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General Certificate of Education

Mathematics 6360

MM1A/W Mechanics 1A

Mark Scheme

2009 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.

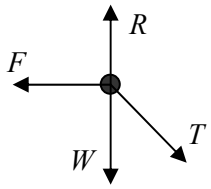
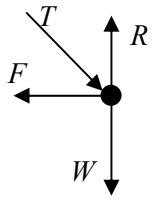
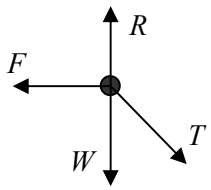
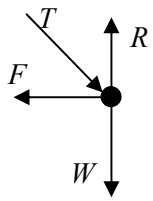
MM1A

Q	Solution	Marks	Total	Comments
1	$4\times8=(4+1)v$	M1		M1: Three term momentum equation
		A1		A1: Correct equation
	$v=\frac{32}{5}=6.4\ \text{ms}^{-1}$	A1	3	A1: Correct speed
	Total		**3**	
2(a)	$t=0,\ t=30,\ t=50$ seconds	B1		B1: Any one correct time
		B1	2	B1: The other two correct times Deduct one mark for each extra time if more than three times are given. (eg 0, 15, 30, 50 scores B1B0) (eg 0, 15, 30, 40, 50 scores B0B0) Condone 49 or 48 instead of 50
(b)	$s_1=\frac{1}{2}\times30\times5=75$ m **AG**	M1		M1: Finding distance by calculation of area. (Must see use of 0.5 or ½)
		A1	2	A1: Correct answer from correct working. (If candidates use two constant acceleration equations, both must be seen for the M1 mark.)
(c)	$s_2=\frac{1}{2}\times4\times20=40$ m	M1		M1: Finding distance using area of the second triangle.
		A1		A1: Correct distance (ignore any negative signs). (If candidates use two constant acceleration equations, both must be seen for the M1 mark.) Accept 38/36 from use of 49/48 instead of 50
	$s=75+40=115$ m	M1		M1: Addition of the 75 metres and their distance. (75 – 40 = 35 OE scores M0)
		A1F	4	A1F: Correct result using their value for second area. eg Accept 113/111 from use of 49/48 instead of 50
(d)	$s=75-40=35$ m	M1		M1: Difference between 75 and their value for the second distance. (Allow their distance – 75) (75 – (– 40) = 115 OE scores M0)
		A1F	2	A1F: Correct result using their value for second area. (eg 40 – 75 = –35 M1A0) eg Accept 37/39 from use of 49/48 instead of 50
	Total		**10**	

MM1A/W (cont)

Q	Solution	Marks	Total	Comments
3(a)	$11g - T = 11a$	M1		M1: Equation of motion for A, containing T, 11g or 107.8 and 11a.
		A1		A1: Correct equation
	$T - 9g = 9a$	M1		M1: Equation of motion for B containing T, 9g or 88.2 and 9a.
		A1		A1: Correct equation
	$2g = 20a$ $a = 0.98$ ms^{-2} **AG**	A1	5	A1: Correct acceleration from correct working. Note: Do not penalise candidates who consistently use signs in the opposite direction throughout, provided they give their final answer as 0.98. If final answer is – 0.98 don't award final A1 mark. Special Case: Whole String Method $2g = 20a$ and $a = 2g / 20 = 0.98$ OE M1A1A1 Use of g = 9.81 gives 0.981. If this is the first time award M1A1M1A1A0, but don't penalise again on the same script.
(b)(i)	$v = 0 + 0.98 \times 0.5 = 0.49$ ms^{-1}	M1		M1: Use of constant acceleration equation to find v with u = 0, a = 0.98 and t =0.5.
		A1	2	A1: Correct v
(ii)	$s = 0 + \frac{1}{2} \times 0.98 \times 0.5^2 = 0.1225$ m	M1		M1: Finding distance travelled by each particle with u = 0, a = 0.98 and t =0.5.
		A1		A1: Correct distance. Accept 0.122 or 0.123
	OR			
	$0.49^2 = 0^2 + 2 \times 0.98s$	(M1)		M1: Finding distance travelled by each particle with u = 0, a = 0.98 and their v.
	$s = \frac{0.49^2}{2 \times 0.98} = 0.1225$	(A1)		A1: Correct distance. Accept 0.122 or 0.123
	$d = 2 \times 0.1225$	M1		M1: Doubling distance or use of d/2 in their original equation.
	$= 0.245$ m	A1	4	A1: Correct final distance. Allow 0.244 or 0.246. (Use of 0.5 × 0.49 = 0.245 scores zero unless justified)
	Total		**11**	

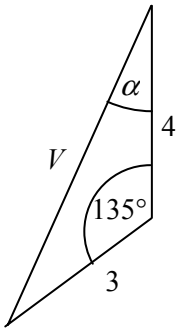
MM1A/W (cont)

