note for consistent use of weight instead of mass penalise by one mark. Allow use of any letter for the mass.
	Total		**3**	
2(a)	$10^2=20^2+2\times a\times 75$ $a=\dfrac{100-400}{150}=-2\text{ ms}^{-2}$	M1A1 A1	 3	M1: Use of a constant acceleration equation to find a, with $v = 10$ and $u = 20$. $20^2=10^2+2\times a\times 75$ scores M0 A1: Correct equation. A1: Correct acceleration. For two equation methods award no marks until an equation for a is obtained.
(b)	$0=20-2t$ $t=10\text{ seconds}$	M1 A1	 2	M1: Using a constant acceleration equation, with $u = 20$ and $v = 0$, to find t using their acceleration from (a) even if positive. Using $s = 75$ scores M0 A1: Correct time from correct working CSO.
(c)	$F=1400\times 2=2800\text{ N}$	M1A1F	2	M1: Use of $F = ma$ with ± their acceleration and mass of 1400. A1F: Correct force. Follow through the magnitude of their acceleration. Answer must be positive. Sign changes do not need to be justified.
	Total		**7**	

Q	Solution	Marks	Total	Comments
3 (a)	$20\cos\theta = 10$ $\cos\theta = \frac{1}{2}$ $\theta = 60°$	M1A1 A1	3	M1: Resolving horizontally. Accept $\sin\theta$ or $\cos\theta$ with the 20. A1: Correct equation. A1: Correct angle. Accept $\frac{\pi}{3}$ or 1.05 (radians). Allow 59.9 or better if they find W first
(b)	$(W =)20\sin 60°$ $= 17.3$ N Or $(W =)\sqrt{20^2 - 10^2} = 17.3$ N	M1A1F	2	M1: Resolving vertically. Accept $\sin\theta$ or $\cos\theta$ with the 20, where θ is their answer to part (a) or 90 minus their answer to part (a). A1: Correct weight CSO or M1: Correct use of Pythagoras eg $10^2 + W^2 = 20^2$ A1: Correct weight CSO Accept $10\sqrt{3}$ or AWRT 17.3
(c)	$m = \frac{20\sin 60°}{9.8} = 1.77$ kg	M1A1F	2	M1: Their answer to part (b) divided by 9.8. A1F: Correct mass. Follow through their answer to part (b). Accept 1.76 or 1.8. Accept 2 sig figs in follow through. Note: Using $g = 9.81$ gives the answer 1.77, also accept 1.76.
	Total		**7**	
4	$20g - T = 20a$ $T - 5g = 5a$ $15g = 25a$ $a = \frac{15g}{25} = 5.88\ \text{ms}^{-2}$	M1 M1A1 A1	4	M1: Three term equation of motion for one particle. M1: Three term equation of motion for the other particle. A1: Both equations correct. A1: Correct acceleration from correct working.
	Total		**4**	

Q	Solution	Marks	Total	Comments
5				
	$\frac{\sin 135°}{50} = \frac{\sin \beta}{20}$	M1		M1: Finding another angle.
	$\sin \beta = \frac{2\sin 135°}{5}$ $\beta = 16.43°$	A1		A1: Correct angle.
	$\frac{V}{\sin 28.57°} = \frac{50}{\sin 135°}$	dM1A1		dM1: Equation to find V. A1: Correct equation.
	$V = \frac{50 \times \sin 28.57°}{\sin 135°} = 33.8\ \text{ms}^{-1}$	A1	5	A1: Correct V.
	Total		**5**	

Q	Solution	Marks	Total	Comments
6 (a)		B1	1	B1: Diagram with **exactly four** forces showing arrow heads and labelled. If components are also shown and they use a different style, eg dashed lines, they can be ignored. Note: Award mark if forces drawn on the diagram in the question. Note: Do not accept 8 kg for the weight. Note Accept μR or $0.3R$ for F.
(b)	$R + 40\sin\theta = 8\times 9.8$ $R = 78.4 - 40\sin\theta$	M1A1 A1	3	M1: Resolving vertically to obtain a three term equation, with R, T sin or cos(30° or 60°) and $8g$ oe. A1: Correct equation A1: Correct expression for R. Accept $(R=)8g - T\sin 30°$ Note if using $g = 9.81$ accept $R = 78.48 - 0.5T$ or $R = 78.5 - 0.5T$
(c)	$8a = 40\cos\theta - 0.3(78.4 - 40\sin\theta)$ $8a = -23.52 + 40\cos\theta + 12\sin\theta$ $p = -2.94$ $q = 8$ $r = 1.5$	M1A1 M1 A1 A1	5	M1: Use of the friction inequality with R from part (b) M1: Use of equation of motion with 40 $\sin\theta$ or 40 $\cos\theta$ and $8a$ and a friction term. A1: Correct equation. A1: One correct value. A1: All three values correct.
	Total		**9**	