Q	Solution	Marks	Total	Comments
4(a)		B1	1	B1: Diagram with four forces showing arrow heads and labelled. Allow *mg* or 8*g*. Allow *T* or 40 or other reasonable notation. Allow μR. Direction of friction must be to the left. Any components must be shown in a different style.
	OR 			
(b)	$8g + 40\sin 30° (= R)$	M1		M1: Expression for normal reaction, with *mg* or 8*g* and 40sin30° or 40cos30°. Allow incorrect signs.
		A1		A1: Correct expression with correct signs.
	$(R =) 98.4$ N **AG**	A1	3	A1: Correct value from correct working. Use of $g = 9.81$ gives 98.5 N. Do not penalise if you have already done so on the scripts. Otherwise penalise by 1 mark.
(c)	$F = 40\cos 30° = 34.6$ N	M1		M1: Use of 40cos30° or 40sin30°. Award M0 if any extra terms.
		A1	2	A1: Correct value for friction. Don't need to see *F*.
(d)	$40\cos 30° \leq \mu \times 98.4$	M1		M1: Use of $F \leq \mu R$ (or $F = \mu R$). Must use $R = 98.4$ and a positive value for *F*.
		A1F		A1F: Correct inequality or equation Allow use of $F = \mu R$ throughout.
		B1	1	B1: Diagram with four forces showing arrow heads and labelled. Allow *mg* or 8*g*. Allow *T* or 40 or other reasonable notation. Allow μR. Direction of friction must be to the left. Any components must be shown in a different style.
	OR 			
	Total		**9**	

MM1A/W (cont)

Q	Solution	Marks	Total	Comments
5(a)	Resultant $=(6\mathbf{i}-3\mathbf{j})+(3\mathbf{i}+15\mathbf{j})$ $=9\mathbf{i}+12\mathbf{j}$	M1 A1	2	M1: Summing the two vectors A1: Correct resultant
(b)	Magnitude $=\sqrt{9^2+12^2}$ $=15$ N	M1 A1F	2	M1: Finding magnitude with an addition sign. A1F: Correct magnitude based on their answer to part (a).
(c)	$1.5m=9$ or $2m=12$ $m=6$ kg $\quad m=6$ kg	M1 A1F	2	M1: Applying Newton's second law to one or both of the components. A1F: Correct mass, follow through their answer to part (a). Do not award this mark if vector division with 2 components has been used, eg $\frac{9\mathbf{i}+12\mathbf{j}}{1.5\mathbf{i}+2\mathbf{j}}=6$or $6\mathbf{i}+6\mathbf{j}$ etc without a correct previous statement gives M0A0
(d)(i)	$\mathbf{r}=\frac{1}{2}(1.5\mathbf{i}+2\mathbf{j})t^2$	M1 A1	2	M1: Using a constant acceleration equation to find the position vector with $\mathbf{u}=0\mathbf{i}+0\mathbf{j}$ A1: Correct position vector.
(ii)	$\mathbf{r}=\frac{1}{2}(1.5\mathbf{i}+2\mathbf{j})\times 2^2=3\mathbf{i}+4\mathbf{j}$ $d=\sqrt{(3)^2+(4)^2}$ $=\sqrt{25}=5$	M1 A1	2	M1: Finding the position vector when $t=2$. ($\mathbf{r}=(1.5\mathbf{i}+2\mathbf{j})\times 2=3\mathbf{i}+4\mathbf{j}$ scores M0 unless it is clear how the 2 was obtained, possibly by a correct formula in (d) (i)) A1: Correct distance
	Total		**10**	

MM1A/W (cont)

Q	Solution	Marks	Total	Comments
6(a)		M1		M1: Forming a triangle or diagram to find v (may be implied by an equation)
	Followed by			
	$V^2 = 3^2 + 4^2 - 2\times3\times4\cos135°$	M1 A1		M1: Using cosine rule to find V A1: Correct equation
	$V = 6.478 = 6.48 \text{ ms}^{-1}$ **AG**	A1		A1: Correct velocity from correct working
	OR			
	$v_1 = 4 + 3\cos45° = 6.121$	(M1)		M1: Two perpendicular equations
	$v_2 = 3\cos45° = 2.121$	(A1)		A1: Both components correct
	$V = \sqrt{(4+3\cos45°)^2 + (3\cos45°)^2}$			
	$V = 6.478 = 6.48 \text{ ms}^{-1}$ **AG**	(A1)	4	A1: Correct velocity from correct working
(b)	$\frac{\sin\theta}{3} = \frac{\sin135°}{6.478}$	M1 A1		M1: Use of sine rule A1: Correct expression
	$\theta = 019°$	A1		A1: Correct bearing (Accept 19°)
	OR			
	$\tan\theta = \frac{3\cos45°}{4+3\cos45°}$	(M1) (A1)		M1: Consideration of perpendicular components A1: Correct expression
	$\theta = 019°$	(A1)	3	A1: Correct bearing (Accept 19°)
	Total		**7**	

MM1A/W (cont)

Q	Solution	Marks	Total	Comments
7(a)	$0^2 = (30\sin 35°)^2 + 2\times(-9.8)s$	M1		M1: Equation to fine the max height, with $v = 0$
		A1		A1: Correct equation
		M1		M1: Solving for the height
	$s = \dfrac{(30\sin 35°)^2}{2\times 9.8} = 15.1$ m	A1	4	A1: Correct height
(b)	$28^2 = (30\cos 35°)^2 + v_y^2$	M1		M1: Equation to find vertical component
		A1		A1: Correct equation
	$v_y = \sqrt{28^2 - (30\cos 35°)^2}$	M1		M1: Solving equation
	$= 13.4198 = 13.4$ ms^{-1} **AG**	A1	4	A1: Correct speed from correct working.
(c)	$\tan\theta = \dfrac{13.4}{30\cos 35°}$	M1		M1: Expression to find the angle.
	$\theta = 28.6°$	A1	2	A1: Correct angle.
	Total		**10**	
	TOTAL		**60**	