Q	Solution	Marks	Total	Comments
7 (a)	$\mathbf{r} = (-\mathbf{i} + 3\mathbf{j})t + \frac{1}{2}(0.1\mathbf{i} - 0.2\mathbf{j})t^2$	M1A1	2	M1: Using constant acceleration equation to get **r**. A1: Correct expression for **r**. Allow equivalent column vector answer.
(b)	$3t - 0.1t^2 = 0$ $t(3 - 0.1t) = 0$ $t = 0$ or $t = 30$ $t = 30$ seconds	M1A1 A1	3	M1: Putting their **j** component equal to zero to form a quadratic equation. A1: Correct equation. A1: For 30 seconds. No need to see $t = 0$.
(c)	$\mathbf{v} = (0.1t - 1)\mathbf{i} + (3 - 0.2t)\mathbf{j}$ $0.1t - 1 = -(3 - 0.2t)$ $2 = 0.1t$ $t = 20$ $\mathbf{v} = \mathbf{i} - \mathbf{j}$ $v = \sqrt{2} = 1.41\,\text{ms}^{-1}$	B1 M1A1 A1 dM1 A1	6	B1: Correct expression for the velocity in terms of t. Can be implied by subsequent working in terms of t. M1: For $0.1t - 1 = \pm(3 - 0.2t)$. May be with their components if velocity stated incorrectly. A1: Correct equation. A1: t =20 dM1: finding velocity and speed at their time A1: Correct speed. **Special cases** If the equation in t in line 2 is not seen: then seeing t = 20 and **v** = **i** - **j** and v =1.41 award 4 out of 6 or then seeing t = 20 and **v** = **i** - **j** award 2 out of 6
	Total		**11**	

Q	Solution	Marks	Total	Comments
8 (a)	$22.4\sin\theta - 2\times 9.8 = 0$ $\sin\theta = \frac{19.6}{22.4} = \frac{7}{8} = 0.875$	M1A1 A1	3	M1: Use of $v = u + at$ vertically with $u = 22.4\sin\theta$, v = 0, t = 2 and a = ±9.8. A1: Correct equation. (May be in terms of g or contain 9.81.. A1: Must see either $22.4\sin\theta = 19.6$ or $\frac{19.6}{22.4}$. M1: Use of $s = ut + \frac{1}{2}at^2$ with $u = 22.4\sin\theta$, s = 0, t = 4 and a = ±9.8. A1: Correct equation. A1: must see $89.6\sin\theta = 78.4$ or $\frac{78.4}{89.6}$ OE
(b)	$h_{MAX} = 22.4\times\frac{7}{8}\times 2 - \frac{1}{2}\times 9.8\times 2^2$ $= 19.6$ m	M1A1 A1	3	M1: Using a constant acceleration equation to find height, with t = 2, u=22.4 sin θ or 19.6 and a = ±9.8. A1: Correct equation. A1: Correct height. AWRT 19.6 Note using g = 9.81 gives 19.6, also accept 19.5. Note: other constant acceleration equations will lead to the same result
(c)	$\cos\theta = \frac{\sqrt{15}}{8} = 0.4841$ or $\theta = 61.04°$ $AB = 22.4\times\frac{\sqrt{15}}{8}\times 4 = 43.4$ m	B1 M1A1F	3	B1: Correct value for cosθ (accept 0.484) or θ (accept 61.0° or 61° or 1.06 or 1.065 or 1.07 radians). Can be implied. M1: Calculation for range with value for cosθ and with t = 4. A1F: Correct distance. Follow through incorrect θ. Accept AWRT 43.4 or 43.3 or 43.2. Do not accept 43.

8 cont (d)	$22.4\times\frac{7}{8}t-4.9t^2=5$ $4.9t^2-19.6t+5=0$ $t=0.274$ or $t=3.726$ Time $=3.726-0.274=3.45$ seconds	M1 A1 dM1 A1 A1	5	M1: Use of $s=ut+\frac{1}{2}at^2$ with correct terms, but not necessarily signs. A1: Correct equation. dM1: Solving their quadratic. A1: At least one correct solution. Allow 0.27 or 0.28 and 3.72 or 3.73 A1: Correct difference. Accept 3.46. Note: there are other methods which will lead to the correct time: M1dM1A1 for a constant acceleration equation that gives a time or times from which the final answer can be obtained A1 Correct time or times A1 Correct final answer
	Total		**14**	
	TOTAL		**60**	